STANDARD SPECIFICATIONS

STATE OF CALIFORNIA
CALIFORNIA STATE TRANSPORTATION AGENCY
DEPARTMENT OF TRANSPORTATION

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Fax (916) 263-0470
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DIVISION I GENERAL PROVISIONS

1 GENERAL

1-1.01 GENERAL

Section 1 includes specifications related to the interpretation of the contract.

The specifications are divided into 12 divisions.

Division I includes general specifications applicable to every contract unless specified as applicable only under certain conditions.

Division II includes specifications for general construction applicable to every contract unless specified as applicable only under certain conditions.

Divisions III through X include construction specifications for specific bid items.

Division XI includes specifications for common materials. For a material specified in this division, that material specified in any section must comply with the specifications in division XI.

Division XII includes construction specifications for buildings.

The bid items set forth the construction specifications that apply. The first 2 digits of a bid item code correspond to the specification section number with the same first 2 digits except for bid item code 999990 that corresponds to section 9 and unless shown otherwise in the table titled "Bid Items and Applicable Sections" in the special provisions.

The specifications are written to the Bidder before award and the Contractor after. Before award, interpret sentences written in the imperative mood as starting with *The Bidder must* and interpret *you* as *the Bidder* and *your* as *the Bidder's*. After award, interpret sentences written in the imperative mood as starting with *The Contractor must* and interpret *you* as *the Contractor* and *your* as *the Contractor's*.

After Contract approval, submit documents and direct questions to the Engineer. Orders, authorizations, and requests to the Contractor are by the Engineer.

The following items from the Department are in writing:

1. Approvals
2. Authorizations
3. Decisions
4. Notifications
5. Orders
6. Responses

The following items from the Contractor must be in writing:

1. Notifications
2. Proposals
3. Reports
4. Requests, including RFIs, sequentially numbered
5. Subcontracts
6. Test results

Where a location is not specified with the words *shown*, *specified*, or *described*, interpret:

1. *Shown* as *shown on the plans*.
2. *Specified* as *specified in the specifications*.
3. *Described* as *described in the Contract*. *Described* means *shown, specified, or both*.

Headings are included for the purposes of organization and referencing. Inclusion of a heading with no related content, *Not Used*, or *Reserved* does not indicate that no specification exists for that subject; applicable specifications may be covered in a general or referenced specification.

Specifications in a section titled *General* apply to all subordinate sections within the section.

SECTION 1 **GENERAL**

Specifications in the general section of a division apply to all sections within the division.

Sections are reserved in the *Standard Specifications* for correlation of special provisions and revised standard specifications with the *Standard Specifications* and for future expansion of the *Standard Specifications*.

The specifications are expressed in US customary units except where a referenced document uses the International System of Units as the standard.

Unless an object or activity is specified to be less than the total, the quantity or amount is all of the object or activity.

All items in a list apply unless the items are specified as choices.

1-1.02 STYLE VARIATIONS

The Department is gradually standardizing the style of the specifications. The use of the new style does not change the meaning of a Contract part not using this style. The new style includes:

1. Use of:
   1.1. Imperative mood
   1.2. Introductory modifiers
   1.3. Conditional clauses
   1.4. Industry-standard terms
2. Elimination of:
   2.1. Language variations
   2.2. Definitions for industry-standard terms
   2.3. Redundant specifications
   2.4. Needless cross-references

Because of the transition, some terms or clauses used in Division I are different from those used in other divisions and in other Contract parts. Interpret the equivalent term or clause shown in the following table as having the same meaning as the corresponding term or clause in Division I:

Terms Equivalencies

Term or clause in Division I	Equivalent term or phrase that may be in other divisions and in other Contract parts	Conditions
Authorize	Approve	Except in a Change Order
Authorized Material List	Pre-Qualified Products List	--
Department	Engineer	Where referring to anyone other than the Resident Engineer or the Resident Engineer's authorized representatives
Department-furnished material	State-furnished material	--
<work description> is change order work	<work description> will be paid for as extra work <with or without a reference to a section>	--

1-1.03–1-1.04 RESERVED

1-1.05 REFERENCES

A reference within parentheses to a law or regulation is included in the Contract for convenience only and is not a comprehensive listing of related laws and regulations. Lack of a reference does not indicate no related laws or regulations exist.

Where the version of a referenced document is not specified, use the most recent version in effect on the date of the *Notice to Bidders*.

A reference to a section includes specifications in sections titled *General* that apply to the section.

Where a section number is referenced without a reference to a document, the reference is to a section of the *Standard Specifications* as revised by any revised standard specification, special provision, or both. Any reference directly to a revised standard specification section is for convenience only. Lack of a direct reference to a revised standard specification section does not indicate a revised standard specification for the section does not exist.

A code not specified as a federal code is a California code.

An agency or a department not specified as a federal or local agency or department is a California agency or department.

1-1.06 ABBREVIATIONS

Unless context indicates otherwise, interpret the meaning of an abbreviation used in the specifications and the Bid Item List as shown in the following tables:

Abbreviations

Abbreviation	Meaning
AASHTO	American Association of State Highway and Transportation Officials
AB	aggregate base
ACI	American Concrete Institute
ADL	aerially deposited lead
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMA	archaeological monitoring area
ANSI	American National Standards Institute
APCD	Air pollution control district
API	American Petroleum Institute
AREMA	American Railway Engineering and Maintenance-of-Way Association
AQMD	Air quality management district
AS	aggregate subbase
ASME	American Society of Mechanical Engineers
ASQ	American Society for Quality
ATPB	asphalt treated permeable base
ATS	active treatment system
AWG	American Wire Gauge
AWPA	American Wood Protection Association
AWS[a]	American Welding Society
AWWA	American Water Works Association
AWIS	automated work zone information system
BBS	battery backup system
BNSF	Burlington Northern Santa Fe
Cal/OSHA	California Division of Occupational Safety and Health Administration
CBC	California Building Code
CDPH	California Department of Public Health
CIDH	cast-in-drilled-hole
CIH	Certified Industrial Hygienist
CIP	cast in place
CISS	cast-in-steel-shell
CJP	complete joint penetration
CMU	concrete masonry unit
CPM	critical path method
CPL	composite plastic lumber
CRCP	continuously reinforced concrete pavement
CRM	crumb rubber modifier
CSL	crosshole sonic logging
CSS	cement stabilized soil
CTB	cement treated base
CTPB	cement treated permeable base
CVN	Charpy V-notch
CWI	AWS Certified Welding Inspector
DBE	disadvantaged business enterprise
DRA	Dispute Resolution Advisor
DRB	Dispute Resolution Board
DTSC	Department of Toxic Substances Control
DVBE	disabled veteran business enterprise
ECTC	Erosion Control Technology Council
EIA/ECIA	Electronic Industries Alliance/Electronic Components Industry Association
ELAP	Environmental Laboratory Accreditation Program
ESA	environmentally sensitive area
ETL	Electrical Testing Laboratories
f_c	extreme fiber compressive stress in concrete at service loads

f'_c	compressive strength of concrete
FHWA	Federal Highway Administration
FDR	full depth reclamation
GAAP	Generally Accepted Accounting Principles
GGBFS	ground granulated blast furnace slag; slag cement
GGL	gamma-gamma logging
GSP	galvanized steel pipe
HMA	hot mix asphalt
HMA-O	hot mix asphalt (open graded)
HS	high strength
ICC	International Code Council
ICEA	Insulated Cable Engineers Association
ITE	Institute of Transportation Engineers
IEEE	Institute of Electrical and Electronics Engineers
JMF	job mix formula
JPCP	jointed plain concrete pavement
ksf	kips per square foot
ksi	kips per square inch
LCB	lean concrete base
LCS	Department's lane closure system
LEED	Leadership in Energy and Environmental Design
LTDS	long term design strength
MC	medium curing
METS	Department's Materials Engineering and Testing Services
MPI	Master Painters Institute
MPQP	*Material Plant Quality Program* published by the Department
MR	movement rating
MSDS[b]	material safety data sheet
MT	magnetic particle testing
MUTCD	*Manual on Uniform Traffic Control Devices*
NAL	numeric action level
NDT	nondestructive testing
NEL	numeric effluent limitation
NETA	International Electrical Testing Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NMAS	nominal maximum aggregate size
NPDES	National Pollutant Discharge Elimination System
NPT	National Pipe Thread Taper
NRTL	Nationally Recognized Testing Laboratory
NTU	nephelometric turbidity unit
OBC	optimum binder content
OGFC	open graded friction course
OSD	Offices of Structure Design
PLAC	permit, license, agreement, certification, or any combination of these
PC	precast
PCC	portland cement concrete
pcf	pounds per cubic foot
PCMS	portable changeable message sign
PG	performance grade
PJP	partial joint penetration
POC	pedestrian overcrossing
PQR	procedure qualification record
PS	prestressed
PSF	pedestrian signal face

PV	programmed visibility
QSD	qualified SWPPP developer
QSP	qualified SWPPP practitioner
RAP	reclaimed asphalt pavement
RCSC	Research Council on Structural Connections
RECP	rolled erosion control product
RFI	request for information
RHMA	rubberized hot mix asphalt
RHMA-G	rubberized hot mix asphalt (gap graded)
RHMA-O	rubberized hot mix asphalt (open graded)
RHMA-O-HB	rubberized hot mix asphalt (open graded high binder)
RPL	recycled plastic lumber
RSC	rapid strength concrete
RSP	rock slope protection
RSS	revised standard specifications
RT	radiographic testing
RWQCB	regional water quality control board
SMSA	Standard Metropolitan Statistical Area
SC	slow curing
SCC	self-consolidating concrete
SCM	supplementary cementitious material
SDS	safety data sheet
SSPC	The Society for Protective Coatings
SWPPP	stormwater pollution prevention plan
SWRCB	State Water Resources Control Board
TEES	Transportation Electrical Equipment Specifications
TIA	Telecommunications Industry Association; time impact analysis
TRO	time-related overhead
TV	target value
UFFA	ultra fine fly ash
UL	Underwriters Laboratories, Inc
USC	United States Code
USLE	Universal Soil Loss Equation
USM	unidentified stock material
UT	ultrasonic testing
VECP	value engineering change proposal
VFD	variable-frequency drive
VPM	volts per mil
WMA	warm mix asphalt
WPC	water pollution control
WPCP	water pollution control program
WPS	welding procedure specification
WQO	water quality objective

[a]Interpret a reference to AWS as a reference to AWS, ANSI/AWS, or AASHTO/AWS
[b]Interpret a reference to MSDS as a reference to SDS under 29 CFR 1910.1200

Bid Item List Abbreviations

Abbreviation	Meaning
ACRE	acre
CF	cubic foot
CY	cubic yard
EA	each
(F)	final pay item
GAL	gallon
HR	hour
LB	pound
LF	linear foot
LS	lump sum
LNMI	lane mile
MFBM	thousand foot board measure
STA	station (100 feet)
SQFT	square foot
SQYD	square yard
TON	2,000 pounds
WDAY	working day

1-1.07 DEFINITIONS

1-1.07A General

Interpret terms as defined in the Contract documents.

1-1.07B Glossary

abandon: Render unserviceable in place.

acts of God: *Acts of God* as defined in Pub Cont Code § 7105.

activity: Task, event, or other project element on a schedule that contributes to completing the project. An activity has a description, start date, finish date, duration, and one or more logic ties.

adjust: Raise or lower a facility to match a new grade line.

aerially deposited lead: Lead primarily from vehicle emissions deposited within unpaved areas or formerly unpaved areas.

authorized laboratory: Independent testing laboratory (1) not employed or compensated by any subcontractor or subcontractor's affiliate providing other services for the Contract and (2) authorized by the Department.

base: Layer of specified material of planned thickness placed immediately below the pavement or surfacing.

basement material: Material in an excavation or embankment under the lowest layer to be placed.

bid item: Work unit for which the Bidder provides a price.

Bid Item List: List of bid items, units of measure, and the associated quantities. The verified Bid Item List is the Bid Item List with verified prices. The Contract Proposal of Low Bidder at the Department's website is the verified Bid Item List. After contract award, interpret a reference to the Bid Item List as a reference to the verified Bid Item List.

borrow: Fill acquired from an excavation source outside the described cut area.

1. **local borrow:** Material obtained by widening cuts or excavating from sources outside the planned or authorized cross section on the job site. The location of the local borrow is described or designated by the Engineer.
2. **imported borrow:** Borrow that is not local borrow.

bridge: Structure that:

1. Has a bridge number
2. Carries a (1) utility, (2) railroad, or (3) vehicle, pedestrian, or other traffic over, under, or around obstructions or waterways

building-construction contract: Contract that has *Building Construction* on the cover of the *Notice to Bidders and Special Provisions*.

California Test: Department-developed test for determining work quality. For California Tests, go to the METS website.

certificate of compliance: Certificate stating the material complies with the Contract.

Certified Industrial Hygienist: Industrial hygienist certified in comprehensive practice by the American Board of Industrial Hygiene.

change order work: Work described in a Change Order, including extra work and work described in the Contract as change order work.

closure: Closure of a traffic lane or lanes, including shoulder, ramp, or connector lanes, within a single traffic control system.

commercial quality: Quality meeting the best general practices.

commercial source: Established business operating as a material source for the general public.

Contract: Written and executed contract between the Department and the Contractor.

Contract acceptance: Director's written acceptance of a completed Contract.

Contract time: Number of original working days as adjusted by any time adjustment.

Contractor: Person or business or its legal representative entering into a Contract with the Department for performance of the work.

controlling activity: Construction activity that will extend the scheduled completion date if delayed.

critical path: Longest continuous chain of activities for the project that has the least amount of total float of all chains. In general, a delay on the critical path extends the scheduled completion date.

critical path method: Network-based planning technique using activity durations and relationships between activities to calculate a schedule for the entire project.

culvert: Structure other than a bridge that provides an opening under a roadway.

data date: Day after the date through which a schedule is current. Everything occurring earlier than the data date is as-built and everything on or after the data date is planned.

day: 24 consecutive hours running from midnight to midnight; calendar day.

1. **business day:** Day on the calendar except a Saturday and a holiday.
2. **working day:** Time measure unit for work progress. A working day is any 24-consecutive-hour period except:
    2.1. Saturday and a holiday.
    2.2. Day during which you cannot perform work on the controlling activity for at least 50 percent of the scheduled work shift with at least 50 percent of the scheduled labor and equipment due to any of the following:
        2.2.1. Adverse weather-related conditions.
        2.2.2. Traffic maintenance under the Contract.
        2.2.3. Suspension of a controlling activity that you and the Engineer agree benefits both parties.
        2.2.4. Unanticipated event not caused by either party, such as:
            2.2.4.1. Act of God
            2.2.4.2. Act of a public enemy.

2.2.4.3. Epidemic.
2.2.4.4. Fire.
2.2.4.5. Flood.
2.2.4.6. Governor-declared state of emergency.
2.2.4.7. Landslide.
2.2.4.8. Quarantine restriction.
2.2.5. Issue involving a third party, including:
2.2.5.1. Industry or area-wide labor strike.
2.2.5.2. Material shortage.
2.2.5.3. Freight embargo.
2.2.5.4. Jurisdictional requirement of a law enforcement agency.
2.2.5.5. Workforce labor dispute of a utility or nonhighway facility owner resulting in a nonhighway facility rearrangement not described and not solely for the Contractor's convenience. Rearrangement of a nonhighway facility includes installation, relocation, alteration, or removal of the facility.
2.3. Day during a concurrent delay.

3. **original working days:**
   3.1. Working days to complete the work shown on the *Notice to Bidders* for a non-cost-plus-time-based bid
   3.2. Working days bid to complete the work for a cost-plus-time-based bid

Where working days is specified without the modifier *original* in the context of the number of working days to complete the work, interpret the number as the number of original working days as adjusted by any time adjustment.

deduction: Money permanently taken from a progress payment or the final payment. Deductions are cumulative and are not retentions under Pub Cont Code § 7107.

delay: Event that extends the completion of an activity.

1. **excusable delay:** Delay caused by the Department and not reasonably foreseeable when the work began, such as:
   1.1. Change in the work
   1.2. Department action that is not part of the Contract
   1.3. Presence of an underground utility main not described in the Contract or in a location substantially different from that specified
   1.4. Described facility rearrangement not rearranged as described, by the utility owner by the date specified, unless the rearrangement is solely for the Contractor's convenience
   1.5. Department's failure to obtain timely access to the right-of-way
   1.6. Department's failure to review a submittal or provide notification in the time specified
2. **critical delay:** Excusable delay that extends the scheduled completion date
3. **concurrent delay:** Occurrence of at least 2 of the following events in the same period of time, either partially or entirely:
   3.1. Critical delay
   3.2. Delay to a controlling activity caused by you
   3.3. Non–working day

Department: Department of Transportation as defined in St & Hwy Code § 20 and authorized in St & Hwy Code § 90; its authorized representatives.

detour: Temporary route for traffic around a closed road part. A passageway through a job site is not a detour.

Director: Department's Director.

disabled veteran business enterprise: Business certified as a DVBE by the Department of General Services, Office of Small Business and DVBE Services.

disadvantaged business enterprise: Disadvantaged business enterprise as defined in 49 CFR 26.5.

dispose of: Remove from the job site.

divided highway: Highway with separated traveled ways for traffic, generally in opposite directions.

Engineer: Resident Engineer responsible for the Contract's administration; Resident Engineer's authorized representatives.

early completion time: Difference in time between an early scheduled completion date and the work completion date.

environmentally sensitive area: Area within or near construction limits where access is prohibited or limited to protect environmental resources.

estimated cost: Estimated cost of the project as shown on the *Notice to Bidders*.

extra work: Any work, desired or performed, but not included in the original Contract.

federal-aid contract: Contract that has a federal-aid project number on the cover of the *Notice to Bidders and Special Provisions*.

final pay item: Bid item whose quantity shown on the Bid Item List is the quantity paid.

finished grade: Final surface of the completed facility. If the work under the Contract includes stage construction, the relation between the finished grade and the work under the Contract is shown.

fixed cost: Labor, material, or equipment cost directly incurred by the Contractor as a result of performing or supplying a particular bid item that remains constant regardless of the item's quantity.

float: Difference between the earliest and latest allowable start or finish times for an activity.

1. **Department-owned float:** Time saved on the critical path by actions of the Department. It is the last activity shown on the schedule before the scheduled completion date.

force account work: Work ordered on a construction project without an existing agreement on its cost, and performed with the understanding that the contractor will bill the owner according to the cost of labor, materials, and equipment, plus a certain percentage for overhead and profit.

grading plane: Basement material surface on which the lowest layer of subbase, base, pavement, surfacing, or other specified layer is placed.

highway: Whole right-of-way or area reserved for use in constructing the roadway and its appurtenances.

holiday: Holiday shown in the following table:

Holidays

Holiday	Date observed
Every Sunday	Every Sunday
New Year's Day	January 1st
Birthday of Martin Luther King, Jr.	3rd Monday in January
Lincoln's Birthday	February 12th
Washington's Birthday	3rd Monday in February
Cesar Chavez Day	March 31st
Memorial Day	Last Monday in May
Independence Day	July 4th
Labor Day	1st Monday in September
Columbus Day	2nd Monday in October
Veterans Day	November 11th
Thanksgiving Day	4th Thursday in November
Day after Thanksgiving Day	Day after Thanksgiving Day
Christmas Day	December 25th

If January 1st, February 12th, March 31st, July 4th, November 11th, or December 25th falls on a Sunday, the Monday following is a holiday. If November 11th falls on a Saturday, the preceding Friday is a holiday.

hours of darkness: Hours of darkness as defined in Veh Code § 280.

idle equipment: Equipment:

1. On the job site at the start of a delay
2. Idled because of the delay
3. Not operated during the delay

informal-bid contract: Contract that has *Informal Bid Authorized by Pub Cont Code § 10122* on the cover of the *Notice to Bidders and Special Provisions*.

job site: Area within the defined boundaries of a project.

***Labor Surcharge and Equipment Rental Rates*:** Department publication that lists labor surcharge and equipment rental rates.

landscaping: Practice of a landscaping contractor under 16 CA Code of Regs § 832.27.

material: Any product or substance specified for use in the construction of a project.

material shortage:

1. Shortage of raw or produced material that is area-wide and caused by an unusual market condition except if any of the following occurs:
   1.1. Shortage relates to a produced, nonstandard material
   1.2. Supplier's and the Contractor's priority for filling an order differs
   1.3. Event outside the United States for a material produced outside the United States
2. Unavailability of water that delays a controlling activity

material source facility audit: Self-audit and a Department audit evaluating a facility's capability to consistently produce materials that comply with Department standards.

median: Portion of a divided highway separating the traveled ways including inside shoulders.

milestone: Event activity that has zero duration and is typically used to represent the start or end of a certain stage of the project.

mobilization: Preparatory work that must be performed or costs incurred before starting work on the various items on the job site (Pub Cont Code § 10104).

modify: Add to or subtract from an appurtenant part.

narrative report: Document submitted with each schedule that discusses topics related to project progress and scheduling.

near critical path: Chain of activities with total float exceeding that of the critical path but having not more than 10 working days of total float.

obliterate: Place an earth cover over or root, plow, pulverize, or scarify.

pavement: Uppermost layer of material placed on a traveled way or shoulder.

permanent erosion control establishment period: Number of working days shown on the *Notice to Bidders* for permanent erosion control establishment work.

plans: Standard plans, revised standard plans, and project plans.

1. **standard plans:** Drawings standard to Department construction projects.
2. **revised standard plans:** New or revised standard plans.
3. **project plans:** Drawings specific to the project, including authorized shop drawings.

plant establishment period: Number of working days shown on the *Notice to Bidders* for plant establishment work.

quality characteristic: Characteristic of a material that is measured to determine conformance with a given requirement.

quality control plan: Contractor's plan to ensure QC.

reconstruct: Remove and disassemble and construct again at an existing or new location.

relocate: Remove and install or place in a new location.

remove: Remove and dispose of.

reset: Remove and install or place laterally at the same station location.

roadbed: Roadway portion extending from the curb line to curb line or the shoulder line to shoulder line. A divided highway has 2 roadbeds.

roadside: Area between the outside shoulder edge and the right-of-way limits.

roadway: Portion of the highway within the outside lines of curbs, sidewalks, slopes, ditches, channels, or waterways. A roadway includes the structures and features necessary for safety, protection of facilities, and drainage.

salvage: Remove, clean, and haul to a specified location.

schedule:

1. **baseline schedule:** Initial schedule showing the original work plan starting on the date of Contract approval. This schedule shows no completed work to date and no negative float or negative lag to any activity.
2. **revised schedule:** Schedule that incorporates a proposed or past change to logic or activity durations.
3. **updated schedule:** Current schedule developed from the accepted baseline and any subsequent accepted updated or revised schedules through regular monthly review to incorporate actual past progress.

scheduled completion date: Planned work completion date shown on the current schedule.

shoulder: Roadway portion contiguous with the traveled way for accommodation of a stopped vehicle, emergency use, and lateral support of base and surface courses.

small tool: Tool or piece of equipment not listed in Labor Surcharge and Equipment Rental Rates that has a replacement value of $500 or less.

specifications: Standard specifications, revised standard specifications, and special provisions.

1. **standard specifications:** Specifications standard to Department construction projects. These specifications are in a book titled *Standard Specifications*.
2. **revised standard specifications:** New or revised standard specifications. These specifications are in a section titled *Revised Standard Specifications* of a book titled *Notice to Bidders and Special Provisions*.
3. **special provisions:** Specifications specific to the project. These specifications are in a section titled *Special Provisions* of a book titled *Notice to Bidders and Special Provisions*.

State: State of California, including its agencies, departments or divisions whose conduct or action is related to the work.

Structure Design: Offices of Structure Design of the Department of Transportation.

subbase: Layer of material between a base and the basement material.

subgrade: Roadbed portion on which pavement, surfacing, base, subbase, or a layer of any other material is placed.

submittal:

1. **action submittal:** Written and graphic information and samples that require the Department's response.
2. **informational submittal:** Written information that does not require the Department's response.

substantial defects: Defects plainly seen as damaged, displaced, or missing parts or improper functioning of materials, parts, equipment, or systems.

substructure: Bridge parts below the bridge seats, pier tops, and haunches for rigid-framed bridges or spring lines for arched bridges; includes abutment backwalls, abutment parapets, and wingwalls.

superstructure: Bridge parts except the substructure.

supplemental project information: Information relevant to the project, specified as supplemental project information, and made available to bidders.

surfacing: Uppermost layer of material placed on a traveled way or shoulders; pavement.

time impact analysis: Analysis using a CPM schedule developed specifically to demonstrate the effect a proposed or past change or delay has on the current scheduled completion date.

time-scaled network diagram: Graphic depiction of a CPM schedule comprised of activity bars with relationships for each activity represented by arrows. The tail of each arrow connects to the activity bar for the predecessor and points to the successor.

total bid: Sum of the item totals as verified by the Department; original Contract price.

total float: Amount of time that an activity or chain of activities can be delayed before extending the scheduled completion date.

traffic: Pedestrians, bicyclists, ridden or herded animals, vehicles, streetcars, and other conveyances either singularly or together while using any highway for purposes of travel.

traffic break: Traffic operation performed by a California Highway Patrol officer or other law enforcement officer to slow or stop traffic within the traveled way.

traffic lane: Portion of traveled way used for the movement of a single line of vehicles.

traveled way: Portion of the roadway for the movement of vehicles, exclusive of the shoulders, berms, sidewalks, and parking lanes.

tunnel: Tunnel as defined in 8 CA Code of Regs § 8405 et seq.

unauthorized work: Work performed beyond the lines and grades described in the Contract or established by the Engineer or extra work performed without Department authorization.

unsuitable material: Material encountered below the natural ground surface in embankment areas or below the grading plane in excavation areas that the Engineer determines to be in any of the following conditions:

1. Of such unstable nature that it cannot be compacted to the specified density using ordinary methods at optimum moisture content.
2. Too wet to be properly compacted and cannot be dried before incorporating it into the work. Excessive moisture alone is not sufficient cause for determining that the material is unsuitable.
3. Inappropriate for the planned use.

withhold: Money temporarily or permanently taken from a progress payment.

work: Resources and activities required for Contract acceptance, including labor, materials, equipment, and the created product.

work plan: Detailed formulation of a program of action.

work zone: Area of a highway with construction, maintenance, or utility work activities.

1-1.08 DISTRICTS

The Department's district composition and office addresses are as shown in the following table:

District Composition and Office Addresses

District	Counties	Street address	Mailing address
1	Del Norte (DN), Humboldt (Hum), Lake (Lak), Mendocino (Men)	1656 UNION ST EUREKA CA	PO BOX 3700 EUREKA CA 95502
2	Lassen (Las), Modoc (Mod), Plumas (Plu), Shasta (Sha), Siskiyou (Sis), Tehama (Teh), Trinity (Tri)	1657 RIVERSIDE DR REDDING CA	PO BOX 496073 REDDING CA 96049-6073
3	Butte (But), Colusa (Col), El Dorado (ED), Glenn (Gle), Nevada (Nev), Placer (Pla), Sacramento (Sac), Sierra (Sie), Sutter (Sut), Yolo (Yol), Yuba (Yub)	703 B ST MARYSVILLE CA	703 B ST MARYSVILLE CA 95901
4	Alameda (Ala), Contra Costa (CC), Marin (Mrn), Napa (Nap), San Francisco (SF), San Mateo (SM), Santa Clara (SCl), Solano (Sol), Sonoma (Son)	111 GRAND AVE OAKLAND CA	PO BOX 23660 OAKLAND CA 94623-0660
5	Monterey (Mon) San Benito (SBt), San Luis Obispo (SLO), Santa Barbara (SB), Santa Cruz (SCr)	50 HIGUERA ST SAN LUIS OBISPO CA	50 HIGUERA ST SAN LUIS OBISPO CA 93401-5415
6	Fresno (Fre), Kern (Ker), Kings (Kin), Madera (Mad), Tulare (Tul)	1352 W. OLIVE AVE FRESNO CA	PO BOX 12616 FRESNO CA 93728-2616
7	Los Angeles (LA), Ventura (Ven)	100 S. MAIN ST LOS ANGELES CA	100 S MAIN ST LOS ANGELES CA 90012
8	Riverside (Riv), San Bernardino (SBd)	464 W 4TH ST SAN BERNARDINO CA	464 W 4TH ST SAN BERNARDINO CA 92401-1400
9	Inyo (Iny), Mono (Mno)	500 S MAIN ST BISHOP CA	500 S MAIN ST BISHOP CA 93514-3423
10	Alpine (Alp), Amador (Ama), Calaveras (Cal), Mariposa (Mpa), Merced (Mer), San Joaquin (SJ), Stanislaus (Sta), Tuolumne (Tuo)	1976 E CHARTER WAY STOCKTON CA	PO BOX 2048 STOCKTON CA 95201
11	Imperial (Imp), San Diego (SD)	4050 TAYLOR ST SAN DIEGO CA	4050 TAYLOR ST SAN DIEGO CA 92110-2737
12	Orange (Ora)	3347 MICHELSON DR STE 100 IRVINE CA	3347 MICHELSON DR STE 100 IRVINE CA 92612-0661

A project with work in District 1, 2, or 3 is a North Region project. For Districts 1, 2, and 3, interpret each reference to the district office as the North Region office. The North Region's office address is the District 3 address.

1-1.09 FREEZE-THAW AREAS

Freeze-thaw areas are areas of the State where freeze-thaw cycles and heavy salting frequently occur. A project is in a freeze-thaw area if the project is specified in the special provisions to be in a freeze-thaw area.

1-1.10 PAVEMENT CLIMATE REGIONS

To help account for the effects of various climatic conditions on pavement performance, the State has been divided into 9 climate regions. The project's pavement climate region is shown on the project plans.

1-1.11 WEBSITES, ADDRESSES, AND TELEPHONE NUMBERS

Websites, Addresses, and Telephone Numbers

Reference or agency or department unit	Website	Address	Telephone no.
Authorized Facility Audit List	http://www.dot.ca.gov/hq/esc/Translab/OSM/documents/smdocuments/Internet_auditlisting.pdf	--	--
Authorized Material List	http://www.dot.ca.gov/hq/esc/approved_products_list/	--	--
Authorized Material Source List	http://www.dot.ca.gov/hq/esc/Translab/authorized_material_source_list/	--	--
Authorized Material Systems List	http://www.dot.ca.gov/hq/esc/Translab/authorized_systems_list/	--	--
Authorized Laboratory List	http://www.dot.ca.gov/hq/esc/Translab/authorized_laboratories_list/	--	--
CA Unified Certification Program's list of certified DBEs	http://www.dot.ca.gov/hq/bep/find_certified.htm	--	--
California MUTCD	http://www.dot.ca.gov	--	--
Department	http://www.dot.ca.gov	--	--
Department of Conservation, Office of Mine Reclamation	http://www.conservation.ca.gov/omr/	--	--
Department of General Services, Office of Small Business and DVBE Services	http://www.dgs.ca.gov/dgs/ProgramsServices/BusServices.aspx	OFFICE OF SMALL BUSINESS AND DVBE SERVICES DEPARTMENT OF GENERAL SERVICES 707 3RD ST WEST SACRAMENTO CA 95605-2811	(800) 559-5529 (916) 375-4940
Department of Industrial Relations	http://www.dir.ca.gov	455 GOLDEN GATE AVE SAN FRANCISCO CA 94102	--
Division of Accounting, Office of External Accounts Payable	http://www.dot.ca.gov/hq/asc/oap/payments/contact.htm#conpets1	MAJOR CONSTRUCTION PAYMENT AND INFORMATION UNIT OFFICE OF EXTERNAL ACCOUNTS PAYABLE DIVISION OF ACCOUNTING DEPARTMENT OF TRANSPORTATION P.O. BOX 168043 SACRAMENTO CA 95816-8043	(916) 227-9013
Division of Construction	http://www.dot.ca.gov/hq/construc/	--	--
Geotechnical Services	http://www.dot.ca.gov/hq/esc/geotech	GEOTECHNICAL SERVICES DEPARTMENT OF TRANSPORTATION 5900 FOLSOM BLVD SACRAMENTO CA 95819-4612	(916) 227-7000

METS	http://www.dot.ca.gov/hq/esc/Translab/	MATERIALS ENGINEERING AND TESTING SERVICES DEPARTMENT OF TRANSPORTATION 5900 FOLSOM BLVD SACRAMENTO CA 95819-4612	(916) 227-7000
MPQP	http://www.dot.ca.gov/manuals.htm	--	--
Office Engineer	--	MSC 43 OFFICE ENGINEER DEPARTMENT OF TRANSPORTATION 1727 30TH ST SACRAMENTO CA 95816-7005	(916) 227-6299
Offices of Structure Design, Documents Unit	--	MSC 9-4/4I DOCUMENTS UNIT OFFICES OF STRUCTURE DESIGN DEPARTMENT OF TRANSPORTATION 1801 30TH ST SACRAMENTO CA 95816-7006	(916) 227-0716
Publication Distribution Unit	--	PUBLICATION UNIT DEPARTMENT OF TRANSPORTATION 1900 ROYAL OAKS DR SACRAMENTO CA 95815-3800	--
South Coast Air Quality Management District	www.aqmd.gov	--	--

1-1.12 MISCELLANY

Make checks and bonds payable to the Department of Transportation.

1-1.13–1-1.15 RESERVED

2 BIDDING

2-1.01 GENERAL

Section 2 includes specifications related to bid eligibility and the bidding process.

2-1.02 BID INELIGIBILITY

A firm that has provided architectural or engineering services to the Department for this contract before bid submittal for this contract is prohibited from any of the following:

1. Submitting a bid
2. Subcontracting for a part of the work
3. Supplying materials

2-1.03 CONTRACTOR REGISTRATION

No contractor or subcontractor may be listed on a bid proposal for a public works project unless registered with the Department of Industrial Relations pursuant to Labor Code section 1725.5 [with limited exceptions from this requirement for bid purposes only under Labor Code section 1771.1(a)].

2-1.04 PREBID OUTREACH MEETING

Section 2-1.04 applies if a mandatory prebid meeting is shown on the *Notice to Bidders*.

The Department will conduct a meeting to provide small businesses, including DVBEs and DBEs, the opportunity to meet and interact with prospective bidders in an effort to increase their participation in the performance of contracts.

Each bidder must attend the meeting. The bidder's representative must be a company officer, project superintendent, or project estimator. For a joint venture, one of the parties must attend the mandatory prebid meeting.

The Department does not accept a bid from a bidder who did not attend the meeting.

A sign-in sheet will be used to identify the attendees. Each bidder must include the name and title of the company representative attending the meeting.

The Department may hold a single prebid meeting for more than one contract. Sign the sign-in sheet for the contract you intend to bid on. If you are bidding on multiple contracts, sign each sign-in sheet for each contract you intend to bid on. The sign-in sheets, with the names of all companies in attendance at each prebid meeting, will be made available at the website shown on the *Notice to Bidders* for bidder inquiries.

The successful bidder is required to report each small business hired to work on this Contract as a result of the meeting.

2-1.05 RESERVED

2-1.06 BID DOCUMENTS

2-1.06A General

The *Bid* book includes bid forms and certifications, including forms not submitted through the electronic bidding service.

The *Notice to Bidders and Special Provisions* includes the *Notice to Bidders*, revised standard specifications, and special provisions.

The *Bid* book, including *Bid* book forms not available through the electronic bidding service, *Notice to Bidders and Special Provisions*, project plans, and any addenda to these documents may be accessed at the Department's Office of Construction Contract Awards website.

The *Standard Specifications* and *Standard Plans* may be viewed at the Department's Office of Construction Contract Awards website and may be purchased at the Publication Distribution Unit.

2-1.06B Supplemental Project Information

The Department makes supplemental information available as specified in the special provisions.

Logs of test borings are supplemental project information.

If an *Information Handout* or electronic design files are available, you may view them at the Contract Plans and Special Provisions link at the Department's Office of Construction Contract Awards website. Electronic design files contain design information such as cross sections, digital models, and roadway design alignments and profiles.

If rock cores are available, you may view them by sending a request to Coreroom@dot.ca.gov.

If other supplemental project information is available for inspection, you may view it by phoning in a request.

Make your request at least 7 days before viewing. Include in your request:

1. District-County-Route
2. Contract number
3. Viewing date
4. Contact information, including telephone number

For rock cores, also include the bridge number in your request.

If bridge as-built drawings are available:

1. For a project in District 1 through 6 or 10, you may request them from the Office of Structure Maintenance and Investigations, fax (916) 227-8357
2. For a project in District 7, 8, 9, 11, or 12, you may request them from the Office of Structure Maintenance and Investigations, fax (916) 227-8357, and they are available at the Office of Structure Maintenance and Investigations, Los Angeles, CA, telephone (213) 897-0877

As-built drawings may not show existing dimensions and conditions. Where new construction dimensions are dependent on existing bridge dimensions, verify the field dimensions and adjust the dimensions of the work to fit the existing conditions.

2-1.06C–2-1.06D Reserved

2-1.07 JOB SITE AND DOCUMENT EXAMINATION

Examine the job site and bid documents. Notify the Department of apparent errors and patent ambiguities in the plans, specifications, and Bid Item List. Failure to do so may result in rejection of a bid or rescission of an award.

Bid submission is your acknowledgment that you have examined the job site and bid documents and are satisfied with:

1. General and local conditions to be encountered
2. Character, quality, and scope of work to be performed
3. Quantities of materials to be furnished
4. Character, quality, and quantity of surface and subsurface materials or obstacles
5. Requirements of the contract

2-1.08 RESERVED

2-1.09 BID ITEM LIST

Submit a bid based on the bid item quantities shown on the Bid Item List.

2-1.10 SUBCONTRACTOR LIST

On the Subcontractor List form, list each subcontractor that will perform work in an amount in excess of 1/2 of 1 percent of the total bid or $10,000, whichever is greater (Pub Cont Code § 4100 et seq.).

For each subcontractor listed, the Subcontractor List form must show:

1. Business name and the location of its place of business.
2. California contractor license number for a non-federal-aid contract.
3. Public works contractor registration number.
4. Portion of work it will perform. Show the portion of the work by:
   4.1. Bid item numbers for the subcontracted work

4.2. Percentage of the subcontracted work for each bid item listed
4.3. Description of the subcontracted work if the percentage of the bid item listed is less than 100 percent

2-1.11 RESERVED

2-1.12 DISADVANTAGED BUSINESS ENTERPRISES

2-1.12A General

Section 2-1.12 applies to a federal-aid contract.

Under 49 CFR 26.13(b):

> The contractor, sub recipient or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of 49 CFR part 26 in the award and administration of DOT-assisted contracts. Failure by the contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the recipient deems appropriate, which may include, but is not limited to:
>
> (1) Withholding monthly progress payments;
> (2) Assessing sanctions;
> (3) Liquidated damages; and/or
> (4) Disqualifying the contractor from future bidding as non-responsible.

Include this assurance in each subcontract you sign with a subcontractor.

2-1.12B Disadvantaged Business Enterprise Goal

2-1.12B(1) General

Section 2-1.12B applies if a DBE goal is shown on the *Notice to Bidders*.

The Department shows a goal for DBEs to comply with the DBE program objectives provided in 49 CFR 26.1.

Make work available to DBEs and select work parts consistent with the available DBEs, including subcontractors, suppliers, service providers, and truckers.

Meet the DBE goal shown on the *Notice to Bidders* or demonstrate that you made adequate good faith efforts to meet this goal.

You are responsible to verify at bid opening the DBE firm is certified as a DBE by the California Unified Certification Program and possesses the work codes applicable to the type of work the firm will perform on the Contract.

Determine that selected DBEs perform a commercially useful function for the type of work the DBE will perform on the Contract as provided in 49 CFR 26.55(c)(1)–(4). Under 49 CFR 26.55(c)(1)–(4), the DBE must be responsible for the execution of a distinct element of work and must carry out its responsibility by actually performing, managing, and supervising the work.

All DBE participation will count toward the Department's federally mandated statewide overall DBE goal.

Credit for materials or supplies you purchase from DBEs will be evaluated on a contract-by-contract basis and counts toward the goal in the following manner:

1. 100 percent if the materials or supplies are obtained from a DBE manufacturer.
2. 60 percent if the materials or supplies are obtained from a DBE regular dealer.
3. Only fees, commissions, and charges for assistance in the procurement and delivery of materials or supplies if they are obtained from a DBE that is neither a manufacturer nor a regular dealer. 49 CFR 26.55 defines *manufacturer* and *regular dealer*.

You receive credit toward the goal if you employ a DBE trucking company that is performing a commercially useful function. The Department uses the following factors in determining whether a DBE trucking company is performing a commercially useful function:

- The DBE must be responsible for the management and supervision of the entire trucking operation for which it is responsible on a particular contract, and there cannot be a contrived arrangement for the purpose of meeting DBE goals.
- The DBE must itself own and operate at least one fully licensed, insured, and operational truck used on the contract.
- The DBE receives credit for the total value of the transportation services it provides on the Contract using trucks it owns, insures, and operates using drivers it employs.
- The DBE may lease trucks from another DBE firm, including an owner-operator who is certified as a DBE. The DBE who leases trucks from another DBE receives credit for the total value of the transportation services the lessee DBE provides on the Contract.
- The DBE may lease trucks without drivers from a non-DBE truck leasing company. If the DBE leases trucks from a non-DBE truck leasing company and uses its own employees as drivers, it is entitled to credit for the total value of these hauling services.
- A lease must indicate that the DBE has exclusive use of and control over the truck. This does not preclude the leased truck from working for others during the term of the lease with the consent of the DBE, so long as the lease gives the DBE absolute priority for use of the leased truck. Leased trucks must display the name and identification number of the DBE.

[49 CFR 26.55(d)]

2-1.12B(2) DBE Commitment Submittal

Submit DBE information under section 2-1.33.

Submit a copy of the quote from each DBE shown on the DBE Commitment form that describes the type and dollar amount of work shown on the form. Submit a DBE Confirmation form for each DBE shown on the DBE Commitment form to establish that it will be participating in the Contract in the type and dollar amount of work shown on the form. If a DBE is participating as a joint venture partner, submit a copy of the joint venture agreement.

2-1.12B(3) DBE Good Faith Efforts Submittal

You can meet the DBE requirements by either documenting commitments to DBEs to meet the Contract goal or by documenting adequate good faith efforts to meet the Contract goal. An adequate good faith effort means that the bidder must show that it took all necessary and reasonable steps to achieve a DBE goal that, by their scope, intensity, and appropriateness to the objective, could reasonably be expected to meet the DBE goal.

If you have not met the DBE goal, complete and submit the DBE Good Faith Efforts Documentation form under section 2-1.33 showing that you made adequate good faith efforts to meet the goal. Only good faith efforts directed toward obtaining participation by DBEs are considered.

Submit good faith efforts documentation within the specified time to protect your eligibility for award of the contract in the event the Department finds that the DBE goal has not been met.

Refer to 49 CFR 26 app A for guidance regarding evaluation of good faith efforts to meet the DBE goal.

The Department considers DBE commitments of other bidders in determining whether the low bidder made good faith efforts to meet the DBE goal.

2-1.13–2-1.14 RESERVED

2-1.15 DISABLED VETERAN BUSINESS ENTERPRISES

2-1.15A General

Section 2-1.15 applies to a non-federal-aid contract.

Take necessary and reasonable steps to ensure that DVBEs have the opportunity to participate in the Contract.

Comply with Mil & Vet Code § 999 et seq.

2-1.15B Projects $5 Million or Less

Section 2-1.15B applies to a project with an estimated cost of $5 million or less.

Make work available to DVBEs and select work parts consistent with the available DVBE subcontractors and suppliers.

Meet the goal shown on the *Notice to Bidders*.

Complete and submit the Certified DVBE Summary form under section 2-1.33. List all DVBE participation on this form.

If a DVBE joint venture is used, submit the joint venture agreement with the Certified DVBE Summary form.

List each 1st-tier DVBE subcontractor on the Subcontractor List form regardless of its percentage of the total bid.

2-1.15C Projects More Than $5 Million

2-1.15C(1) General

Section 2-1.15C applies to a project with an estimated cost of more than $5 million.

The Department encourages bidders to obtain DVBE participation to ensure the Department achieves its State-mandated overall DVBE goal.

If you obtain DVBE participation:

1. Complete and submit the Certified DVBE Summary form under section 2-1.33. List all DVBE participation on this form.
2. List each 1st-tier DVBE subcontractor on the Subcontractor List form regardless of its percentage of the total bid.

If a DVBE joint venture is used, submit the joint venture agreement with the Certified DVBE Summary form.

2-1.15C(2) DVBE Incentive

The Department grants a DVBE incentive to each bidder who achieves a DVBE participation of 1 percent or greater (Mil & Vet Code 999.5 and Code of Regs § 1896.98 et seq.).

To receive this incentive, submit the Certified DVBE Summary form under section 2-1.33.

Bidders other than the apparent low bidder, the 2nd low bidder, and the 3rd low bidder may be required to submit the Certified DVBE Summary form if the bid ranking changes. If the Department requests a Certified DVBE Summary form from you, submit the completed form within 4 business days of the request.

2-1.15C(3) Incentive Evaluation

The Department applies the small business and non–small business preference during bid verification and proceeds with the evaluation specified below for the DVBE incentive.

The DVBE incentive is a reduction, for bid comparison only, in the submitted total bid by the lesser of the following amounts:

1. Percentage of the DVBE achievement rounded to 2 decimal places of the verified total bid of the low bidder
2. 5 percent of the verified total bid of the low bidder
3. $250,000

The Department applies the DVBE incentive and determines whether the bid ranking changes.

A non–small business bidder cannot displace a small business bidder. However, a small business bidder with a higher DVBE achievement can displace another small business bidder.

The Department proceeds with awarding the contract to the new low bidder and posts the new verified bid results at the Department's website.

2-1.16–2-1.17 RESERVED

2-1.18 SMALL BUSINESS AND NON–SMALL BUSINESS SUBCONTRACTOR PREFERENCES

2-1.18A General

Section 2-1.18 applies to a non-federal-aid contract.

The Department applies small business preferences and non–small business preferences under Govt Code § 14835 et seq. and 2 CA Code of Regs § 1896 et seq.

Any contractor, subcontractor, supplier, or service provider who qualifies as a small business is encouraged to apply for certification as a small business by submitting its application to the Department of General Services, Office of Small Business and DVBE Services.

Contract award is based on the total bid, not the reduced bid.

2-1.18B Small Business Preference

The Department allows a bidder certified as a small business by the Department of General Services, Office of Small Business and DVBE Services, a preference if:

1. Bidder submitted a completed Request for Small Business Preference or Non–Small Business Preference form with its bid
2. Low bidder did not request the preference or is not certified as a small business

The Bidder's signature on the Request for Small Business Preference or Non–Small Business Preference form certifies that the Bidder is certified as a small business at the date and time of bid or has submitted a complete application to the Department of General Services. The complete application and any required substantiating documentation must be received by the Department of General Services by 5:00 p.m. on the bid opening date.

The Department of General Services determines whether a bidder was certified on the bid opening date. The Department of Transportation confirms the Bidder's status as a small business before applying the small business preference.

The small business preference is a reduction for bid comparison in the total bid submitted by the small business contractor by the lesser of the following amounts:

1. 5 percent of the verified total bid of the low bidder
2. $50,000

If the Department determines that a certified small business bidder is the low bidder after the application of the small business preference, the Department does not consider a request for non–small business preference.

2-1.18C Non–Small Business Subcontractor Preference

The Department allows a bidder not certified as a small business by the Department of General Services, Office of Small Business and DVBE Services, a preference if:

1. Bidder submitted a completed Request for Small Business Preference or Non–Small Business Preference form with its bid
2. Certified Small Business Listing for the Non–Small Business Preference form shows that you are subcontracting at least 25 percent to certified small businesses

Each listed subcontractor and supplier must be certified as a small business at the date and time of bid or must have submitted a complete application to the Department of General Services. The complete application and any required substantiating documentation must be received by the Department of General Services by 5:00 p.m. on the bid opening date.

The non–small business subcontractor preference is a reduction for bid comparison in the total bid submitted by the non–small business contractor requesting the preference by the lesser of the following amounts:

1. 5 percent of the verified total bid of the low bidder

2. $50,000

2-1.19–2-1.26 RESERVED

2-1.27 CALIFORNIA COMPANIES

Section 2-1.27 applies to a non-federal-aid contract.

Under Pub Cont Code § 6107, the Department gives preference to a *California company*, as defined, for bid comparison purposes over a nonresident contractor from any state that gives or requires a preference to be given to contractors from that state on its public entity construction contracts.

Complete a California Company Preference form.

The California company's reciprocal preference amount is equal to the preference amount applied by the state of the nonresident contractor with the lowest responsive bid unless the California company is eligible for a small business preference or a non–small business subcontractor preference, in which case the preference amount is the greater of the two, but not both.

If the low bidder is not a California company and a California company's bid with reciprocal preference is equal to or less than the lowest bid, the Department awards the contract to the California company on the basis of its total bid.

2-1.28–2-1.30 RESERVED

2-1.31 OPT OUT OF PAYMENT ADJUSTMENTS FOR PRICE INDEX FLUCTUATIONS

You may opt out of the payment adjustments for price index fluctuations specified in section 9-1.07. To opt out, submit a completed Opt Out of Payment Adjustments for Price Index Fluctuations form under section 2-1.33.

2-1.32 RESERVED

2-1.33 BID DOCUMENT COMPLETION AND SUBMITTAL

2-1.33A General

Complete the forms in the *Bid* book.

Use the forms provided by the Department except as otherwise specified for a bidder's bond.

Do not fax forms except for the copies of forms with the public works contractor registration number submitted after the time of bid. Fax these copies to (916) 227-6282.

Failure to submit the forms and information as specified may result in a nonresponsive bid.

If an agent other than the authorized corporate officer or a partnership member signs the bid, file a Power of Attorney with the Department either before opening bids or with the bid. Otherwise, the bid may be nonresponsive.

Complete and submit the *Bid* book under the *Electronic Bidding Guide* at the Department's Office of Construction Contract Awards.

Your authorized digital signature is your confirmation of and agreement to all certifications and statements contained in the *Bid* book.

On forms and certifications that you submit through the electronic bidding service, you agree that each form and certification where a signature is required is deemed as having your signature.

2-1.33B Bid Form Submittal Schedules

2-1.33B(1) General

The *Bid* book includes forms specific to the contract. The deadlines for the submittal of the forms vary depending on the requirements of each contract. Determine the requirements of the contract and submit the forms based on the applicable schedule specified in section 2-1.33B.

Bid forms and information on the form that are due after the time of bid may be submitted at the time of bid.

2-1.33B(2) Federal-Aid Contracts

2-1.33B(2)(a) General

Section 2-1.33B(2) applies to a federal-aid contract.

2-1.33B(2)(b) Contracts with a DBE Goal

2-1.33B(2)(b)(i) General

Section 2-1.33B(2)(b) applies if a DBE goal is shown on the *Notice to Bidders*.

2-1.33B(2)(b)(ii) Non-Informal-Bid Contract

For a non-informal-bid contract, submit the bid forms according to the schedule shown in the following table:

Bid Form Submittal Schedule for a Non-Informal Bid Federal-Aid Contract with a DBE Goal

Form	Submittal deadline
Bid to the Department of Transportation	Time of bid except for the public works contractor registration number
Copy of the Bid to the Department of Transportation as submitted at the time of bid with the public works contractor registration number	10 days after bid opening
Subcontractor List	Time of bid except for the public works contractor registration number
Copy of the Subcontractor List as submitted at the time of bid with the public works contractor registration number	10 days after bid opening
Small Business Status	Time of bid
Opt Out of Payment Adjustments for Price Index Fluctuations[a]	Time of bid
DBE Commitment	No later than 4 p.m. on the 5th day after bid opening[b]
DBE Confirmation	No later than 4 p.m. on the 5th day after bid opening[b]
DBE Good Faith Efforts Documentation	No later than 4 p.m. on the 5th day after bid opening[b]

[a]Submit only if you choose the option.

[b]If the last day for submitting the bid form falls on a Saturday or holiday, it may be submitted on the next business day with the same effect as if it had been submitted on the day specified.

2-1.33B(2)(b)(iii) Informal-Bid Contract

For an informal-bid contract, submit the bid forms according to the schedule shown in the following table:

Bid Form Submittal Schedule for an Informal-Bid Federal-Aid Contract with a DBE Goal

Form	Submittal deadline
Bid to the Department of Transportation	Time of bid
Subcontractor List	Time of bid
Small Business Status	Time of bid
Opt Out of Payment Adjustments for Price Index Fluctuations[a]	Time of bid
DBE Commitment	No later than 4 p.m. on the 5th day after bid opening[b]
DBE Confirmation	No later than 4 p.m. on the 5th day after bid opening[b]
DBE Good Faith Efforts Documentation	No later than 4 p.m. on the 5th day after bid opening[b]

[a]Submit only if you choose the option.
[b]If the last day for submitting the bid form falls on a Saturday or holiday, it may be submitted on the next business day with the same effect as if it had been submitted on the day specified.

2-1.33B(2)(c) Contracts without a DBE Goal

2-1.33B(2)(c)(i) General

Section 2-1.33B(2)(c) applies if a DBE goal is not shown on the *Notice to Bidders*.

2-1.33B(2)(c)(ii) Non-Informal-Bid Contract

For a non-informal-bid contract, submit the bid forms according to the schedule shown in the following table:

Bid Form Submittal Schedule for a Non-Informal-Bid Federal-Aid Contract without a DBE Goal

Form	Submittal deadline
Bid to the Department of Transportation	Time of bid except for the public works contractor registration number
Copy of the Bid to the Department of Transportation as submitted at the time of bid with the public works contractor registration number	10 days after bid opening
Subcontractor List	Time of bid except for the public works contractor registration number
Copy of the Subcontractor List as submitted at the time of bid with the public works contractor registration numbers	10 days after bid opening
Small Business Status	Time of bid
Opt Out of Payment Adjustments for Price Index Fluctuations[a]	Time of bid

[a]Submit only if you choose the option.

2-1.33B(2)(c)(iii) Informal-Bid Contract

For an informal-bid contract, submit the bid forms according to the schedule shown in the following table:

Bid Form Submittal Schedule for an Informal-Bid Federal-Aid Contract without a DBE Goal

Form	Submittal deadline
Bid to the Department of Transportation	Time of bid
Subcontractor List	Time of bid
Small Business Status	Time of bid
Opt Out of Payment Adjustments for Price Index Fluctuations[a]	Time of bid

[a]Submit only if you choose the option.

2-1.33B(2)(d)–2-1.33B(2)(h) Reserved

2-1.33B(3) Non-Federal-Aid Contracts

2-1.33B(3)(a) General

Section 2-1.33B(3) applies to non-federal-aid contracts.

2-1.33B(3)(b) Contracts with a DVBE Goal

2-1.33B(3)(b)(i) General

Section 2-1.33B(3)(b) applies if a DVBE goal is shown on the *Notice to Bidders*.

2-1.33B(3)(b)(ii) Non-Informal-Bid Contract

For a non-informal-bid contract, submit the bid forms according to the schedule shown in the following table:

Bid Form Submittal Schedule for a Non-Informal-Bid Non-Federal-Aid Contract with a DVBE Goal

Form	Submittal deadline
Bid to the Department of Transportation	Time of bid except for the public works contractor registration number for a joint-venture contract
For a joint-venture contract, copy of the Bid to the Department of Transportation as submitted at the time of bid with the public works contractor registration number	10 days after bid opening
Subcontractor List	Time of bid
Opt Out of Payment Adjustments for Price Index Fluctuations[a]	Time of bid
Certified DVBE Summary	No later than 4 p.m. on the 4th business day after bid opening
California Company Preference	Time of bid
Request for Small Business Preference or Non–Small Business Preference[a]	Time of bid
Certified Small Business Listing for the Non–Small Business Preference[a]	No later than 4 p.m. on the 2nd business day after bid opening

[a]Submit only if you choose the option or preference.

2-1.33B(3)(b)(iii) Informal-Bid Contract

For an informal-bid contract, submit the bid forms according to the schedule shown in the following table:

Bid Form Submittal Schedule for an Informal-Bid Non-Federal-Aid Contract with a DVBE Goal

Form	Submittal deadline
Bid to the Department of Transportation	Time of bid
Subcontractor List	Time of bid
Opt Out of Payment Adjustments for Price Index Fluctuations[a]	Time of bid
Certified DVBE Summary	Time of bid
California Company Preference	Time of bid
Request for Small Business Preference or Non–Small Business Preference[a]	Time of bid
Certified Small Business Listing for the Non–Small Business Preference[a]	Time of bid

[a]Submit only if you choose the option or preference.

2-1.33B(3)(c) Contracts without a DVBE Goal

2-1.33B(3)(c)(i) General

Section 2-1.33B(3)(c) applies if a DVBE goal is not shown on the *Notice to Bidders*.

2-1.33B(3)(c)(ii) Non-Informal-Bid Contract

For a non-informal-bid contract, submit the bid forms according to the schedule shown in the following table:

Bid Form Submittal Schedule for a Non-Informal-Bid Non-Federal-Aid Contract without a DVBE Goal

Form	Submittal deadline
Bid to the Department of Transportation	Time of bid except for the public works contractor registration number for a joint-venture contract
For a joint-venture contract, copy of the Bid to the Department of Transportation as submitted at the time of bid with the public works contractor registration number	10 days after bid opening
Subcontractor List	Time of bid
Opt Out of Payment Adjustments for Price Index Fluctuations[a]	Time of bid
California Company Preference	Time of bid
Certified DVBE Summary[b]	No later than 4 p.m. on the 4th business day after bid opening
Request for Small Business Preference or Non–Small Business Preference[a]	Time of bid
Certified Small Business Listing for the Non–Small Business Preference[a]	No later than 4 p.m. on the 2nd business day after bid opening

[a]Submit only if you choose the option or preference.

[b]Submit only if you obtain DVBE participation or you are the apparent low bidder, 2nd low bidder, or 3rd low bidder and you choose to receive the specified incentive.

2-1.33B(3)(c)(iii) Informal-Bid Contract

For an informal-bid contract, submit the bid forms according to the schedule shown in the following table:

Bid Form Submittal Schedule for an Informal-Bid Non-Federal-Aid Contract without a DVBE Goal

Form	Submittal deadline
Bid to the Department of Transportation	Time of bid
Subcontractor List	Time of bid
Opt Out of Payment Adjustments for Price Index Fluctuations[a]	Time of bid
Certified DVBE Summary[b]	Time of bid
Request for Small Business Preference or Non–Small Business Preference[a]	Time of bid
Certified Small Business Listing for the Non–Small Business Preference[a]	Time of bid

[a]Submit only if you choose the option or preference.
[b]Submit only if you obtain DVBE participation or you are the apparent low bidder, 2nd low bidder, or 3rd low bidder and you choose to receive the specified incentive.

2-1.33B(3)(d)–2-1.33B(3)(h) Reserved

2-1.33B(4)–2-1.33B(9) Reserved

2-1.34 BIDDER'S SECURITY

Submit one of the following forms of bidder's security equal to at least 10 percent of the bid:

1. Cash
2. Cashier's check
3. Certified check
4. Signed bidder's bond by an admitted surety insurer
5. Electronic bidder's bond by an admitted surety insurer submitted using an electronic registry service approved by the Department

Submit cash, cashier's check, certified check, or bidder's bond to the Department's Office of Construction Contract Awards before the bid opening time.

Submit an electronic bidder's bond with the electronic bid.

If using a bidder's bond, you may use the form in the *Bid* book. If you do not use the form in the *Bid* book, use a form containing the same information.

2-1.35–2-1.39 RESERVED

2-1.40 BID WITHDRAWAL

Bids are not filed with the Department until the date and time of bid opening.

A bidder may withdraw or revise a bid after it has been submitted to the electronic bidding service if this is done before the bid opening date and time.

2-1.41–2-1.42 RESERVED

2-1.43 BID OPENING

The Department publicly opens and reads bids at the time and place shown on the *Notice to Bidders*.

2-1.44–2-1.45 RESERVED

2-1.46 DEPARTMENT'S DECISION ON A BID

The Department's decision on the bid amount is final.

The Department may reject:

1. All bids
2. A nonresponsive bid
3. A bid from any entity that is a parent, affiliate, or subsidiary, or that is under common ownership, control, or management with any other entity submitting a bid on the project

2-1.47 BID RELIEF

The Department may grant bid relief under Pub Cont Code § 5100 et seq. Submit any request for bid relief to the Office Engineer. The Relief of Bid Request form is available at the Department's website.

2-1.48 RESERVED

2-1.49 SUBMITTAL FAILURE HISTORY

The Department considers a bidder's past failure to submit documents required after bid opening in determining a bidder's responsibility.

2-1.50 BID RIGGING

Section 2-1.50 applies to a federal-aid contract.

The US Department of Transportation (DOT) provides a toll-free hotline to report bid rigging activities. Use the hotline to report bid rigging, bidder collusion, and other fraudulent activities. The hotline number is (800) 424-9071. The service is available 24 hours 7 days a week and is confidential and anonymous. The hotline is part of the DOT's effort to identify and investigate highway construction contract fraud and abuse and is operated under the direction of the DOT Inspector General.

3 CONTRACT AWARD AND EXECUTION

3-1.01 GENERAL

Section 3 includes specifications related to contract award and execution.

3-1.02 CONSIDERATION OF BIDS

3-1.02A General

For a lump-sum-based bid, the Department compares bids based on the total price.

For a unit-price-based bid, the Department compares bids based on the sum of the item totals.

For a cost-plus-time-based bid, the Department compares bids based on the sum of the item totals and the total bid for time.

3-1.02B Tied Bids

The Department breaks a tied bid with a coin toss except:

1. If a small business bidder and a non–small business bidder request preferences and the reductions result in a tied bid, the Department awards the contract to the small business bidder.
2. If a DVBE small business bidder and a non-DVBE small business bidder request preferences and the reduction results in a tied bid, the Department awards the contract to the DVBE small business bidder.

3-1.03 CONTRACTOR REGISTRATION

No contractor or subcontractor may be awarded a contract for public work on a public works project (awarded on or after April 1, 2015) unless registered with the Department of Industrial Relations pursuant to Labor Code section 1725.5.

3-1.04 CONTRACT AWARD

Submit any bid protest to the Office Engineer.

If the Department awards the contract, the award is made to the lowest responsible bidder within the number of days shown in the following table:

Contract Award Period

Days after bid opening	Project estimated cost shown on the *Notice to Bidders*
30	< $200 million
60	≥ $200 million

The Department may extend the specified award period if the Bidder agrees.

You may request to extend the award period by faxing a request to (916) 227-6282 before 4:00 p.m. on the last day of the award period. If you do not make this request, after the specified award period:

1. Your bid becomes invalid
2. You are not eligible for the award of the contract

3-1.05 CONTRACT BONDS (PUB CONT CODE §§ 10221 AND 10222)

The successful bidder must furnish 2 bonds:

1. Payment bond to secure the claim payments of laborers, workers, mechanics, or materialmen providing goods, labor, or services under the Contract. This bond must be equal to at least 100 percent of the total bid.
2. Performance bond to guarantee the faithful performance of the Contract. This bond must be equal to at least 50 percent of the total bid.

The Department provides bond forms to the successful bidder.

3-1.06 CONTRACTOR LICENSE

For a federal-aid contract, the Contractor must be properly licensed as a contractor from contract award through Contract acceptance (Pub Cont Code § 10164).

For a non-federal-aid contract:

1. Contractor must be properly licensed as a contractor from bid opening through Contract acceptance (Bus & Prof Code § 7028.15)
2. Joint venture bidders must obtain a joint venture license before contract award (Bus & Prof Code § 7029.1)

3-1.07 INSURANCE POLICIES

The successful bidder must submit:

1. Copy of its commercial general liability policy and its excess policy or binder until such time as a policy is available, including the declarations page, applicable endorsements, riders, and other modifications in effect at the time of contract execution. Standard ISO form no. CG 00 01 or similar exclusions are allowed if not inconsistent with section 7-1.06. The allowance of additional exclusions is at the discretion of the Department.
2. Certificate of insurance showing all other required coverages. Certificates of insurance, as evidence of required insurance for the auto liability and any other required policy, must set forth deductible amounts applicable to each policy and all exclusions that are added by endorsement to each policy. The evidence of insurance must provide that no cancellation, lapse, or reduction of coverage will occur without 10 days prior written notice to the Department.
3. Declaration under the penalty of perjury by a CPA certifying the accountant has applied GAAP guidelines confirming the successful bidder has enough funds and resources to cover any self-insured retentions if the self-insured retention is over $50,000.

If the successful bidder uses any form of self-insurance for workers compensation in lieu of an insurance policy, the Bidder must submit a certificate of consent to self-insure under Labor Code § 3700.

3-1.08 SMALL BUSINESS PARTICIPATION REPORT

The Department has established an overall 25 percent small business participation goal. The Department is tracking small business participation on all contracts to determine whether the goal is achieved.

Complete and sign the Small Business (SB) Participation Report form included in the contract documents whether or not no small business participation is reported.

3-1.09–3-1.10 RESERVED

3-1.11 PAYEE DATA RECORD

Complete and deliver to the Office Engineer a Payee Data Record form when requested by the Department.

3-1.12 RESERVED

3-1.13 FORM FHWA-1273

For a federal-aid contract, form FHWA-1273 is included with the Contract form in the documents sent to the successful bidder for execution. Comply with its provisions. Interpret the training and promotion section as specified in section 7-1.11A.

3-1.14–3-1.17 RESERVED

3-1.18 CONTRACT EXECUTION

The successful bidder must sign the Contract form.

Deliver to the Office Engineer:

1. Signed Contract form, including the attached form FHWA-1273
2. Contract bonds
3. Documents identified in section 3-1.07
4. Small Business (SB) Participation Report form

The Office Engineer must receive these documents before the 10th business day after the Bidder receives the contract.

The Bidder's security may be forfeited for failure to execute the contract within the time specified (Pub Cont Code §§ 10181, 10182, and 10183).

The following is a copy of the Contract form:

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
CONTRACT
DES-OE-0103A (REV 03/2010)

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
CONTRACT NO. _____

This contract is entered into between the State of California's Department of Transportation and the Contractor named below:

_____
CONTRACTOR'S NAME

The parties agree to comply with the terms of the following exhibits that are by this reference made a part of this contract.

Exhibit A - *Bid* book dated _____
Exhibit B - *Notice to Bidders and Special Provisions* dated _____
Exhibit C - Project plans approved _____
Exhibit D - *Standard Specifications* dated _____
Exhibit E - *Standard Plans* dated _____
Exhibit F - Addenda

Exhibits A, B, C, and F are those exhibits identified with the same contract number as this contract.

This contract has been executed by the following parties:

CONTRACTOR

CONTRACTOR'S NAME *(If other than an individual, state whether a corporation, partnership, etc.)*

BY *(Authorized Signature)*	DATE SIGNED *(Do not type)*
PRINTED NAME AND TITLE OF PERSON SIGNING	
FEDERAL EMPLOYER IDENTIFICATION NUMBER	LICENSE NUMBER

DEPARTMENT OF TRANSPORTATION

BY *(Authorized Signature)*	DATE SIGNED *(Do not type)*
PRINTED NAME AND TITLE OF PERSON SIGNING	

This contract has been certified as complying with the State Contract Act:

BY *(Authorized Signature)*	DATE SIGNED *(Do not type)*
PRINTED NAME AND TITLE OF PERSON SIGNING	

ADA Notice For individuals with sensory disabilities, this document is available in alternate formats. For information call (916) 654-6410 or TDD (916) 654-3880 or write Records and Forms Management, 1120 N Street, MS-89, Sacramento, CA 95814.

3-1.19 BIDDERS' SECURITIES

The Department keeps the securities of the 1st, 2nd, and 3rd low bidders until the contract has been executed. The other bidders' securities, other than bidders' bonds, are returned upon determination of the 1st, 2nd, and 3rd low bidders, and their bidders' bonds are of no further effect (Pub Cont Code § 10184).

4 SCOPE OF WORK

4-1.01 GENERAL

Section 4 includes specifications related to the scope of work.

4-1.02 INTENT

The Contract intent is to provide for work completion using the best general practices.

Nothing in the specifications voids the Contractor's public safety responsibilities.

4-1.03 WORK DESCRIPTION

Construct the work described on the *Notice to Bidders* and as described in the Contract.

4-1.04 USE OF MATERIALS FOUND ON THE JOB SITE

You may use aggregate or other materials found in excavation that comply with the specifications. The Department pays for the material excavated at the excavation item Contract price. Replace the quantity of material removed and used with an equal quantity of material. The material must have been designated for use in the work. Except for material used as structure backfill, the Department does not pay for replacing the material. The Department pays for replacing excavated material used for structure backfill at the Contract price for structure backfill. Do not excavate material from outside the excavation's slope and grade lines without authorization.

4-1.05 CHANGES AND EXTRA WORK

4-1.05A General

The Department may make changes within the scope of work and add extra work. The Engineer describes the changes and extra work, the payment basis, and any time adjustment in a Change Order.

A Change Order is approved when the Department signs the Change Order.

Until the Department approves a Change Order, continue to perform the work under the Contract unless the Engineer orders you to start the work described in the Change Order before its approval.

Submit detailed cost data for a unit price adjustment for a bid item if (1) the Engineer requests the data or (2) you request a unit price adjustment resulting from a change of more than 25 percent in the bid item's quantity.

4-1.05B Work-Character Changes

The Department adjusts the unit price for an item if:

1. Ordered plan or specification change materially changes the character of a work item from that on which the bid item price was based
2. Unit cost of the changed item differs from the unit cost of that item under the original plans and specifications
3. No approved Change Order addresses the payment

4-1.06 DIFFERING SITE CONDITIONS (23 CFR 635.109)

4-1.06A General

Reserved

4-1.06B Contractor's Notification

Promptly notify the Engineer if you find either of the following conditions:

1. Physical conditions differing materially from either of the following:
   1.1. Contract documents
   1.2. Job site examination
2. Physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the Contract

Include details explaining the information you relied on and the material differences you discovered.

If you fail to promptly notify the Engineer, you waive your claim of a differing site condition for the period between your discovery of the differing site condition and your notification to the Engineer.

If you disturb the site after discovery and before the Engineer's investigation, you waive the differing-site-condition claim.

4-1.06C Engineer's Investigation and Decision

Upon your notification, the Engineer investigates job site conditions and:

1. Notifies you whether to resume affected work
2. Decides whether the condition differs materially and is cause for an adjustment of time, payment, or both

4-1.07 VALUE ENGINEERING

4-1.07A General

Reserved

4-1.07B Value Engineering Change Proposal

You may submit a VECP to reduce any of the following:

1. Total cost of construction
2. Construction activity duration
3. Traffic congestion

Before preparing a VECP, meet with the Engineer to discuss:

1. Proposal concept
2. Permit issues
3. Impact on other projects
4. Project impacts, including traffic, schedule, and later stages
5. Peer reviews
6. Overall proposal merits
7. Review times required by the Department and other agencies

The VECP must not impair the project's essential functions or characteristics, including:

1. Service life
2. Operation economy
3. Maintenance ease
4. Desired appearance
5. Design and safety

The VECP must include:

1. Description of the Contract specifications and drawing details for performing the work and the proposed changes.
2. Itemization of Contract specifications and plan details that would be changed.
3. Detailed cost estimate for performing the work under the existing Contract and under the proposed change. Determine the estimates under section 9-1.04.
4. Deadline for the Engineer to decide on the changes.
5. Bid items affected and resulting quantity changes.

The Department is not required to consider a VECP. If a VECP is similar to a change in the plans or specifications being considered by the Department at the time the proposal is submitted or if the proposal is based on or similar to plans or specifications adopted by the Department before Contract award, the Department does not accept the VECP and may make these changes without VECP payments.

If the Department does not approve a Change Order before the deadline stated in the VECP or other date you subsequently stated in writing, the VECP is rejected. The Department does not adjust time or payment for a rejected VECP.

The Department decides whether to accept a VECP and the estimated net construction-cost savings from adopting the VECP or parts of it.

The Department may require you to accept a share of the investigation cost as a condition of reviewing a VECP. After written acceptance, the Department considers the VECP and deducts the agreed cost.

If the Department accepts the VECP or parts of it, the Department issues a Change Order that:

1. Incorporates changes in the Contract necessary to implement the VECP or the parts adopted
2. Includes the Department's acceptance conditions
3. States the estimated net construction-cost savings resulting from the VECP
4. Obligates the Department to pay you 50 percent of the estimated net savings

In determining the estimated net construction-cost savings, the Department excludes your VECP preparation cost and the Department's VECP investigation cost, including parts paid by you.

If a VECP providing for a reduction in working days is accepted by the Department, 50 percent of the reduction is deducted from the Contract time.

If a VECP providing for a reduction in traffic congestion or avoiding traffic congestion is accepted by the Department, the Department pays 60 percent of the estimated net savings in construction costs attributable to the VECP. Submit detailed traffic handling comparisons between the existing Contract and the proposed change, including estimates of the traffic volumes and congestion.

The Department may apply an accepted VECP for general use on other contracts.

If an accepted VECP is adopted for general use, the Department pays only the contractor who first submitted the VECP and only for the contracts awarded to that contractor before the submission of the accepted VECP.

If the Department does not adopt a general-use VECP, an identical or similar submitted proposal is eligible for acceptance.

4-1.07C Value Analysis Workshop

Section 4-1.07C applies to a non-building-construction contract with a total bid of over $5 million.

You may request a value analysis workshop by submitting a request after Contract approval.

The Department offers a value analysis workshop to:

1. Identify value-enhancing opportunities
2. Consider changes to the Contract that will reduce the total cost of construction, construction activity duration, or traffic congestion without impairing the essential functions specified for a VECP in section 4-1.07B

If the request is authorized, you and the Engineer:

1. Schedule a value analysis workshop
2. Select a facilitator and workshop site
3. Agree to other workshop administrative details

The workshop must be conducted under the methods described in the Department's *Value Analysis Team Guide*. For the guide, go to the Department's Division of Design website.

The facilitator must be a certified value specialist as recognized by the Society of American Value Engineers.

The Department reimburses you for 1/2 of the workshop cost. The workshop cost is the sum of the workshop-facilitator cost and the workshop-site cost. The Engineer determines the workshop cost based on the facilitator and workshop-site invoice prices minus any available or offered discounts. The Department does not reimburse you for any other associated costs.

4-1.08–4-1.12 RESERVED

4-1.13 CLEANUP

Before final inspection, leave the job site neat and presentable and dispose of:

1. Rubbish
2. Excess materials
3. Falsework
4. Temporary structures
5. Equipment

The Department does not require you to remove warning, regulatory, or guide signs before Contract acceptance.

5 CONTROL OF WORK

5-1.01 GENERAL

Section 5 includes specifications related to the Contract parties' relations and Contract acceptance.

Furnish the resources except Department-furnished materials required to complete the work as described in the Contract.

Provide QC.

Work is subject to the Department's inspection, sampling, and testing. The Department's inspection, sampling, and testing do not relieve you of your responsibility to provide QC.

Ensure the Department's safe and unrestricted access to the work. Furnish facilities necessary for the Department's inspection.

Where the means and methods to complete the work are not described in the Contract, choose the means and methods to complete the work.

Where the Contract describes more than 1 construction method or more than 1 type of material or equipment, the Department does not assure that each construction method or type of material or equipment can be used successfully throughout all or any part of the project. You are responsible to use the alternative or alternatives that will accomplish the work under the conditions encountered.

Failure to comply with any Contract part is a waiver of your right to an adjustment of time and payment related to that part.

Use contract administration forms available at the Department's website.

5-1.02 CONTRACT COMPONENTS

A component in one Contract part applies as if appearing in each. The parts are complementary and describe and provide for a complete work.

If a discrepancy exists:

1. Governing ranking of Contract parts in descending order is:
    1.1. Special provisions
    1.2. Project plans
    1.3. Revised standard specifications
    1.4. Standard specifications
    1.5. Revised standard plans
    1.6. Standard plans
    1.7. Supplemental project information
2. Written numbers and notes on a drawing govern over graphics
3. Detail drawing governs over a general drawing
4. Specific specification governs over a general specification
5. Specification in a section governs over a specification referenced by that section

If a discrepancy is found or confusion arises, submit an RFI.

5-1.03 ENGINEER'S AUTHORITY

The Engineer makes the final decision on questions regarding the Contract, including:

1. Work quality and acceptability
2. Manner of performance of the work
3. Drawing and specification interpretation
4. Contract fulfillment
5. Time and progress rate
6. Measurement and payment

The Engineer has the authority to enforce or fulfill an order that you fail to fulfill promptly.

Failure to enforce a Contract part does not waive enforcement of any Contract provision.

The Engineer may reject work that does not comply with the Contract at any time, including after a payment has been made.

5-1.04–5-1.05 RESERVED

5-1.06 PROTESTS

You may protest an Engineer's decision by submitting an RFI.

5-1.07–5-1.08 RESERVED

5-1.09 PARTNERING

5-1.09A General

The Department strives to work cooperatively with all contractors; partnering is our way of doing business. The Department encourages project partnering among the project team made up of significant contributors from the Department and the Contractor and their invited stakeholders.

For a contract with a total bid over $1 million, professionally facilitated project partnering is encouraged.

For a contract with a total bid over $10 million and 100 or more working days, professionally facilitated project partnering is required.

In implementing project partnering, you and the Engineer manage the Contract by:

1. Using early and regular communication with involved parties
2. Establishing and maintaining a relationship of shared trust, equity, and commitment
3. Identifying, quantifying, and supporting the attainment of mutual goals
4. Developing strategies for using risk management concepts
5. Implementing timely communication and decision making
6. Resolving potential problems at the lowest possible level to avoid negative impacts
7. Holding periodic partnering meetings and workshops as appropriate to maintain partnering relationships and benefits throughout the life of the project
8. Establishing periodic joint evaluations of the partnering process and attainment of mutual goals
9. Evaluating potential VECPs with stakeholders

Partnering does not void any Contract part.

The Department's *Field Guide to Partnering on Caltrans Construction Projects* is available to the project team as a reference. This guide provides structure, context, and clarity to the partnering process requirements. For the guide, go to the Department's Division of Construction website.

In implementing project partnering, the project team must:

1. Create a partnering charter that includes:
   1.1. Mutual goals, including core project goals and may also include project-specific goals and mutually supported individual goals, including VECPs
   1.2. Partnering maintenance and close-out plan
   1.3. Dispute resolution plan that includes a dispute resolution ladder and may also include use of facilitated dispute-resolution sessions
   1.4. Team commitment statement and signatures
2. Participate in monthly partnering-evaluation surveys to measure progress on mutual goals and may also measure short-term key issues as they arise.
3. Evaluate the partnering facilitator on the Partnering Facilitator Evaluation forms. The Engineer provides the evaluation forms to the project team and collects the results. The Department makes evaluation results available upon your request. Facilitator evaluations must be completed at the end of:
   3.1. Initial partnering workshop
   3.2. Project close-out partnering workshop
4. Conduct a project close-out partnering workshop.
5. Document lessons learned before Contract acceptance.

5-1.09B Partnering Facilitator, Workshops, and Monthly Evaluation Surveys

The Engineer sends you a written invitation to enter into a partnering relationship after Contract approval. Respond within 15 days to accept the invitation and request the initial and additional partnering workshops. After the Engineer receives the request, you and the Engineer cooperatively:

1. Select a partnering facilitator that offers the service of a monthly partnering-evaluation survey with a 5-point rating and agrees to follow the Department's *Partnering Facilitator Standards and Expectations* available at the Department's Division of Construction website
2. Schedule the initial partnering workshop
3. Determine the initial workshop site and duration
4. Agree to other workshop administrative details

Additional partnering workshops and sessions are recommended quarterly and encouraged throughout the life of the project as determined necessary by you and the Engineer.

5-1.09C Training in Partnering Skills Development

For a contract with a total bid over $10 million and 100 or more working days, training in partnering skills development is required.

You and the Engineer cooperatively schedule the training session and select a professional trainer, training site, and 1 to 4 topics from the following list to be covered in the training:

1. Active listening
2. Building teams
3. Change management
4. Communication
5. Conflict resolution
6. Cultural diversity
7. Dealing with difficult people
8. Decision making
9. Effective escalation ladders
10. Emotional intelligence
11. Empathy
12. Ethics
13. Facilitation skills
14. Leadership
15. Partnering process and concepts
16. Project management
17. Project organization
18. Problem solving
19. Running effective meetings
20. Time management
21. Win-win negotiation

Before the initial partnering workshop, the trainer conducts a 1-day training session in partnering skills development for the Contractor's and the Engineer's representatives. This training session must be a separate session from the initial partnering workshop and must be conducted locally. The training session must be consistent with the partnering principles under the Department's *Field Guide to Partnering on Caltrans Construction Projects*.

Send field supervisory personnel to the training session. One of these must be your assigned representative specified in section 5-1.16.

5-1.09D Payment

The Department pays for:

1. 1/2 of partnering workshops and sessions based on facilitator and workshop site costs
2. 1/2 of the monthly service cost for partnering-evaluation surveys
3. Cost of the trainer and training site for partnering skills development

The Engineer determines the costs based on invoice prices minus any available or offered discounts. The Department does not pay markups on these costs.

The Department does not pay for your employees' wages, travel expenses, or other costs associated with (1) attending the partnering workshops and sessions, (2) completing monthly partnering-evaluation surveys, or (3) attending training in partnering skills development.

5-1.10–5-1.11 RESERVED

5-1.12 ASSIGNMENT

The performance of the Contract or any Contract part may be assigned only with prior written consent from the Department. To request consent, submit a Contractor Action Request - Assignment of Contract Performance form. The Department does not consent to any requested assignment that would relieve you or your surety of the responsibility to complete the work or any part of the work.

If you assign the right to receive Contract payments, the Department accepts the assignment upon the Engineer's receipt of a Contractor Action Request - Assignment of Contract Monies, Assignee Change of Name/Address form. Assigned payments remain subject to deductions and withholds described in the Contract. The Department may use withheld payments for work completion whether the payments are assigned or not.

5-1.13 SUBCONTRACTING

5-1.13A General

No subcontract releases you from the Contract or relieves you of your responsibility for a subcontractor's work.

Before subcontracted work starts, submit a Subcontracting Request form.

Do not use a debarred contractor. For a list of debarred contractors, go to the Department of Industrial Relations' website.

If you violate Pub Cont Code § 4100 et seq., the Department may exercise the remedies provided in Pub Cont Code § 4110. The Department may refer the violation to the Contractors State License Board as provided under Pub Cont Code § 4111.

Except for a building-construction non-federal-aid contract, perform work equaling at least 30 percent of the value of the original total bid with your employees and with equipment you own or rent, with or without operators.

Each subcontract must comply with the Contract.

The Department encourages you to include a dispute resolution process in each subcontract.

Each subcontractor must have an active and valid:

1. State contractor license with a classification appropriate for the work to be performed (Bus & Prof Code § 7000 et seq.)
2. Public works contractor registration number with the Department of Industrial Relations

Submit copies of subcontracts upon request.

Upon request, immediately remove and do not again use a subcontractor who fails to satisfactorily prosecute the work.

5-1.13B Disadvantaged Business Enterprises

5-1.13B(1) General

Section 5-1.13B applies to a federal-aid contract.

Use each DBE as listed on the DBE Commitment form unless you receive authorization for a substitution. Ensure that all subcontracts and agreements with DBEs to supply labor or materials are performed under 49 CFR 26.

Maintain records, including:

1. Name and business address of each 1st-tier subcontractor
2. Name and business address of each DBE subcontractor, DBE vendor, and DBE trucking company, regardless of tier
3. Date of payment and total amount paid to each business

If you are a DBE contractor, include the date of work performed by your own forces and the corresponding value of the work.

Before the 15th day of each month for the previous month's work, submit:

1. Monthly DBE Trucking Verification form
2. Monthly DBE Payment form

If a DBE is decertified before completing its work, the DBE must notify you in writing of the decertification date. If a business becomes a certified DBE before completing its work, the business must notify you in writing of the certification date. Submit the notifications. Upon work completion, complete a Disadvantaged Business Enterprises (DBE) Certification Status Change form. Submit the form within 30 days of Contract acceptance.

Upon work completion, complete a Final Report – Utilization of Disadvantaged Business Enterprises (DBE), First-Tier Subcontractors form. Submit it within 30 days of Contract acceptance. The Department withholds $10,000 until the form is submitted. The Department releases the withhold upon submission of the completed form.

5-1.13B(2) Disadvantaged Business Enterprises

Section 5-1.13(B)(2) applies if a DBE goal is shown on the *Notice to Bidders*.

DBEs must perform work or supply materials as listed on the DBE Commitment form.

Do not terminate or substitute a listed DBE for convenience and perform the work with your own forces or those of an affiliate, a non-DBE firm, or another DBE firm or obtain materials from other sources without authorization from the Department.

The Department authorizes a request to use other forces or sources of materials if it shows any of the following justifications:

1. Listed DBE fails or refuses to execute a written contract based on the plans and specifications for the project.
2. You stipulated that a bond is a condition of executing the subcontract and the listed DBE fails to meet your bond requirements.
3. Work requires a contractor license and the listed DBE does not have a valid license under the Contractors License Law.
4. Listed DBE fails or refuses to perform the work or furnish the listed materials.
5. Listed DBE's work is unsatisfactory and not in compliance with the Contract.
6. Listed DBE is ineligible to work on the project because of suspension or debarment.
7. Listed DBE becomes bankrupt or insolvent.
8. Listed DBE voluntarily withdraws with written notice from the Contract.
9. Listed DBE is ineligible to receive credit for the type of work required.
10. Listed DBE owner dies or becomes disabled resulting in the inability to perform the work on the Contract.
11. Department determines other documented good cause under 49 CFR 26.53.

Notify the original DBE of your intent to use other forces or material sources and provide the reasons. Provide the DBE with 5 business days to respond to your notice and advise you and the Department of the reasons why the use of other forces or sources of materials should not occur. Your request to use other forces or material sources must include:

1. 1 or more of the reasons listed in the preceding paragraph
2. Notices from you to the DBE regarding the request
3. Notices from the DBE to you regarding the request

If the Department authorizes the termination or substitution of a listed DBE, make good faith efforts to find another DBE. The substitute DBE must (1) perform at least the same dollar amount of work as the original DBE under the Contract to the extent needed to meet the DBE goal and (2) be certified as a DBE with the work code applicable to the type of work the DBE will perform on the Contract at the time of your request for substitution. Submit your documentation of good faith efforts within 7 days of your request for

authorization of the substitution. The Department may authorize a 7-day extension of this submittal period at your request. Refer to 49 CFR 26 app A for guidance regarding evaluation of good faith efforts to meet the DBE goal.

Unless the Department authorizes a request to terminate or substitute a listed DBE, the Department does not pay for work unless it is performed or supplied by the DBE listed on the DBE Commitment form. You may be subject to other sanctions under 49 CFR 26.

5-1.13B(3) Use of Joint Checks

You may use a joint check between the Contractor or lower-tier subcontractor and a DBE subcontractor purchasing materials from a material supplier if you obtain prior approval from the Department for your proposed use of joint checks upon submittal of a DBE Joint Check Agreement Request form.

To use a joint check, the following conditions must be met:

1. All parties, including the Contractor, must agree to the use of a joint check
2. Entity issuing the joint check acts solely to guarantee payment
3. DBE must release the check to the material supplier
4. Department must authorize the request before implementation
5. Any party to the agreement must provide requested documentation within 10 days of the Department's request for the documentation
6. Agreement to use a joint check must be short-term, not to exceed 1 year, allowing sufficient time needed to establish or increase a credit line with the material supplier

A request for a joint check agreement may be initiated by any party.

If a joint check is used, the DBE remains responsible for all elements of 49 CFR 26.55(c)(1).

Failure to comply with section 5-1.13B(3) disqualifies DBE participation and results in no credit and no payment to the Contractor for DBE participation.

A joint check may not be used between the Contractor or subcontractor and a DBE regular dealer, bulk material supplier, manufacturer, wholesaler, broker, trucker, packager, manufacturer’s representative, or other persons who arrange or expedite transactions.

5-1.13C Disabled Veteran Business Enterprises

Section 5-1.13C applies to a non-federal-aid contract.

Use each DVBE as shown on the Certified DVBE Summary form unless you receive authorization from the Department for a substitution. The substitute must be another DVBE unless DVBEs are not available, in which case, you must substitute with a small business. Any authorization for a substitute is contingent upon the Department of General Services' approval of the substitute.

The requirement that DVBEs be certified by the bid opening date does not apply to DVBE substitutions after Contract award.

The Department authorizes substitutions for any of the reasons provided in 2 CA Code of Regs § 1896.73.

Include in your substitution request:

1. Copy of the written notice issued to the DVBE with proof of delivery
2. Copy of the DVBE's response to the notice
3. Name and certification number of the listed DVBE and the proposed substitute

Requests for substitutions of a listed DVBE with a small business must include documentation of the unavailability of DVBEs, including:

1. Contact with the small business/DVBE advocate from the Department and the Department of Veterans Affairs
2. Search results from the Department of General Services' website of available DVBEs
3. Communication with a DVBE community organization nearest the job site, if applicable

4. Documented communication with the DVBE and small businesses describing the work to be performed, the percentage of the total bid, the corresponding dollar amount, and the responses to the communication

The Department forwards your substitution request to the Department of General Services. The Department of General Services issues a notice of approval or denial. The Department provides you this notice.

If you fail to use a listed DVBE without an authorized substitution request, the Department issues a penalty of up to 10 percent of the dollar amount of the work of the listed DVBE.

Maintain records of subcontracts made with DVBEs. Include in the records:

1. Name and business address of each business
2. Total amount paid to each business

For the purpose of determining compliance with Pub Cont Code § 10115 et seq.:

1. Upon work completion, complete and submit Final Report - Utilization of Disabled Veteran Business Enterprises (DVBE) State Funded Projects Only form.
2. Upon reasonable notice and during normal business hours, permit access to its premises for the purposes of:
   2.1. Interviewing employees.
   2.2. Inspecting and copying books, records, accounts and other material that may be relevant to a matter under investigation.

5-1.13D Non–Small Businesses

Section 5-1.13D applies to a non-federal-aid contract.

Use each subcontractor as shown on the Certified Small Business Listing for the Non-Small Business Preference form unless you receive authorization for a substitution.

The requirement that small businesses be certified by the bid opening date does not apply to small business substitutions after contract award.

Maintain records of subcontracts made with small business subcontractors and records of materials purchased from certified small business suppliers. Include in the records:

1. Name and business address of each business
2. Total amount paid to each business

For the purpose of determining compliance with 2 CA Code of Regs § 1896 et seq.:

1. Provide the Department relevant information requested
2. Upon reasonable notice and during normal business hours, permit access to its premises for the purposes of:
   2.1. Interviewing employees
   2.2. Inspecting and copying books, records, accounts and other material that may be relevant to a matter under investigation

5-1.13E–5-1.13I Reserved

5-1.14–5-1.15 RESERVED

5-1.16 REPRESENTATIVE

Before starting work, assign a representative to:

1. Receive the Engineer's orders
2. Prosecute the Engineer's orders
3. Supervise the workers
4. Coordinate the subcontractors' work

The representative must be present at the job site while work is in progress. Submit the representative's name and telephone number so the representative can be easily contacted to perform emergency work while work is not in progress.

5-1.17 CHARACTER OF WORKERS

If a worker appears to the Engineer to be incompetent or acts disorderly or improperly, discharge the worker immediately upon request. Do not employ that worker again on the work.

5-1.18–5.19 RESERVED

5-1.20 COORDINATION WITH OTHER ENTITIES

5-1.20A General

Other entities may perform work at or near the job site and material sources at any time. Coordinate activities to avoid delays.

Each contractor or other entity performing work at or near the job or material site is responsible to the other for damage to work, persons, or property and for costs due to unnecessary delays.

5-1.20B Permits, Licenses, Agreements, and Certifications

5-1.20B(1) General

Comply with PLACs. The Department makes PLAC changes under section 4-1.05. Maintain a copy of each PLAC at the job site.

5-1.20B(2) Before Award

To make a change to a PLAC made available to you before award, submit the proposed change. The Department sends the proposed change to the appropriate authority for consideration.

5-1.20B(3) After Award

Confirm with the Engineer which after-award PLACs are obtained by the Department and which are obtained by the Contractor.

To make a change to an after-award PLAC obtained by the Department, submit the proposed change. The Department sends the proposed change to the appropriate authority for consideration.

Obtain those PLACs to be issued to you and pay the fees and costs associated with obtaining them. Submit copies of Contractor-obtained after-award PLACs.

5-1.20B(4) Contractor–Property Owner Agreement

Before procuring material from or disposing of material on nonhighway property:

1. Submit a written agreement from the property owner:
   1.1. For the use of the property
   1.2. Absolving the Department from responsibility in connection with the property
2. Obtain authorization to start

Before Contract acceptance, submit a document signed by the owner of the material source or disposal site stating that the Contractor has complied with the Contractor-owner agreement.

5-1.20C Railroad Relations

If the Contract includes an agreement with a railroad company, the Department makes the provisions of the agreement available in the *Information Handout* in the document titled "Railroad Relations and Insurance Requirements." Comply with the requirements in the document.

5-1.20D Occupied Improvements within the Right-of-Way

Reserved

5-1.20E Water Meter Charges

Reserved

5-1.20F Irrigation Water Service Charges

Reserved

5-1.20G–5-1.20J Reserved

5-1.21–5-1.22 RESERVED

5-1.23 SUBMITTALS

5-1.23A General

Section 5-1.23 includes specifications for action and informational submittals.

Any submittal not specified as an informational submittal is an action submittal.

Submit action and informational submittals to the Engineer.

Each sheet of a submittal must include:

1. Contract number
2. District–County–Route–Post Mile
3. Structure name and number, if any

The Department rejects a submittal if it has any error or omission.

If the last day for submitting a document falls on a Saturday or holiday, it may be submitted on the next business day with the same effect as if it had been submitted on the day specified.

Convert foreign language documents to English and US customary units.

5-1.23B Action Submittals

5-1.23B(1) General

Maintain a sequential list of action submittals except for samples, test samples, and material sources. With each individual submittal, submit a copy of the updated list.

Submit an action submittal before the start of the affected work to allow for review and corrections without work delays.

Except for test samples, obtain the Department's authorization for action submittals before you perform work based on them.

Except for shop drawings and test samples, allow 15 days for review.

For a revised action submittal, allow the same number of days for review as for the original submittal.

The time allowed for the review of an action submittal starts when the Department receives the submittal.

Do not change the scope of work on revised submittals.

The Department's authorization of an action submittal does not void any Contract part.

5-1.23B(2) Shop Drawings

Submit shop drawings as specified and as otherwise required to control the work.

Each drawing and calculation sheet must be in black ink and sequentially numbered.

Each drawing sheet must:

1. Be 11 by 17 inches
2. Be on a minimum of 20 lb paper
3. Have text of a minimum nominal height of 5/32 inch

Each calculation sheet must:

1. Be 8-1/2 by 11 inches
2. Have text of a minimum 12-point font

Text and graphics must be legible for photocopying and reduction.

Calculations must demonstrate the design adequacy. Calculations specified as independently checked must be sealed and signed by an engineer who is registered as a civil engineer in the State and who did not seal and sign the drawings.

Allow 20 days for the review.

If multiple sets are submitted simultaneously or an additional set is submitted before the review of a previously submitted set is complete, designate the sequence that the sets are to be reviewed. Allow the review time specified plus 15 days for each additional set. A set consists of 40 or fewer sheets.

If drawings require corrections, the Department:

1. Describes the deficiencies
2. Stamps the drawings with the date that the review stopped
3. Returns the drawings

Show the set revision number. Uniquely number each revised detail. Show the number in an inverted triangle near the revised portion of the detail. In a legend, describe and date the revision.

Upon review completion, the Department returns 1 copy that shows the authorized date.

To make a change to an authorized drawing, submit it as specified for a new submittal. Note the changes.

After the work shown on the drawings is complete, submit electronic copies of as-built drawings. Include an index of the sheet numbers and titles on the 1st sheet for each structure. Arrange the drawings in the drawing-number order shown in the index.

5-1.23B(3)–5-1.23B(10) Reserved

5-1.23C Informational Submittals

Informational submittals include:

1. Certificates of compliance
2. Manufacturer's instructions not associated with drawing submittals
3. Notifications
4. PLACs
5. Subcontracts
6. QC test data, QC test results, and QC evaluation reports

5-1.24–5-1.25 RESERVED

5-1.26 CONSTRUCTION SURVEYS

The Department places stakes and marks under Chapter 12, "Construction Surveys," of the Department's *Surveys Manual*.

Submit your request for Department-furnished stakes:

1. Once the staking area is ready for stakes
2. On a Request for Construction Staking form

After your submittal, the Department starts staking within 2 business days.

Preserve stakes and marks placed by the Department. If the stakes or marks are destroyed, the Department replaces them at the Department's earliest convenience and deducts the cost.

5-1.27 RECORDS

5-1.27A General

Reserved

5-1.27B Record Retention

Retain project records from bid preparation through:

1. Final payment
2. Resolution of claims, if any

For at least 3 years after the later of these, retain cost records, including records of:

1. Bid preparation
2. Overhead
3. Payrolls
4. Payments to subcontractors and suppliers
5. Cost accounting

Maintain the records in an organized way in the original format, electronic and hard copy, conducive to professional review and audit.

5-1.27C Record Inspection, Copying, and Auditing

Make your records available for inspection, copying, and auditing by State representatives for the same time frame specified under section 5-1.27B. The records of subcontractors and suppliers must be made available for inspection, copying, and auditing by State representatives for the same period. Before Contract acceptance, the State representative notifies the Contractor, subcontractor, or supplier 5 business days before inspection, copying, or auditing.

If an audit is to start more than 30 days after Contract acceptance, the State representative notifies the Contractor, subcontractor, or supplier of the date when the audit is to start.

5-1.27D Cost Accounting Records

Maintain cost accounting records for the project distinguishing between the following work cost categories:

1. Work performed based on bid item prices
2. Change order work other than extra work. Distinguish this work by:
    2.1. Bid item prices
    2.2. Force account
    2.3. Agreed price
3. Extra work. Distinguish extra work by:
    3.1. Bid item prices
    3.2. Force account
    3.3. Agreed price
    3.4. Specialist billing
4. Work performed under potential claim records
5. Overhead
6. Work performed by subcontractors, suppliers, owner-operators, and professional services

Cost accounting records must include:

1. Final cost code lists and definitions
2. Itemization of the materials used and copies of the corresponding vendors' invoices
3. Direct cost of labor
4. Equipment rental charges
5. Workers' certified payrolls
6. Equipment:
    6.1. Size
    6.2. Type
    6.3. Identification number
    6.4. Hours operated

5-1.27E Change Order Bills

Maintain separate records for change order work costs.

Submit change order bills using the Department's Internet change order billing system.

The Contractor submitting and the Engineer authorizing a change-order bill using the Internet change-order billing system is the same as each party signing the bill.

The Department provides billing system:

1. Training within 30 days of your request
2. Accounts and user identification to your assigned representatives after a representative has received training

Each representative must maintain a unique password.

5-1.28–5-1.29 RESERVED

5-1.30 NONCOMPLIANT AND UNAUTHORIZED WORK

Correct or remove and replace work that (1) does not comply with the Contract, (2) is unauthorized, or (3) both. The Department does not pay for any of the following:

1. Corrective, removal, or replacement work
2. Unauthorized work

If ordered, submit a work plan for the corrective, removal, or replacement work.

If you fail to comply promptly with an order under section 5-1.30, the Department may correct, remove, or replace noncompliant or unauthorized work. The Department deducts the cost of this work.

5-1.31 JOB SITE APPEARANCE

Keep the job site neat. In areas visible to the public:

1. If practicable, dispose of debris removed during clearing and grubbing concurrently with its removal. If stockpiling is necessary, dispose of debris weekly.
2. Furnish trash bins for construction debris. Place the debris in trash bins daily.
3. For falsework to be reused, stack the forms neatly and concurrently with their removal.

5-1.32 AREAS FOR USE

Occupy the highway only for purposes necessary to perform the work.

If no State-owned area is designated for the Contractor's use, you may arrange for temporary storage with the Department.

Defend, indemnify, and hold the State harmless to the same extent as under section 7-1.05.

The Department does not allow temporary residences within the highway.

5-1.33 EQUIPMENT

Legibly stencil or stamp at a clearly visible location on each piece of equipment except hand tools an identifying number and:

1. On compacting equipment, its make, model number, and empty gross weight that is either the manufacturer's rated weight or the scale weight
2. On meters and on the load-receiving element and indicators of each scale, the make, model, serial number, and manufacturer's rated capacity

Submit a list describing each piece of equipment and its identifying number.

Upon request, submit the manufacturer's information that designates portable vehicle scale capacities.

For proportioning materials, use measuring devices, material plant controllers, and undersupports complying with section 9-1.02B.

Measuring devices must be tested and approved under California Test 109 in the Department's presence by any of the following:

1. County Sealer of Weights and Measures
2. Scale Service Agency
3. Official of the Division of Measurement Standards

The indicator over-travel must be at least 1/3 of the loading travel. The indicators must be enclosed against moisture and dust.

Group the measuring system dials such that the smallest increment for each indicator can be read from the location at which proportioning is controlled.

5-1.34–5-1.35 RESERVED

5-1.36 PROPERTY AND FACILITY PRESERVATION

5-1.36A General

Preserve and protect:

1. Highway improvements and facilities
2 Adjacent property
3. Waterways
4. ESAs
5. Lands administered by other agencies
6. Railroads and railroad equipment
7. Nonhighway facilities, including utilities
8. Survey monuments
9. Department's instrumentation
10 Temporary work
11. Roadside vegetation not to be removed

Comply with Govt Code § 4216 et seq. Notify the Engineer at least 3 business days before you contact the regional notification center. Failure to contact the notification center prohibits excavation.

Immediately report damage to the Engineer.

If you cause damage, you are responsible.

The Department may make a temporary repair to restore service to a damaged facility.

Install suitable safeguards to preserve and protect facilities from damage.

Install temporary facilities, such as sheet piling, cribbing, bulkheads, shores, or other supports, necessary to support existing facilities or to support material carrying the facilities.

5-1.36B Railroad Property

If working on or adjacent to railroad property, do not interfere with railroad operations.

For an excavation on or affecting railroad property, submit work plans showing the system to be used to protect the railroad facilities. Instead of the 15 days specified in section 5-1.23B, allow 65 days for the review of the plans.

If the Contract does not include an agreement with a railroad company, do not allow personnel or equipment on railroad property.

Prevent material, equipment, and debris from falling onto railroad property.

5-1.36C Nonhighway Facilities

5-1.36C(1) General

Before starting work that could damage or interfere with underground infrastructure, locate the infrastructure described in the Contract, including laterals and other appurtenances, and determine the presence of other underground infrastructure inferred from visible facilities, such as buildings, meters, and junction boxes.

Underground infrastructure described in the Contract may be in different locations from those described, and additional infrastructure may exist.

Upon discovering an underground main or trunk line not described in the Contract, immediately notify the Engineer and the infrastructure owner. The Engineer orders the locating and protecting of the

infrastructure. The locating and protecting is change order work. If ordered, repair infrastructure damage. If the damage is not due to your negligence, the repair is change order work.

Immediately notify the Engineer of a delay due to the presence of main-line underground infrastructure not described in the Contract or in a substantially different location.

Notify the Engineer if the infrastructure described in the Contract cannot be found. If after giving the notice, you find the infrastructure in a substantially different location from that described, finding the infrastructure is change order work.

5-1.36C(2) Nonhighway Facility Protection

Reserved

5-1.36C(3) Nonhighway Facility Rearrangement

The Department may rearrange a nonhighway facility during the Contract. Rearrangement of a nonhighway facility includes installation, relocation, alteration, or removal of the facility.

The Department may authorize facility owners and their agents to enter the highway to perform rearrangement work for their facilities or to make connections or repairs to their property. Coordinate activities to avoid delays.

If necessary rearrangement of underground infrastructure is not described in the Contract, the Engineer may order you to perform the work. The rearrangement is change order work.

Immediately notify the Engineer of a delay due to a rearrangement different from that described in the Contract.

If you want infrastructure rearrangement different from that described in the Contract:

1. Notify the Engineer
2. Make an arrangement with the infrastructure owner
3. Obtain authorization for the rearrangement
4. Pay the infrastructure owner any additional cost

The Department does not adjust time or payment for a rearrangement different from that described the Contract.

5-1.36D Survey Monuments

Protect survey monuments on and off the highway. Upon discovery of a survey monument not identified and located by the Department, immediately:

1. Stop work near the monument
2. Notify the Engineer

Do not resume work near the monument until authorized.

5-1.36E Landscape

If you damage plants not to be removed:

1. Dispose of them unless the Engineer authorizes you to reduce them to chips and spread the chips within the highway at locations designated by the Engineer
2. Replace them

Replace plants with plants of the same species.

Replace trees with 24-inch-box trees.

Replace shrubs with no. 15-container shrubs.

Replace ground cover plants with plants from flats. Replace *Carpobrotus* ground cover plants with plants from cuttings. Plant ground cover plants 1 foot on center.

If a plant establishment or permanent erosion control establishment period is specified, replace plants before the start of the plant establishment or permanent erosion control establishment period; otherwise, replace plants at least 30 days before Contract acceptance.

Water each plant immediately after planting. Saturate the backfill soil around and below the roots or the ball of earth around the roots of each plant. Water as necessary to maintain plants in a healthy condition until Contract acceptance.

5-1.36F Irrigation Facilities

Keep existing irrigation facilities in place that are described to be removed, relocated, or modified until the Engineer determines they are no longer needed.

Maintain the existing water supply. If the existing water supply is interrupted for more than 3 consecutive days, provide an alternative water supply. Water the existing plants in the area irrigated from that water supply, including those maintained by the Department, as necessary to maintain healthy plant growth.

If you and the Department irrigate existing plants from the same water supply, furnish enough water to the Department for watering plantings on and off the highway as necessary to maintain a healthy condition through Contract acceptance.

If you damage irrigation facilities not to be removed:

1. Remove and dispose of them.
2. Repair and replace damaged facilities within 10 days.
3. Use similar commercial-quality components from the same manufacturer or components that are compatible with the existing irrigation system if authorized.
4. After completing the repair or replacement of the facilities, perform an operational test in the presence of the Engineer. If you repair or replace the remote control valves, conduct the test with the irrigation controller in the automatic mode.

Notify the Engineer:

1. At least 4 business days before shutting off the water supply to any portion of the existing irrigation system
2. Immediately after restoring the water supply to any portion of the existing irrigation system

5-1.37 MAINTENANCE AND PROTECTION

5-1.37A General

Maintain and protect work until the Department has granted relief from maintenance or accepted the Contract.

Do not remove any padlock used to secure a portion of the work until the Engineer is present to replace it. Notify the Engineer at least 3 business days before removing the lock.

Prevent construction equipment that exceeds the maximum weight limits in Veh Code Div 15 from operating on completed or existing treated base, pavement, or structures.

5-1.37B Load Limits

5-1.37B(1) General

For areas within the project limits and subject to the Contractor providing protective measures and repairing related damage, construction equipment exceeding the size or weight limits in Veh Code Div 15 may move over:

1. Public roads within the highway
2. Treated base or pavement under construction or completed
3. Culverts and pipes
4. Structures not open to traffic that are designed for AASHTO HS20-44 live loading, except culverts and pipes. Before crossing one of these structures, submit the dimensions and maximum axle loadings of the equipment; and unless a material hauling equipment lane on a bridge is shown on the drawings, comply with the following specifications:

4.1. The maximum loading on a bridge due to pneumatic-tired truck and trailer combinations must not exceed:
  4.1.1. 28,000 lb for single axles
  4.1.2. 48,000 lb for tandem axles
  4.1.3. 60,000 lb total gross load for single vehicles
  4.1.4. 110,000 lb total gross load for truck and trailer or semi-trailer combinations

4.2. The loading on a bridge due to 2- and 3-axle pneumatic-tired earthmovers must not exceed that shown in the following table:

Allowable Construction Loading on Bridges for 2- and 3-Axle Earthmovers

Bridge girder center-to-center spacing (feet)	Maximum axle loading (pounds)
4	28,000
5	29,000
6	30,000
7	32,000
8	34,000
9	37,000
10 and over	40,000

NOTE: Minimum axle spacing:
For 2-axle earthmovers:
Axles 1 to 2 = 20 feet

For 3-axle earthmovers:
Axles 1 to 2 = 8 feet
Axles 2 to 3 = 20 feet

5. Completed or existing base, pavement, and structures under the Department's *Transportation Permits Manual*, whether open to the public or not

Loads imposed on existing, new, or partially completed structures must not exceed the load-carrying capacity of the structure or any portion of the structure as determined by AASHTO LRFD with interims and California Amendments, Design Strength Limit State II. The f'_c to be used in computing the load-carrying capacity must be the smaller of the following:

1. Actual compressive strength at the time of loading
2. Value of f'_c shown on the plans for that portion of the structure or 2.5 times the value of f_c shown on the plans for portions of the structure where no f'_c is shown

5-1.37B(2) Increased Load Carrying Capacity

You may submit a request to the Department to redesign a structure to increase its load-carrying capacity.

The Department does not authorize a redesign for any of the following:

1. Load increase of more than 130,000 lb per single axle or pair of axles less than 8 feet apart
2. Total gross vehicle weight more than 330,000 lb

Your request to the Department must include:

1. Description of the structure or structures
2. Detailed overload description
3. Date the revised plans are required
4. Signed statement agreeing to pay the costs, including the engineering costs
5. Signed statement agreeing to waive a time extension request for any delay

If the Department authorizes a redesign to strengthen the structure, the Engineer notifies you of the change's estimated cost and availability date of the revised plans. If the cost and date are satisfactory to you, the Engineer prepares a Change Order for the changes.

5-1.37B(3) Material Hauling Equipment Lane on Bridges

Section 5-1.37B(3) applies to a bridge constructed with a material hauling equipment lane.

You may cross the bridge with pneumatic-tired material hauling equipment that exceeds the size and weight limits specified but that does not exceed the load limits shown on the material-hauling-equipment loading diagram on the plans.

For each bridge with a material hauling equipment lane:

1. Construct a minimum 150-foot approach at each bridge end to a grade that provides a smooth transition to the bridge roadway grade. Maintain these approaches in a smooth and uniform condition during the operation of the equipment.
2. Operate equipment such that jolting and bouncing of the equipment while crossing the bridge is prevented.
3. Confine equipment to the material hauling lane using temporary barriers unless the plans show that the entire bridge may be used for hauling equipment and the permanent barriers are completed.
4. Allow at most 1 piece of equipment on the bridge at one time.

If ordered, verify the weight of loaded material hauling equipment by weighing. The Department furnishes individual wheel or axle type scales. The Department weighs the equipment within the project limits and within the highway at a location accessible to the equipment. You determine the exact weighing location. Install and maintain the scales. Installing and maintaining scales is change order work.

5-1.38 MAINTENANCE AND PROTECTION RELIEF

You may request relief from maintenance and protection responsibilities for a completed work part. The work part must have been completed under the Contract and to the Engineer's satisfaction. Work parts eligible for relief include:

1. Completed 0.3 mi section of roadway or a 0.3 mi section of one roadway of a divided highway or frontage road including:
   1.1. Planned roadway protection work
   1.2. Lighting
   1.3. Required traffic control
   1.4. Access facilities
2. Bridge or other major structure
3. Complete unit of a traffic control signal system or a highway lighting system
4. Nonhighway facility constructed for another agency

If relieved by the Department, you are not required to perform further work on that part of work. You are not responsible for damage to a relieved work part, including damage caused by traffic or the elements, except for that caused by your own activities or negligence.

5-1.39 DAMAGE REPAIR AND RESTORATION

5-1.39A General

Before Contract acceptance, restore damaged work to the same state of completion as before the damage. Restoration of damaged work includes restoration of erected falsework and formwork.

The Department does not adjust payment for repair or restoration that the Engineer determines was caused by your failure to construct the work under the Contract or protect the work.

5-1.39B Damage Caused by an Act of God

Under Pub Cont Code § 7105, the Department pays for repair or restoration to damaged work in excess of 5 percent of the total bid if the damage was caused by an act of God.

Submit a request for repair or restoration work payment before performing work other than emergency work.

The Engineer determines the repair or restoration work cost under section 9-1.04 except markups are not allowed.

The Department may change the Contract for the areas requiring repair or restoration. If the cost for the changes exceeds the repair or restoration cost based on the Bid Item List, the Engineer determines the payment adjustment under section 9-1.04.

5-1.39C Landscape Damage

5-1.39C(1) General

Repair slopes or other existing facilities that were damaged after starting job site activities and before starting plant establishment or permanent erosion control establishment.

As ordered, replace plants that have been damaged from either or both of the following conditions:

1. Ambient air temperature falling below 32 degrees F during the plant establishment period
2. Department or its supplier restricting or stopping water delivery during the plant establishment period

This plant replacement work is change order work.

5-1.39C(2) Plant Establishment Period of 3 Years or More

Section 5-1.39C(2) applies if a plant establishment period of 3 years or more is shown on the *Notice to Bidders*.

Repair slopes or other existing facilities that were damaged before starting job site activities. This work is change order work.

Repair slopes or other existing facilities that were damaged by a change in the runoff pattern from that which existed on the date of the *Notice to Bidders* and was the result of work by others within the highway. This work is change order work.

Replace plants and repair slopes, irrigation systems, and other highway facilities damaged as a result of rain during the plant establishment period. The Department pays 1/2 the accumulated costs in excess of the greater of 5 percent of the plant establishment work or $2,000; the Contractor pays the other 1/2. The Engineer determines the repair cost under section 9-1.04.

5-1.40–5-1.41 RESERVED

5-1.42 REQUESTS FOR INFORMATION

Submit an RFI upon recognition of any event or question of fact arising under the Contract.

The Engineer responds to the RFI within 5 business days. Proceed with the work unless otherwise ordered. You may protest the Engineer's response by:

1. Submitting an Initial Potential Claim Record form within 5 business days after receiving the Engineer's response
2. Complying with section 5-1.43

5-1.43 POTENTIAL CLAIMS AND DISPUTE RESOLUTION

5-1.43A General

Minimize and mitigate the impacts of work or events for which you will make a potential claim.

For each potential claim, assign an identification number determined by chronological sequencing and the 1st date of the potential claim.

Use the identification number for each potential claim on the:

1. Initial Potential Claim Record form
2. Supplemental Potential Claim Record form
3. Full and Final Potential Claim Record form

Failure to comply with this procedure is:

1. Waiver of the potential claim and a waiver of the right to a corresponding claim for the disputed work in the administrative claim procedure
2. Bar to arbitration (Pub Cont Code § 10240.2)

5-1.43B Initial Potential Claim Record

Submit an Initial Potential Claim Record form within 5 business days of the Engineer's response to the RFI or within 5 business days from the date when a dispute arises due to an act or failure to act by the Engineer. The Initial Potential Claim Record form establishes the claim's nature and circumstances. The nature and circumstances must remain consistent.

The Engineer responds within 5 business days of receiving the form. Proceed with the work for which you will make a potential claim unless otherwise ordered.

Within 20 days of a request, provide access to the project records determined necessary by the Engineer to evaluate the potential claim.

5-1.43C Supplemental Potential Claim Record

Within 15 days of submitting the Initial Potential Claim Record form, submit a Supplemental Potential Claim Record form including:

1. Complete nature and circumstances causing the potential claim
2. Contract specifications supporting the basis of a claim
3. Estimated claim cost and an itemized breakdown of the individual costs stating how the estimate was determined
4. TIA

The Engineer evaluates the Supplemental Potential Claim Record form and responds within 20 days of receiving the submittal. To pursue a potential claim, comply with sections 5-1.43D and 5-1.43E.

If the estimated cost or effect on the scheduled completion date changes, update the Supplemental Potential Claim Record form information as soon as the change is recognized and submit this information.

5-1.43D Full and Final Potential Claim Record

Notify the Engineer within 10 days of the completion date of the potentially claimed work. The Engineer authorizes this completion date or notifies you of a revised date.

Within 30 days of the completion of the potentially claimed work, submit a Full and Final Potential Claim Record form including:

1. Detailed factual account of the events causing the potential claim, including:
    1.1. Pertinent dates
    1.2. Locations
    1.3. Work items affected by the potential claim
2. Contract documents supporting the potential claim and a statement of the reasons these parts support entitlement
3. Itemized cost breakdown if a payment adjustment is requested. Segregate costs into the following categories:
    3.1. Labor, including:
        3.1.1. Individuals
        3.1.2. Classifications
        3.1.3. Regular and overtime hours worked
        3.1.4. Dates worked
    3.2. Materials, including:
        3.2.1. Invoices
        3.2.2. Purchase orders
        3.2.3. Location of materials either stored or incorporated into the work
        3.2.4. Dates materials were transported to the job site or incorporated into the work
    3.3. Equipment, including:
        3.3.1. Detailed descriptions, including make, model, and serial number
        3.3.2. Hours of use
        3.3.3. Dates of use
        3.3.4. Equipment rates at the rental rate listed in Labor Surcharge and Equipment Rental Rates in effect when the affected work related to the claim was performed
4. Detailed account of the time impact if a time adjustment is requested:

4.1. Dates for the requested time.
4.2. Reasons for a time adjustment.
4.3. Contract documentation supporting the requested time adjustment.
4.4. TIA. The TIA must demonstrate entitlement to a time adjustment.
5. Identification and copies of your documents and copies of communications supporting the potential claim, including certified payrolls, bills, canceled checks, job cost reports, payment records, and rental agreements
6. Relevant information, references, and arguments that support the potential claim

The Department does not consider a Full and Final Potential Claim Record form that does not have the same nature, circumstances, and basis of claim as those specified on the Initial Potential Claim Record form and Supplemental Potential Claim Record form.

The Engineer evaluates the information presented in the Full and Final Potential Claim Record form and responds within 30 days of its receipt unless the Full and Final Potential Claim Record form is submitted after Contract acceptance, in which case, a response may not be provided. The Engineer's receipt of the Full and Final Potential Claim Record form must be evidenced by postal return receipt or the Engineer's written receipt if delivered by hand.

5-1.43E Alternative Dispute Resolution

5-1.43E(1) General

5-1.43E(1)(a) General

Section 5-1.43E applies to a contract with 100 or more original working days.

The ADR process must be used for the timely resolution of disputes that arise out of the work.

You must comply with section 5-1.43E to pursue a claim, file for arbitration, or file for litigation.

The ADR process is not a substitute for submitting an RFI or a potential claim record.

Do not use the ADR process for disputes between you and subcontractors or suppliers that have no grounds for a legal action against the Department. If you fail to comply with section 5-1.43 for a potential claim on behalf of a subcontractor or supplier, you release the Department of the subcontractor's or supplier's potential claim.

Do not use the ADR process for quantification of disputes for overhead expenses or costs. For a dispute for overhead expenses or costs, comply with section 9-1.17D.

Each party and the DRA or DRB must complete the Dispute Resolution Advisor Agreement form or Dispute Resolution Board Agreement form and comply with the provisions of the agreement. For these forms, go to the Department's Division of Construction website.

No DRA- or DRB-related meetings are allowed until each party and the DRA or DRB, execute the agreement. However, each party and the DRA or DRB, may agree to sign and execute the agreement at the 1st meeting.

5-1.43E(1)(b) Definitions

dispute meeting: Traditional and informal dispute meeting.

DRA: 1-member board established by the parties to assist in resolving disputes.

DRB: 3-member board established by the parties to assist in resolving disputes.

party: You or the Department.

1. **the parties:** You and the Department jointly.
2. **each party:** You and the Department severally.

outside technical services: Consultants with no prior direct involvement in the Contract.

5-1.43E(1)(c) Establishment of Procedures

Upon selecting the DRA or DRB, the parties must meet with the DRA or DRB to establish and agree to procedures for:

1. Submitting documents
2. Conducting hearings
3. Providing recommendations
4. Associated tasks

The established procedures must comply with the Contract and the Dispute Resolution Advisor Agreement or Dispute Resolution Board Agreement. The procedures need not comply with laws of evidence.

5-1.43E(1)(d) Progress Meetings

The parties must periodically meet with the DRA or DRB at the job site so the DRA or DRB members can keep abreast of construction activities and become familiar with the work in progress.

The meetings must be held at the start of job site activities and at least once every 3 months after that.

The parties must attend each meeting.

The parties may agree to waive the scheduled meetings when the only work remaining is plant establishment work or permanent erosion control establishment work.

5-1.43E(1)(e) Dispute Meetings

You must follow the traditional dispute meeting process to pursue a potential claim.

Either party may refer a dispute to the DRA or DRB. To request a dispute meeting, a party must submit a copy of the referral and supporting documentation to the DRA or DRB. The documentation must describe the dispute in individual discrete segments such that resolved and unresolved segments are differentiated. The party must include an estimate of the cost of the affected work and impacts to the work completion date.

A copy of all documents submitted to the DRA or DRB must be simultaneously submitted to the other party.

The Department furnishes the DRA or DRB with the Contract documents and provides meeting facilities at no cost to you.

Neither party may meet with or discuss Contract issues with the DRA or DRB members unless the other party is present.

If the dispute involves a subcontractor, the subcontractor's superintendent or project manager must attend the meeting.

Only the following persons are allowed to participate and present information at the meeting:

1. Engineer
2. Department's area construction engineer
3. Department's structure representative.
4. Your superintendent
5. Your project manager
6. Either party's employees that have direct knowledge of the dispute and direct involvement in the project
7. Consultants directly involved in the development of the estimate or construction
8. Subcontractor's superintendent or project manager if the dispute involves a subcontractor

The following persons are not allowed to attend the meeting:

1. Attorneys
2. Claim consultants
3. Outside technical services not employed by either party unless requested by the DRA or DRB

If the DRA or DRB needs outside technical services to help the DRA or DRB make a recommendation, the parties must agree to the services before they are provided. If the parties and the DRA or DRB agree, the technical services may be provided by technical staff who works for either party.

During a dispute meeting, each party presents its position, makes rebuttals, furnishes relevant documents, and responds to DRA or DRB questions and requests. The following is not allowed:

1. Testimony under oath
2. Cross-examination
3. Reporting of the procedures by a shorthand reporter or by electronic means

If either party fails to attend a dispute meeting, all documents submitted by the nonattending party is considered as the nonattending party's entire position, and the DRA or DRB and the attending party may proceed with the dispute process.

5-1.43E(1)(f) Informal Dispute Meetings

The parties may resolve small and uncomplicated disputes using an informal process. The parties may use this process only if the parties and the DRA or DRB agree its use is appropriate for resolving the dispute.

The informal dispute meeting process is independent from the traditional process. The Department does not grant time extensions for the traditional dispute process if the informal dispute process is used.

Each party furnishes the DRA or DRB a 1-page brief description of the dispute with supporting documentation and any additional information requested by the DRA or DRB.

In an informal dispute meeting, each party presents its position and receives the DRA's or DRB's recommendation orally on the same day the dispute is heard. The DRA or DRB furnishes a 1-page report confirming the recommendation within 5 business days.

Either party may ask for clarification of the DRA's or DRB's recommendation at the dispute meeting.

If the dispute remains unresolved, the parties must notify the DRA or DRB within 5 business days after receipt of the DRA's or DRB's written confirmation of the recommendation.

The DRA or DRB will not be bound by its informal recommendation if a dispute is later heard in a traditional dispute meeting.

If the dispute is not resolved using the informal dispute meeting process, the parties must comply with the traditional dispute meeting specifications.

5-1.43E(1)(g) Recommendations

Recommendations resulting from the ADR process are nonbinding.

If the parties resolve the dispute with the aid of the DRA's or DRB's recommendation, the parties must implement the resolution.

5-1.43E(1)(h) Completion of Alternative Dispute Resolution

All ADR activities must be completed before Contract acceptance. Accelerated timeframes may be used if the parties and the DRA or DRB agree.

If a dispute becomes an unresolved claim after Contract acceptance, comply with section 9-1.17D(2).

Neither party may call the DRA or DRB members who served on the Contract as a witness in arbitration or other proceedings that may arise from the Contract.

The parties must indemnify and hold harmless the DRA or DRB members from and against all claims, damages, losses, and expenses, including attorney's fees, arising out of and resulting from the findings and recommendations of the DRA or DRB.

5-1.43E(1)(i) Payment

Pay the DRA or each DRB member $2,000 per day for the DRA's or DRB's participation at each on-site meeting except if the DRA or a DRB member serves on more than 1 Department DRA or DRB, the $2,000 must be divided evenly among the contracts.

On-site meetings include:

1. Initial project meeting
2. Progress meetings
3. Dispute meetings

The payment includes full compensation for on-site time, travel expenses, transportation, lodging, travel time, and incidentals for each day or portion thereof the DRA or DRB member is at a DRA or DRB meeting.

Before a DRA or DRB member spends any time reviewing the plans or specifications, evaluating positions, preparing recommendations, completing forms, or performs any other off-site DRA- or DRB-related tasks, the parties must agree to pay for the tasks. Pay the DRA or DRB member $200 per hour for these tasks. This payment includes full compensation for incidentals such as expenses for telephone, fax, and computer services.

The Department reimburses you for 1/2 of the invoiced costs to the DRA or DRB and 1/2 of the costs of any outside technical services. Submit a change order bill and associated invoices with the original supporting documents in the form of a canceled check or bank statement to receive reimbursement. Do not add mark-ups to the change order bill.

The Department does not pay for (1) any DRA- or DRB-related work performed after Contract acceptance or (2) your cost of preparing for or attending ADR resolution meetings.

5-1.43E(2) Dispute Resolution Advisor

5-1.43E(2)(a) General

Section 5-1.43E(2) applies to a contract with a total bid from $3 million to $10 million.

5-1.43E(2)(b) DRA Selection

Within 30 days after Contract approval, the parties must select the DRA using the following procedure:

1. Each party nominates 3 DRA member candidates. Each candidate must be (1) on the Department's Dispute Resolution Advisor Candidates List at the Department's Division of Construction website or (2) must:
   1.1. Be knowledgeable in the type of construction and contract documents anticipated by the Contract
   1.2. Have completed training by the Dispute Resolution Board Foundation
   1.3. Have served on at least 3 dispute resolution boards on a Department contract as a member or at least 2 dispute resolution boards on a Department contract as the chairman
   1.4. Have no prior direct involvement on the Contract
   1.5. Have no financial interest in the Contract or with the parties, subcontractors, suppliers, consultants, or associated legal or business services within 6 months before award and during the Contract except for payments for Department DRA or DRB services or payments for retirement or pensions from either party not tied to, dependent on, or affected by the net worth of the party
2. The parties must request a disclosure statement from each nominated DRA candidate and must furnish them to the other party. Each statement must include:
   2.1. Resume of the candidate's experience
   2.2. Declaration statement that describes past, present, anticipated, and planned professional or personal relationships with each of the following:
      2.2.1. Each party involved in the Contract
      2.2.2. Each parties' principals
      2.2.3. Each parties' counsel
      2.2.4. Associated subcontractors and suppliers

3. The parties must select 1 of the 6 candidates to be the DRA. If the parties cannot agree on 1 candidate, each party must select 1 of the 3 nominated by the other and the DRA is decided between the 2 candidates by a coin toss.

5-1.43E(2)(c) DRA Replacement

The services of the DRA may end at any time with a notice of at least 15 days if either of the following occurs:

1. DRA resigns.
2. Either party replaces the DRA for failing to comply with the required employment or financial disclosure conditions of the DRA as described in the Contract and the Dispute Resolution Advisor Agreement.

A DRA replacement is selected the same way as the original DRA. The selection of a replacement DRA must start upon determination of the need for a replacement and must be completed within 15 days. The Dispute Resolution Advisor Agreement must be amended to reflect the change of the DRA.

5-1.43E(2)(d) DRA Traditional Dispute Meeting

If you choose to pursue a potential claim, refer the dispute to the DRA within 5 business days after receiving the Engineer's response to your Supplemental Potential Claim Record. The dispute meeting must be held no later than 25 days after the DRA receives the referral unless the parties otherwise agree.

At least 10 days before the scheduled dispute meeting, each party must furnish the DRA documentation that supports its position and any additional information requested by the DRA.

If the DRA requests additional information within 5 business days after the dispute meeting, the party receiving the request must furnish this information within 5 business days after receiving the request.

The DRA furnishes a written recommendation within 10 days after the dispute meeting unless the parties agree to allow more time.

Within 5 business days after receiving the DRA's recommendation, either party may request clarification of any part of the recommendation. Only 1 request for clarification from each party is allowed per dispute.

Within 10 days after receiving the DRA's recommendation, each party must furnish a written response to the DRA indicating acceptance or rejection of the recommendation. If a party rejects the recommendation and has new information that supports its position, the party may request reconsideration. The reconsideration request must be made within 10 days after receiving the DRA’s recommendation. Only 1 reconsideration request from each party is allowed per dispute.

If the parties accept the DRA's recommendation but cannot agree on the time or payment adjustment within 30 days after accepting the recommendation, either party may request that the DRA recommend an adjustment.

5-1.43E(3) Dispute Resolution Board

5-1.43E(3)(a) General

Section 5-1.43E(3) applies to a contract with a total bid of over $10 million.

5-1.43E(3)(b) DRB Member Selection

Within 45 days after Contract approval, the parties must select DRB members and establish the DRB using the following procedure:

1. Each party nominates a DRB member candidate. Each candidate must be (1) on the Department’s Dispute Resolution Candidates List at the Department's Division of Construction website or (2) must:
   1.1. Be knowledgeable in the type of construction and contract documents anticipated by the Contract
   1.2. Have completed training by the Dispute Resolution Board Foundation
   1.3. Have no prior direct involvement on the Contract
   1.4. Have no financial interest in the Contract or with the parties, subcontractors, suppliers, consultants, or associated legal or business services within 6 months before award and during the Contract except for payments for Department DRA or DRB services or payments for

retirement or pensions from either party not tied to, dependent on, or affected by the net worth of the party

2. The parties must request a disclosure statement from each nominated DRB member candidate and must each furnish it to the other party. Each statement must include:
   2.1. Resume of the candidate's experience
   2.2. Declaration statement that describes past, present, anticipated, and planned professional or personal relationships with each of the following:
      2.2.1. Each party involved in the Contract
      2.2.2. Each parties' principals
      2.2.3. Each parties' counsel
      2.2.4. Associated subcontractors and suppliers
3. The parties are allowed:
   3.1. One-time objection to the other's candidate without stating a reason
   3.2. Objection to any of the other's subsequent candidates based on a specific breach of the candidate's responsibilities or qualifications under items 1 and 2 above
4. If either party objects to the other's candidate, the party whose candidate was objected to must nominate another DRB candidate within 15 days.
5. The 1st candidate from a party that receives no objection becomes that party's DRB member.
6. Each party furnishes written notification to the selected DRB member.
7. Within 15 days after their notifications, the selected DRB members recommend to the parties the 3rd DRB member candidate and furnish that candidate's disclosure statement.
8. Within 15 days after the recommendation, each party must notify the first 2 DRB members whether the party approves or disapproves of the recommended 3rd DRB member candidate.
9. If the 2 DRB members cannot agree on the 3rd DRB candidate, they will submit a list of candidates to the parties for the final selection and approval.
10. If (1) the 2 DRB members do not recommend a 3rd DRB candidate within 15 days of notification of their selections, (2) the parties do not agree on the 3rd DRB member candidate within 15 days after the recommendation, or (3) the parties do not agree on any of the candidates on the list furnished by the first 2 selected DRB members, each party must select 3 candidates from the current list of arbitrators certified by the Public Works Contract Arbitration Committee established by Pub Cont Code § 10245 et seq. who will be willing to serve as a DRB member. The first 2 selected DRB members must select the 3rd member in a blind draw of these 6 candidates.
11. The 3 DRB members then decide which of the 3 will act as the DRB chairman. If the parties do not agree with the selected chairman, the 3rd member will act as the DRB chairman.

5-1.43E(3)(c) DRB Member Replacement

The services of a DRB member may end at any time with a notice of at least 15 days if any of the following occurs:

1. A member resigns
2. The Department replaces its selected member
3. You replace your selected member
4. The Department's and your selected members replace the 3rd member
5. Either party replaces any member for failing to comply with the required employment or financial disclosure conditions of the DRB membership as described in the Contract and in the Dispute Resolution Board Agreement.

Replacing any DRB member must be accomplished by written notification to the DRB and the other party with substantiation for replacing the member.

A replacement DRB member is selected the same way as the original DRB member. The selection of a replacement DRB member must start upon determination of the need for a replacement and must be completed within 15 days. The Dispute Resolution Board Agreement must be amended to reflect the change to the DRB.

5-1.43E(3)(d) DRB Traditional Dispute Meeting

If you choose to pursue a potential claim, refer the dispute to the DRB within 21 days after receiving the Engineer's response to your Supplemental Potential Claim Record unless a facilitated dispute resolution is included in the signed original partnering charter, in which case, make the referral within 41 days after

receiving the response. The dispute meeting must be held no sooner than 30 days and no later than 60 days after the DRB receives the referral unless the parties otherwise agree.

At least 15 days before the scheduled dispute meeting, each party must provide the DRB documentation that supports its position and any additional information requested by the DRB.

If the DRB requests additional information at the dispute meeting, the party receiving the request must provide this information within 10 days after receiving the request.

The DRB furnish a written recommendation report within 30 days after the dispute meeting unless the parties agree to allow more time.

Within 10 days after receiving the DRB's recommendation report, either party may request clarification of any part of the recommendation. Only 1 request for clarification from each party is allowed per dispute.

Within 30 days after receiving the DRB's recommendation, each party must furnish a written response to the DRB indicating acceptance or rejection of the recommendation. If a party rejects the recommendation, the party must include a list of specific reasons for the rejection. If a party has new information that supports its position, the party may request a reconsideration. The reconsideration request must be made within 30 days after receiving the DRB's recommendation. Only 1 request for reconsideration from each party is allowed per dispute.

If the parties accept the DRB's recommendation but cannot agree on the time or payment adjustment within 60 days after accepting the recommendation, either party may request that the DRB recommend an adjustment.

5-1.43F Reserved

5-1.44–5-1.45 RESERVED

5-1.46 FINAL INSPECTION AND CONTRACT ACCEPTANCE

When you complete the work, request the Engineer's final inspection.

If the Engineer determines that the work is complete, the Engineer recommends Contract acceptance. Immediately after Contract acceptance, you are relieved from:

1. Maintenance and protection duties
2. Responsibility for injury to persons or property or damage to the work occurring after Contract acceptance except as specified in section 5-1.47

5-1.47 GUARANTEE

Guarantee that work remains free from substantial defects for 1 year after Contract acceptance except for work parts for which you were relieved of maintenance and protection. Guarantee each of these relieved work parts for 1 year after the relief date.

The guarantee excludes damage or displacement caused by an event outside your control, including:

1. Normal wear and tear
2. Improper operation
3. Insufficient maintenance
4. Abuse
5. Unauthorized change
6. Act of God

During the guarantee period, repair or replace each work part having a substantial defect.

The Department does not pay for corrective work.

During corrective work activities, provide the same insurance specified before Contract acceptance.

The Contract bonds must be in force until the later of (1) the expiration of the guarantee period or (2) the completion of the corrective work.

If a warranty specification conflicts with section 5-1.47, comply with the warranty specification.

During the guarantee period, the Engineer monitors the completed work. If the Engineer finds work having a substantial defect, the Engineer lists the defective work parts and furnishes you the list.

Within 10 days of receipt of the list, submit for authorization a detailed plan for correcting the work. Include a schedule that includes:

1. Start and completion dates
2. List of labor, equipment, materials, and any special services you plan to use
3. Work related to the corrective work, including traffic control and temporary and permanent pavement markings

The Engineer notifies you when the plan is authorized. Start the corrective work and related work within 15 days of notice.

If the Engineer determines corrective work is urgently required to prevent injury or property damage:

1. The Engineer furnishes you an order to start emergency repair work and a list of parts requiring corrective work
2. Mobilize within 24 hours and start work
3. Submit a corrective work plan within 5 business days of starting the emergency repair work

If you fail to perform the work as specified, the Department may perform the work and bill you.

5-1.48–5-1.50 RESERVED

6 CONTROL OF MATERIALS

6-1 GENERAL

6-1.01 GENERAL

Section 6 includes specifications related to the control of materials.

Store materials and samples in a way that preserves the quality and facilitates prompt inspection.

Material incorporated into the work must be new.

Before the preconstruction conference, submit material source information on a Notice of Materials to be Used form.

6-1.02 DEPARTMENT-FURNISHED MATERIALS

Request Department-furnished materials except sign panels at least 15 days before their scheduled installation. Request sign panels at least 30 days before their scheduled installation.

If the Department furnishes the material:

1. At the job site, unload and store the material
2. At a location other than the job site, deliver the material to the job site and store it

The Engineer orders the return and disposal of surplus Department-furnished material. This returning and disposing of material is change order work.

You are responsible for the cost of replacing lost or damaged Department-furnished material. The Department deducts replacement costs. Department-furnished material not used in the work remains the property of the Department.

6-1.03 LOCAL MATERIALS

Local material must be rock, sand, gravel, earth, or mineral material other than local borrow or selected material obtained or produced from a source in the work vicinity specifically for use on the project. Local borrow must not be a material from an established commercial source.

Upon your request, the Department tests material from an untested local source. If satisfactory material from that source is used in the work, the Department does not charge you for the tests; otherwise, the Department deducts the test costs.

6-1.04 BUY AMERICA

6-1.04A General

Reserved

6-1.04B Crumb Rubber (Pub Res Code § 42703(d))

Furnish crumb rubber with a certificate of compliance. Crumb rubber must be:

1. Produced in the United States
2. Derived from waste tires taken from vehicles owned and operated in the United States

6-1.04C Steel and Iron Materials

Steel and iron materials must be melted and manufactured in the United States except:

1. Foreign pig iron and processed, pelletized, and reduced iron ore may be used in the domestic production of the steel and iron materials
2. If the total combined cost of the materials does not exceed the greater of 0.1 percent of the total bid or $2,500, materials produced outside the United States may be used if authorized

Furnish steel and iron materials to be incorporated into the work with certificates of compliance and certified mill test reports. Mill test reports must indicate where the steel and iron were melted and manufactured.

All melting and manufacturing processes for these materials, including an application of a coating, must occur in the United States. Coating includes all processes that protect or enhance the value of the material to which the coating is applied.

6-1.05 SPECIFIC BRAND OR TRADE NAME AND SUBSTITUTION

A reference to a specific brand or trade name establishes a quality standard and is not intended to limit competition. You may use a product that is equal to or better than the specified brand or trade name if authorized.

Submit a substitution request with a time period that:

1. Follows Contract award
2. Allows 30 days for review
3. Causes no delay

Include substantiating data with the substitution request that proves that substitution:

1. Causes no delay
2. Is of equal or better quality and suitability

6-2 QUALITY ASSURANCE

6-2.01 GENERAL

6-2.01A General

Section 6-2 includes provisions related to quality.

Quality assurance includes all activities used to (1) provide an overall level of quality for the project and (2) determine compliance with the Contract documents.

Quality control includes sampling, testing, and inspections performed under your QC program to (1) control material quality and (2) ensure the specified quality characteristics for the project are met.

Department acceptance includes sampling, testing, and inspections performed by the Department to verify compliance with the Contract.

The Department's independent assurance program is described in the Department's *Independent Assurance Manual: Procedures for Accreditation of Laboratories and Qualification of Testers*. For the manual, go to the METS website.

For a material specified to comply with a State Specification number, the material may comply with a later version of the specification. Obtain State Specifications from METS.

For a material specified to comply with a requirement for a quality characteristic shown in the following table, the quality characteristic is tested under the corresponding California Test:

California Tests

Quality characteristic	California Test
Relative compaction	216 or 231
Sand equivalent	217
Resistance (R-value)	301
Gradation (sieve analysis)	202
Durability index	229

6-2.01B Authorized Facility Audit Lists

Section 6-2.01B applies where a facility is specified to be on an Authorized Facility Audit List.

An audit authorized by the Department not more than 3 years before completion of the fabrication process is acceptable if the Department determines the audit was for the same type of work to be performed.

For procedures to be included on an Authorized Facility Audit List, go to the Authorized Facility Audit List website.

6-2.01C Authorized Material Lists

Section 6-2.01C applies where a material is specified to be on an Authorized Material List.

The material must be on an Authorized Material List before it is incorporated into the work.

For procedures to be included on an Authorized Material List, go to the Authorized Material List website.

6-2.01D Authorized Material Source Lists

Section 6-2.01D applies where a material is specified to be on an Authorized Material Source List.

The material source must be on an Authorized Material Source List before the item from the source is incorporated into the work.

For procedures to be included on an Authorized Material Source List, go to the Authorized Material Source List website.

6-2.01E Material Source Inspection and Testing

Section 6-2.01E applies if a material is to be inspected or tested at the source.

Submit an inspection request form:

1. At least 3 business days before the requested inspection date for a material source within California.
2. At least 5 business days before the requested inspection date for a material source outside California but within the United States.
3. 50 days before the planned production start for a material source outside the United States. Notify the Engineer at least 20 days before the actual start.

For the inspection request form and the procedure for its submittal, go to the METS website. Notify the Engineer of each submittal.

For each item shown in the following table, the Department deducts the corresponding amount shown:

Source Inspection Expense Deductions

Item	Distance[a]	Deduction
Steel pipe piling	> 300	$5,000
Prestressing system Tier 1 and tier 2 precast concrete members Epoxy-coated reinforcement Structural steel for sign structures Miscellaneous metal	> 3,000	$8,000
Extinguishable message signs Variable message signs Changeable message signs Service equipment enclosures Telephone demarcation cabinets Closed circuit television cabinets Weigh-in-motion cabinets Highway advisory radio cabinets	> 300	$2,000
Poles for electrical systems	> 300	$1,000 for ≤ 10 poles and $1,000 for every multiple of 10 poles thereafter
Structural steel	> 300	The greater of: 1. $5,000 2. $0.02/lb
	> 3,000	The greater of: 1. $8,000 2. $0.036/lb
Structural steel paint	> 300	The greater of: 1. $2,000 2. $0.01/sq ft
	> 3,000	The greater of: 1. $5,000 2. $0.015/sq ft
Check samples	> 300	$2,000
High mast poles	> 300	$2,500
	> 3,000	$5,000
PTFE bearings, ≤ 2 lots	> 300	$5,000
	> 3,000	$15,000
PTFE bearings, > 2 lots	> 300	$10,000
	> 3,000	$20,000

[a]Distance is air-line miles from both Sacramento and Los Angeles to the inspection source.

6-2.01F Test Samples

Section 6-2.01F applies where a test sample is specified or if a test sample is requested.

Notify the Engineer 10 days before taking a sample.

Submit material to be tested with a Sample Identification Card. For the card, go to the METS website.

Restore work immediately after sampling.

If requested, obtain the Department's authorization for the material before incorporating the material represented by the test sample into the work.

6-2.01G–6-2.01K Reserved

6-2.02 QUALITY CONTROL

6-2.02A General

Material production and testing equipment must measure accurately and precisely.

6-2.02B Quality Control Program

Develop, implement, and maintain a QC program.

Prepare and maintain QC records, including:

1. Names and qualifications of:
   1.1. Samplers
   1.2. Testers
   1.3. Inspectors
2. Testing laboratories' identification and certifications
3. Testing equipment calibrations and certifications
4. Inspection reports
5. Sampling and testing records organized by date and type of material
6. Test results with comparison of quality characteristic requirements
7. Test results in relation to action and any suspension limits
8. Records of corrective actions and suspensions

Within 24 hours, notify the Engineer of any noncompliance identified by your QC program.

Allow the Department access to all QC records.

Submit QC test data and QC test results within 2 business days of test completion.

6-2.02C Quality Control Manager

Section 6-2.02C applies to work requiring a QC manager.

The QC manager must be responsible directly to you for the quality of the work, including materials and workmanship performed by you and your subcontractors.

Assign the QC manager before the start of the affected work. The QC manager must be the sole individual responsible for:

1. Receiving, reviewing, and approving all correspondence, submittals, and reports before they are submitted to the Department
2. Signing the QC plan
3. Implementing the QC plan
4. Maintaining the QC records

The QC manager must be your employee or must be hired by a subcontractor providing only QC services. The QC manager must not be employed or compensated by a subcontractor or by other persons or entities hired by subcontractors who will provide other services or materials for the project.

Notify the Engineer of the name and contact information of the QC manager.

6-2.02D Quality Control Plans

Submit 7 copies of each authorized QC plan.

Make 1 copy available at each location where work is performed.

6-2.03 DEPARTMENT ACCEPTANCE

6-2.03A General

The Department may use multiple acceptance methods for a material.

Specifications in sections titled "Department Acceptance" do not include all requirements on which the Department makes its acceptance.

The Department may inspect, sample, and test materials for compliance with the Contract at any time.

Allow the Department to record, including photograph and video, to ensure a material is produced to comply with the Contract.

You may examine the records and reports of tests the Department performs.

Schedule work to allow time for the Department's inspection, sampling, and testing.

The Department deducts testing costs for work that does not comply with the Contract.

The Department may retest material previously tested and authorized for use. If the Department notifies you of a retest, furnish resources for retesting.

6-2.03B Job Site Inspection and Testing

Section 6-2.03B applies if a material is to be inspected or tested at the job site.

The material must be authorized for use before it is incorporated into the work.

6-2.03C Certificates of Compliance

Section 6-2.03C applies (1) where a certificate of compliance is specified and (2) if any material is produced outside the United States.

Submit a certificate of compliance:

1. Before the material is incorporated into the work
2. For each lot of the material. Identify the lot on the certificate
3. Signed by the producer of the material and stating that the material complies with the Contract

7 LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

7-1.01 GENERAL

Section 7 includes specifications related to your:

1. Compliance with laws
2. Responsibilities for public safety and convenience
3. Responsibilities for indemnification, insurance, and liability

7-1.02 LAWS

7-1.02A General

Comply with laws, regulations, orders, and decrees applicable to the project. Indemnify and defend the State against any claim or liability arising from the violation of a law, regulation, order, or decree by you or your employees. Immediately report to the Engineer a discrepancy or inconsistency between the Contract and a law, regulation, order, or decree.

If the Department incurs any fines or penalties because of your failure to comply with a law, regulation, order, or decree, the Department deducts the amount of the fine or penalty.

Immediately notify the Engineer if a regulatory agency requests access to the job site or to records. Submit a list of documents provided to the agency and issued enforcement actions.

7-1.02B US Fair Labor Standards Act

Comply with 29 USC § 201 et seq.

7-1.02C Emissions Reduction

Submit to the Department the following certification before performing the work:

> I am aware of the emissions reduction regulations being mandated by the California Air Resources Board. I will comply with such regulations before commencing the performance of the work and maintain compliance throughout the duration of this Contract.

Contract signing constitutes submittal of this certification.

7-1.02D–7-1.02H Reserved

7-1.02I Government Code

7-1.02I(1) General

Reserved

7-1.02I(2) Nondiscrimination

Under 2 CA Code of Regs § 11105:

1. During the performance of this contract, the recipient, contractor, and its subcontractors shall not deny the contract's benefits to any person on the basis of race, religious creed, color, national origin, ancestry, physical disability, mental disability, medical condition, genetic information, marital status, sex, gender, gender identity, gender expression, age, sexual orientation, or military and veteran status, nor shall they discriminate unlawfully against any employee or applicant for employment because of race, religious creed, color, national origin, ancestry, physical disability, mental disability, medical condition, genetic information, marital status, sex, gender, gender identity, gender expression, age, sexual orientation, or military and veteran status. Contractor shall insure that the evaluation and treatment of employees and applicants for employment are free of such discrimination.
2. Contractor shall comply with the provisions of the Fair Employment and Housing Act (Gov. Code, § 12900 et seq.), the regulations promulgated thereunder (Cal. Code Regs., tit. 2, § 11000 et seq.), the provisions of Article 9.5, Chapter 1, Part 1, Division 3, Title 2 of the Government Code (Gov. Code, §§ 11135-11139.5), and the regulations or standards adopted by the awarding state agency to implement such article.
3. Contractor or recipient shall permit access by representatives of the Department of Fair Employment and Housing and the awarding state agency upon reasonable notice at any time during the normal business hours, but in no case less than 24 hours' notice, to such of its books, records, accounts, and

all other sources of information and its facilities as said Department or Agency shall require to ascertain compliance with this clause.

4. Recipient, contractor and its subcontractors shall give written notice of their obligations under this clause to labor organizations with which they have a collective bargaining or other agreement.
5. The contractor shall include the nondiscrimination and compliance provisions of this clause in all subcontracts to perform work under the contract.

Under 2 CA Code of Regs § 11122:

STANDARD CALIFORNIA NONDISCRIMINATION CONSTRUCTION CONTRACT SPECIFICATIONS (GOV. CODE SECTION 12990)

These specifications are applicable to all state contractors and subcontractors having a construction contract or subcontract of $5,000 or more.

1. As used in the specifications:
   a. "Act" means the Fair Employment and Housing Act.
   b. "Administrator" means Administrator, Office of Compliance Programs, California Department of Fair Employment and Housing, or any person to whom the Administrator delegates authority;
2. Whenever the contractor or any subcontractor subcontracts a portion of the work, it shall include in each subcontract of $5,000 or more the nondiscrimination clause in this contract directly or through incorporation by reference. Any subcontract for work involving a construction trade shall also include the Standard California Construction Contract Specifications, either directly or through incorporation by reference.
3. The contractor shall implement the specific nondiscrimination standards provided in paragraphs 6(a) through (e) of these specifications.
4. Neither the provisions of any collective bargaining agreement, nor the failure by a union with whom the contractor has a collective bargaining agreement, to refer members of any group protected by the Act shall excuse the contractor's obligations under these specifications, Government Code section 12990, or the regulations promulgated pursuant thereto.5. In order for the nonworking training hours of apprentices and trainees to be counted, such apprentices and trainees must be employed by the contractor during the training period, and the contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. Department of Labor or the California Department of Industrial Relations.
5. In order for the nonworking training hours of apprentices and trainees to be counted, such apprentices and trainees must be employed by the contractor during the training period, and the contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. Department of Labor or the California Department of Industrial Relations.
6. The contractor shall take specific actions to implement its nondiscrimination program. The evaluation of the contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The contractor must be able to demonstrate fully its efforts under steps a. through e. below:
   a. Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and at all facilities at which the contractor's employees are assigned to work. The contractor shall specifically ensure that all foremen, superintendents, and other on-site supervisory personnel are aware of and carry out the contractor's obligations to maintain such a working environment.
   b. Provide written notification within seven days to the director of the DFEH when the referral process of the union or unions with which the contractor has a collective bargaining agreement has impeded the contractor's efforts to meet its obligations.
   c. Disseminate the contractor's equal employment opportunity policy by providing notice of the policy to unions and training, recruitment and outreach programs and requesting their cooperation in assisting the contractor to meet its obligations; and by posting the company policy on bulletin boards accessible to all employees at each location where construction work is performed.
   d. Ensure all personnel making management and employment decisions regarding hiring, assignment, layoff, termination, conditions of work, training, rates of pay or other employment

decisions, including all supervisory personnel, superintendents, general foremen, on-site foremen, etc., are aware of the contractor's equal employment opportunity policy and obligations, and discharge their responsibilities accordingly.

e. Ensure that seniority practices, job classifications, work assignments, and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the equal employment opportunity policy and the contractor's obligations under these specifications are being carried out.

7. Contractors are encouraged to participate in voluntary associations that assist in fulfilling their equal employment opportunity obligations. The efforts of a contractor association, joint contractor-union, contractor-community, or other similar group of which the contractor is a member and participant, may be asserted as fulfilling any one or more of its obligations under these specifications provided that the contractor actively participates in the group, makes every effort to assure that the group has a positive impact on equal employment opportunity in the industry, ensures that the concrete benefits of the program are reflected in the contractor's workforce participation, and can provide access to documentation that demonstrates the effectiveness of actions taken on behalf of the contractor. The obligation to comply, however, is the contractor's.
8. The contractor is required to provide equal employment opportunity for all persons. Consequently, the contractor may be in violation of the Fair Employment and Housing Act (Government Code section 12990 et seq.) if a particular group is employed in a substantially disparate manner.
9. The contractor shall not use the nondiscrimination standards to discriminate against any person because race, religious creed, color, national origin, ancestry, physical disability, mental disability, medical condition, genetic information, marital status, sex, gender, gender identity, gender expression, age, sexual orientation, or military and veteran status.
10. The contractor shall not enter into any subcontract with any person or firm decertified from state contracts pursuant to Government Code section 12990.
11. The contractor shall carry out such sanctions and penalties for violation of these specifications and the nondiscrimination clause, including suspension, termination and cancellation of existing subcontracts as may be imposed or ordered pursuant to Government Code section 12990 and its implementing regulations by the awarding agency. Any contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and Government Code section 12990.
12. The contractor shall designate a responsible official to monitor all employment related activity to ensure that the company equal employment opportunity policy is being carried out, to submit reports relating to the provisions hereof as may be required by OCP and to keep records. Records shall at least include for each employee the name, address, telephone numbers, construction trade, union affiliation if any, employee identification number when assigned, status, (e.g., mechanic, apprentice trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in any easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.

7-1.02J Reserved

7-1.02K Labor Code

7-1.02K(1) General

Work on the job site must comply with Labor Code §1720 et seq. and 8 CA Code of Regs § 16000 et seq. Work includes roadside production and processing of materials, and hauling and delivery of ready-mixed concrete.

Payroll records include time cards, canceled checks, cash receipts, trust fund forms, books, documents, schedules, forms, reports, receipts or other information which reflect job assignments, work schedules by days and hours, and the disbursement of payment to workers (8 CA Code of Regs § 16000).

7-1.02K(2) Wages

The Department obtains the general prevailing rate of wages applicable to the work to be done. The rate includes:

1. Basic hourly rate
2. Employer payments for health and welfare, pension, vacation, apprenticeship training fees, travel time, and subsistence pay as provided for in Labor Code § 1773.1

3. Similar purposes

The general prevailing wage rates and any applicable changes to these wage rates are available:

1. At the Department's Labor Compliance Office of the district in which the work is located
2. From the Department of Industrial Relations' website

Post the general prevailing wage rates at a prominent place at the job site (Labor Code § 1773.2).

The wage determinations refer to expiration dates. The determinations with a single asterisk after the expiration date, and in effect on the date of advertisement for bids, are good for the life of the Contract. The determinations with double asterisks after the expiration date indicate the wage rate to be paid for work performed after this date has been determined. If work is to extend past this date, pay the new rate and incorporate it into the Contract. Changes in general prevailing wage determinations apply to the Contract when the Director of Industrial Relations has issued them at least 10 days before advertisement. (Labor Code § 1773.6 and 8 CA Code of Regs 16204)

The Department does not recognize any claim for additional payment because of a payment by the Contractor of any wage rate in excess of the prevailing wage rate specified in the Contract.

The Contractor and any subcontractor must forfeit to the Department not more than $200 per day or part of a day for each worker paid less than the prevailing wage rate and pay the worker the difference between the prevailing wage rate and the rate paid (Labor Code § 1775). The Labor Commissioner determines the amount of this penalty and bases the amount on:

1. Whether the failure to pay the correct prevailing wage rate was a good-faith mistake that the Contractor or subcontractor promptly and voluntarily corrected upon notice
2. Prior record of the Contractor or subcontractor in meeting its prevailing wage obligations
3. Contractor or subcontractor's willful failure to pay the correct rate of prevailing wages

If a worker employed by a subcontractor on a public works project is not paid the general prevailing per diem wages by the subcontractor, the Contractor is not liable for the penalties described in section 7-1.02K(2) unless the Contractor had knowledge of the failure to pay the correct general prevailing per diem wages or unless the Contractor fails to comply with the following requirements (Labor Code § 1775):

1. The contract executed between the Contractor and the subcontractor for the performance of work on the public works project must include a copy of the requirements in Labor Code §§ 1771, 1775, 1776, 1777.5, 1813, and 1815.
2. The Contractor must monitor the payment of the specified general prevailing rate of per diem wages by periodic review of the certified payroll records of the subcontractor.
3. Upon becoming aware of the subcontractor's failure to pay the specified prevailing rate of wages to the subcontractor's workers, the Contractor must diligently take corrective action to stop or rectify the failure, including withholding sufficient funds due the subcontractor for work performed on the public works project.
4. Before making final payment to the subcontractor for work performed on the public works project, the Contractor must obtain an affidavit signed under penalty of perjury from the subcontractor that the subcontractor has paid the specified general prevailing rate of per diem wages to its employees on the public works project and any amounts due under Labor Code § 1813.

Under Labor Code § 1775, the Department must notify the contractor on a public works project within 15 days of receipt by the Department of a complaint of the failure of a subcontractor on that public works project to pay workers the general prevailing rate of per diem wages.

7-1.02K(3) Certified Payroll Records (Labor Code § 1776)

Keep accurate payroll records.

Submit a copy of your certified payroll records, weekly, including those of subcontractors. Include:

1. Each employee's:
   1.1. Full name
   1.2. Address

1.3. Social security number
1.4. Work classification
1.5. Straight time and overtime hours worked each day and week
1.6. Actual wages paid for each day to each:
  1.6.1. Journeyman
  1.6.2. Apprentice
  1.6.3. Worker
  1.6.4. Other employee you employ for the work
1.7. Pay rate
1.8. Itemized deductions made
1.9. Check number issued
2. Apprentices and the apprentice-to-journeyman ratio

Each certified payroll record must include a Statement of Compliance form signed under penalty of perjury that declares:

1. Information contained in the payroll record is true, correct, and complete
2. Employer has complied with the requirements of sections 1771, 1811, and 1815 for any work performed by his or her employees on the public works project
3. Wage rates paid are at least those required by the Contract

The Department allows the use of a form with identical wording as the Statement of Compliance form provided by the Department.

Submitted certified payrolls for hauling and delivering ready-mixed concrete must be accompanied by a written time record. The time record must include:

1. Truck driver's full name and address
2. Name and address of the factory or batching plant
3. Time the concrete was loaded at the factory or batching plant
4. Time the truck returned to the factory or batching plant
5. Truck driver's signature certifying under penalty of perjury that the information contained in this written time record is true and correct

You may submit certified payroll records electronically to the mailbox address that corresponds to the district in which the work is located. The districts' electronic mailbox addresses are as shown in the following table:

Electronic Mailboxes

District	Address
1	district1.payrolls@dot.ca.gov
2	district2.payrolls@dot.ca.gov
3	district3.payrolls@dot.ca.gov
4	district4.payrolls@dot.ca.gov
5	district5.payrolls@dot.ca.gov
6	district6.payrolls@dot.ca.gov
7	district7.payrolls@dot.ca.gov
8	district8.payrolls@dot.ca.gov
9	district9.payrolls@dot.ca.gov
10	district10.payrolls@dot.ca.gov
11	district11.payrolls@dot.ca.gov
12	district12.payrolls@dot.ca.gov

Before submitting the payroll records electronically, you must complete and sign the Contractor's Acknowledgement and submit it to the district's electronic mailbox address.

The Department responds with an e-mail containing a Caltrans Internet Certificate to be used for the electronic submission of payroll records. When you accept the certificate and reply to the e-mail, the Department is ready to accept your electronic submissions.

Each electronic submission must:

1. Include certified payroll records in a nonmodifiable PDF file. No spreadsheets, Microsoft Word documents, or password-protected documents are accepted.
2. Include a signed Statement of Compliance form with each weekly record.
3. Be received by the Department by close of business on the 15th day of the month for the prior month's work.
4. Be encrypted before submission.
5. Contain the following information in the subject line:
   5.1. Contract number.
   5.2. Week ending date as W/E mm/dd/yy.
6. Contain 1 contract number and week ending date per submission.

For additional information on electronic submission of certified payroll records, go to the Department's Labor Compliance website.

Make certified payroll records available for inspection at all reasonable hours at your main office on the following basis:

1. Upon the employee's request or upon request of the employee's authorized representative, make available for inspection a certified copy of the employee's payroll record.
2. Refer the public's requests for certified payroll records to the Department. Upon the public's request, the Department makes available for inspection or furnishes copies of your certified payroll records. Do not give the public access to the records at your main office.

Make all payroll records available for inspection and copying or furnish a copy upon request of a representative of the:

1. Department
2. Division of Labor Standards Enforcement of the Department of Industrial Relations
3. Division of Apprenticeship Standards of the Department of Industrial Relations

Furnish the Department the location of the records. Include the street address, city, and county. Furnish the Department a notification of a location and address change within 5 business days of the change.

Comply with a request for the records within 10 days after you receive a written request. If you do not comply within this period, the Department withholds from progress payments a $100 penalty for each day or part of a day for each worker until you comply. You are not assessed this penalty for a subcontractor's failure to comply with Labor Code § 1776.

The Department withholds from progress payments for delinquent or inadequate records (Labor Code § 1771.5). If you have not submitted an adequate record by the month's 15th day for the period ending on or before the 1st of that month, the Department withholds up to 10 percent of the monthly progress estimate, exclusive of mobilization. The Department does not withhold more than $10,000 or less than $1,000.

7-1.02K(4) Apprentices

Comply with the apprentice to journeyman ratio requirements (Labor Code § 1777.5(g)).

Comply with the training contribution requirements (Labor Code § 1777.5(m)(1)).

For answers to questions, contact the Division of Apprenticeship Standards before starting work.

The Department deducts from progress payments civil penalties assessed by the Chief of the Division of Apprenticeship Standards for violating Labor Code § 1777.5 (Labor Code § 1777.7).

7-1.02K(5) Working Hours

Eight hours is a legal day's work (Labor Code § 1810).

The time of service of any worker employed on public work is limited and restricted to 8 hours in 1 day and 40 hours in 1 calendar week, except as provided by Labor Code § 1815 (Labor Code § 1811).

A Contractor's employee may work more than 8 hours per day and 40 hours per week if the Contractor pays the employee 1-1/2 times the basic pay rate for the hours worked in excess of 8 hours per day and 40 hours per week (Labor Code § 1815).

For each worker employed in the work for each day the worker works more than 8 hours in 1 day and 40 hours in 1 calendar week without overtime pay, the Department deducts $25 as a penalty for violating Labor Code § 1815 (Labor Code § 1813).

7-1.02K(6) Occupational Safety and Health Standards

7-1.02K(6)(a) General

Comply with applicable occupational safety and health standards, rules, regulations, and orders. The Occupational Safety and Health Standards Board is the only agency authorized in the State to adopt and enforce occupational safety and health standards (Labor Code § 142 et seq.).

You must contact the local public health service department for information concerning public health conditions within the area of the project.

You are the controlling employer and must ensure hazardous conditions are corrected (Labor Code § 6400).

The Engineer may notify Cal/OSHA if you fail to establish or maintain a safe and healthful workplace.

Submit copies of your Injury and Illness Prevention Program and permits required by Cal/OSHA. The program must address the use of personal and company-issued electronic devices during work. Do not allow the use of entertainment and personal communication devices in the work zone. Workers may use a communication device for business purposes in the work area, at a location where their safety and the safety of other workers and the traveling public is not compromised.

The Department is not responsible for the health and safety of:

1. Contractor's personnel
2. Subcontractor's personnel
3. Supplier's personnel
4. Any other persons present at the job site at the request of you or your subcontractors.

7-1.02K(6)(b) Excavation Safety

Comply with Labor Code § 6705 while excavating. For an excavation 5 feet or more in depth, submit shop drawings for a protective system.

The drawings must show the design and details for providing worker protection from caving ground during excavation.

Shop drawings of protective systems for which the Construction Safety Orders require design by a registered professional engineer must be sealed and signed by an engineer who is registered as a civil engineer in the State.

The submittal must allow review time and include the contents shown in the following table except the review time is 65 days for an excavation on or affecting railroad property:

Drawing Review Time and Contents

Topic	Plan not requiring a signature	Plan requiring a signature
Review time	5 business days before excavating	20 days before excavating
Contents	Drawings Calculations Material information Proprietary system information	Drawings Calculations Material information Proprietary system information Soil classification Soil properties Soil design calculations

7-1.02K(6)(c) Tunnel Safety

Cal/OSHA classifies tunnels into one of the following classifications:

1. Nongassy
2. Potentially gassy
3. Gassy
4. Extrahazardous

If a tunnel location is described in the Contract, the classification is included in the *Information Handout* and you must:

1. Designate an on-site Safety Representative under 8 CA Code of Regs § 8406
2. Submit the name of your on-site Safety Representative at least 7 days before starting work at each tunnel
3. Prominently post a notice at the job site of:
   3.1. Tunnel classifications
   3.2. Any special orders, rules, special conditions, or regulations related to tunnel work
4. Ensure your workers are informed of these classifications

Notify the Engineer at least 20 days before a worker enters a tunnel not described in the Contract. The Department obtains the classification of the tunnel. The Engineer may suspend the work because of a change directly resulting from the Contractor's planned activities that causes activities to fall under the Tunnel Safety Orders of 8 CA Code of Regs § 8422.

7-1.02K(6)(d) Confined Space Safety

Comply with 8 CA Code of Regs § 5158 while working in a confined space.

7-1.02K(6)(e) Scaffolding

Reserved

7-1.02K(6)(f)–7-1.02K(6)(i) Reserved

7-1.02K(6)(j) Lead Safety

7-1.02K(6)(j)(i) General

Reserved

7-1.02K(6)(j)(ii) Lead Compliance Plan

Section 7-1.02K(6)(j)(ii) applies if a bid item for a lead compliance plan is shown on the Bid Item List.

Regulations containing specific Cal/OSHA requirements when working with lead include 8 CA Code of Regs § 1532.1.

Submit a plan:

1. That documents your compliance program to prevent or minimize worker exposure to lead
2. Including the items listed in 8 CA Code of Regs § 1532.1(e)(2)(B)
3. Sealed and signed by a CIH with knowledge of and experience complying with 8 CA Code of Regs

Allow 7 days for review. Obtain authorization for the plan before starting any activity that presents the potential for lead exposure.

Before starting any activity that presents the potential for lead exposure to employees who have no prior training, including State employees, provide a safety training program to these employees that complies with 8 CA Code of Regs § 1532.1 and your lead compliance plan.

Submit copies of air monitoring or job site inspection reports made by or under the direction of the CIH under 8 CA Code of Regs § 1532.1 within 10 days after the date of monitoring or inspection.

Supply personal protective equipment, training, and washing facilities required by your lead compliance plan for 5 State employees.

7-1.02K(6)(j)(iii) Earth Material Containing Lead

Reserved

7-1.02K(6)(j)(iv–viii) Reserved

7-1.02K(6)(k)–7-1.02K(6)(t) Reserved

7-1.02L Public Contract Code

7-1.02L(1) General

Reserved

7-1.02L(2) Antitrust Claims

In entering into a public works contract or a subcontract to supply goods, services, or materials pursuant to a public works contract, the contractor or subcontractor offers and agrees to assign to the awarding body all rights, title, and interest in and to all causes of action it may have under section 4 of the Clayton Act (15 U.S.C. Sec. 15) or under the Cartwright Act (Chapter 2 (commencing with § 16700) of Part 2 of Division 7 of the Business and Professions Code), arising from purchases of goods, services, or materials pursuant to the public works contract or the subcontract. This assignment shall be made and become effective at the time the awarding body tenders final payment to the contractor, without further acknowledgment by the parties. [Pub Cont Code § 7103.5 (b)]

7-1.02M Public Resources Code

7-1.02M(1) General

Reserved

7-1.02M(2) Fire Protection

Reserved

7-1.02M(3) Surface Mining and Reclamation Act

Imported borrow or aggregate material must come from a surface mine permitted under the Surface Mining and Reclamation Act of 1975, Pub Res Code § 2710 et seq., or from a source not subject to this act.

For the list of permitted sites, go to the Department of Conservation, Office of Mine Reclamation website.

If you import borrow or aggregate material from a surface mine not on this list, submit proof that the source is not subject to this act.

7-1.02M(4)–7-1.02M(7) Reserved

7-1.02N Reserved

7-1.02O Vehicle Code

Under Veh Code § 591, the Department determines areas within the project limits are open to public traffic. For those areas, comply with the requirements set forth in Divisions 11, 12, 13, 14 and 15 of the Veh Code.

Veh Code § 591 does not relieve you or any other person from the duty of exercising due care.

7-1.02P–7-1.02Z Reserved

7-1.03 PUBLIC CONVENIENCE

Compliance with section 7-1.03 does not relieve you of your responsibility for public safety.

Construction activities must not inconvenience the public or abutting property owners. Schedule and conduct work to avoid unnecessary inconvenience to the public and abutting property owners. Avoid undue delay in construction activities to reduce the public's exposure to construction.

Where possible, route traffic on new or existing paved surfaces.

Maintain convenient access to driveways, houses, and buildings. When an abutting property owner's access across the right-of-way line is to be eliminated or replaced under the Contract, the existing access must not be closed until the replacement access facility is usable. Construct temporary approaches to a crossing and an intersecting highway.

Provide a reasonably smooth and even surface for use by traffic at all time during the excavation of a roadway and construction of an embankment. Before other grading activities, place fill at culverts and bridges to allow traffic to cross. If ordered, excavate a roadway cut in layers and construct an embankment in partial widths at a time alternating construction from one side to the other and routing traffic over the side opposite the one under construction. Install or construct culverts on only 1/2 the width of the traveled way at a time; keep the traveled way portion being used by traffic open and unobstructed until the opposite side of the traveled way is ready for use by traffic.

Upon completion of rough grading or placing any subsequent layer, bring the surface of the roadbed to a smooth and even condition, free of humps and depressions, and satisfactory for the use of the public.

After subgrade preparation for a specified layer of material has been completed, repair any damage to the roadbed or completed subgrade, including damage caused by public use.

While subgrade and paving activities are underway, allow the public to use the shoulders. If half-width paving methods are used, allow the public to use the side of the roadbed opposite the one under construction. If enough width is available, keep open a passageway wide enough to accommodate at least 2 lanes of traffic at locations where subgrade and paving activities are underway. Shape shoulders or reshape subgrade as necessary to accommodate traffic during subgrade preparation and paving activities.

Apply a dust palliative for the prevention or alleviation of dust nuisance.

If a height differential of more than 0.04 foot is created by construction activities at a joint transverse to the direction of traffic on the traveled way or a shoulder subject to public traffic, construct a temporary taper at the joint with a slope complying with the requirements shown in the following table:

Temporary Tapers

Height differential (foot)	Slope (horizontal:vertical)	
	Taper use of 14 days or less	Taper use of more than 14 days
Greater than 0.08	100:1 or flatter	200:1 or flatter
0.04–0.08	70:1 or flatter	70:1 or flatter

For a taper on existing asphalt concrete or concrete pavement, construct the taper with minor HMA under section 39-2.07.

Grind existing surfaces to accommodate a minimum taper thickness of 0.10 foot under either of the following conditions:

1. HMA material such as rubberized HMA, polymer-modified bonded wearing course, or open-graded friction course is unsuitable for raking to a maximum 0.02 foot thickness at the edge
2. Taper will be in place for more than 14 days

For a taper on a bridge deck or approach slab, construct the taper with polyester concrete under section 60-3.04B.

The completed surface of the taper must be uniform and must not vary more than 0.02 foot from the lower edge of a 12-foot straightedge when placed on its surface parallel and perpendicular to traffic.

If authorized, you may use alternative materials or methods to construct the required taper.

Install signs, lights, flares, Type K temporary railing, barricades and other facilities to direct traffic. Provide flaggers whenever necessary to direct the movement of the public through or around the work. Flagging must comply with section 12-1. The Department pays you for this work under section 12-1.04.

You are required to pay for the cost of replacing or repairing all facilities installed under change order work for the convenience, direction, or warning of the public that are lost while in your custody or are damaged by your operations to such an extent as to require replacement or repair.

The Engineer may order or consent to your request to open a completed section of surfacing, pavement, or structure roadway surface for public use. You will not be compensated for any delay to your

construction activities caused by the public. This does not relieve you from any other contractual responsibility.

7-1.04 PUBLIC SAFETY

You are responsible to provide for public safety.

Do not construct a temporary facility that interferes with the safe passage of traffic.

Control dust resulting from the work, inside and outside the right-of-way.

Move workers, equipment, and materials without endangering traffic.

Whenever your activities create a condition hazardous to the public, furnish, erect and maintain those fences, temporary railing, barricades, lights, signs, and other devices and take any other necessary protective measures to prevent damage or injury to the public.

Any fences, temporary railing, barricades, lights, signs, or other devices furnished, erected and maintained by you are in addition to those for which payment is provided elsewhere in the specifications.

Provide flaggers whenever necessary to ensure that the public is given safe guidance through the work zone. Flagging must comply with section 12-1. The Department pays you for this work under section 12-1.04.

At locations where traffic is being routed through construction under one-way controls, move your equipment in compliance with the one-way controls unless otherwise ordered.

Use of signs, lights, flags, or other protective devices must comply with the *California MUTCD* and any directions of the Engineer. Signs, lights, flags or other protective devices must not obscure the visibility of, nor conflict in intent, meaning, and function of either existing signs, lights and traffic control devices, or any construction area signs.

Keep existing traffic signals and highway lighting in operation. Other forces within the Department will perform routine maintenance of these facilities during the work.

Cover signs that direct traffic to a closed area. Except for work specified in section 12, maintaining, and removing the covers on construction area signs is change order work.

Install temporary illumination such that the illumination and the illumination equipment do not interfere with public safety. The installation of general roadway illumination does not relieve you from furnishing and maintaining any protective devices.

Equipment must enter and leave the highway via existing ramps and crossovers and must move in the direction of traffic. All movements of workmen and construction equipment on or across lanes open to traffic must be performed in a manner that do not endanger the public. Your vehicles or other mobile equipment leaving an open traffic lane to enter the construction area must slow down gradually in advance of the location of the turnoff to give the traffic following an opportunity to slow down. When leaving a work area and entering a roadway carrying traffic, your vehicles and equipment must yield to traffic.

Immediately remove hauling spillage from a roadway lane or shoulder open to traffic. When hauling on roadways, trim loads and remove material from shelf areas to minimize spillage.

Notify the Engineer not less than 25 days and not more than 125 days before the anticipated start of an activity that will change the vertical or horizontal clearance available to traffic, including shoulders.

If vertical clearance is temporarily reduced to 15.5 feet or less, place low clearance warning signs in compliance with the *California MUTCD* and any directions of the Engineer. Signs must comply with the dimensions, color, and legend requirements of the *California MUTCD* and section 12-3.11 except that the signs must have black letters and numbers on an orange retroreflective background. W12-2P signs must be illuminated so that the signs are clearly visible.

Pave or provide full width continuous and cleared wood walks for pedestrian openings through falsework. Protect pedestrians from falling objects and concrete-curing water. Extend overhead protection for pedestrians at least 4 feet beyond the edge of the bridge deck. Illuminate all pedestrian openings through

falsework. Temporary pedestrian facilities must comply with the *California MUTCD*, Part 6, Chapter 6D, "Pedestrian and Worker Safety."

Do not store vehicles, material, or equipment in a way that:

1. Creates a hazard to the public
2. Obstructs traffic control devices

Do not install or place temporary facilities used to perform the work which interfere with the free and safe passage of traffic.

Temporary facilities that could be a hazard to public safety if improperly designed must comply with design requirements described in the Contract for those facilities or, if none are described, with standard design criteria or codes appropriate for the facility involved. Submit shop drawings and design calculations for the temporary facilities and show the standard design criteria or codes used. Shop drawings and supplemental calculations must be sealed and signed by an engineer who is registered as a civil engineer in the State.

If you appear to be neglectful or negligent in furnishing warning devices and taking protective measures, the Engineer may direct your attention to the existence of a hazard. You must furnish and install the necessary warning devices. If the Engineer points out the inadequacy of warning devices and protective measures, that action on the part of the Engineer does not relieve you from your responsibility for public safety or abrogate your obligation to furnish and pay for these devices and measures.

Install Type K temporary railing or other authorized protective systems under any of the following conditions:

1. Excavations: Where the near edge of the excavation is within 15 feet from the edge of an open traffic lane
2. Temporarily unprotected permanent obstacles: When the work includes the installation of a fixed obstacle together with a protective system, such as a sign structure together with protective railing, and you elect to install the obstacle before installing the protective system; or you, for your convenience and as authorized, remove a portion of an existing protective railing at an obstacle and do not replace such railing completely the same day
3. Storage areas: When material or equipment is stored within 15 feet of the edge of an open traffic lane and the storage is not otherwise prohibited by the Contract
4. Height differentials: When construction operations create a height differential greater than 0.15 feet within 15 feet of the edge of traffic lane

Installation of Type K temporary railing is not required if an excavation within 15 feet from the edge of an open traffic lane is protected by any of the following:

1. Steel plate or concrete covers of adequate thickness to prevent accidental entry by traffic or the public
2. Side slope where the downhill slope is 4:1 (horizontal:vertical) or less unless a naturally occurring condition
3. Barrier or railing

Offset the approach end of Type K temporary railing a minimum of 15 feet from the edge of an open traffic lane. Install the temporary railing on a skew toward the edge of the traffic lane of not more than 1 foot transversely to 10 feet longitudinally with respect to the edge of the traffic lane. If the 15-foot minimum offset cannot be achieved, the temporary railing must be installed on the 10 to 1 skew to obtain the maximum available offset between the approach end of the railing and the edge of the traffic lane, and an array of temporary crash cushion modules must be installed at the approach end of the temporary railing.

Secure Type K temporary railing in place before starting work for which the temporary railing is required.

If a traffic lane is closed with channelizers for excavation work, move the devices to the adjacent edge of the traveled way when not excavating. Space the devices as specified for the closure.

Do not move or temporarily suspend anything over a traffic lane open to the public unless the public is protected.

7-1.05 INDEMNIFICATION

7-1.05A General

You must defend, indemnify, and save harmless the State, including its officers, employees, and agents (excluding agents who are design professionals), from any and all claims, demands, causes of action, damages, costs, expenses, actual attorneys' fees, losses or liabilities, in law or in equity (Section 7-1.05 Claims) arising out of or in connection with your performance of this Contract for:

1. Bodily injury including, but not limited to, bodily injury, sickness or disease, emotional injury or death to persons, including, but not limited to, the public, any employees or agents of you, the State, or any other contractor; and
2. Damage to property of anyone including loss of use thereof; caused or alleged to be caused in whole or in part by any negligent or otherwise legally actionable act or omission of you or anyone directly or indirectly employed by you or anyone for whose acts you may be liable.

Except as otherwise provided by law, these requirements apply regardless of the existence or degree of fault of the State. You are not obligated to indemnify the State for Claims arising from conduct delineated in Civ Code § 2782 and for Claims arising from any defective or substandard condition of the highway that existed at or before the start of work, unless this condition has been changed by the work or the scope of the work requires you to maintain existing highway facilities and the Claim arises from your failure to maintain. Your defense and indemnity obligation shall extend to Claims arising after the work is completed and accepted if the Claims are directly related to alleged acts or omissions by you that occurred during the course of the work. Any inspection of the work by the State is not a waiver of full compliance with these requirements.

Your obligation to defend and indemnify is not excused because of your inability to evaluate liability or because you evaluate liability and determine that you are not liable. You must respond within 30 days to the tender of any Claim for defense and indemnity by the State, unless this time has been extended by the State. If you fail to accept or reject a tender of defense and indemnity within 30 days, in addition to any other remedy authorized by law, the Department may withhold such funds the State reasonably considers necessary for its defense and indemnity until disposition has been made of the Claim or until the Contractor accepts or rejects the tender of defense, whichever occurs first.

With respect to third-party claims against you, you waive all rights of any type to express or implied indemnity against the State, its officers, employees, or agents (excluding agents who are design professionals).

Nothing in the Contract is intended to establish a standard of care owed to any member of the public or to extend to the public the status of a third-party beneficiary for any of these indemnification specifications.

7-1.05B Responsibility to Other Entities

You are responsible for any liability imposed by law and for injuries to or death of any person, including workers and the public, or damage to property. Indemnify and save harmless any county, city or district and its officers and employees connected with the work, within the limits of which county, city, or district the work is being performed, all in the same manner and to the same extent specified for the protection of the State.

7-1.05C Other

You are responsible to the fullest extent allowed by law, to defend and indemnify the State for any and all injury, illness, disease, or death arising out of or caused by an organism, including but not limited to animals, microscopic bacteria, fungi, plants and the like, to which persons, including but not limited to the public, any employees or agents of yours, the State, or any other contractors that are exposed in connection with the work on the project.

7-1.06 INSURANCE

7-1.06A General

Nothing in the Contract is intended to establish a standard of care owed to any member of the public or to extend to the public the status of a third-party beneficiary for any of these insurance specifications.

7-1.06B Casualty Insurance

Obtain and maintain insurance on all of your operations with companies acceptable to the State as follows:

1. Keep all insurance in full force and effect from the start of the work through Contract acceptance.
2. All insurance must be with an insurance company with a rating from A.M. Best Financial Strength Rating of A- or better and a Financial Size Category of VII or better.
3. Maintain completed operations coverage with a carrier acceptable to the State through the expiration of the patent deficiency in construction statute of repose set forth in Civ Pro Code § 337.1.

7-1.06C Workers' Compensation and Employer's Liability Insurance

Under Labor Code § 1860, secure the payment of worker's compensation under Labor Code § 3700.

Submit to the Department the following certification before performing the work (Labor Code § 1861):

> I am aware of the provisions of Section 3700 of the Labor Code which require every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that code, and I will comply with such provisions before commencing the performance of the work of this contract.

Contract signing constitutes your submittal of this certification.

Provide Employer's Liability Insurance in amounts not less than:

1. $1,000,000 for each accident for bodily injury by accident
2. $1,000,000 policy limit for bodily injury by disease
3. $1,000,000 for each employee for bodily injury by disease

If there is an exposure of injury to your employees under the US Longshoremen's and Harbor Workers' Compensation Act, the Jones Act, or under laws, regulations, or statutes applicable to maritime employees, coverage must be included for such injuries or claims.

7-1.06D Liability Insurance

7-1.06D(1) General

Carry General Liability and Umbrella or Excess Liability Insurance covering all operations by or on behalf of you providing insurance for bodily injury liability and property damage liability for the following limits and including coverage for:

1. Premises, operations and mobile equipment
2. Products and completed operations
3. Broad form property damage (including completed operations)
4. Explosion, collapse, and underground hazards
5. Personal injury
6. Contractual liability

7-1.06D(2) Liability Limits/Additional Insureds

The limits of liability must be at least the values shown in the following table:

Liability Limits

Total bid	For each occurrence[a]	Aggregate for products/completed operation	General aggregate[b]	Umbrella or excess liability[c]
≤ $1,000,000	$1,000,000	$2,000,000	$2,000,000	$5,000,000
> $1,000,000 ≤ $10,000,000	$1,000,000	$2,000,000	$2,000,000	$10,000,000
> $10,000,000 ≤ $25,000,000	$2,000,000	$2,000,000	$4,000,000	$15,000,000
> $25,000,000	$2,000,000	$2,000,000	$4,000,000	$25,000,000

[a]Combined single limit for bodily injury and property damage.
[b]This limit must apply separately to your work under this Contract.
[c]The umbrella or excess policy must contain a clause stating that it takes effect (drops down) in the event the primary limits are impaired or exhausted.

Do not require a small business subcontractor to carry liability insurance that exceeds the limits shown in the preceding table. For a small business subcontractor, interpret *Total Bid* in the table as the dollar amount of subcontracted work.

As used in section 7-1.06D(2), a small business:

1. For a non-federal-aid contract is defined in 2 CA Code of Regs § 1896 and is incorporated by this reference
2. For a federal-aid contract is defined in 13 CFR 121.201 and is incorporated by this reference

The State, including its officers, directors, agents (excluding agents who are design professionals), and employees, must be named as additional insureds under the General Liability and Umbrella Liability Policies with respect to liability arising out of or connected with work or operations performed by or on behalf of you under this Contract. Coverage for such additional insureds does not extend to liability:

1. Arising from any defective or substandard condition of the roadway which existed at or before the time you started work, unless such condition has been changed by the work or the scope of the work requires you to maintain existing roadway facilities and the claim arises from your failure to maintain;
2. For claims occurring after the work is completed and accepted unless these claims are directly related to alleged acts or omissions of you that occurred during the course of the work; or
3. To the extent prohibited by Ins Code § 11580.04.

Additional insured coverage must be provided by a policy provision or by an endorsement providing coverage at least as broad as Additional Insured (Form B) endorsement form CG 2010, as published by the Insurance Services Office (ISO), or other form designated by the Department.

7-1.06D(3) Contractor's Insurance Policy is Primary

The policy must stipulate that the insurance afforded the additional insureds applies as primary insurance. Any other insurance or self-insurance maintained by the State is excess only and must not be called upon to contribute with this insurance.

7-1.06E Automobile Liability Insurance

Carry automobile liability insurance, including coverage for all owned, hired, and nonowned automobiles. The primary limits of liability must be not less than $1,000,000 combined single limit for each accident for bodily injury and property damage. The umbrella or excess liability coverage required under section 7-1.06D(2) also applies to automobile liability.

7-1.06F Policy Forms, Endorsements, and Certificates

Provide your General Liability Insurance under Commercial General Liability policy form no. CG0001 as published by the Insurance Services Office (ISO) or under a policy form at least as broad as policy form no. CG0001.

7-1.06G Deductibles

The State may expressly allow deductible clauses, which it does not consider excessive, overly broad, or harmful to the interests of the State. Regardless of the allowance of exclusions or deductions by the

State, you are responsible for any deductible amount and must warrant that the coverage provided to the State complies with section 7-1.06.

7-1.06H Enforcement

The Department may assure your compliance with your insurance obligations. Ten days before an insurance policy lapses or is canceled during the Contract period you must submit to the Department evidence of renewal or replacement of the policy.

If you fail to maintain any required insurance coverage, the Department may maintain this coverage and withhold or charge the expense to you or terminate your control of the work.

You are not relieved of your duties and responsibilities to indemnify, defend, and hold harmless the State, its officers, agents, and employees by the Department's acceptance of insurance policies and certificates.

The minimum insurance coverage amounts do not relieve you for liability in excess of such coverage, nor do they preclude the State from taking other actions available to it, including the withholding of funds under this Contract.

7-1.06I Self-Insurance

Self-insurance programs and self-insured retentions in insurance policies are subject to separate annual review and approval by the State.

If you use a self-insurance program or self-insured retention, you must provide the State with the same protection from liability and defense of suits as would be afforded by first-dollar insurance. Execution of the Contract is your acknowledgment that you will be bound by all laws as if you were an insurer as defined under Ins Code § 23 and that the self-insurance program or self-insured retention shall operate as insurance as defined under Ins Code § 22.

7-1.07 LEGAL ACTIONS AGAINST THE DEPARTMENT

7-1.07A General

If legal action is brought against the Department over compliance with a State or federal law, rule, or regulation applicable to highway work, then:

1. If the Department in complying with a court order prohibits you from performing work, the resulting delay is a suspension related to your performance, unless the Department terminates the Contract.
2. If a court order other than an order to show cause or the final judgment in the action prohibits the Department from requiring you to perform work, the Department may delete the prohibited work or terminate the Contract.

7-1.07B Seal Coat Claims

Pay for claims for personal property damage caused by screening and bituminous binder. Seal coat claims are limited to:

1. 10 percent of the total bid
2. Damage occurring between the 1st day of screening spreading and 4 days after the last day of screening spreading for each seal coat location

Within 30 days of the last screening spreading, do the following:

1. Process and resolve all claims reported or submitted to you by the public as follows:
   1.1. Within 3 business days of receipt of a claim, submit to the Department a copy of the claim, a written analysis of the claim, and a statement indicating whether or not you will pay the claim. If you reject a claim, provide the reasons for rejection in writing.
   1.2. If the claimant becomes dissatisfied with your handling of the claim, immediately refer the claimant to the local district claims office for assistance in resolving the claim.
2. Submit to the Department evidence of your paid claims.

All claims presented to the Department, any district claims office, or the State Board of Control (Govt Code § 900 et seq.) are processed and resolved by the Department as follows:

1. The claims are processed as formal government claims subject to all laws and policies and are resolved as the Department determines including referring the claim to you for handling.
2. If the Department or the State Board of Control approves settlement of a claim or is ordered to pay pursuant to a court order, the claim is paid from funds withheld from you.
3. Within 3 business days of the Department's determination that you are responsible for resolving the claim, the Department sends a copy of the claim to you for resolution or notifies you of the Department's decision to resolve the claim.

The Department withholds an amount not to exceed 5 percent of the total bid to resolve all claims. The amount is held no longer than 60 days following the last spreading of screenings so that the Department has ample time to resolve any pending claims. After 60 days, any remaining amount withheld is returned to you.

If no withheld funds remain or have been returned, the Department may pay any claims and seek reimbursement from you through an offset or any other legal means. Any reimbursement or offset to be recovered from you, including all other paid claims, is limited to 10 percent of the total bid.

Section 7-1.07B does not limit your obligation to defend and indemnify the Department.

7-1.08 PERSONAL LIABILITY

Neither the Director, the Engineer nor any other officer or authorized employee of the State of California, nor any officer or employee of any county, city or district shall be personally responsible for any liability arising under or by virtue of the Contract.

7-1.09–7-1.10 RESERVED

7-1.11 FEDERAL LAWS FOR FEDERAL-AID CONTRACTS

7-1.11A General

Section 7-1.11 includes specifications required in a federal-aid construction contract and applies to a federal-aid contract.

Comply with 46 CFR 381.7(a)–(b).

A copy of form FHWA-1273 is included in section 7-1.11B. The training and promotion section of section II refers to training provisions as if they were included in the special provisions. The Department specifies the provisions in section 7-1.11D of the *Standard Specifications*. If a number of trainees or apprentices is required, the Department shows the number on the *Notice to Bidders*. Interpret each FHWA-1273 clause shown in the following table as having the same meaning as the corresponding Department clause:

FHWA-1273 Nondiscrimination Clauses

FHWA-1273 section	FHWA-1273 clause	Department clause
Training and Promotion	In the event a special provision for training is provided under this contract, this subparagraph will be superseded as indicated in the special provision.	If section 7-1.11D applies, section 7-1.11D supersedes this subparagraph.
Records and Reports	If on-the-job training is being required by special provision, the contractor will be required to collect and report training data.	If the Contract requires on-the-job training, collect and report training data.

7-1.11B FHWA-1273

FHWA-1273 -- Revised May 1, 2012

REQUIRED CONTRACT PROVISIONS
FEDERAL-AID CONSTRUCTION CONTRACTS

I. GENERAL

1. Form FHWA-1273 must be physically incorporated in each construction contract funded under Title 23 (excluding emergency contracts solely intended for debris removal). The contractor (or subcontractor) must insert this form in each subcontract and further require its inclusion in all lower tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services).

The applicable requirements of Form FHWA-1273 are incorporated by reference for work done under any purchase order, rental agreement or agreement for other services. The prime contractor shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.

Form FHWA-1273 must be included in all Federal-aid design-build contracts, in all subcontracts and in lower tier subcontracts (excluding subcontracts for design services, purchase orders, rental agreements and other agreements for supplies or services). The design-builder shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.

Contracting agencies may reference Form FHWA-1273 in bid proposal or request for proposal documents, however, the Form FHWA-1273 must be physically incorporated (not referenced) in all contracts, subcontracts and lower-tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services related to a construction contract).

2. Subject to the applicability criteria noted in the following sections, these contract provisions shall apply to all work performed on the contract by the contractor's own organization and with the assistance of workers under the contractor's immediate superintendence and to all work performed on the contract by piecework, station work, or by subcontract.

3. A breach of any of the stipulations contained in these Required Contract Provisions may be sufficient grounds for withholding of progress payments, withholding of final payment, termination of the contract, suspension / debarment or any other action determined to be appropriate by the contracting agency and FHWA.

4. Selection of Labor: During the performance of this contract, the contractor shall not use convict labor for any purpose within the limits of a construction project on a Federal-aid highway unless it is labor performed by convicts who are on parole, supervised release, or probation. The term Federal-aid highway does not include roadways functionally classified as local roads or rural minor collectors.

II. NONDISCRIMINATION

The provisions of this section related to 23 CFR Part 230 are applicable to all Federal-aid construction contracts and to all related construction subcontracts of $10,000 or more. The provisions of 23 CFR Part 230 are not applicable to material supply, engineering, or architectural service contracts.

In addition, the contractor and all subcontractors must comply with the following policies: Executive Order 11246, 41 CFR 60, 29 CFR 1625-1627, Title 23 USC Section 140, the Rehabilitation Act of 1973, as amended (29 USC 794), Title VI of the Civil Rights Act of 1964, as amended, and related regulations including 49 CFR Parts 21, 26 and 27; and 23 CFR Parts 200, 230, and 633.

The contractor and all subcontractors must comply with: the requirements of the Equal Opportunity Clause in 41 CFR 60-1.4(b) and, for all construction contracts exceeding $10,000, the Standard Federal Equal Employment Opportunity Construction Contract Specifications in 41 CFR 60-4.3.

Note: The U.S. Department of Labor has exclusive authority to determine compliance with Executive Order 11246 and the policies of the Secretary of Labor including 41 CFR 60, and 29 CFR 1625-1627. The contracting agency and the FHWA have the authority and the responsibility to ensure compliance with Title 23 USC Section 140, the Rehabilitation Act of 1973, as amended (29 USC 794), and Title VI of the Civil Rights Act of 1964, as amended, and related regulations including 49 CFR Parts 21, 26 and 27; and 23 CFR Parts 200, 230, and 633.

The following provision is adopted from 23 CFR 230, Appendix A, with appropriate revisions to conform to the U.S. Department of Labor (US DOL) and FHWA requirements.

1. Equal Employment Opportunity: Equal employment opportunity (EEO) requirements not to discriminate and to take affirmative action to assure equal opportunity as set forth under laws, executive orders, rules, regulations (28 CFR 35, 29 CFR 1630, 29 CFR 1625-1627, 41 CFR 60 and 49 CFR 27) and orders of the Secretary of Labor as modified by the provisions prescribed herein, and imposed pursuant to 23 U.S.C. 140 shall constitute the EEO and specific affirmative action standards for the contractor's project activities under

this contract. The provisions of the Americans with Disabilities Act of 1990 (42 U.S.C. 12101 et seq.) set forth under 28 CFR 35 and 29 CFR 1630 are incorporated by reference in this contract. In the execution of this contract, the contractor agrees to comply with the following minimum specific requirement activities of EEO:

a. The contractor will work with the contracting agency and the Federal Government to ensure that it has made every good faith effort to provide equal opportunity with respect to all of its terms and conditions of employment and in their review of activities under the contract.

b. The contractor will accept as its operating policy the following statement:

"It is the policy of this Company to assure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, sex, color, national origin, age or disability. Such action shall include: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship, pre-apprenticeship, and/or on-the-job training."

2. EEO Officer: The contractor will designate and make known to the contracting officers an EEO Officer who will have the responsibility for and must be capable of effectively administering and promoting an active EEO program and who must be assigned adequate authority and responsibility to do so.

3. Dissemination of Policy: All members of the contractor's staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, will be made fully cognizant of, and will implement, the contractor's EEO policy and contractual responsibilities to provide EEO in each grade and classification of employment. To ensure that the above agreement will be met, the following actions will be taken as a minimum:

a. Periodic meetings of supervisory and personnel office employees will be conducted before the start of work and then not less often than once every six months, at which time the contractor's EEO policy and its implementation will be reviewed and explained. The meetings will be conducted by the EEO Officer.

b. All new supervisory or personnel office employees will be given a thorough indoctrination by the EEO Officer, covering all major aspects of the contractor's EEO obligations within thirty days following their reporting for duty with the contractor.

c. All personnel who are engaged in direct recruitment for the project will be instructed by the EEO Officer in the contractor's procedures for locating and hiring minorities and women.

d. Notices and posters setting forth the contractor's EEO policy will be placed in areas readily accessible to employees, applicants for employment and potential employees.

e. The contractor's EEO policy and the procedures to implement such policy will be brought to the attention of employees by means of meetings, employee handbooks, or other appropriate means.

4. Recruitment: When advertising for employees, the contractor will include in all advertisements for employees the notation: "An Equal Opportunity Employer." All such advertisements will be placed in publications having a large circulation among minorities and women in the area from which the project work force would normally be derived.

a. The contractor will, unless precluded by a valid bargaining agreement, conduct systematic and direct recruitment through public and private employee referral sources likely to yield qualified minorities and women. To meet this requirement, the contractor will identify sources of potential minority group employees, and establish with such identified sources procedures whereby minority and women applicants may be referred to the contractor for employment consideration.

b. In the event the contractor has a valid bargaining agreement providing for exclusive hiring hall referrals, the contractor is expected to observe the provisions of that agreement to the extent that the system meets the contractor's compliance with EEO contract provisions. Where implementation of such an agreement has the effect of discriminating against minorities or women, or obligates the contractor to do the same, such implementation violates Federal nondiscrimination provisions.

c. The contractor will encourage its present employees to refer minorities and women as applicants for employment. Information and procedures with regard to referring such applicants will be discussed with employees.

5. Personnel Actions: Wages, working conditions, and employee benefits shall be established and administered, and personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, shall be taken without regard to race, color, religion, sex, national origin, age or disability. The following procedures shall be followed:

a. The contractor will conduct periodic inspections of project sites to insure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.

b. The contractor will periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.

c. The contractor will periodically review selected personnel actions in depth to determine whether there is evidence of discrimination. Where evidence is found, the contractor will promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, such corrective action shall include all affected persons.

d. The contractor will promptly investigate all complaints of alleged discrimination made to the contractor in connection with its obligations under this contract, will attempt to resolve such complaints, and will take appropriate corrective action within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, such corrective action shall include such other persons. Upon completion of each investigation, the contractor will inform every complainant of all of their avenues of appeal.

6. Training and Promotion:

a. The contractor will assist in locating, qualifying, and increasing the skills of minorities and women who are

applicants for employment or current employees. Such efforts should be aimed at developing full journey level status employees in the type of trade or job classification involved.

b. Consistent with the contractor's work force requirements and as permissible under Federal and State regulations, the contractor shall make full use of training programs, i.e., apprenticeship, and on-the-job training programs for the geographical area of contract performance. In the event a special provision for training is provided under this contract, this subparagraph will be superseded as indicated in the special provision. The contracting agency may reserve training positions for persons who receive welfare assistance in accordance with 23 U.S.C. 140(a).

c. The contractor will advise employees and applicants for employment of available training programs and entrance requirements for each.

d. The contractor will periodically review the training and promotion potential of employees who are minorities and women and will encourage eligible employees to apply for such training and promotion.

7. Unions: If the contractor relies in whole or in part upon unions as a source of employees, the contractor will use good faith efforts to obtain the cooperation of such unions to increase opportunities for minorities and women. Actions by the contractor, either directly or through a contractor's association acting as agent, will include the procedures set forth below:

a. The contractor will use good faith efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minorities and women for membership in the unions and increasing the skills of minorities and women so that they may qualify for higher paying employment.

b. The contractor will use good faith efforts to incorporate an EEO clause into each union agreement to the end that such union will be contractually bound to refer applicants without regard to their race, color, religion, sex, national origin, age or disability.

c. The contractor is to obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information to the contractor, the contractor shall so certify to the contracting agency and shall set forth what efforts have been made to obtain such information.

d. In the event the union is unable to provide the contractor with a reasonable flow of referrals within the time limit set forth in the collective bargaining agreement, the contractor will, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion, sex, national origin, age or disability; making full efforts to obtain qualified and/or qualifiable minorities and women. The failure of a union to provide sufficient referrals (even though it is obligated to provide exclusive referrals under the terms of a collective bargaining agreement) does not relieve the contractor from the requirements of this paragraph. In the event the union referral practice prevents the contractor from meeting the obligations pursuant to Executive Order 11246, as amended, and these special provisions, such contractor shall immediately notify the contracting agency.

8. Reasonable Accommodation for Applicants / Employees with Disabilities: The contractor must be familiar with the requirements for and comply with the Americans with Disabilities Act and all rules and regulations established there under. Employers must provide reasonable accommodation in all employment activities unless to do so would cause an undue hardship.

9. Selection of Subcontractors, Procurement of Materials and Leasing of Equipment: The contractor shall not discriminate on the grounds of race, color, religion, sex, national origin, age or disability in the selection and retention of subcontractors, including procurement of materials and leases of equipment. The contractor shall take all necessary and reasonable steps to ensure nondiscrimination in the administration of this contract.

a. The contractor shall notify all potential subcontractors and suppliers and lessors of their EEO obligations under this contract.

b. The contractor will use good faith efforts to ensure subcontractor compliance with their EEO obligations.

10. Assurance Required by 49 CFR 26.13(b):

a. The requirements of 49 CFR Part 26 and the State DOT's U.S. DOT-approved DBE program are incorporated by reference.

b. The contractor or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of DOT-assisted contracts. Failure by the contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the contracting agency deems appropriate.

11. Records and Reports: The contractor shall keep such records as necessary to document compliance with the EEO requirements. Such records shall be retained for a period of three years following the date of the final payment to the contractor for all contract work and shall be available at reasonable times and places for inspection by authorized representatives of the contracting agency and the FHWA.

a. The records kept by the contractor shall document the following:

(1) The number and work hours of minority and non-minority group members and women employed in each work classification on the project;

(2) The progress and efforts being made in cooperation with unions, when applicable, to increase employment opportunities for minorities and women; and

(3) The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minorities and women;

b. The contractors and subcontractors will submit an annual report to the contracting agency each July for the duration of the project, indicating the number of minority, women, and non-minority group employees currently engaged in each work classification required by the contract work. This information is to be reported on Form FHWA-1391. The staffing data should represent the project work force on board in all or any part of the last payroll period preceding the end of July. If on-the-job training is being required by special provision, the contractor

will be required to collect and report training data. The employment data should reflect the work force on board during all or any part of the last payroll period preceding the end of July.

III. NONSEGREGATED FACILITIES

This provision is applicable to all Federal-aid construction contracts and to all related construction subcontracts of $10,000 or more.

The contractor must ensure that facilities provided for employees are provided in such a manner that segregation on the basis of race, color, religion, sex, or national origin cannot result. The contractor may neither require such segregated use by written or oral policies nor tolerate such use by employee custom. The contractor's obligation extends further to ensure that its employees are not assigned to perform their services at any location, under the contractor's control, where the facilities are segregated. The term "facilities" includes waiting rooms, work areas, restaurants and other eating areas, time clocks, restrooms, washrooms, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing provided for employees. The contractor shall provide separate or single-user restrooms and necessary dressing or sleeping areas to assure privacy between sexes.

IV. DAVIS-BACON AND RELATED ACT PROVISIONS

This section is applicable to all Federal-aid construction projects exceeding $2,000 and to all related subcontracts and lower-tier subcontracts (regardless of subcontract size). The requirements apply to all projects located within the right-of-way of a roadway that is functionally classified as Federal-aid highway. This excludes roadways functionally classified as local roads or rural minor collectors, which are exempt. Contracting agencies may elect to apply these requirements to other projects.

The following provisions are from the U.S. Department of Labor regulations in 29 CFR 5.5 "Contract provisions and related matters" with minor revisions to conform to the FHWA-1273 format and FHWA program requirements.

1. Minimum wages

a. All laborers and mechanics employed or working upon the site of the work, will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph 1.d. of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph 1.b. of this section) and the Davis-Bacon poster (WH–1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

b.(1) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(i) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(ii) The classification is utilized in the area by the construction industry; and

(iii) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(2) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(3) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Wage and Hour Administrator for determination. The Wage and Hour Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or

will notify the contracting officer within the 30-day period that additional time is necessary.

(4) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs 1.b.(2) or 1.b.(3) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

c. Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

d. If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

2. Withholding

The contracting agency shall upon its own action or upon written request of an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract, or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the contracting agency may, after written notice to the contractor, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

3. Payrolls and basic records

a. Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

b.(1) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the contracting agency. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g. , the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH–347 is available for this purpose from the Wage and Hour Division Web site at http://www.dol.gov/esa/whd/forms/wh347instr.htm or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the contracting agency for transmission to the State DOT, the FHWA or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the contracting agency..

(2) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(i) That the payroll for the payroll period contains the information required to be provided under §5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under §5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(ii) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(iii) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(3) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH–347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph 3.b.(2) of this section.

(4) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

c. The contractor or subcontractor shall make the records required under paragraph 3.a. of this section available for inspection, copying, or transcription by authorized representatives of the contracting agency, the State DOT, the FHWA, or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the FHWA may, after written notice to the contractor, the contracting agency or the State DOT, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

4. Apprentices and trainees

a. Apprentices (programs of the USDOL).

Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice.

The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed.

Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination.

In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

b. Trainees (programs of the USDOL).

Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration.

The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration.

Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed.

In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

c. Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

d. Apprentices and Trainees (programs of the U.S. DOT).

Apprentices and trainees working under apprenticeship and skill training programs which have been certified by the Secretary of Transportation as promoting EEO in connection with Federal-aid highway construction programs are not subject to the requirements of paragraph 4 of this Section IV. The straight time hourly wage rates for apprentices and trainees under such programs will be established by the particular programs. The ratio of apprentices and trainees to journeymen shall not be greater than permitted by the terms of the particular program.

5. Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

6. Subcontracts. The contractor or subcontractor shall insert Form FHWA-1273 in any subcontracts and also require the subcontractors to include Form FHWA-1273 in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

7. Contract termination: debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

8. Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

9. Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

10. Certification of eligibility.

a. By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

b. No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

c. The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

V. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT

The following clauses apply to any Federal-aid construction contract in an amount in excess of $100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by 29 CFR 5.5(a) or 29 CFR 4.6. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

1. Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

2. Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (1.) of this section, the contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (1.) of this section, in the sum of $10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (1.) of this section.

3. Withholding for unpaid wages and liquidated damages. The FHWA or the contacting agency shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (2.) of this section.

4. Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (1.) through (4.) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (1.) through (4.) of this section.

VI. SUBLETTING OR ASSIGNING THE CONTRACT

This provision is applicable to all Federal-aid construction contracts on the National Highway System.

1. The contractor shall perform with its own organization contract work amounting to not less than 30 percent (or a greater percentage if specified elsewhere in the contract) of the total original contract price, excluding any specialty items designated by the contracting agency. Specialty items may be performed by subcontract and the amount of any such specialty items performed may be deducted from the total original contract price before computing the amount of work required to be performed by the contractor's own organization (23 CFR 635.116).

a. The term "perform work with its own organization" refers to workers employed or leased by the prime contractor, and equipment owned or rented by the prime contractor, with or without operators. Such term does not include employees or equipment of a subcontractor or lower tier subcontractor, agents of the prime contractor, or any other assignees. The term may include payments for the costs of hiring leased employees from an employee leasing firm meeting all relevant Federal and State regulatory requirements. Leased employees may only be included in this term if the prime contractor meets all of the following conditions:

(1) the prime contractor maintains control over the supervision of the day-to-day activities of the leased employees;
(2) the prime contractor remains responsible for the quality of the work of the leased employees;
(3) the prime contractor retains all power to accept or exclude individual employees from work on the project; and
(4) the prime contractor remains ultimately responsible for the payment of predetermined minimum wages, the submission of payrolls, statements of compliance and all other Federal regulatory requirements.

b. "Specialty Items" shall be construed to be limited to work that requires highly specialized knowledge, abilities, or equipment not ordinarily available in the type of contracting organizations qualified and expected to bid or propose on the contract as a whole and in general are to be limited to minor components of the overall contract.

2. The contract amount upon which the requirements set forth in paragraph (1) of Section VI is computed includes the cost of material and manufactured products which are to be purchased or produced by the contractor under the contract provisions.

3. The contractor shall furnish (a) a competent superintendent or supervisor who is employed by the firm, has full authority to direct performance of the work in accordance with the contract requirements, and is in charge of all construction operations (regardless of who performs the work) and (b) such other of its own organizational resources (supervision, management, and engineering services) as the contracting officer determines is necessary to assure the performance of the contract.

4. No portion of the contract shall be sublet, assigned or otherwise disposed of except with the written consent of the contracting officer, or authorized representative, and such consent when given shall not be construed to relieve the contractor of any responsibility for the fulfillment of the contract. Written consent will be given only after the contracting agency has assured that each subcontract is evidenced in writing and that it contains all pertinent provisions and requirements of the prime contract.

5. The 30% self-performance requirement of paragraph (1) is not applicable to design-build contracts; however, contracting agencies may establish their own self-performance requirements.

VII. SAFETY: ACCIDENT PREVENTION

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

1. In the performance of this contract the contractor shall comply with all applicable Federal, State, and local laws governing safety, health, and sanitation (23 CFR 635). The contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions as it determines, or as the contracting officer may determine, to be reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract.

2. It is a condition of this contract, and shall be made a condition of each subcontract, which the contractor enters into pursuant to this contract, that the contractor and any subcontractor shall not permit any employee, in performance of the contract, to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to his/her health or safety, as determined under construction safety and health standards (29 CFR 1926) promulgated by the Secretary of Labor, in accordance with Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 3704).

3. Pursuant to 29 CFR 1926.3, it is a condition of this contract that the Secretary of Labor or authorized representative thereof, shall have right of entry to any site of contract performance to inspect or investigate the matter of compliance with the construction safety and health standards and to carry out the duties of the Secretary under Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C.3704).

VIII. FALSE STATEMENTS CONCERNING HIGHWAY PROJECTS

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

In order to assure high quality and durable construction in conformity with approved plans and specifications and a high degree of reliability on statements and representations made by engineers, contractors, suppliers, and workers on Federal-aid highway projects, it is essential that all persons concerned with the project perform their functions as carefully, thoroughly, and honestly as possible. Willful falsification, distortion, or misrepresentation with respect to any facts related to the project is a violation of Federal law. To prevent any misunderstanding regarding the seriousness of these and similar acts, Form FHWA-1022 shall be posted on each Federal-aid highway project (23 CFR 635) in one or more places where it is readily available to all persons concerned with the project:

18 U.S.C. 1020 reads as follows:

"Whoever, being an officer, agent, or employee of the United States, or of any State or Territory, or whoever, whether a person, association, firm, or corporation, knowingly makes any false statement, false representation, or false report as to the character, quality, quantity, or cost of the material used or to be used, or the quantity or quality of the work performed or to be performed, or the cost thereof in connection with the submission of plans, maps, specifications, contracts, or costs of construction on any highway or related project submitted for approval to the Secretary of Transportation; or

Whoever knowingly makes any false statement, false representation, false report or false claim with respect to the character, quality, quantity, or cost of any work performed or to be performed, or materials furnished or to be furnished, in connection with the construction of any highway or related project approved by the Secretary of Transportation; or

Whoever knowingly makes any false statement or false representation as to material fact in any statement, certificate, or report submitted pursuant to provisions of the Federal-aid Roads Act approved July 1, 1916, (39 Stat. 355), as amended and supplemented;

Shall be fined under this title or imprisoned not more than 5 years or both."

IX. IMPLEMENTATION OF CLEAN AIR ACT AND FEDERAL WATER POLLUTION CONTROL ACT

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

By submission of this bid/proposal or the execution of this contract, or subcontract, as appropriate, the bidder, proposer, Federal-aid construction contractor, or subcontractor, as appropriate, will be deemed to have stipulated as follows:

1. That any person who is or will be utilized in the performance of this contract is not prohibited from receiving an award due to a violation of Section 508 of the Clean Water Act or Section 306 of the Clean Air Act.
2. That the contractor agrees to include or cause to be included the requirements of paragraph (1) of this Section X in every subcontract, and further agrees to take such action as the contracting agency may direct as a means of enforcing such requirements.

X. CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION

This provision is applicable to all Federal-aid construction contracts, design-build contracts, subcontracts, lower-tier subcontracts, purchase orders, lease agreements, consultant contracts or any other covered transaction requiring FHWA approval or that is estimated to cost $25,000 or more – as defined in 2 CFR Parts 180 and 1200.

1. Instructions for Certification – First Tier Participants:

a. By signing and submitting this proposal, the prospective first tier participant is providing the certification set out below.

b. The inability of a person to provide the certification set out below will not necessarily result in denial of participation in this covered transaction. The prospective first tier participant shall submit an explanation of why it cannot provide the certification set out below. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective first tier participant to furnish a certification or an explanation shall disqualify such a person from participation in this transaction.

c. The certification in this clause is a material representation of fact upon which reliance was placed when the contracting agency determined to enter into this transaction. If it is later determined that the prospective participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the contracting agency may terminate this transaction for cause of default.

d. The prospective first tier participant shall provide immediate written notice to the contracting agency to whom this proposal is submitted if any time the prospective first tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

e. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180 and 1200. "First Tier Covered Transactions" refers to any covered transaction between a grantee or subgrantee of Federal funds and a participant (such as the prime or general contract). "Lower Tier Covered Transactions" refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). "First Tier Participant" refers to the participant who has entered into a covered transaction with a grantee or subgrantee of Federal funds (such as the prime or general contractor). "Lower Tier Participant" refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).

f. The prospective first tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency entering into this transaction.

g. The prospective first tier participant further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transactions," provided by the department or contracting agency, entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the $25,000 threshold.

h. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the Excluded Parties List System website (https://www.epls.gov/), which is compiled by the General Services Administration.

i. Nothing contained in the foregoing shall be construed to require the establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of the prospective participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

j. Except for transactions authorized under paragraph (f) of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

* * * * *

2. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion – First Tier Participants:

a. The prospective first tier participant certifies to the best of its knowledge and belief, that it and its principals:

(1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency;

(2) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(3) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (a)(2) of this certification; and

(4) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

b. Where the prospective participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

2. **Instructions for Certification - Lower Tier Participants:**

(Applicable to all subcontracts, purchase orders and other lower tier transactions requiring prior FHWA approval or estimated to cost $25,000 or more - 2 CFR Parts 180 and 1200)

a. By signing and submitting this proposal, the prospective lower tier is providing the certification set out below.

b. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department, or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

c. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous by reason of changed circumstances.

d. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180 and 1200. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations. "First Tier Covered Transactions" refers to any covered transaction between a grantee or subgrantee of Federal funds and a participant (such as the prime or general contract). "Lower Tier Covered Transactions" refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). "First Tier Participant" refers to the participant who has entered into a covered transaction with a grantee or subgrantee of Federal funds (such as the prime or general contractor). "Lower Tier Participant" refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).

e. The prospective lower tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.

f. The prospective lower tier participant further agrees by submitting this proposal that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transaction," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the $25,000 threshold.

g. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the Excluded Parties List System website (https://www.epls.gov/), which is compiled by the General Services Administration.

h. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

i. Except for transactions authorized under paragraph e of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the

department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

* * * * *

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion--Lower Tier Participants:

1. The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency.

2. Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

* * * * *

XI. CERTIFICATION REGARDING USE OF CONTRACT FUNDS FOR LOBBYING

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts which exceed $100,000 (49 CFR 20).

1. The prospective participant certifies, by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:

a. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

b. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

2. This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C. 1352. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

3. The prospective participant also agrees by submitting its bid or proposal that the participant shall require that the language of this certification be included in all lower tier subcontracts, which exceed $100,000 and that all such recipients shall certify and disclose accordingly.

7-1.11C Female and Minority Goals

To comply with section II, "Nondiscrimination," of "Required Contract Provisions Federal-Aid Construction Contracts," the Department is including in section 7-1.11C female and minority utilization goals for federal-aid construction contracts and subcontracts that exceed $10,000.

The nationwide goal for female utilization is 6.9 percent.

The goals for minority utilization [45 Fed Reg 65984 (10/3/1980)] are as shown in the following table:

Minority Utilization Goals

	Economic area	Goal (%)
174	Redding CA: Non-SMSA Counties: CA Lassen; CA Modoc; CA Plumas; CA Shasta; CA Siskiyou; CA Tehama	6.8
175	Eureka, CA Non-SMSA Counties: CA Del Norte; CA Humboldt; CA Trinity	6.6
176	San Francisco-Oakland-San Jose, CA: SMSA Counties: 7120 Salinas-Seaside-Monterey, CA CA Monterey 7360 San Francisco-Oakland, CA CA Alameda; CA Contra Costa; CA Marin; CA San Francisco; CA San Mateo 7400 San Jose, CA CA Santa Clara, CA 7485 Santa Cruz, CA CA Santa Cruz 7500 Santa Rosa, CA CA Sonoma 8720 Vallejo-Fairfield-Napa, CA CA Napa; CA Solano Non-SMSA Counties: CA Lake; CA Mendocino; CA San Benito	 28.9 25.6 19.6 14.9 9.1 17.1 23.2
177	Sacramento, CA: SMSA Counties: 6920 Sacramento, CA CA Placer; CA Sacramento; CA Yolo Non-SMSA Counties: CA Butte; CA Colusa; CA El Dorado; CA Glenn; CA Nevada; CA Sierra; CA Sutter; CA Yuba	 16.1 14.3
178	Stockton-Modesto, CA: SMSA Counties: 5170 Modesto, CA CA Stanislaus 8120 Stockton, CA CA San Joaquin Non-SMSA Counties: CA Alpine; CA Amador; CA Calaveras; CA Mariposa; CA Merced; CA Tuolumne	 12.3 24.3 19.8
179	Fresno-Bakersfield, CA SMSA Counties: 0680 Bakersfield, CA CA Kern 2840 Fresno, CA CA Fresno Non-SMSA Counties: CA Kings; CA Madera; CA Tulare	 19.1 26.1 23.6
180	Los Angeles, CA: SMSA Counties: 0360 Anaheim-Santa Ana-Garden Grove, CA CA Orange 4480 Los Angeles-Long Beach, CA CA Los Angeles	 11.9 28.3

	6000 Oxnard-Simi Valley-Ventura, CA	
	CA Ventura	21.5
	6780 Riverside-San Bernardino-Ontario, CA	
	CA Riverside; CA San Bernardino	19.0
	7480 Santa Barbara-Santa Maria-Lompoc, CA	
	CA Santa Barbara	19.7
	Non-SMSA Counties:	
	CA Inyo; CA Mono; CA San Luis Obispo	24.6
	San Diego, CA:	
	SMSA Counties:	
18	7320 San Diego, CA	
1	CA San Diego	16.9
	Non-SMSA Counties:	
	CA Imperial	18.2

For each July during which work is performed under the Contract, you and each non-material-supplier subcontractor with a subcontract of $10,000 or more must complete Form FHWA PR-1391 (Appendix C to 23 CFR 230). Submit the forms by August 15.

7-1.11D Training

Section 7-1.11D applies if a number of trainees or apprentices is shown on the *Notice to Bidders*.

As part of your equal opportunity affirmative action program, provide on-the-job training to develop full journeymen in the types of trades or job classifications involved.

You have primary responsibility for meeting this training requirement.

If you subcontract a Contract part, determine how many trainees or apprentices are to be trained by the subcontractor.

Where feasible, 25 percent of apprentices or trainees in each occupation must be in their 1st year of apprenticeship or training.

Distribute the number of apprentices or trainees among the work classifications on the basis of your needs and the availability of journeymen in the various classifications within a reasonable recruitment area.

Before starting work, submit:

1. Number of apprentices or trainees to be trained for each classification
2. Training program to be used
3. Training starting date for each classification

Obtain the Department's approval for this submitted information before you start work. The Department credits you for each apprentice or trainee you employ on the work who is currently enrolled or becomes enrolled in an approved program.

The primary objective of section 7-1.11D is to train and upgrade minorities and women toward journeymen status. Make every effort to enroll minority and women apprentices or trainees, such as conducting systematic and direct recruitment through public and private sources likely to yield minority and women apprentices or trainees, to the extent they are available within a reasonable recruitment area. Show that you have made the efforts. In making these efforts, do not discriminate against any applicant for training.

Do not employ as an apprentice or trainee an employee:

1. In any classification in which the employee has successfully completed a training course leading to journeyman status or in which the employee has been employed as a journeyman
2. Who is not registered in a program approved by the US Department of Labor, Bureau of Apprenticeship and Training

Ask the employee if the employee has successfully completed a training course leading to journeyman status or has been employed as a journeyman. Your records must show the employee's answers to the questions.

In your training program, establish the minimum length and training type for each classification. The Department and FHWA approves a program if one of the following conditions is met:

1. Program is calculated to:
   1.1. Meet your equal employment opportunity responsibilities.
   1.2. Qualify the average apprentice or trainee for journeyman status in the classification involved by the end of the training period.
2. Program is registered with the US Department of Labor, Bureau of Apprenticeship and Training and it is administered in a way consistent with the equal employment responsibilities of federal-aid highway construction contracts.

Obtain Department approval for your training program before you start work involving the classification covered by the program.

Provide training in the construction crafts, not in clerk-typist or secretarial-type positions. Training is allowed in lower-level management positions such as office engineers, estimators, and timekeepers if the training is oriented toward construction applications. Training is allowed in the laborer classification if significant and meaningful training is provided and approved by the FHWA division office. Off-site training is allowed if the training is an integral part of an approved training program and does not make up a significant part of the overall training.

The Department reimburses you 80 cents per hour of training given an employee on this Contract under an approved training program:

1. For on-site training
2. For off-site training if the apprentice or trainee is currently employed under a federal-aid contract and you do at least one of the following:
   2.1. Contribute to the cost of the training
   2.2. Provide the instruction to the apprentice or trainee
   2.3. Pay the apprentice's or trainee's wages during the off-site training period
3. If you comply with section 7-1.11D

Each apprentice or trainee must:

1. Start training on the project as soon as feasible after the start of work involving the apprentice's or trainee's craft
2. Remain on the project as long as training opportunities exist in the apprentice's or trainee's work classification or until the apprentice or trainee has completed the training program

Furnish the apprentice or trainee:

1. Copy of the program you will comply with in providing the training
2. Certification showing the type and length of training satisfactorily completed

Maintain records and submit reports documenting your performance under section 7-1.11D.

8 PROSECUTION AND PROGRESS

8-1.01 GENERAL

Section 8 includes specifications related to prosecuting the Contract and work progress.

8-1.02 SCHEDULE

8-1.02A General

Upon completion of all work, the Department returns the withholds associated with section 8-1.02 and makes a payment adjustment for work not performed in the same manner as work-character changes.

8-1.02B Level 1 Critical Path Method Schedule

8-1.02B(1) General

Section 8-1.02B applies to a contract with a total bid less than $1 million and less than 100 original working days.

Before or at the preconstruction conference, submit a CPM baseline schedule.

For each schedule, submit:

1. Plotted original, time-scaled network diagram on a sheet at least 8-1/2 by 11 inches with a title block and timeline
2. Read-only compact disc or other Engineer-authorized data-storage device containing the schedule data if software is used to make the schedule. Label the device with:
   2.1. Contract number
   2.2. CPM schedule number and date produced
   2.3. File name

8-1.02B(2) Schedule Format

On each schedule, show:

1. Planned and actual start and completion dates of each work activity, including applicable:
   1.1. Submittal development
   1.2. Submittal review and acceptance
   1.3. Material procurement
   1.4. Contract milestones and constraints
   1.5. Equipment and plant setup
   1.6. Interfaces with outside entities
   1.7. Erection and removal of falsework and shoring
   1.8. Test periods
   1.9. Major traffic stage change
   1.10. Final cleanup
2. Order that you propose to prosecute the work
3. Logical links between the time-scaled work activities
4. All controlling activities
5. Legible description of each activity
6. At least 1 predecessor and 1 successor to each activity except for project start and project end milestones
7. Duration of at least 1 working day for each activity
8. Start milestone date as the Contract approval date

8-1.02B(3) Updated Schedule

Submit a monthly updated schedule that includes the status of work completed to date and the work yet to be performed as planned.

You may include changes to updated schedules that do not alter a critical path or extend the scheduled completion date compared to the current schedule. Changes may include:

1. Adding or deleting activities
2. Changing activity constraints
3. Changing durations

4. Changing logic

If any proposed change in planned work would alter the critical path or extend the scheduled completion date, submit a revised schedule within 15 days of the proposed change.

8-1.02C Level 2 Critical Path Method Schedule

8-1.02C(1) General

Section 8-1.02C applies to a contract with (1) a total bid less than $1 million and 100 or more original working days, (2) a total bid from $1 to $5 million, or (3) a total bid over $5 million and less than 100 original working days.

Submit baseline, monthly updated, and final updated schedules, each consistent in all respects with the time and order of Contract work requirements. Perform work in the sequence indicated on the current accepted schedule.

Use computer software to prepare each schedule.

Ensure that all activity sequences are logical and that each schedule shows a coordinated plan for completing of the work.

If the Contract includes construction staging and you propose changes to the described staging, do not perform work affected by the proposed changes until the Engineer accepts your schedule. A change to the schedule that changes the described staging is change order work.

The Engineer's review and acceptance of schedules does not void any Contract part and does not void your responsibility for submitting complete and accurate information.

Correct rejected schedules and resubmit them within 7 days of notification by the Engineer. Allow 7 days for review of the resubmittal.

Errors or omissions on schedules do not void your responsibility for completing all work within the time specified for completion of the work.

If either you or the Engineer discovers that any aspect of the schedule has an error or omission after a schedule has been accepted, correct it on the next updated schedule.

8-1.02C(2) Schedule Format

For the schedule format, comply with the 1st paragraph of section 8-1.02B(2) and show:

1. Calculations using the CPM to determine controlling activities.
2. Duration activities less than 20 working days.
3. Each required constraint. Constraints other than those required by the specifications may be included only if authorized.

8-1.02C(3) Computer Software

8-1.02C(3)(a) General

Submit a description of your proposed schedule software for authorization.

Software must be compatible with the current version of the Microsoft Windows operating system in use by the Engineer.

The schedule software must include the latest version of Primavera P6 for Windows or equal.

Any proposed schedule software equal to Primavera P6 must be capable of:

1. Generating files that can be imported into Primavera P6
2. Comparing 2 schedules and providing reports of changes in activity ID, activity description, constraints, calendar assignments, durations, and logic ties

8-1.02C(3)(b) Reserved

8-1.02C(4) Data and Network Diagrams

For each schedule, submit:

1. 1 data-storage device containing the schedule data
2. 2 sets of originally plotted, time-scaled network diagrams

The data-storage device must comply with item 2 of the 3rd paragraph of section 8-1.02B(1).

The time-scaled network diagrams must:

1. Show a continuous flow of information from left to right
2. Be based on early start and early finish dates of activities
3. Clearly show the primary critical path using graphical presentation
4. Be on 11 by 17 inches or larger sheets
5. Include a title block and a timeline on each page

8-1.02C(5) Baseline Schedule

Submit a baseline schedule and all support data within 20 days of Contract approval. Allow 20 days for review after the submittal.

Starting the week the baseline schedule is first submitted, meet with the Engineer weekly to discuss and resolve schedule issues until the baseline schedule is accepted.

The baseline schedule must include the entire scope of work and how you plan to complete all work contemplated.

The baseline schedule must show the activities that define the critical path. Multiple critical paths and near-critical paths must be kept to a minimum. A total of not more than 50 percent of the baseline schedule activities must be critical or near critical unless otherwise authorized.

The baseline schedule must not extend beyond the number of original working days.

8-1.02C(6) Updated Schedule

Each updated schedule must comply with section 8-1.02B(3).

Meet with the Engineer to review work progress on or before the 1st day of each month, starting 1 month after the baseline schedule is accepted.

Allow 15 days for review after the updated schedule and all support data are submitted. The review period does not start until the previous month's required schedule is accepted.

Updated schedules not accepted or rejected within the review period are accepted.

The updated schedule must:

1. Have a data date of the 21st day of the month or other date established by the Engineer
2. Show changes from accepted revised schedules

8-1.02C(7) Final Updated Schedule

Submit a final updated as-built schedule with actual start and finish dates for the activities within 30 days after work completion.

Submit a written certificate with this submittal signed by your project manager or an officer of the company stating:

> "To my knowledge and belief, the enclosed final updated schedule reflects the actual start and finish dates of the actual activities for the project contained herein."

An officer of the company may delegate in writing the authority to sign the certificate to a responsible manager.

8-1.02D Level 3 Critical Path Method Schedule

8-1.02D(1) General

Section 8-1.02D applies to a contract with a total bid over $5 million and 100 or more original working days.

Comply with section 8-1.02C(1).

8-1.02D(2) Schedule Format

For the schedule format, comply with section 8-1.02C(2) and show:

1. At least 50 but not more than 500 activities unless authorized. The number of activities must be sufficient to assure adequate planning of the project, to permit monitoring and evaluation of progress, and to do an analysis of time impacts.
2. Department-owned float as the predecessor activity to the scheduled completion date.
3. Activities with identification codes for responsibility, stage, work shifts, location, and bid items.

You may show early completion time on any schedule if you comply with the Contract. Early completion time is a resource for your exclusive use. You may increase early completion time by improving production, reallocating resources to be more efficient, performing sequential activities concurrently, or by completing activities earlier than planned. You may also submit a VECP that will reduce construction time.

You may show a scheduled completion date that is later than the work completion date on an updated schedule after the baseline schedule is accepted. Provide an explanation for a late scheduled completion date in the narrative report included with the schedule.

8-1.02D(3) Computer Software

Computer software must comply with section 8-1.02C(3).

8-1.02D(4) Data, Network Diagrams, and Reports

For each schedule submittal, submit:

1. 1 data-storage device containing the schedule data
2. 2 sets of originally plotted, time-scaled network diagrams
3. 2 copies of a narrative report

The data-storage device must comply with item 2 of the 3rd paragraph of section 8-1.02B(1).

The network diagrams must comply with section 8-1.02C(4) except the sheets must be 34 by 44 inches.

The narrative report must be organized in the following sequence with all applicable documents included:

1. Transmittal letter
2. Work completed during the period
3. Identification of unusual conditions or restrictions regarding labor, equipment, or material; including multiple shifts, 6-day work weeks, specified overtime or work at times other than regular days or hours
4. Description of the current critical path
5. Changes to the critical path and scheduled completion date since the last schedule submittal
6. Description of problem areas
7. Current and anticipated delays, including:
   - 7.1. Cause of delay
   - 7.2. Impact of delay on other activities, milestones, and completion dates
   - 7.3. Corrective action and schedule adjustments to correct the delay
8. Pending items and status of:
   - 8.1. Permits
   - 8.2. Change orders
   - 8.3. Time adjustments
   - 8.4. Noncompliance notices
9. Reasons for an early or late scheduled completion date in comparison to the work completion date

8-1.02D(5) Preconstruction Scheduling Conference

Hold a preconstruction scheduling conference with your project manager and the Engineer within 15 days after Contract approval. The Engineer conducts the conference and reviews the specifications for a Level 3 CPM schedule with you.

Within 10 days after Contract approval, submit a general time-scaled logic diagram showing the major activities and sequence of planned operations. Be prepared to discuss the proposed work plan and schedule methodology during the preconstruction scheduling conference.

If the Contract includes construction staging and you propose changes to the described staging, the general time-scaled logic diagram must show the changes and resulting time impacts. Be prepared to discuss your proposal.

At this conference, submit the alphanumeric coding structure and activity identification system for labeling work activities.

To easily identify relationships, each activity description must indicate its associated scope or location of work by including such terms as quantity of material, type of work, bridge number, station to station location, side of highway (such as left, right, northbound, or southbound), lane number, shoulder, ramp name, ramp line descriptor, or mainline.

The Engineer reviews the logic diagram, coding structure, and activity identification system and provides any required baseline schedule changes to you for implementation.

8-1.02D(6) Baseline Schedule

The baseline schedule must comply with section 8-1.02C(5).

The baseline schedule must have a data date of Contract approval.

If you start work before Contract approval, the baseline schedule must have a data date of the 1st day you performed work at the job site.

If you submit an early completion baseline schedule that shows work completion in less than 85 percent of the original working days, the baseline schedule must be supplemented with resource allocations for every task activity and include time-scaled resource histograms. Resource allocations must be shown to a level of detail that facilitates report generation based on labor crafts and equipment classes for you and your subcontractors.

Use average composite crews to display the labor loading of job site construction activities. Optimize and level labor to reflect a reasonable plan for accomplishing the work and to assure that resources are not duplicated in concurrent activities.

The time-scaled resource histograms must show labor crafts and equipment classes to be used.

The Engineer may review the baseline schedule activity resource allocations using *Means Productivity Standards for Construction* or equivalent to determine whether the schedule is practicable.

8-1.02D(7) Updated Schedule

The updated schedule must comply with section 8-1.02C(6) except the 5th paragraph.

The updated schedule must:

1. Have a data date of the 21st day of the month or other date established by the Engineer
2. Show the status of work actually completed to date and the work yet to be performed as planned
3. Show actual activity start dates, percent complete, and finish dates
4. Show durations for work that has been completed as the work actually occurred, including the Engineer's review and your resubmittal times

Justify in writing the reasons for any changes to planned work. If any proposed changes in planned work results in altering a critical path or near critical path or extending the schedule completion date, submit a revised schedule and a TIA within 15 days of the proposed change.

8-1.02D(8) Time Impact Analysis

8-1.02D(8)(a) General

Submit a TIA with each request for adjustment of Contract time or whenever you or the Engineer considers that an authorized or anticipated change may impact the critical path or work progress.

The TIA must:

1. Illustrate the impacts of each change or delay on the current scheduled completion date or internal milestone.
2. Use the accepted schedule that has a data date closest to and before the event. If the Engineer determines that the accepted schedule used does not appropriately represent the conditions before the event, the accepted schedule must be updated to the day before the event being analyzed.
3. Include an impact schedule developed from incorporating the event into the accepted schedule by adding or deleting activities or by changing durations or logic of existing activities. If the impact schedule shows that incorporating the event modifies the critical path and scheduled completion date of the accepted schedule, the difference between scheduled completion dates of the 2 schedules must be equal to the adjustment of Contract time.

The Engineer may construct and use an appropriate project schedule or other recognized method to determine adjustments in Contract time until you submit the TIA.

Submit 2 copies of the TIA within 20 days of receiving a written request for a TIA. Allow 15 days for review of the submitted TIA. Authorized TIA schedule changes must be shown on the next updated schedule.

If a TIA you submit is rejected, meet with the Engineer to discuss and resolve issues related to the TIA. If clarification is needed after you meet, you are allowed 15 days to submit a protest. If agreement is not reached, you are allowed 5 business days from the date you receive the Engineer's response to your protest to submit an Initial Potential Claim Record form.

Show only actual as-built work, not unauthorized changes related to the TIA, in subsequent updated schedules.

If agreement is reached at a later date, the authorized TIA schedule changes must be shown on the next updated schedule.

The Department withholds remaining payment on the progress schedule (critical path method) bid item if a TIA is requested and not submitted within 20 days.

The Department returns the withhold in the next progress payment after the submittal of the requested TIA.

8-1.02D(8)(b) Department-Owned Float

Prepare a TIA whenever requested to determine the effect of Department-owned float. Department-owned float is a resource for the exclusive use of the Department.

The Engineer may accrue Department-owned float by early review completion of any submittal if the early review completion saves time on the critical path.

The Engineer documents Department-owned float by ordering you to update the Department-owned float activity on the next updated schedule.

Include a log of the action on the Department-owned float activity and include a discussion of the action in the narrative report.

The Engineer may use Department-owned float to mitigate past, present, or future Department delays by offsetting a potential time extension for a Change Order.

8-1.02D(8)(c) Ordered Changes

For an ordered change that affects the scheduled completion date, prepare a TIA to determine the effect of adjusting Contract working days.

Include the impacts of the ordered change in the next updated schedule.

An ordered change that affects the controlling activity on the critical path is a basis for a time adjustment.

The Department grants a time extension only if the total float is absorbed and the scheduled completion date is delayed 1 or more working days due to the ordered change.

8-1.02D(9) Final Updated Schedule

The final updated schedule must comply with section 8-1.02C(7).

8-1.02D(10) Payment

The Department pays you for progress schedule (critical path method) as follows:

1. A total of 25 percent of the item total is paid upon:
   1.1. Completion of 5 percent of all work
   1.2. Acceptance of schedules and authorization of TIAs required when 5 percent of all work is complete
2. A total of 50 percent of the item total is paid upon completion of 25 percent of all work and acceptance of schedules and authorization of TIAs required when 25 percent of all work is complete
3. A total of 75 percent of the item total is paid upon completion of 50 percent of all work and acceptance of schedules and authorization of TIAs required when 50 percent of all work is complete
4. A total of 100 percent of the item total is paid upon completion of all work, acceptance of schedules and authorization of TIAs required when all work is complete, and submittal of the certified final updated schedule

The Department does not adjust payment for any increased or decreased work ordered in submitting schedules.

8-1.02E–8-1.02F Reserved

8-1.03 PRECONSTRUCTION CONFERENCE

Attend a preconstruction conference with key personnel, including your assigned representative, at a time and location determined by the Engineer. Submit documents as required before the preconstruction conference. You may start work before the preconstruction conference.

Be prepared to discuss the topics and documents shown in the following table:

Topic	Document
Potential claim and dispute resolution	Potential claim forms
Contractor's representation	Assignment of Contractor's representative
DBE and DVBE	Final utilization reports
Equipment	Equipment list
Labor compliance and equal employment opportunity	Job site posters and benefit and payroll reports
Material inspection	Notice of Materials to be Used form
Materials on hand	Request for Payment for Materials on Hand form
Measurements	--
Partnering	--
Quality control	QC plans
Safety	Injury and Illness Prevention Program and job site posters
Schedule	Baseline schedule and Weekly Statement of Working Days form
Subcontracting	Subcontracting Request form
Surveying	Survey Request form
Traffic control	Traffic contingency plan and traffic control plans
Utility work	--
Weight limitations	--
Water pollution control	SWPPP or WPCP
Work restrictions	PLACs
Action submittals	--

8-1.04 START OF JOB SITE ACTIVITIES

8-1.04A General

Reserved

8-1.04B Standard Start

For a project that does not require a SWPPP, start job site activities within 15 days after receiving notice that the Contract has been approved by the Attorney General or the attorney appointed and authorized to represent the Department.

For a project that requires a SWPPP, start job site activities within 55 days after receiving notice that the Contract has been approved by the Attorney General or the attorney appointed and authorized to represent the Department.

Submit a notice 72 hours before starting job site activities. If the project has more than 1 work location, submit a separate notice for each location.

You may start job site activities before receiving notice of Contract approval if you:

1. Deliver the signed Contract, bonds, and evidence of insurance to the Department
2. Submit a 72-hour notice
3. Obtain an encroachment permit from the Department
4. Receive the Department's authorization to start
5. Perform work at your own risk
6. Perform work under the Contract

If the Contract is approved, work already performed that complies with the Contract is authorized.

If the Contract is not approved, leave the job site in a neat condition. If a facility has been changed, restore it to its former condition or an equivalent condition. The Department does not pay for the restoration.

The Department does not adjust time for work performed before Contract approval.

8-1.04C Delayed Start

Reserved

8-1.04D Early Return-Early Start

Reserved

8-1.04E Next-Day Start

Reserved

8-1.04F Flexible Start

Reserved

8-1.04G Potential Budget Impasse Start

Reserved

8-1.04H–8-1.04J Reserved

8-1.05 TIME

The contract time starts on the earlier of the following:

1. Day you start job site activities after Contract approval
2. Last day specified to start job site activities in section 8-1.04

Complete the work within the Contract time.

Meet each specified interim work-completion date.

The Engineer issues a Weekly Statement of Working Days form by the end of the following week.

The Weekly Statement of Working Days form shows:

1. Working days and non–working days during the reporting week
2. Time adjustments
3. Calculations of work completion dates, including working days remaining

4. Controlling activities

8-1.06 SUSPENSIONS

The Engineer may suspend work wholly or in part due to conditions unsuitable for work progress. Provide for public safety and a smooth and unobstructed passageway through the work zone during the suspension as specified in sections 7-1.03 and 7-1.04. Providing the passageway is force account work. The Department makes a time adjustment for the suspension due to a critical delay.

The Engineer may suspend work wholly or in part due to your failure to (1) fulfill the Engineer's orders, (2) fulfill a Contract part, or (3) perform weather-dependent work when conditions are favorable so that weather-related unsuitable conditions are avoided or do not occur. The Department may provide for a smooth and unobstructed passageway through the work during the suspension and deduct the cost from payments. The Department does not make a time adjustment for the suspension.

Upon the Engineer's order of suspension, suspend work immediately. Resume work when ordered.

8-1.07 DELAYS

8-1.07A General

To request a delay-related time or payment adjustment, submit an RFI.

8-1.07B Time Adjustments

The Department may make a time adjustment for a critical delay. The Engineer uses information from the schedule to evaluate requests for time adjustments.

To request an adjustment, submit a revised schedule showing the delay's effect on the controlling activity. If the delay has:

1. Occurred, submit records of the dates and what work was performed during the delayed activity
2. Not occurred, submit the expected dates or duration of the delayed activity

Update the schedule to the last working day before the start of the delay if ordered.

8-1.07C Payment Adjustments

The Department may make a payment adjustment for an excusable delay that affects your costs.

Only losses for idle equipment, idle workers, and moving or transporting equipment are eligible for delay-related payment adjustments.

The Engineer determines payment for idle time of equipment in the same manner as determinations are made for equipment used in the performance of force account work under section 9-1.04 with the following exceptions:

1. Delay factor in the *Labor Surcharge and Equipment Rental Rates* applies to each equipment rental rate.
2. Daily number of payable hours equals the normal working hours during the delay, not to exceed 8 hours per day.
3. Delay days exclude non–working days.
4. Markups are not added.

The Engineer determines payment adjustment for the idle workers under section 9-1.04B, but does not add markups.

The Engineer includes costs due to necessary extra moving or transporting of equipment.

The Department does not make a payment adjustment for overhead incurred during non–working days of additional construction seasons experienced because of delay.

8-1.08–8-1.09 RESERVED

8-1.10 LIQUIDATED DAMAGES

8-1.10A General

The Department specifies liquidated damages (Pub Cont Code § 10226). Liquidated damages, if any, accrue starting on the 1st day after the expiration of the working days through the day of Contract acceptance except as specified in sections 8-1.10B and 8-1.10C.

The Department withholds liquidated damages before the accrual date if the anticipated liquidated damages may exceed the value of the remaining work.

Liquidated damages for all work except plant establishment or permanent erosion control establishment are as shown in the following table:

Liquidated Damages

Total bid		Liquidated damages per day
From over	To	
$0	$60,000	$1,400
$60,000	$200,000	$2,900
$200,000	$500,000	$3,200
$500,000	$1,000,000	$3,500
$1,000,000	$2,000,000	$4,000
$2,000,000	$5,000,000	$4,800
$5,000,000	$10,000,000	$6,800
$10,000,000	$20,000,000	$10,000
$20,000,000	$50,000,000	$13,500
$50,000,000	$100,000,000	$19,200
$100,000,000	$250,000,000	$25,300

If all work except plant establishment or permanent erosion control establishment is complete and the total number of working days have expired, liquidated damages are $950 per day.

8-1.10B Failure to Complete Work Parts within Specified Times

The Department may deduct specified damages from payments for each day needed to complete a work part in excess of the time specified for completing the work part.

Damages for untimely completion of work parts may not be equal to the daily amount specified as liquidated damages for the project as a whole, but the Department does not simultaneously assess damages for untimely completion of work parts and for the whole work.

Damages accrue starting the 1st day after a work part exceeds the specified time through the day the specified work part is complete.

8-1.10C Failure to Complete Work Parts by Specified Dates

The Department may deduct specified damages from payments for each day needed to complete a work part in excess of the specified completion date for the work part.

Damages for untimely completion of a work part may not be equal to the daily amount specified as liquidated damages for the project as a whole, but the Department does not simultaneously assess damages for untimely completion of a work part and the whole work.

Damages accrue starting the 1st day after an unmet completion date through the day the work part is complete.

8-1.10D Reserved

8-1.11–8-1.12 RESERVED

8-1.13 CONTRACTOR'S CONTROL TERMINATION

The Department may terminate your control of the work for failure to do any of the following (Pub Cont Code § 10253):

1. Supply an adequate workforce
2. Supply material as described
3. Pay subcontractors (Pub Cont Code §10262)
4. Prosecute the work as described in the Contract

The Department may also terminate your control for failure to maintain insurance coverage.

For a federal-aid project, the Department may terminate your control of the work for failure to include "Required Contract Provisions, Federal-Aid Construction Contracts" in subcontracts.

The Department gives notice to you and your surety at least 5 business days before terminating control. The notice describes the failures and the time allowed to remedy the failures. If failures are not remedied within the time provided, the Department takes control of the work.

The Department may complete the work if the Department terminates the Contractor's control or you abandon the project (Pub Cont Code § 10255). The Department determines the unpaid balance under Pub Cont Code § 10258 and the Contract.

At any time before final payment of all claims, the Department may convert a Contractor's control termination to a Contract termination.

8-1.14 CONTRACT TERMINATION

8-1.14A General

The Director may terminate the Contract if it serves the State's best interest. The Department issues you a written notice, implements the termination, and pays you.

8-1.14B Relief from Responsibility for Work

Upon receiving a termination notice:

1. Stop work
2. Notify subcontractors and suppliers of the Contract termination and stop Contract-related work
3. Perform the Engineer-ordered work to secure the job site for termination
4. Remove equipment
5. Subject to the Engineer's authorization, settle termination-related claims and liabilities involving subcontractors and suppliers; assign to the Department the rights, titles, or interests held by you with respect to these parties

8-1.14C Responsibility for Materials

Upon receiving a termination notice, protect unused material until:

1. You submit an inventory of materials already produced, purchased, or ordered but not yet used; include the location of the material.
2. The Engineer identifies materials that will be retained by the Department. Submit bills of sales or other records of material title.
3. The Engineer confirms that unused materials paid by progress payment and materials furnished by the State have been delivered and stored as ordered.
4. The titles are transferred for materials purchased by the Department.

Dispose of materials that will not be retained by the Department.

8-1.14D Contract Acceptance after Termination

The Engineer recommends Contract acceptance after determining the completion of:

1. Work ordered to be completed before termination
2. Other work ordered to secure the project before termination
3. Material delivery and title transfer

The Department pays you under section 9-1.17.

8-1.14E Payment Adjustment for Termination

If the Department issues a termination notice, the Engineer determines the payment for termination based on the following:

1. Direct cost for the work:
    1.1. Including:
        1.1.1. Mobilization.
        1.1.2. Demobilization.
        1.1.3. Securing the job site for termination.
        1.1.4. Losses from the sale of materials.
    1.2. Not including:
        1.2.1. Cost of materials you keep.
        1.2.2. Profit realized from the sale of materials.
        1.2.3. Cost of material damaged by:
            1.2.3.1. Act of God.
            1.2.3.2. Act of a public enemy.
            1.2.3.3. Fire.
            1.2.3.4. Flood.
            1.2.3.5. Governor-declared state of emergency.
            1.2.3.6. Landslide.
            1.2.3.7. Tsunami.
        1.2.4. Other credits.
2. Cost of remedial work, as estimated by the Engineer, is not reimbursed.
3. Allowance for profit not to exceed 4 percent of the cost of the work. Prove a likelihood of having made a profit had the Contract not been terminated.
4. Material handling costs for material returned to the vendor or disposed of as ordered.
5. Costs in determining the payment adjustment due to the termination, excluding attorney fees and litigation costs.

Termination of the Contract does not relieve the surety of its obligation for any just claims arising out of the work performed.

8-1.15–8-1.16 RESERVED

9 PAYMENT

9-1.01 GENERAL

Section 9 includes specifications related to work payment.

9-1.02 MEASUREMENT

9-1.02A General

The Department determines bid item quantities under US customary units.

Except for final pay item quantities, the Engineer measures quantities for payment.

9-1.02B Weighing Equipment and Procedures

9-1.02B(1) General

Measure material quantities for payment with devices that comply with:

1. 4 CA Code of Regs § 4000 et seq.
2. Bus & Prof Code § 12001 et seq.

To determine the material payment quantities, use measuring devices that have been sealed by the Department of Food and Agriculture's Division of Measurement Standards or its designated representative.

If a device is not type approved by the Division of Measurement Standards, type approve it under California Test 109.

Notify the Engineer at least 1 business day before equipment testing.

Use material plant controllers having elements affecting the data accuracy and delivery that have been sealed by the Engineer. Make these elements available to the Engineer for inspection. If the elements are adequate for use, the Engineer seals them. If manipulation of a security seal occurs, stop material production. Do not resume production until the Engineer reinspects and reseals the device.

Measure material paid for by weight on sealed scales regularly inspected by the Department of Food and Agriculture's Division of Measurement Standards or its designated representative.

Obtain authorization of portable vehicle scale installations before sealing.

9-1.02B(2) Equipment

Each scale must be long enough to fit an entire vehicle or a combination vehicle on the scale deck. The Department allows you to weigh a combination vehicle separately if you disconnect the vehicles.

Construct scale undersupports:

1. Using portland cement concrete containing at least 470 pounds of cementitious material per cubic yard produced from commercial quality materials
2. Such that footing heights are at least 20 inches thick
3. With a bearing surface at least 30 inches wide and bearing pressure on the footing not over 4,000 lb/sq ft

In constructing a scale:

1. Provide drainage to prevent water from saturating the ground under the scale
2. Use bulkheads that prevent displacement
3. If shimming is necessary:
   3.1. Use securely attached metal shims or grout
   3.2. Do not use wedges to shim the supports
   3.3. Do not use shim material in excess of 3 inches
4. Install mechanical indicating elements level, plumb, and rigidly mounted on the concrete undersupports
5. For a hopper scale, rigidly attach the lever systems and mechanical indicating elements such that no weight is lost from bending or support distortion

Each scale used to determine material payment quantities must be operated by a licensed weighmaster (Bus & Prof Code § 12700 et seq.).

Submit a public weighmaster's certificate or certified daily summary weigh sheets for each weighed material quantity. The Department may witness material weighing and check and compile the daily scale-weight record.

Each vehicle operator must obtain weight or load slips from the weighmaster. Submit these records at the delivery point.

9-1.02B(3) Procedures

Each day weigh empty vehicles used to haul material paid for by weight. Each vehicle must have a legible identification mark. The Department may verify a material weight by having an empty and loaded vehicle weighed on any scale the Engineer designates.

If imported topsoil, soil amendment, wood mulch, or compost is measured by volume:

1. Each vehicle must allow for an accurate determination of its contents
2. Unless vehicles are of uniform capacity, each vehicle must have a legible identification mark showing its volumetric capacity
3. Load vehicles to at least the volumetric capacity
4. Level vehicle loads on arrival at the delivery point

If determining a quantity paid on a volume basis is impractical or if authorized, weigh the material and the Engineer converts the result to a volume measurement. The Engineer determines the conversion factors and, if you agree, adopts this method of measurement.

9-1.02C Final Pay Item Quantities

The Department shows a bid item quantity as a final pay item for payment purposes only. For a final pay item, accept payment based on the Bid Item List quantity, regardless of the actual quantity used unless dimensions are changed by the Engineer.

9-1.02D Quantities of Aggregate and Other Roadway Materials

The Engineer determines the weights of aggregate and other roadway material that are being paid for by weight as shown in the following table and does not include the deducted weight of water in their payment quantities:

Determination of Quantities of Aggregate and Other Roadway Materials

Material	Quantity determination
Aggregate or other roadway material except as otherwise shown in this table	By deducting the weight of water in the material[a] in excess of 3 percent of the dry weight of the material from the weight of the material
Imported borrow, imported topsoil, AB	By deducting the weight of water in the material[a] in excess of 6 percent of the dry weight of the material from the weight of the material
Straw	By deducting the weight of water in the material[a] in excess of 15 percent of the dry weight of the material from the weight of the material
Fiber[b]	Engineer does not deduct the weight of water
AB and aggregate for CTBs	As specified in section 26 and section 27

NOTE: Percentage of water is determined by California Test 226.

[a]At the time of weighing

[b]Weight of water in the fiber[a] must not exceed 15 percent of the dry weight of the fiber.

9-1.03 PAYMENT SCOPE

The Department pays you for furnishing the resources and activities required to complete the work. The Department's payment is full compensation for furnishing the resources and activities, including:

1. Risk, loss, damage repair, or cost of whatever character arising from or relating to the work and performance of the work

2. PLACs and taxes
3. Any royalties and costs arising from patents, trademarks, and copyrights involved in the work

The Department does not pay for your loss, damage, repair, or extra costs of whatever character arising from or relating to the work that is a direct or indirect result of your choice of construction methods, materials, equipment, or manpower, unless specifically mandated by the Contract.

Payment is:

1. Full compensation for all work involved in each bid item shown on the Bid Item List by the unit of measure shown for that bid item
2. For the price bid for each bid item shown on the Bid Item List or as changed by change order with a specified price adjustment

Full compensation for work specified in divisions I, II, and XI is included in the payment for the bid items involved unless:

1. Bid item for the work is shown on the Bid Item List
2. Work is specified as change order work

Work paid for under one bid item is not paid for under any other bid item.

Payment for a bid item includes payment for work in sections referenced by the section set forth by that bid item.

If an alternative is described in the Contract, the Department pays based on the bid items for the details and specifications not described as an alternative unless the bid item is described as an alternative, in which case, the Department pays based on the details and specifications for that alternative.

The Department pays for change order work based on one or a combination of the following:

1. Bid item prices
2. Force account
3. Agreed price
4. Specialist billing

If the Engineer chooses to pay for change order work based on an agreed price, but you and the Engineer cannot agree on the price, the Department pays by force account.

If a portion of extra work is covered by bid items, the Department pays for this work as changed quantities in those items. The Department pays for the remaining portion of the extra work by force account or agreed price.

The Department pays 10 percent annual interest for unpaid and undisputed:

1. Progress payments
2. After-acceptance payment except for claims

For these payments, interest starts to accrue 30 days after the 1st working day following the 20th day of the month that payment is due. For a change order bill not submitted within 7 days after performing the work, interest starts to accrue 60 days after the 1st working day following the 20th day of the month that payment is due.

The Department pays 6 percent annual interest for unpaid and undisputed claims. Interest starts to accrue 61 days after the Department accepts a claim statement.

The Department pays 6 percent annual interest for awards in arbitration (Civ Code § 3289).

If the amount of a deduction or withhold exceeds the final payment, the Department invoices you for the difference, to be paid upon receipt.

Pay your subcontractors within 7 days of receipt of each progress payment under Pub Cont Code §§ 10262 and 10262.5.

9-1.04 FORCE ACCOUNT

9-1.04A General

For work paid by force account, the Engineer compares the Department's records to your daily force-account work report. When you and the Engineer agree on the contents of the daily force-account work reports, the Engineer accepts the report and the Department pays for the work. If the records differ, the Department pays for the work based only on the information shown on the Department's records.

If a subcontractor performs work at force account, accept an additional 10 percent markup to the total cost of that work paid at force account, including markups specified in section 9-1.04, as reimbursement for additional administrative costs.

The markups specified for labor, materials, and equipment include compensation for all delay costs, overhead costs, and profit.

If an item's unit price is adjusted for work-character changes, the Department excludes your cost of determining the adjustment.

Payment for owner-operated labor and equipment is made at the market-priced invoice submitted.

For nonsubcontracted work paid by force account for a contract with a TRO bid item, the markups are those shown in the following table instead of those specified in sections 9-1.04B–D:

Cost	Percent markup
Labor	30
Materials	10
Equipment rental	10

9-1.04B Labor

Labor payment is full compensation for the cost of labor used in the direct performance of the work plus a 35 percent markup. Force-account labor payment consists of:

1. Employer payment to the worker for:
   1.1. Basic hourly wage
   1.2. Health and welfare
   1.3. Pension
   1.4. Vacation
   1.5. Training
   1.6. Other State- and federal-recognized fringe benefit payments
2. Labor surcharge percentage in *Labor Surcharge and Equipment Rental Rates* current during the work paid at force account for:
   2.1. Workers' compensation insurance
   2.2. Social security
   2.3. Medicare
   2.4. Federal unemployment insurance
   2.5. State unemployment insurance
   2.6. State training taxes
3. Subsistence and travel allowances paid to the workers
4. Employer payment to supervisors if authorized

The 35 percent markup consists of payment for all overhead costs related to labor but not designated as costs of the labor used in the direct performance of the work, including:

1. Home office overhead
2. Field office overhead
3. Bond costs
4. Profit
5. Labor liability insurance
6. Other fixed or administrative costs that are not costs of the labor used in the direct performance of the work

9-1.04C Materials

Material payment is full compensation for materials you furnish and use in the work. The Engineer determines the cost based on the material purchase price, including delivery charges, except:

1. 15 percent markup is added
2. Supplier discounts are subtracted whether you took them or not
3. If the Engineer believes the material purchase prices are excessive, the Department pays the lowest current wholesale price for a similar material quantity
4. If you procured the materials from a source you wholly or partially own, the determined cost is based on the lower of the:
   4.1. Price paid by the purchaser for similar materials from that source on Contract items
   4.2. Current wholesale price for those materials
5. If you do not submit a material cost record within 30 days of billing, the determined cost is based on the lowest wholesale price:
   5.1. During that period
   5.2. In the quantities used

9-1.04D Equipment Rental

9-1.04D(1) General

Equipment rental payment is full compensation for:

1. Rental equipment costs, including moving the equipment to and from the change order work site using its own power.
2. Transport equipment costs for rental equipment that cannot be transported economically using its own power. No payment is made during transport for the transported equipment.
3. 15 percent markup.

If you want to return the equipment to a location other than its original location, the payment to move the equipment must not exceed the cost of returning the equipment to its original location. If you use the equipment for work other than work paid by force account, the transportation cost is included in the other work.

Before moving or loading the equipment, obtain authorization for the equipment rental's original location.

The Engineer determines rental costs:

1. Using the rates in *Labor Surcharge and Equipment Rental Rates*:
   1.1. By classifying equipment using manufacturer's ratings and manufacturer-approved changes.
   1.2. Current during the work paid by force account.
   1.3. Regardless of equipment ownership; but the Department uses the rental document rates or minimum rental cost terms if:
      1.3.1. Rented from an equipment business you do not own.
      1.3.2. Hourly rate in *Labor Surcharge and Equipment Rental Rates* is $10.00 per hour or less.
2. Using the rates established by the Engineer for equipment not listed in *Labor Surcharge and Equipment Rental Rates*. You may submit cost information that helps the Engineer establish the rental rate; but the Department uses the rental document rates or minimum rental cost terms if:
   2.1. Rented from an equipment business you do not own.
   2.2. The Engineer establishes a rate of $10.00 per hour or less.
3. Using rates for transport equipment not exceeding the hourly rates charged by established haulers.

Equipment rental rates include the cost of:

1. Fuel
2. Oil
3. Lubrication
4. Supplies
5. Small tools that are not consumed by use
6. Necessary attachments
7. Repairs and maintenance
8. Depreciation
9. Storage
10. Insurance
11. Incidentals

The Department pays for small tools consumed by use. The Engineer determines the payment for small tools consumed by use based on Contractor-submitted invoices.

The Engineer may authorize rates in excess of those in the *Labor Surcharge and Equipment Rental Rates* if:

1. You submit a request to use rented equipment
2. Equipment is not available from your normal sources or from one of your subcontractors
3. Rented equipment is from an independent rental company
4. Proposed equipment rental rate is reasonable
5. The Engineer authorizes the equipment source and the rental rate before you use the equipment

The Department pays for fuel consumed during the operation of rented equipment not included in the invoiced rental rates.

9-1.04D(2) Equipment On the Job Site

For equipment on the job site at the time required to perform work paid by force account, the time paid is the time:

1. To move the equipment to the location of work paid by force account plus an equal amount of time to move the equipment to another location on the job site when the work paid by force account is completed
2. To load and unload equipment
3. Equipment is operated to perform work paid by force account and:
   3.1. Hourly rates are paid in 1/2-hour increments
   3.2. Daily rates are paid in 1/2-day increments

9-1.04D(3) Equipment Not On the Job Site and Not Required for Original-Contract Work

For equipment not on the job site at the time required to perform work paid by force account and not required for the original Contract work, the time paid is the time the equipment is operated to perform work paid by force account and the time to return the equipment to its source when the work paid by force account is completed.

The minimum total time paid is:

1. 1 day if daily rates are paid
2. 8 hours if hourly rates are paid

If daily rates are recorded, equipment:

1. Idled is paid as 1/2 day
2. Operated less than 4 hours is paid as 1/2 day
3. Operated 4 hours or more is paid as 1 day

If the minimum total time exceeds 8 hours and if hourly rates are listed, the Department rounds up hours operated to the nearest 1/2-hour increment and pays based on the hours shown the following table. The table does not apply when equipment is not operated due to breakdowns, in which case rental hours are the hours the equipment was operated.

Equipment Rental Hours

Hours operated	Hours paid
0.0	4.00
0.5	4.25
1.0	4.50
1.5	4.75
2.0	5.00
2.5	5.25
3.0	5.50
3.5	5.75
4.0	6.00

4.5	6.25
5.0	6.50
5.5	6.75
6.0	7.00
6.5	7.25
7.0	7.50
7.5	7.75
≥ 8.0	hours used

9-1.04D(4) Equipment Not On the Job Site and Required for Original-Contract Work

For equipment not on the job site at the time required to perform work paid by force account and required for the original Contract work, the time paid is the time:

1. To move the equipment to the location of work paid by force account plus an equal amount of time to move the equipment to a location on the job site or its source when the work paid by force account is completed
2. Equipment is operated to perform work paid by force account

9-1.04D(5) Non-Owner-Operated Dump Truck Rental

Submit the rental rate for a non-owner-operated dump truck. The Engineer determines the payment rate. Payment for the rental of a non-owner-operated dump truck is for the cost of renting a dump truck, including its driver. For the purpose of markup payment only, the non-owner-operated dump truck is rental equipment and the owner is a subcontractor.

9-1.05 EXTRA WORK PERFORMED BY SPECIALISTS

If the Engineer determines that you or your subcontractors are not capable of performing specialty extra work, a specialist may be used. Itemize the labor, material, and equipment rental costs unless it is not the special service industry's established practice to provide itemization, in which case, the Engineer accepts current market-priced invoices for the work.

The Engineer may accept an invoice as a specialist billing for work performed at an off–job site manufacturing plant or machine shop.

The Engineer determines the cost based on the specialist invoice price minus any available or offered discounts plus a 10 percent markup.

9-1.06 CHANGED QUANTITY PAYMENT ADJUSTMENTS

9-1.06A General

The unit prices specified in section 9-1.06 are adjusted under section 9-1.04.

9-1.06B Increases of More Than 25 Percent

If the total bid item quantity exceeds 125 percent of the quantity shown on the Bid Item List and if no approved Change Order addresses payment for the quantity exceeding 125 percent, the Engineer may adjust the unit price for the excess quantity under section 9-1.04 or the following:

1. The adjustment is the difference between the unit price and the unit cost of the total item pay quantity.
2. In determining the unit cost, the Engineer excludes the item's fixed costs. You have recovered the fixed costs in the payment for 125 percent shown on the Bid Item List.
3. After excluding fixed costs, the Engineer determines the item unit cost under section 9-1.04.

If the payment for the number of units of a bid item in excess of 125 percent of the Bid Item List is less than $5,000 at the unit price, the Engineer may not adjust the unit price unless you request it.

9-1.06C Decreases of More Than 25 Percent

If the total item pay quantity is less than 75 percent of the quantity shown on the Bid Item List and if no approved Change Order addresses payment for the quantity less than 75 percent, you may request a unit price adjustment. The Engineer may adjust the unit price for the decreased quantity under section 9-1.04 or the following:

1. The adjustment is the difference between the unit price and the unit cost of the total pay quantity.
2. In determining the unit cost, the Engineer includes the item's fixed costs.
3. After including fixed costs, the Engineer determines the item unit cost under section 9-1.04.

The Department does not pay more than 75 percent of the item total in the Bid Item List.

9-1.06D Eliminated Items

If the Engineer eliminates an item, the Engineer notifies you and the Department pays your costs incurred before the notification date.

If you order authorized material for an eliminated item before the notification date and the order cannot be canceled, either of the following occurs:

1. If the material is returnable to the vendor, the Engineer orders you to return the material and the Department pays your handling costs and vendor charges.
2. The Department pays your cost for the material and its handling and becomes the material owner.

The Engineer determines the payment for the eliminated bid item under section 9-1.04.

9-1.07 PAYMENT ADJUSTMENTS FOR PRICE INDEX FLUCTUATIONS

9-1.07A General

Section 9-1.07 applies to asphalt contained in materials for pavement structures and pavement surface treatments such as HMA, tack coat, asphaltic emulsions, bituminous seals, asphalt binders, and modified asphalt binders placed in the work. Section 9-1.07 does not apply if you opted out of payment adjustments for price index fluctuations at the time of bid.

The Engineer adjusts payment whenever the California statewide crude oil price index for the month the material is placed is more than 5 percent higher or lower than the price index at the time of bid.

The Department determines the California statewide crude oil price index each month on or about the 1st business day of the month using the average of the posted prices in effect for the previous month as posted by Chevron, ExxonMobil, and ConocoPhillips for the Buena Vista and Midway Sunset fields.

If a company discontinues posting its prices for a field, the Department determines the index from the remaining posted prices. The Department may include additional fields to determine the index.

For the California statewide crude oil price index, go to the Department's Division of Construction website.

If the adjustment is a decrease in payment, the Department deducts the amount from the monthly progress payment.

The Department makes payment adjustments due to price index fluctuations for changed quantities under section 9-1.06.

If you do not complete the work within the Contract time, payment adjustments during the overrun period are determined using the California statewide crude oil price index in effect for the month in which the overrun period began.

If the price index at the time of placement increases:

1. 50 percent or more over the price index at bid opening, notify the Engineer.
2. 100 percent or more over the price index at bid opening, do not furnish material containing asphalt until the Engineer authorizes you to proceed with that work. The Department may decrease bid item quantities, eliminate bid items, or terminate the Contract.

Before placing material containing asphalt, submit the current sales and use tax rate in effect in the tax jurisdiction where the material is to be placed.

Submit a public weighmaster's certificate for HMA, tack coat, asphaltic emulsions, and modified asphalt binders, including those materials not paid for by weight. For slurry seals, submit a separate public weighmaster's certificate for the asphaltic emulsion.

9-1.07B Asphalt Quantities

9-1.07B(1) General

Reserved

9-1.07B(2) Hot Mix Asphalt

The Engineer calculates the quantity of asphalt in HMA using the following formula:

$Qh = HMATT \times Xa$

where:
Qh = quantity in tons of asphalt used in HMA
HMATT = HMA, total tons placed
Xa = theoretical asphalt content from the job mix formula, expressed as a percentage of the total weight of HMA

9-1.07B(3) Rubberized Hot Mix Asphalt

The Engineer calculates the quantity of asphalt in RHMA using the following formula:

$Qrh = RHMATT \times 0.80 \times Xarb$

where:
Qrh = quantity in tons of asphalt in asphalt rubber binder used in RHMA
RHMATT = RHMA, total tons placed
Xarb = theoretical asphalt rubber binder content from the job mix formula, expressed as a percentage of the total weight of rubberized HMA

9-1.07B(4) Hot Mix Asphalt with Modified Asphalt Binder

The Engineer calculates the quantity of asphalt in HMA with modified asphalt binder using the following formula:

$Qmh = MHMATT \times [(100 - Xam)/100] \times Xmab$

where:
Qmh = quantity in tons of asphalt in modified asphalt binder used in HMA
MHMATT = modified asphalt binder HMA, total tons placed
Xam = specified percentage of asphalt modifier
Xmab = theoretical modified asphalt binder content from the job mix formula, expressed as a percentage of the total weight of HMA

9-1.07B(5) Hot Mix Asphalt Containing Reclaimed Asphalt Pavement

The Engineer calculates the quantity of asphalt in HMA containing RAP using the following formula:

$Qrap = HMATT \times Xaa$

where:
$Xaa = Xta - [(100 - Xnew) \times (Xra/100)]$

and:
Qrap = quantity in tons of asphalt used in HMA containing RAP
HMATT = HMA, total tons placed
Xaa = asphalt content of HMA adjusted to account for the asphalt content in RAP expressed as a percentage of the total weight of HMA
Xta = total asphalt content of HMA expressed as a percentage of the total weight of HMA
Xnew = theoretical percentage of new aggregate in the HMA containing RAP determined from the RAP percentage in the job mix formula
Xra = asphalt content of RAP expressed as percentage

9-1.07B(6) Tack Coat

The Engineer calculates the quantity of asphalt in tack coat (Qtc) as either of the following:

1. Asphalt binder using the asphalt binder total tons placed as tack coat
2. Asphaltic emulsion by applying the formula in section 9-1.07B(7) to the asphaltic emulsion total tons placed as tack coat

9-1.07B(7) Asphaltic Emulsion

The Engineer calculates the quantity of asphalt in asphaltic emulsions, including fog seals and tack coat, using the following formula:

$Qe = AETT \times (Xe/100)$

where:
Qe = quantity in tons of asphalt used in asphaltic emulsions
AETT = undiluted asphaltic emulsions, total tons placed
Xe = minimum percent residue specified in section 94 based on the type of emulsion used

You may determine *Xe* by submitting daily test results for asphalt residue for the asphaltic emulsion used. If you choose this option, you must:

1. Take 1 sample for every 200 tons but not less than 1 sample per day in the presence of the Engineer from the delivery truck, at midload from a sampling tap or thief, and as follows:
   1.1. Draw and discard the 1st gallon
   1.2. Take 2 separate 1/2 gal samples
2. Submit the 1st sample at the time of sampling
3. Furnish the 2nd sample within 3 business days of sampling to an authorized laboratory that participates in the AASHTO Proficiency Sample Program
4. Submit test results from the laboratory within 10 business days of the sample date

9-1.07B(8) Slurry Seal

The Engineer calculates the quantity of asphalt in slurry seals (Qss) by applying the formula in section 9-1.07B(7) to the quantity of asphaltic emulsion used in producing the slurry seal mix.

9-1.07B(9) Modified Asphalt Binder

The Engineer calculates the quantity of asphalt in modified asphalt binder using the following formula:

$Qmab = MABTT \times [(100 - Xam)/100]$

where:
Qmab = quantity in tons of asphalt used in modified asphalt binder
MABTT = modified asphalt binder, total tons placed
Xam = specified percentage of asphalt modifier

The quantity of extender oil is included in the quantity of asphalt.

9-1.07B(10) Other Materials

For materials containing asphalt not covered in sections 9-1.07B(1) through 9-1.07B(9), the Engineer determines the method for calculating the quantity of asphalt (*Qo*).

9-1.07C Payment Adjustments

The Engineer includes payment adjustments for price index fluctuations in progress estimates. If material containing asphalt is placed within 2 months during 1 estimate period, the Engineer calculates 2 separate adjustments. Each adjustment is calculated using the price index for the month in which the quantity of material containing asphalt subject to adjustment is placed in the work. The sum of the 2 adjustments is used for increasing or decreasing payment in the progress estimate.

The Engineer calculates each payment adjustment using the following formula:

$PA = Qt \times A$

where:

PA = payment adjustment in dollars for asphalt contained in materials placed in the work for a given month
Qt = sum of all quantities of asphalt (*Qh* + *Qrh* + *Qmh* + *Qrap* + *Qtc* + *Qe* + *Qss* + *Qmab* + *Qo*)
A = adjustment in dollars per ton of asphalt used to produce materials placed in the work rounded to the nearest $0.01

where:
A = [(*Iu*/*Ib*) − 1.05] x *Ib* x [1 + (*T*/100)] for an increase in the crude oil price index exceeding 5 percent
A = [(*Iu*/*Ib*) − 0.95] x *Ib* x [1 + (T/100)] for a decrease in the crude oil price index exceeding 5 percent

and:
Iu = California statewide crude oil price index for the month in which the quantity of asphalt subject to adjustment was placed in the work
Ib = California statewide crude oil price index for the month in which the bid opening for the project occurred
T = Sales and use tax rate expressed as a percent currently in effect in the tax jurisdiction where the material is placed. If the tax rate information is not submitted timely, the statewide sales and use tax rate is used in the payment adjustment calculations until the tax rate information is submitted.

9-1.08–9-1.10 RESERVED

9-1.11 TIME-RELATED OVERHEAD

9-1.11A General

Section 9-1.11 applies if a bid item for time-related overhead is included in the Contract. If a bid item for time-related overhead is included, you must exclude the time-related overhead from every other bid item price.

9-1.11B Payment Quantity

The TRO quantity does not include the number of working days to complete plant establishment or permanent erosion control establishment work.

For a contract with a TRO lump sum quantity on the Bid Item List, the Department pays you based on the following conversions:

1. LS unit of measure is replaced with WDAY
2. Lump sum quantity is replaced with the number of working days bid
3. Lump sum unit price is replaced with the item total divided by the number of working days bid

9-1.11C Payment Inclusions

Payment for the TRO bid item includes payment for time-related field- and home-office overhead for the time required to complete the work.

The field office overhead includes time-related expenses associated with the normal and recurring construction activities not directly attributed to the work, including:

1. Salaries, benefits, and equipment costs of:
   1.1. Project managers
   1.2. General superintendents
   1.3. Field office managers
   1.4. Field office staff assigned to the project
2. Rent
3. Utilities
4. Maintenance
5. Security
6. Supplies
7. Office equipment costs for the project's field office

The home-office overhead includes the fixed general and administrative expenses for operating your business, including:

1. General administration
2. Insurance
3. Personnel and subcontract administration
4. Purchasing
5. Accounting
6. Project engineering and estimating

Payment for the TRO bid item does not include payment for:

1. Home-office overhead expenses specifically related to:
   1.1. Your other contracts or other businesses
   1.2. Equipment coordination
   1.3. Material deliveries
   1.4. Consultant and legal fees
2. Non-time-related costs and expenses such as mobilization, licenses, permits, and other charges incurred once during the Contract
3. Additional overhead involved in incentive/disincentive provisions to satisfy an internal milestone or multiple calendar requirements
4. Additional overhead involved in performing additional work that is not a controlling activity
5. Overhead costs incurred by your subcontractors of any tier or suppliers

9-1.11D Payment Schedule

For progress payments, the total work completed for the TRO bid item is the number of working days shown for the pay period on the Weekly Statement of Working Days form.

For progress payments, the Department pays a unit price equal to the lesser of the following amounts:

1. Price per working day as bid or as converted under section 9-1.11B
2. 20 percent of the total bid divided by the number of original working days

For a contract without plant establishment or permanent erosion control establishment work, the Department pays you the balance due for the TRO item total as specified in section 9-1.17B.

For a contract with plant establishment or permanent erosion control establishment work, the Department pays you the balance due for the TRO item total in the 1st progress payment after all non–plant establishment or non–permanent erosion control establishment work is completed.

9-1.11E Payment Adjustments

The overhead adjustment specified in section 9-1.17C does not apply.

The Department does not adjust the unit price for an increase or decrease in the TRO quantity except as specified in section 9-1.11E.

Section 9-1.17D(2)(b) does not apply to TRO except as specified for the audit report below.

If the TRO bid item quantity exceeds 149 percent of the quantity shown on the Bid Item List or as converted under section 9-1.11B, the Engineer may adjust or you may request an adjustment of the unit price for the excess quantity. For the adjustment, submit an audit report within 60 days of the Engineer's request. The report must be prepared as specified for an audit report for an overhead claim in section 9-1.17D(2)(b).

Within 20 days of the Engineer's request, make your financial records available for an audit by the State for the purpose of verifying the actual rate of TRO described in your audit. The actual rate of TRO described is subject to the Engineer's authorization.

The Department pays the authorized actual rate for TRO in excess of 149 percent of the quantity shown on the Bid Item List or as converted under section 9-1.11B.

The Department pays for 1/2 the cost of the report; the Contractor pays for the other 1/2. The cost is determined under section 9-1.05.

9-1.12–9-1.14 RESERVED

9-1.15 WORK-CHARACTER CHANGES

The Department adjusts a bid item unit price based on the difference between the cost to perform the work as planned and the cost to perform the work as changed. The Engineer determines the payment adjustment under section 9-1.04. The Department adjusts payment for only the work portion that changed in character.

9-1.16 PROGRESS PAYMENTS

9-1.16A General

The Department pays you based on Engineer-prepared monthly progress estimates. Each estimate reflects:

1. Total work completed during the pay period
2. Change order bills if:
   2.1. Submitted by the 15th day of a month
   2.2. Approved by the 20th day of a month
3. Amount for materials on hand
4. Amount earned for mobilization
5. Deductions
6. Withholds
7. Resolved potential claims
8. Payment adjustments

Submit certification stating the work complies with the QC procedures. The Engineer does not process a progress estimate without a signed certification.

9-1.16B Schedule of Values

Section 9-1.16B applies to a lump sum bid item for which a schedule of values is specified to be submitted.

The sum of the amounts for the work units listed in the schedule of values must equal the lump sum price bid for the bid item.

Obtain authorization for a schedule of values before you perform work shown on the schedule. The Department does not process a progress payment for the bid item without an authorized schedule of values.

Accept progress payments for overhead, profit, bond costs, and other fixed or administrative costs as distributed proportionally among the items listed except that for a contract with a bid item for mobilization, accept progress payments for bond costs as included in the mobilization bid item.

For changed quantities of the work units listed, the Department adjusts payments in the same manner as specified for changed quantities of bid items under section 9-1.06.

9-1.16C Materials On Hand

A material on hand but not incorporated into the work is eligible for a progress payment if:

1. Listed in a special provision as eligible and is in compliance with other Contract parts
2. Purchased
3. Invoice is submitted
4. Stored within the State and you submit evidence that the stored material is subject to the Department's control
5. Requested on the Department-furnished form

9-1.16D Mobilization

9-1.16D(1) General

Section 9-1.16D applies if a bid item for mobilization is shown on the Bid Item List.

Payments for mobilization made under section 9-1.16D are in addition to the partial payments made under Pub Cont Code § 10261.

Section 9-1.16D(2) applies unless the Contract includes a special provision for section 9-1.16D(1) that specifies section 9-1.16D(3) applies.

9-1.16D(2) Mobilization for Projects Except for Those Over Water Requiring Marine Access

The Department makes partial payments for mobilization under Pub Cont Code § 10264(a) except the amount of work completed does not include the amount earned for mobilization. The partial payment amount is reduced by a prorated amount bid in excess of the maximum allowed under Pub Cont Code § 10264(a)(5).

The Department pays the item total for mobilization in excess of the maximum allowed under Pub Cont Code § 10264(a)(5) in the 1st payment after Contract acceptance.

9-1.16D(3) Mobilization for Projects Over Water Requiring Marine Access

The Department makes partial payments for mobilization under Pub Cont Code § 10264(b) except the amount of work completed does not include the amount earned for mobilization. The partial payment amount is reduced by a prorated amount bid in excess of the maximum allowed under Pub Cont Code § 10264(b)(6).

The Department pays the item total for mobilization in excess of the maximum allowed under Pub Cont Code § 10264(b)(6) in the 1st payment after Contract acceptance.

9-1.16E Withholds

9-1.16E(1) General

The Department may withhold payment for noncompliance.

The Department returns the noncompliance withhold in the progress payment following the correction of noncompliance except as specified in section 9-1.16E(3).

Withholds are not retentions under Pub Cont Code § 7107 and do not accrue interest under Pub Cont Code § 10261.5.

Withholds are cumulative and independent of deductions.

Section 9-1.16E does not include all withholds that may be taken; the Department may withhold other payments as specified.

9-1.16E(2) Progress Withholds

The Department withholds 10 percent of a progress payment for noncompliant progress. Noncompliant progress occurs when:

1. Total days to date exceed 75 percent of the working days
2. Percent of the working days elapsed exceeds the percent of value of the work completed by more than 15 percent

The Engineer determines the percent of the working days elapsed by dividing the total days to date by the revised Contract working days and converting the quotient to a percentage.

The Engineer determines the percent value of the work completed by summing payments made to date and the amount due on the current progress estimate, dividing this sum by the current total estimated value of the work, and converting the quotient to a percentage. These amounts are shown on the Progress Payment Voucher form.

When the percent of the working days elapsed minus the percent value of work completed is less than or equal to 15 percent, the Department returns the withhold in the next progress payment.

9-1.16E(3) Performance Failure Withholds

During each estimate period you fail to comply with a Contract part, including the submittal of a document as specified, the Department withholds a part of the progress payment except as specified below for the failure to submit a document during the last estimate period. These documents include QC plans, schedules, traffic control plans, and water pollution control submittals.

For 1 performance failure, the Department withholds 25 percent of the progress payment but does not withhold more than 10 percent of the total bid.

For multiple performance failures, the Department withholds 100 percent of the progress payment but does not withhold more than 10 percent of the total bid.

During the last estimate period, if you fail to submit a document as specified, the Department withholds $10,000 for each document. The Department returns the withhold within 30 days after receipt of the document.

9-1.16E(4) Stop Notice Withholds

The Department withholds payments to cover claims filed under Civ Code § 9000 et seq.

Stop notice information may be obtained from the Division of Accounting, Office of External Accounts Payable.

9-1.16E(5) Penalty Withholds

Penalties include fines and damages that are proposed, assessed, or levied against you or the Department by a governmental agency or private lawsuit. Penalties are also payments made or costs incurred in settling alleged violations of federal, State, or local laws, regulations, requirements, or PLACs. The cost incurred may include the amount spent for mitigation or correcting a violation.

If the Department is assessed a penalty, the Department may withhold the penalty amount until the penalty disposition has been resolved. The Department may withhold penalty amounts without notifying you.

Instead of the withhold, you may provide a bond equal to the highest estimated liability for any disputed penalties proposed except you may not provide a bond for withholds related to labor compliance violations.

9-1.16E(6)–9-1.16E(10) Reserved

9-1.16F Retentions

Section 9-1.16F applies before January 1, 2020.

The Department does not retain moneys from progress payments due to the Contractor for work performed (Pub Cont Code § 7202).

9-1.16G–9-1.16M Reserved

9-1.17 PAYMENT AFTER CONTRACT ACCEPTANCE

9-1.17A General

Reserved

9-1.17B Payment Before Final Estimate

After Contract acceptance, the Department pays you based on the Engineer-prepared estimate that includes withholds and the balance due after the deduction of previous payments.

9-1.17C Proposed Final Estimate

The Engineer estimates the amount of work completed and shows the amount payable in a proposed final estimate based on:

1. Contract items
2. Payment adjustments
3. Work paid by force account or agreed price
4. Extra work
5. Deductions

Submit either a written acceptance of the proposed final estimate or a claim statement postmarked or hand delivered before the 31st day after receiving the proposed final estimate.

If you claim that the proposed final estimate is less than 90 percent of your total bid, the Department adjusts the final payment to cover your overhead. The adjustment is 10 percent of the difference between

the total bid and the final estimate. The Department does not make this adjustment on a terminated contract.

9-1.17D Final Payment and Claims

9-1.17D(1) General

If you accept the proposed final estimate or do not submit a claim statement within 30 days of receiving the estimate, the Engineer provides you the final estimate and the Department pays the amount due within 30 days. This final estimate and payment is conclusive except as specified in sections 5-1.27, 5-1.47, and 9-1.21.

If you submit a claim statement within 30 days of receiving the Engineer's proposed final estimate, the Engineer provides you a semifinal estimate and the Department pays the amount due within 30 days. The semifinal estimate is conclusive as to the amount of work completed and the amount payable except as affected by any claims or as specified in sections 5-1.27, 5-1.47, and 9-1.21.

9-1.17D(2) Claim Statement

9-1.17D(2)(a) General

For each claim, submit a claim statement showing only the identification number that corresponds to the Full and Final Potential Claim Record form and the final amount of the additional payment requested except:

1. If the final amount of the requested payment differs from the amount requested in the Full and Final Potential Claim Record form
2. For a claim for quantities, withholds, deductions, liquidated damages, or change order bills
3. For an overhead claim

If the final amount of the requested payment differs from the amount requested in the Full and Final Potential Claim Record form, submit:

1. Identification number that corresponds to the Full and Final Potential Claim Record form
2. Final amount of additional payment requested
3. Basis for the changed amount
4. Contract documentation that supports the changed amount
5. Statement of the reasons the Contract documentation supports the claim

The Engineer notifies you of an omission of or a disparity in the exclusive identification number. Within 15 days of the notification, correct the omission or disparity. If the omission or disparity is not resolved after 15 days, the Engineer assigns a new number.

For a claim for quantities, withholds, deductions, or change order bills submit:

1. Final amount of the additional payment requested
2. Enough detail to enable the Engineer to determine the basis and amounts of the additional payment requested

9-1.17D(2)(b) Overhead Claims

Include with an overhead claim:

1. Final amount of additional payment requested
2. Independent CPA audit report

Failure to submit the audit report with an overhead claim with the claim statement is a waiver of the overhead claim and operates as a bar to arbitration on the claim (Pub Cont Code § 10240.2).

The Department deducts an amount for field and home office overhead paid on added work from any claim for overhead. The value of the added work equals the value of the work completed minus the total bid. The home office overhead deduction equals 5 percent of the added work. The field office overhead deduction equals 5-1/2 percent of the added work.

If you intend to pursue a claim for reimbursement for field or home office overhead beyond that provided expressly by the Contract:

1. Notify the Engineer within 30 days of receiving the proposed final estimate of your intent to seek reimbursement for specific overhead costs beyond that provided by the Contract
2. Specifically identify each claim and each date associated with each claim for which you seek reimbursement for specific overhead costs beyond that provided by the Contract
3. Timely submit all other claims
4. Within 30 days of receiving the proposed final estimate, submit an audit report prepared by an independent CPA, including
   4.1. Calculations with supporting documentation of actual home office and project field overhead costs
   4.2. Calculations specifying the actual daily rates for both field and home office overhead, not including a profit markup, for the entire duration of the project expressed as a rate per working day
   4.3. Start and end dates of the actual project performance period, number of working days, overhead cost pools, and all allocation bases used to calculate your actual field and home office overhead daily rates
5. Field overhead costs from which the daily rate is calculated must be:
   5.1. Allowable under 48 CFR 31
   5.2. Supported by reliable records
   5.3. Related solely to the project
   5.4. Incurred during the actual project performance period
   5.5. Comprised of only time-related field overhead costs
   5.6. Not a direct cost
6. Home-office overhead costs from which the daily rate is calculated must be:
   6.1. Allowable under 48 CFR 31
   6.2. Supported by reliable records
   6.3. Incurred during the actual project performance period
   6.4. Comprised of only fixed home-office overhead costs
   6.5. Not a direct cost

The actual rate of time-related overhead is subject to authorization by the Engineer.

The CPA's audit must be performed as an examination-level engagement under the attestation engagements in the *Government Auditing Standards* published by the Comptroller General of the United States. The CPA's audit report must express an opinion of whether or not your calculations of your actual field and home office overhead daily rates comply with section 9-1.17D(2)(b). The attest documentation prepared by the CPA in connection with the audit must be reproduced and submitted for review with the audit report.

The Department provides markups for all work paid by force account. Overhead for field and home office costs are included in the markups. Overhead claims in excess of Contract markups are not allowed under the Contract. If you seek reimbursement for costs not allowed under the Contract, the Department does not pay your cost of performing the independent CPA examination specified in section 9-1.17D(2)(b), including preparation of the audit report.

9-1.17D(2)(c) Declaration

Submit a declaration that includes the following language with the claim statement:

> I declare under penalty of perjury, according to the laws of the State of California, that the foregoing claims, with specific reference to the California False Claims Act (Govt Code § 12650 et seq.) and to the extent the project contains federal funding, the US False Claims Act (31 USC § 3729 et seq.), are true and correct, and that this declaration was signed on _____(date)_____, 20__ at _____, California.

9-1.17D(2)(d) Waiver

A claim is waived if:

1. Claim does not have a corresponding Full and Final Potential Claim Record form identification number
2. Claim does not have the same nature, circumstances, and basis of the claim as the corresponding Full and Final Potential Claim Record form

3. Claim is not included in the claim statement
4. You do not comply with the claim procedures
5. You do not submit the declaration specified in section 9-1.17D(2)(c)

9-1.17D(3) Final Determination of Claims

Failure to allow timely access to the supporting data for a claim when requested waives the claim.

The Department's costs in reviewing or auditing a claim not supported by the Contractor's accounting or other records are damages incurred by the State within the meaning of the California False Claims Act.

If the Engineer determines that a claim requires additional analysis, the Engineer schedules a review board meeting. Meet with the board of review and make a presentation supporting the claim.

After the Engineer or review board finishes reviewing the claim, the Department makes the final determination of claims and provides it to you.

The Engineer provides you a final estimate and the Department pays the amount due within 30 days. The final estimate is conclusive as to the amount of work completed and the amount payable except as specified in sections 5-1.27, 5-1.47, and 9-1.21.

Your failure to comply with the claim procedures is a bar to arbitration under Pub Cont Code § 10240.2.

9-1.18–9-1.20 RESERVED

9-1.21 CLERICAL ERRORS

For 3 years after Contract acceptance, estimates and payments are open to correction and adjustment for clerical errors. Either you or the Department pays to the other the amount due except for clerical errors resulting in an adjustment less than $200, in which case, no payment is made.

9-1.22 ARBITRATION

Pub Cont Code § 10240 through 10240.13 provides for the resolution of contract claims by arbitration.

Start arbitration by filing a complaint with the Office of Administrative Hearings in Sacramento (1 CA Code Regs § 1350). File the arbitration complaint no later than 90 days after receiving the Department's final written decision on a claim (Pub Cont Code § 10240.1).

DIVISION II GENERAL CONSTRUCTION

10 GENERAL

10-1 GENERAL

10-1.01 GENERAL

Section 10 includes general specifications for performing construction work.

10-1.02 WORK SEQUENCING

10-1.02A General

Reserved

10-1.02B Traffic Elements

Before starting the operational test of a traffic management system that directly impacts traffic, the system must be ready for operation, and all signs, pavement delineation, and pavement markings must be in place at the system's location.

If maintaining existing traffic management system elements during construction is shown on the Bid Item List, a list of the systems shown within the project limits and their operational status is included in the *Information Handout*. Before starting job site activities, conduct a preconstruction operational status check of the existing system's elements and each element's communication status with the transportation management center to which it communicates. If an existing system element is discovered and has not been identified, the Department adds the element to the list of systems. The pre- and postconstruction operational status check of the discovered elements is change order work.

If maintaining existing traffic management system elements during construction is not shown on the Bid Item List and an existing system element is discovered during the work, notify the Engineer. The Engineer orders a pre- and postconstruction operational status check of the discovered elements. The status check of the discovered elements is change order work.

Conduct the status check with the Engineer and an electrical representative from the traffic operations office of the district in which the work is located. The Department provides you a list of the preconstruction operational status-check results, including:

1. Existing traffic management system elements and their locations within the project limits
2. Fully functioning elements
3. Nonoperational elements

Before Contract acceptance, conduct a postconstruction operational status check of all elements shown on the list with the Engineer and an electrical representative from the traffic operations office of the district in which the work is located.

10-1.02C Landscaping and Irrigation Facilities

10-1.02C(1) General

Reserved

10-1.02C(2) Irrigation Facilities

Upon discovering an irrigation facility not described in the Contract, immediately notify the Engineer. The Engineer orders the locating and protecting of the irrigation facility. The locating and protecting is change order work.

10-1.02C(3) Landscaping

Reserved

10-1.02D Traffic Stripes, Pavement Markings, and Pavement Markers

Before obliterating any traffic stripes, pavement markings, and pavement markers to be replaced at the same location, reference the stripes, markings, and markers. Include limits and transitions with control points to reestablish the new stripes, markings, and markers. Submit your references to the control points at least 5 business days before obliterating the stripes, markings, and markers.

10-1.02E Excavation

If a difference in excess of 0.15 foot exists between the elevation of the existing pavement and the elevation of an excavation within 5 feet of the left edge or within 8 feet of the right edge of the traveled way at the end of each working day, place and compact material against the vertical cut adjacent to the traveled way. During the excavation, you may use native material for this purpose except you must use structural material once you start placing the structural section. Place the material to the top of the existing pavement and taper at a slope of 4:1 (horizontal:vertical) or flatter to the bottom of the excavation. Do not use treated base for the taper.

10-1.03 TIME CONSTRAINTS

Reserved

10-1.04 TRAINING AND MEETINGS

Training and meetings are held at times and locations you and the Engineer agree to.

10-1.05–10-1.10 RESERVED

10-2–10-3 RESERVED

10-4 WATER USAGE

Section 10-4 includes general specifications for using water for construction activities.

The Department encourages you to conserve water in all construction activities.

The Engineer notifies you of any (1) water shortage or (2) mandate from a local water authority to ration water. Within 10 days of the notification, submit a water conservation plan. The plan must include:

1. List of construction activities that require water
2. Measures you will implement for each activity to conserve water
3. Method for curing concrete other than the water method if included in the work
4. Dust palliative you will use for dust control

10-5 DUST CONTROL

Section 10-5 includes general specifications for controlling dust resulting from the work.

Prevent and alleviate dust by:

1. Applying a dust palliative under section 18
2. Applying temporary soil stabilization under section 13-5
3. Managing material stockpiles under section 13-4.03C(3)

10-6 WATERING

Section 10-6 includes specifications for developing a water supply, furnishing water, and applying water.

Developing a water supply includes developing a supply of water and furnishing pipes or other equipment needed to convey the water to the water application equipment.

Water may be potable or nonpotable. Nonpotable water must be either recycled water or nonpotable water developed from other sources.

The sources and discharge of recycled water must comply with the water-recycling criteria of the CDPH and the requirements of the appropriate RWQCB. Obtain either a waste discharge permit or a waiver from the appropriate RWQCB for each water source. Submit a copy of the permit or waiver before using the water in the work.

If an available source of water is described in the *Information Handout*, verify the quality and quantity of water.

Nonpotable water must not be conveyed in tanks or drain pipes that will be used to convey potable water. Nonpotable water supplies and potable water supplies must not be connected. Nonpotable water supply, tanks, pipes, and other conveyances of nonpotable water must be labeled Nonpotable Water / Do Not Drink.

Each water storage tank and distribution system must be equipped with positive shut-off valves.

Keep at least 1 mobile unit with a capacity of at least 1,000 gal the job site at all times for applying water unless all water is applied through pipes or another authorized method.

For compacting embankment material, subbase, base, and surfacing material and for dust control, apply water with equipment that will apply it uniformly.

For compaction, you may use a chemical additive if authorized.

If a bid item for develop water supply is shown on the Bid Item List, the Department does not adjust the lump sum price for any increase or decrease in the quantity of water required or for change order work.

10-7–10-50 RESERVED

11 WELDING

11-1.01 GENERAL

Section 11 includes general specifications for welding where welding is specified to comply with an AWS welding code.

Do not perform welding using flux-cored welding electrodes that comply with AWS A5.20, E6XT-4 or E7XT-4.

Wherever reference is made to the following AWS welding codes in the Contract, the year of adoption for these codes is as shown in the following table:

AWS code	Year of adoption
D1.1	2010
D1.3	2008
D1.4	2011
D1.5	2010
D1.6	2007
D1.8	2009

11-1.02 DEFINITIONS

continuous inspection: QC Inspector must be within close proximity of all welders or welding operators such that inspections by the QC Inspector of each welding activity at each welding location do not lapse for a period exceeding 30 minutes.

gross nonconformance: Rejectable indications are present in more than 20 percent of the tested weld length.

11-1.03 QUALITY CONTROL INSPECTOR

Replace clause 6.1.3 of AWS D1.1, the 1st paragraph of clause 7.1.2 of AWS D1.4, and clause 6.1.2 of AWS D1.5 with:

> The QC Inspector must be the duly assigned person who acts for and on your behalf for inspection, testing, and quality related matters for all welding.
> The QA Inspector is the authorized representative who acts for and on behalf of the Engineer.
> The QC Inspector must be responsible for QC acceptance or rejection of materials and workmanship.
> Where the term *Inspector* is used without further qualification, it refers to the QC Inspector.

The QC Inspector must document inspection and approval of:

1. All joint preparations, assembly practices, joint fit-ups, and welding techniques
2. Performance of each welder, welding operator, and tack welder on a daily basis for each day welding is performed

For each inspection, including fit-up, WPS verification, and final weld inspection, the QC Inspector must confirm and document compliance with the specifications, AWS welding codes and any referenced drawings.

11-1.04 PERSONNEL QUALIFICATIONS AND CERTIFICATIONS

The Engineer has the authority to verify the qualifications or certifications of any welder, QC Inspector, or NDT personnel to specified levels by retests or other means determined by the Engineer. If welding will be performed without gas shielding, then qualification must also include welding without gas shielding.

Replace clause 6.14.6.1 of AWS D1.1, clause 7.8 of AWS D1.4, and clause 6.1.3.4 of AWS D1.5 with:

> Personnel performing NDT must be qualified and certified under American Society for Nondestructive Testing (ASNT) Recommended Practice No. SNT-TC-1A and the written practice of the NDT firm. The written practice of the NDT firm must comply with or exceed the guidelines of the ASNT Recommended Practice No. SNT-TC-1A. Individuals who perform NDT, review the results, and prepare the written reports must be one of the following:

1. Certified NDT Level II technicians
2. Level III technicians certified to perform the work of Level II technicians

11-1.05 WELD JOINT DETAILS

If weld joint details proposed for use in the work are not prequalified under clause 3 of AWS D1.1 or figure 2.4 or 2.5 of AWS D1.5, submit the proposed WPS and the intended weld joint locations.

Upon authorization of the proposed joint detail locations and qualification of the proposed joint details, welders and welding operators using these details must weld an additional qualification test plate using the WPS variables and the weld joint detail to be used in production. The test plate must:

1. Have the maximum thickness to be used in production and a minimum length of 18 inches.
2. Be mechanically and radiographically tested. Mechanical and radiographic testing and acceptance criteria must comply with the applicable AWS codes.

If a nonprequalified weld joint configuration is proposed using a combination of WPSs for work welded under AWS D1.1, you may conduct a single test combining the WPSs to be used in production, if the essential variables, including weld bead placement, of each process are limited to those established in table 4.5 of AWS D1.1.

The Engineer will witness all procedure qualification tests for WPSs that were not previously authorized by the Department.

Submit an inspection request form to METS at least 7 days before performing any procedure qualification tests. Notify the Engineer of your submittal. Witnessing of qualification tests by the Engineer does not constitute authorization of the intended joint locations, welding parameters, or essential variables.

11-1.06 NONDESTRUCTIVE TESTING

Replace paragraph 3 of clause 6.26.3.2 of AWS D1.5 with:

3. If indications that exhibit these planar characteristics are present at scanning sensitivity, or other evidence exists to suggest the presence of transverse cracks, a more detailed evaluation of the discontinuity by other means must be performed (e.g., alternate UT techniques, RT, grinding, or gouging for visual inspection or MT of the excavated areas.). For welds that have transverse cracks, excavate the full length of the crack plus 2 inches of weld metal on each side adjacent to the crack and reweld.

Clause 6.6.5 of AWS D1.1, clause 7.6.5 of AWS D1.4, and clause 6.6.5 of AWS D1.5 do not apply.

The Engineer may order you to perform NDT that is in addition to the visual inspection or NDT specified in the specifications or AWS welding code. The additional NDT and associated repair work is change order work. If the NDT discloses an attempt to defraud or reveals a gross nonconformance, the Department does not pay for the costs associated with the repair of the deficient area, the NDT of the weld and of the repair, or any delays caused by the repair.

If less than 100 percent of NDT is specified for any weld, the entire length of weld must comply with the specified acceptance criteria. If any welding deficiencies are discovered by additional NDT ordered or performed by the Engineer that uses the same NDT method as that originally specified, the Department does not pay for the costs associated with the repair of the deficient area, including NDT of the weld and of the weld repair, or any delays caused by the repair.

If any welding deficiencies are discovered by visual inspection ordered or performed by the Engineer, the Department does not pay for the costs associated with the repair of a deficient area or any delays caused by the repair.

11-2 WELDING QUALITY CONTROL

11-2.01 GENERAL

Section 11-2 applies to (1) work welded under sections 49, 52, 55, and 60-4.09, and (2) work in section 99 that must comply with an AWS welding code.

Section 11-2 does not apply to stud welding.

All welding requires inspection by the Engineer.

You must provide continuous inspection when any welding is being performed.

11-2.02 WELDING QUALITY CONTROL MANAGER

Assign a welding QC manager. The welding QC manager must be registered as a civil engineer in the State or currently certified as a CWI.

11-2.03 SUBMITTALS

11-2.03A General

If welding is performed at the job site, submit an inspection request form at least 3 business days before performing welding at the job site. Notify the Engineer of your submittal.

11-2.03B Welding Quality Control Plan

Before submitting a welding QC plan, hold a prewelding meeting to discuss the requirements for the welding QC plan. The meeting attendees must include the Engineer, your welding QC manager, and a representative from each entity performing welding or inspection for the Contract.

For the contents, format, and organization required for a welding QC plan, go to the METS Web site.

Submit 2 copies of a welding QC plan for each subcontractor or supplier for each item of work for which welding is performed.

Submit an amended welding QC plan or an addendum to the welding QC plan for any changes to:

1. WPSs
2. NDT firms
3. QC personnel or procedures
4. NDT personnel or procedures
5. Systems for tracking and identifying welds
6. Welding personnel

Allow 15 days for the Engineer's review of an amended welding QC plan or an addendum to the welding QC plan.

Submit 7 copies of each authorized QC plan and any authorized addendums. Make 1 copy available at each location where work is performed.

11-2.03C Welding Report

Submit a welding report within 7 days following the performance of any welding. The welding report must include:

1. Daily production log for welding for each day that welding is performed
2. Reports of all visual weld inspections and NDT performed, whether specified, additional, or informational
3. Radiographs and radiographic reports, and other required NDT reports
4. Summary of welding and NDT activities that occurred during the reporting period
5. Reports of each application of heat straightening
6. Summarized log listing the rejected lengths of weld by welder, position, process, joint configuration, and piece number
7. Documentation that you have:
   - 7.1. Evaluated all radiographs and radiograph reports and NDT and NDT reports
   - 7.2. Corrected all rejectable deficiencies and that all repaired welds have been reexamined using the required NDT and found acceptable
8. Reports or chart recordings of each application of any stress relieving used
9. Reports and chart recordings for any electroslag welding used

The daily production log must include:

1. Locations of all welding

2. For each location, the welders' names, quantity of welding performed, any problems or deficiencies discovered, and any testing or repair work performed
3. Daily report from each QC Inspector

Clearly write the following information on the outside of radiographic film envelopes:

1. Name of the QC manager
2. Name of the NDT firm
3. Name of the radiographer
4. Date
5. Contract number
6. Complete part description
7. All included weld numbers, report numbers, and station markers or views as detailed in the welding QC plan

Clearly write on all interleaves the part description and all included weld numbers and station markers or views as detailed in the welding QC plan. Use a maximum of 2 pieces of film for each interleave.

The QC Inspector or certified technician must sign all visual inspection and NDT reports and submit them daily to the welding QC manager for review and signature before submittal to the Engineer. Corresponding names must be clearly printed or typewritten adjacent to all signatures.

The Engineer reviews the welding report to determine whether you are complying with the welding QC plan and the Contract. Except for field welded steel pipe piling and field welded bar reinforcement in CIP concrete piling:

1. Allow the Engineer 15 days to review the report.
2. You may encase in concrete or cover welds for which the welding report has been submitted before receiving authorization of the welding report. If you choose this option, you will not be relieved of the responsibility for incorporating material in the work that complies with the Contract. Material not complying with the Contract is subject to rejection.

For field welded steel pipe piling and field welded bar reinforcement in CIP concrete piling:

1. Allow the Engineer 2 business days to review the welding report
2. Do not install the steel pipe piling or encase the reinforcement in concrete until the Engineer has authorized the welding report

11-2.03D Certificates of Compliance

Submit a certificate of compliance for each item of work for which welding is performed. The certificate must be signed by the welding QC manager. The certificate must state that all of the materials and workmanship incorporated in the work, and all required tests and inspections of this work, have been performed in compliance with the Contract.

11-2.04 PERSONNEL QUALIFICATIONS AND CERTIFICATIONS

Clauses 6.1.4.1 and 6.1.4.3 of AWS D1.1, the 2nd paragraph of clause 7.1.2 of AWS D1.4, clauses 6.1.3.1 through 6.1.3.3 of AWS D1.5, and clause 7.2.3 of AWS D1.8 are replaced with:

> The QC Inspector must be currently certified as an AWS Certified Welding Inspector under AWS QC1.
> The QC Inspector may be assisted by an Assistant QC Inspector provided that this individual is currently certified as an AWS Certified Associate Welding Inspector under AWS QC1. The Assistant QC Inspector may perform inspection under the direct supervision of the QC Inspector provided the assistant is always within visible and audible range of the QC Inspector. The QC Inspector must be responsible for signing all reports and for determining if welded materials comply with the workmanship and acceptance criteria. The ratio of QC Assistants to QC Inspectors must not exceed 5 to 1.

Welding inspection personnel or NDT firms to be used in the work must not be employed or compensated by any subcontractor or by other persons or entities hired by subcontractors who will provide other services or materials for the Contract, unless one of the following conditions is met:

1. Work is welded at a permanent fabrication or manufacturing plant that is certified under the AISC Certification Program for Steel Bridge Fabricators, Intermediate Bridges, and Fracture-Critical Member endorsement if required.
2. Structural steel for building construction work is performed at a permanent fabrication or manufacturing plant that is certified under the AISC Quality Certification Program, Category STD, Standard for Steel Building Structures.

Except for the exempt facilities identified above, an authorized independent third party must witness the qualification tests for welders or welding operators. The independent third party must be currently certified as a CWI and must not be an employee of the Contractor performing the welding. Allow 15 days for the Engineer to review the qualifications and copy of the current certification of the independent third party.

11-2.05 WELDING INSPECTION

Replace clause 6.5.4 of AWS D1.5 with:

> The QC Inspector must inspect and approve each joint preparation, assembly practice, welding technique, joint fit-up, and the performance of each welder, welding operator, and tack welder to make certain that the applicable requirements of this code and the qualified WPS are met. The QC Inspector must examine the work to make certain that it complies with clauses 3 and 6.26. The size and contour of all welds must be measured using suitable gauges. Visual inspection for cracks in welds and base metal, and for other discontinuities must be aided by strong light, magnifiers, or other devices as necessary. You may use acceptance criteria different from those specified in this code if authorized.

11-2.06 WELDING PROCEDURES QUALIFICATION

Welding procedures qualification for work welded under AWS D1.5 must comply with clause 5.12 or 5.12.4 of AWS D1.5 and the following:

1. Unless considered prequalified, qualify fillet welds in each position. Conduct the fillet weld soundness test using the essential variables of the WPS as established by the PQR.
2. For qualifying joints that do not comply with figures 2.4 and 2.5 of AWS D1.5, conduct the test complying with figure 5.3 using the welding parameters that were established for the test conducted complying with figure 5.1.
3. Macroetch tests are required for WPS qualification tests, and acceptance must comply with clause 5.19.3 of AWS D1.5.
4. If a nonstandard weld joint is to be made using a combination of WPSs, you may conduct a test under figure 5.3, combining the qualified or prequalified WPSs to be used in production, if the essential variables, including weld bead placement, of each process are limited to those established in table 5.3 of AWS D1.5.
5. Before preparing mechanical test specimens, inspect the PQR welds by visual and radiographic tests. The backing bar must be 3 inches in width and must remain in place during NDT. Results of the visual and radiographic tests must comply with clause 6.26.2 of AWS D1.5 excluding clause 6.26.2.2. All other requirements for clause 5.17 are applicable.

11-2.07 REPAIR WORK

Notify the Engineer immediately if you discover welding problems, deficiencies, base metal repairs, or any other type of repairs not included in the welding QC plan. Submit the proposed repair procedures to correct them.

Allow the Engineer 7 days to review the repair procedures.

You must receive authorization before performing:

1. 3rd-time excavations of welds or base metal to repair unacceptable discontinuities, regardless of NDT method
2. Repairs of cracks
3. Repairs not included in the welding QC plan

Requests to perform 3rd-time excavations, repairs of cracks, or repairs not included in the welding QC plan must include an engineering evaluation. At a minimum, the engineering evaluation must address:

1. Cause of each defect
2. Why the repair will not degrade the material properties
3. What steps are being taken to prevent similar defects from happening again

11-3 WELDING FOR OVERHEAD SIGN STRUCTURES, STANDARDS, AND POLES

11-3.01 GENERAL

Section 11-3 applies to work welded under sections 56-2 and 56-3.02.

Fabricate overhead sign structures, standards, and poles at a plant on the Authorized Facility Audit List.

11-3.02 WELDING INSPECTION

Welding inspection personnel or NDT firms to be used in the work must not be employed or compensated by any subcontractor or by other persons or entities hired by subcontractors who provide other services or materials for the Contract except for welding performed at a permanent fabrication or manufacturing plant that is certified under the AISC Quality Certification Program.

The AISC Certification category for overhead sign structures is Bridge and Highway Metal Component (CPT) or Simple Steel Bridge Structures (SBR).

The AISC Certification category for pole structures is Bridge and Highway Metal Component (CPT) or Standard for Steel Building Structures (STD).

11-3.03 SUBMITTALS

Submit a welding report under section 11-2.03C except submit the welding report 2 business days before submitting the certificate of compliance.

11-4–11-9 RESERVED

12 TEMPORARY TRAFFIC CONTROL

12-1 GENERAL

12-1.01 GENERAL

Section 12-1 includes general specifications for providing temporary traffic control.

Temporary traffic control, including flagging, apparel, temporary traffic control devices, and equipment for flaggers, must comply with the *California MUTCD,* Part 6, "Temporary Traffic Control."

12-1.02 MATERIALS

Not Used

12-1.03 CONSTRUCTION

Assign flaggers to:

1. Control traffic
2. Warn the public of any dangerous conditions resulting from the work activities
3. Provide for the passage of traffic through the work as specified for the passage of traffic for public convenience and public safety

Maintain flagging apparel, traffic control devices, and equipment for flaggers in good repair.

12-1.04 PAYMENT

The Department determines the cost of furnishing flaggers, including transporting flaggers, as specified for force account work and pays you 1/2 of that cost.

12-2 RESERVED

12-3 TEMPORARY TRAFFIC CONTROL DEVICES

12-3.01 GENERAL

12-3.01A General

12-3.01A(1) Summary

Section 12-3.01 includes general specifications for providing temporary traffic control devices.

Providing temporary traffic control devices includes installing, placing, maintaining, repairing, replacing, and removing temporary traffic control devices.

Do not use different types of channelizing devices on the same alignment. The types include plastic drums, portable delineators, channelizers, tubular markers, traffic cones, and Type I and Type II barricades.

12-3.01A(2) Definitions

Category 1 temporary traffic control devices: Small devices weighing less than 100 lb certified as crashworthy by crash testing or crash testing of similar devices. Category 1 temporary traffic control devices include traffic cones, plastic traffic drums, portable delineators, and channelizers.

Category 2 temporary traffic control devices: Small devices weighing less than 100 lb that are not expected to produce significant changes in vehicular velocity but could cause harm to impacting vehicles. Category 2 temporary traffic control devices include barricades and portable sign supports.

Category 3 temporary traffic control devices: Devices weighing 100 lb or more that are expected to produce significant changes in the vehicular velocity of impacting vehicles. Category 3 temporary traffic control devices include crash cushions, impact attenuator vehicles, temporary railing, temporary barrier, and end treatments for temporary railings and barriers.

orange: Orange, red-orange, fluorescent orange, or fluorescent red-orange.

useable shoulder area: Any longitudinal paved or unpaved contiguous surface adjacent to the traveled way with:

1. Enough weight-bearing capacity to support temporary traffic control devices, such as flashing arrow signs, PCMSs, and impact attenuator vehicles

2. Slope not greater than 6:1 (horizontal:vertical)

12-3.01A(3) Submittals

If requested, submit the following as informational submittals:

1. Self-certification for crashworthiness of Category 1 temporary traffic control devices at least 5 business days before starting any work using the devices or within 2 business days after the request if the devices are already in use. Either you or the manufacturer must perform the self-certification. Include the following information:
   1.1. Date
   1.2. Federal aid number for a federal-aid contract
   1.3. Contract number, district, county, route, and post miles of the project limits
   1.4. Company name, street address, city, state, and zip code of the certifying vendor
   1.5. Printed name, signature, and title of the certifying person
   1.6. Types of Category 1 temporary traffic control devices
2. List of proposed Category 2 temporary traffic control devices at least 5 business days before starting any work using the devices or within 2 business days after the request if the devices are already in use.

Obtain a standard form for self-certification from the Engineer.

Submit a sample of the type of portable delineator that you will be using before placing the delineators on the job site.

12-3.01A(4) Quality Assurance

Reserved

12-3.01B Materials

The condition of temporary traffic control devices must comply with the most current edition of the American Traffic Safety Services Association publication *Quality Guidelines for Temporary Traffic Control Devices and Features*.

Category 2 temporary traffic control devices must be on FHWA's list of acceptable crashworthy Category 2 hardware for work zones. For this list, go to FHWA's Safety Program website.

Category 2 temporary traffic control devices must be labeled with the FHWA acceptance letter code and the name of the manufacturer. The label must be legible and permanently affixed to the temporary traffic control device by the manufacturer.

Category 3 temporary traffic control devices must be on the Authorized Material List for highway safety features.

Retroreflectivity for the following materials must comply with Table 2A-3, "Minimum Maintained Retroreflectivity Levels," of the *California MUTCD* and be on the Authorized Material List for signing and delineation materials:

1. Retroreflective sheeting for barricades
2. Retroreflective bands for portable delineators
3. Retroreflective sheeting for construction area signs
4. Retroreflective sheeting for channelizers
5. Reflectors for Type K temporary railing
6. Retroreflective cone sleeves
7. White and orange retroreflective stripes for plastic traffic drums

The following temporary traffic control devices must be visible from 1,000 feet during the hours of darkness under an illumination of legal high-beam headlights by persons with 20/20 vision or vision corrected to 20/20:

1. Retroreflective bands on portable delineators
2. Retroreflective sheeting on channelizers
3. Retroreflective cone sleeves on traffic cones

12-3.01C Construction

Perform all layout work necessary to place channelizing devices:

1. On the proper alignment
2. Uniformly at the location and spacing described
3. Straight on a tangent alignment
4. On a true arc in a curved alignment

If temporary traffic control devices are damaged, displaced, or stop operating or functioning as described from any cause during the progress of the work, immediately repair, repaint, or replace the components and restore them to their original locations and positions.

If ordered, furnish and place additional temporary traffic control devices. This work is change order work unless the temporary traffic control devices are being furnished and placed for public safety or public convenience.

12-3.01D Payment

Not Used

12-3.02 TRAFFIC CONES

12-3.02A General

Section 12-3.02 includes specifications for placing traffic cones.

12-3.02B Materials

A traffic cone must be flexible, orange, and manufactured from commercial-quality material designed for the intended purpose.

The outer section of the portion above the base of the traffic cone must be translucent and fabricated of a highly pigmented, orange, PV compound. The overall height of a traffic cone must be at least 28 inches and the bottom inside diameter of the traffic cone must be at least 10.5 inches.

During the hours of darkness, a traffic cone must have a retroreflective cone sleeve.

Retroreflective cone sleeves must be permanently affixed, double-band, sleeves consisting of 2 white retroreflective bands. The top band must be 6 inches wide and placed a maximum of 4 inches from the top of the cone. The lower band must be 4 inches wide and placed 2 inches below the bottom of the top band. You may use traffic cones with double-band retroreflective cone sleeves during daylight hours.

12-3.02C Construction

Use the same type of retroreflective cone sleeve for all cones used on the project.

Anchor the base of a traffic cone if it does not have enough size and weight to keep the cone in an upright position.

12-3.02D Payment

Not Used

12-3.03 PLASTIC TRAFFIC DRUMS

12-3.03A General

12-3.03A(1) Summary

Section 12-3.03 includes specifications for placing plastic traffic drums.

12-3.03A(2) Definitions

Reserved

12-3.03A(3) Submittals

Submit a certificate of compliance for plastic traffic drums.

12-3.03A(4) Quality Assurance

Reserved

12-3.03B Materials

A plastic traffic drum must comply with the manufacturer's instructions for weight and ballast.

A plastic traffic drum must:

1. Be orange LDPE
2. Be flexible and collapsible upon vehicle impact
3. Have a weighted base to maintain an upright position and prevent displacement by passing traffic
4. Have a height such that the top of the drum is at least 36 inches above the traveled way

The weighted base must:

1. Be detachable
2. Be shaped to prevent rolling upon impact
3. Have a 38-inch maximum outside diameter
4. Have a 4-inch maximum height above the ground surface

12-3.03C Construction

Use 1 type of plastic traffic drum on the project.

Use the same type and brand of retroreflective sheeting for all plastic traffic drums used on the project.

Do not use sandbags or comparable ballast.

Moving plastic traffic drums from location to location if ordered after initial placement is change order work.

12-3.03D Payment

Not Used

12-3.04 PORTABLE DELINEATORS

12-3.04A General

Section 12-3.04 includes specifications for placing portable delineators.

12-3.04B Materials

A portable delineator, including its base, must be made of a material that has enough rigidity to remain upright when unattended and must be flexible or collapsible upon impact by a vehicle. The base must be (1) shaped to prevent rolling after impact and (2) anchored or weigh enough to keep the delineator in an upright position. Ballast for a portable delineator must comply with the manufacturer's instructions.

A portable delineator must be a minimum of 36 inches in height. The vertical portion of a portable delineator must be predominantly orange. The post must be not less than 3 inches in width or diameter. Retroreflectorization of a portable delineator that has a height of less than 42 inches must be provided by two 3-inch-wide white bands placed a maximum of 2 inches from the top with a maximum of 6 inches between the bands. Retroreflectorization of a portable delineator that has a height of 42 inches or more must be provided by four 4- to 6-inch-wide alternating orange and white stripes with the top stripe being orange.

12-3.04C Construction

Use only 1 type of portable delineator on the project.

12-3.04D Payment

Not Used

12-3.05 CHANNELIZERS

12-3.05A General

Section 12-3.05 includes specifications for placing channelizers.

12-3.05B Materials

A channelizer must be on the Authorized Material List for signing and delineation materials.

Its post must be orange.

A channelizer must be affixed with 3-by-12-inch, retroreflective, white sheeting.

12-3.05C Construction

Install channelizers on clean, dry surfaces.

Cement the channelizer bases to the pavement as specified for cementing pavement markers to the pavement in section 81-3.

When no longer required for the work, remove the channelizers and the underlying adhesive used to cement the channelizer bases to the pavement.

Do not remove channelizers that are shown to be left in place at the time of work completion.

12-3.05D Payment

Not Used

12-3.06–12-3.09 RESERVED

12-3.10 BARRICADES

12-3.10A General

Section 12-3.10 includes specifications for placing barricades.

12-3.10B Materials

Markings for barricade rails must be alternating orange and white retroreflective stripes.

Orange retroreflective sheeting must match color PR no. 6, Highway Orange, of the FHWA Color Tolerance Chart.

The interface between the rail surface and the retroreflective sheeting must be free of air bubbles or voids.

The predominant color of barricade components other than the rails must be white or unpainted galvanized metal or aluminum.

You may use a Type III barricade as a sign support if the barricade has been successfully crash tested under *NCHRP Report 350* criteria as a single unit with an attached sign panel of the size and type to be used.

A sign panel for a construction area sign or marker panel to be mounted on a barricade must comply with section 12-3.11B(2).

Do not imprint an owner identification on the retroreflective face of any rail.

12-3.10C Construction

Place each barricade such that the stripes slope downward in the direction road users are to pass.

Place each sand-filled bag near the ground level on the lower parts of the frame or stays to serve as ballast for the barricades. Do not place ballast on top of barricades or over any retroreflective barricade rail face that is facing traffic.

Do not remove barricades that are shown to be left in place at the time of work completion.

Moving a barricade from location to location is change order work if ordered after initial placement of the barricade.

12-3.10D Payment

Not Used

12-3.11 CONSTRUCTION AREA SIGNS

12-3.11A General

12-3.11A(1) Summary

Section 12-3.11 includes specifications for placing construction area signs.

Construction area signs include all temporary signs and object markers required for the direction of traffic through or within the project limits and general information signs.

12-3.11A(2) Definitions

background: Dominant sign color.

legend: Letters, numerals, tildes, bars, arrows, route shields, symbols, logos, borders, artwork, and miscellaneous characters that are intended to convey specific meanings on traffic signs.

12-3.11A(3) Submittals

Reserved

12-3.11A(4) Quality Assurance

Reserved

12-3.11B Materials

12-3.11B(1) General

A construction area sign must be the product of a commercial sign manufacturer and have Type III or higher grade retroreflective sheeting.

The style, font, size, and spacing of the legend must comply with the *Standard Alphabets* published in the FHWA's Standard Highway Signs Book.

The sign must be visible from 500 feet and legible from 300 feet at noon on a cloudless day and during the hours of darkness under an illumination of legal low-beam headlights by persons with 20/20 vision or vision corrected to 20/20. A fabric sign panel on a portable sign is not subject to the visibility and legibility requirements for headlight illumination during the hours of darkness.

A construction area warning or guide sign must have a black legend on a retroreflective, orange background. A W10-1 advance warning sign for highway-rail grade crossings must have a black legend on a retroreflective yellow background.

12-3.11B(2) Stationary-Mounted Signs

Materials for a stationary-mounted sign must comply with section 82-2 for the type of panel involved.

A temporary sign support of any type placed within 15 feet from the edge of the traveled way must comply with the specifications for a Category 2 temporary traffic control device.

The sign post must be good, sound wood posts with the breakaway feature as shown for a roadside sign.

Fastening hardware and back braces must be commercial-quality materials.

12-3.11B(3) Portable Signs

Each portable sign must consist of a base, standard or framework, and a sign panel. Units delivered to the job site must be capable of being placed into immediate operation.

A sign panel for a portable sign must comply with the specifications for a stationary-mounted sign panel or be fabricated from one of the following materials:

1. Type VI, retroreflective, elastomeric roll-up fabric on the Authorized Material List for signing and delineation materials
2. Nonretroreflective, cotton, drill fabric
3. Nonretroreflective, flexible, industrial, nylon fabric
4. Another type of fabric if authorized

Do not use nonretroreflective portable signs during the hours of darkness.

The bottom of the portable sign panel must be at least 1 foot above the edge of the traveled way.

12-3.11B(4) Temporary Object Markers

A temporary object marker must be mounted on a stationary wood or metal post and must comply with section 82.

A marker panel for a Type N (CA), Type P (CA), or Type R (CA) object marker must comply with the specifications for a marker panel for a stationary sign panel in section 12-3.11B(2).

A target plate, post, and the hardware for a Type K (CA) and Type L (CA) temporary object marker must comply with the specifications for these items in section 82.

12-3.11B(5) General Information Signs

Reserved

12-3.11C Construction

12-3.11C(1) General

Place all construction area signs outside of the traveled way. Do not block a bicycle or pedestrian pathway with a construction area sign.

Place, install, maintain, and remove temporary object markers shown as construction area signs as specified for construction area signs.

Maintain accurate information on construction area signs. Immediately replace or correct signs that convey inaccurate information.

During the progress of work, immediately cover or remove unneeded signs.

Cover each unneeded sign such that the message cannot be seen. Securely fasten the cover to prevent movement from wind.

Check each covered sign daily for damage to the cover and immediately replace any cover if needed.

Clean each construction area sign panel at the time of installation and at least once every 4 months thereafter.

Be prepared to furnish additional construction area sign panels, posts, and mounting hardware or portable sign mounts on short notice due to changing traffic conditions or damage caused by traffic or other conditions. Maintain an inventory of commonly required items at the job site or make arrangements with a supplier who is able to furnish the items daily on short notice.

Replace any damaged construction area sign or repair the sign if authorized.

Remove any sign panel that exhibits irregular luminance, shadowing, or dark blotches at nighttime under vehicular headlight illumination.

12-3.11C(2) Stationary-Mounted Signs

Install stationary-mounted signs as described for the installation of roadside signs except:

1. Back braces and blocks for sign panels are not required for signs 48 inches or smaller in width and diamond-shaped signs 48 by 48 inches or smaller.
2. Bottom of the sign panel must be at least 7 feet above the edge of the traveled way.
3. You may install a construction area sign on an above-ground, temporary platform sign support or on an existing lighting standard or other support if authorized. Do not make holes in a standard to support the sign if it is installed on an existing lighting standard.
4. Post embedment must be at least 2.5 feet if the post hole is backfilled around the post with commercial-quality concrete. The concrete must contain at least 295 pounds of cementitious material per cubic yard.

The Engineer determines the post size and number of posts if the type of sign installation is not shown.

Excavate each post hole by hand methods without the use of power equipment. You may use power equipment where you determine that subsurface utilities are not present in the area of the proposed post

hole if authorized. The post-hole diameter must be at least 4 inches greater than the longest cross-sectional dimension of the post if it is backfilled with commercial-quality concrete.

Furnishing, installing, maintaining, moving, and removing any additional construction area signs if ordered is change order work.

12-3.11C(3) General Information Signs

Reserved

12-3.11D Payment

Not Used

12-3.12 TELESCOPING FLAG TREES

12-3.12A General

Section 12-3.12 includes specifications for placing telescoping flag trees.

12-3.12B Materials

Telescoping flag trees must be manufactured from commercial-quality material designed for the intended purpose and capable of maintaining an upright position at all times while in use.

12-3.12C Construction

Not Used

12-3.12D Payment

Not Used

12-3.13–12-3.19 RESERVED

12-3.20 TYPE K TEMPORARY RAILING

12-3.20A General

12-3.20A(1) Summary

Section 12-3.20 includes specifications for placing Type K temporary railing and Type K temporary terminal sections.

Type K temporary railing must consist of interconnected PC concrete barrier panels.

You may have your name or logo on each panel of Type K temporary railing. The name or logo must not be more than 4 inches in height and must be located not more than 12 inches above the bottom of the rail panel.

Reinforcing steel must comply with section 52.

12-3.20A(2) Definitions

Reserved

12-3.20A(3) Submittals

Submit a certificate of compliance for Type K temporary railing not cast at the job site.

12-3.20A(4) Quality Assurance

Reserved

12-3.20B Materials

12-3.20B(1) General

Concrete must comply with the specifications for minor concrete except load tickets and a certificate of compliance are not required.

Steel bars to receive bolts at the ends of the concrete panels must comply with ASTM A36/A36M. The bolts must comply with ASTM A307.

You may substitute a round bar of the same diameter for the end-connecting bolt shown. If a round bar is used, the round bar must:

1. Comply with ASTM A36/A36M
2. Have a minimum length of 26 inches
3. Have a 3-inch-diameter, 3/8-inch-thick plate welded on the upper end using a 3/16-inch fillet weld

The final surface finish of the railing must comply with section 51-1.03F(2).

Cure the exposed surfaces of the railing by the water method, the forms-in-place method, or the curing compound method using curing compound no. 1.

12-3.20B(2) Type K Temporary Terminal Section

The closure plate for a Type K temporary terminal section must be a white, commercial-quality steel plate shaped to conform to the cross section of the barrier. The mechanical expansion anchors for connecting the closure plate to the railings must comply with section 75-3 for concrete anchorage devices.

12-3.20C Construction

12-3.20C(1) General

Before placing Type K temporary railing on the job site, paint the exposed surfaces of the railing with white paint complying with the specifications for acrylic emulsion paint for exterior masonry. The repainting of the units is change order work if it is ordered after the units are in place.

Place Type K temporary railing on a firm, stable foundation. Grade the foundation to provide a uniform bearing surface throughout the entire length of the railing.

Structure excavation and backfill must comply with section 19-3 except compaction of earth fill placed behind Type K temporary railing in a curved layout is not required.

Place and maintain the abutting ends of PC concrete units in alignment without substantial offset from each other.

The drilling of holes and bonding of threaded rods or dowels must comply with the specifications for drilling and bonding dowels in section 51-1.

Install a reflector on the top or face of the rail of each rail unit placed within 10 feet of a traffic lane. Apply adhesive for mounting the reflector under the reflector manufacturer's instructions.

Install a Type P marker panel at each end of railing placed adjacent to a 2-lane, two-way highway and at the end facing traffic for railing installed adjacent to a one-way roadbed. If the railing is placed on a skew, install the marker at the end of the skew nearest the traveled way. Type P marker panels must comply with section 82 except you must furnish the marker panels.

After removing Type K temporary railing:

1. Restore the area to its previous condition or construct it to its planned condition if temporary excavation or embankment was used to accommodate the railing.
2. Remove all threaded rods or dowels to a depth of at least 1 inch below the surface of the concrete. Fill the resulting holes with mortar under section 51-1 except cure the mortar by the water method or by the curing compound method using curing compound no. 6.

If the Engineer orders a lateral move of Type K temporary railing and repositioning is not shown, the lateral move is change order work and the railing is not measured in the new position.

12-3.20C(2) Type K Temporary Terminal Section

When the Type K temporary terminal section is no longer required, remove the anchor bolts connecting the closure plate to the concrete barrier or cut the bolts flush with the face of the barrier. If the anchor bolts are removed, fill the holes with grout.

12-3.20D Payment

The payment quantity for temporary railing (Type K) is the length measured along the top of the railing.

12-3.21 TEMPORARY TRAFFIC SCREENS

12-3.21A General

Section 12-3.21 includes specifications for installing temporary traffic screens.

12-3.21B Materials

Temporary traffic screen panels must be CDX grade or better, plywood or weather-resistant strand board.

Wale boards must be Douglas fir, rough sawn, construction grade or better.

Pipe screen supports must be schedule 40, galvanized steel pipe.

Nuts, bolts, and washers must be cadmium plated.

Screws must be black or cadmium-plated flat head, cross-slotted screws with full-thread length.

12-3.21C Construction

Install and anchor temporary traffic screens to the top of the Type K temporary railing. The temporary traffic screen must have 3-foot-long openings spaced at 200-foot intervals.

A lateral move of Type K temporary railing with attached temporary traffic screen is change order work if ordered and repositioning is not shown.

12-3.21D Payment

The payment quantity for temporary traffic screen is the length measured along the line of the screen with no deductions for openings in the temporary traffic screen.

12-3.22 TEMPORARY CRASH CUSHION MODULES

12-3.22A General

Section 12-3.22 includes specifications for placing sand-filled temporary crash cushion modules in groupings or arrays.

If activities expose traffic to a fixed obstacle, protect the traffic from the obstacle with a sand-filled temporary crash cushion. The crash cushion must be in place before opening traffic lanes adjacent to the obstacle.

12-3.22B Materials

Each sand-filled temporary crash cushion module must be manufactured after March 31, 1997 and be on the Authorized Material List for highway safety features.

The color of each module must be standard yellow with black lids as furnished by the manufacturer. Each module must be free from structural flaws and objectionable surface defects.

For a module requiring a seal, the top edge of the seal must be securely fastened to the wall of the module by a continuous strip of heavy-duty tape.

Fill each module with sand under the manufacturer's instructions and to the sand capacity in pounds for each module shown. Sand for filling the modules must be clean, commercial-quality, washed concrete sand. When sand is placed in a module, the sand must contain no more than 7 percent water when tested under California Test 226.

12-3.22C Construction

Use the same type of crash cushion module for a single grouping or array.

Temporary crash cushion arrays must not encroach on the traveled way.

Secure the sand-filled modules in place before starting an activity requiring a temporary crash cushion.

Maintain sand-filled temporary crash cushions in place at each location, including times when work is not actively in progress. You may remove the crash cushions during the work shift for access to the work if the exposed fixed obstacle is 15 feet or more from the nearest lane carrying traffic. Reset the crash cushion before the end of the work shift.

Immediately repair sand-filled temporary crash cushion modules damaged due to your activities. Remove and replace any module damaged beyond repair. Repair and replacement of temporary crash cushion modules damaged by traffic are change order work.

You may place sand-filled temporary crash cushion modules on movable pallets or frames complying with the dimensions shown. The pallets or frames must provide a full-bearing base beneath the modules. Do not move the modules and supporting pallets or frames by sliding or skidding along the pavement or bridge deck.

Attach a Type R or Type P marker panel to the front of the temporary crash cushion if the closest point of the crash cushion array is within 12 feet of the traveled way. Firmly fasten the marker panel to the crash cushion with commercial quality hardware or by other authorized methods. Attach the Type R marker panel such that the top of the panel is 1 inch below the module lid. Attach the Type P marker panel such that the bottom of the panel rests upon the pallet or roadway surface if pallets are not used.

A lateral move of a temporary crash cushion module is change order work if ordered and the repositioning is not shown.

Remove sand-filled temporary crash cushion modules, including sand, pallets or frames, and marker panels, at Contract acceptance. Do not install sand-filled temporary crash cushion modules in the permanent work.

12-3.22D Payment

The payment quantity for temporary crash cushion module does not include:

1. Modules placed for public safety
2. Modules placed in excess of the number described
3. Repositioned modules

12-3.23 IMPACT ATTENUATOR VEHICLES

12-3.23A General

12-3.23A(1) Summary

Section 12-3.23 includes specifications for using impact attenuator vehicles.

12-3.23A(2) Definitions

impact attenuator vehicle: Support truck towing a deployed attenuator mounted to a trailer or a support truck with a deployed attenuator mounted to the support truck.

12-3.23A(3) Submittals

Submit a certificate of compliance for each attenuator.

12-3.23A(4) Quality Assurance

Before using an impact attenuator vehicle, conduct a meeting with the Engineer, subcontractors, and other parties involved with traffic control to discuss the operation of the impact attenuator vehicle during moving lane closures and when placing and removing components of a stationary traffic control system.

Schedule the location, time, and date for the meeting with all participants. Furnish a meeting facility located within 5 miles of the job site or at another location if authorized.

12-3.23B Materials

An impact attenuator vehicle must be on the Authorized Material List for highway safety features. The vehicle must comply with Veh Code Div 12.

Each attenuator must be individually identified with the manufacturer's name, address, attenuator model number, and a specific serial number. The name and number must be a minimum 1/2 inch high and located on the left, street side, lower front corner.

An impact attenuator vehicle must comply with the following test levels as specified in the National Cooperative Highway Research Program Report 350:

1. Test level 3 if the preconstruction posted speed limit is 50 mph or more

2. Test level 2 or 3 if the preconstruction posted speed limit is 45 mph or less

The impact attenuator vehicle must comply with the attenuator manufacturer's instructions for:

1. Support truck except the weight of the support truck must be within the allowable vehicle weight limits shown on the Authorized Material List for highway safety features and the manufacturer's instructions
2. Trailer-mounted attenuator
3. Truck-mounted attenuator

A flashing arrow sign must comply with section 12-3.30 except you may use a PCMS instead of a flashing arrow sign. A PCMS used as a flashing arrow sign must comply with the specifications for an arrow board in the *California MUTCD*.

Each impact attenuator vehicle must have:

1. Inverted V chevron pattern placed across the entire rear of the attenuator composed of alternating 4-inch-wide, nonreflective black stripes and 4-inch-wide, yellow retroreflective stripes sloping at 45 degrees
2. Type II flashing arrow sign
3. Flashing or rotating amber light
4. Operable 2-way communication system for maintaining contact with workers

12-3.23C Construction

Do not use an impact attenuator vehicle until authorized.

Monitor the placement and use of the attenuator vehicle on a regular basis and adjust the use of the attenuator to match changing field conditions as construction progresses.

After placing the components of a stationary traffic control system, you may place the impact attenuator vehicle in advance of the work area or at another authorized location to protect traffic and workers.

Secure objects, including equipment, tools, and ballast, on impact attenuator vehicles to prevent their loosening upon impact by an errant vehicle.

Do not use a damaged attenuator in the work. Replace any attenuator damaged from an impact during work activities.

12-3.23D Payment

Not Used

12-3.24–12-3.29 RESERVED

12-3.30 FLASHING ARROW SIGNS

12-3.30A General

Section 12-3.30 includes specifications for placing flashing arrow signs.

12-3.30B Materials

A flashing arrow sign must comply with the requirements shown in the following table:

Flashing Arrow Sign Requirements

Type	Panel size (min, inches)	Number of panel lights (min)	Legibility distance[a] (min, miles)
I	48 x 96	15	1
II	36 x 72	13	3/4

[a]The legibility distance is the distance that a flashing arrow sign must be legible at noon on a cloudless day and during the hours of darkness by persons with 20/20 vision or vision corrected to 20/20.

A flashing arrow sign must be finished with commercial-quality nonreflective black enamel and must be equipped with yellow or amber lamps that form arrows or arrowheads. Each lamp must be equipped with a visor and the lamps must be controlled by an electronic circuit that provides from 30 to 45 complete

operating cycles per minute for each of the displays and modes specified. The control must be capable of dimming the lamps by reducing the voltage to 50 ± 5 percent for nighttime use. Type I signs must have both manual and automatic photoelectric-dimming controls. Dimming in both modes must be continuously variable over the entire dimming range.

A flashing arrow sign must be capable of operating in the following display modes:

1. Pass left display
2. Pass right display
3. Simultaneous display
4. Caution display or alternating diamond

A flashing arrow sign must be capable of operating in the flashing arrow mode or the sequential mode.

In the flashing arrow mode, all lamps forming the arrowhead and shaft must flash on and off simultaneously.

In the sequential mode, either arrowheads or arrows must flash sequentially in the direction indicated.

In the simultaneous display mode, the lamps forming both the right and left arrowheads and the lamps forming the arrow shaft or center 3 lamps for Type I signs must flash simultaneously. For Type II signs, the lamps forming the right and left arrowhead, but not the center lamp, may be illuminated continuously; the lamps forming the shaft and the center lamp of the arrowheads must flash on and off simultaneously.

In the caution display mode, a combination of lamps not resembling any other display or mode must flash.

Each flashing arrow sign must be:

1. Mounted on a truck or trailer
2. Capable of operating when the vehicle is moving
3. Capable of being placed and maintained in operation at locations described

A Type II flashing arrow sign must be controllable by the operator of the vehicle while the vehicle is in motion.

The bottom of the flashing arrow sign must be a minimum of 7 feet above the roadway when mounted.

The trailer for a flashing arrow sign must be equipped with (1) devices to level and plumb the sign and (2) a supply of electrical energy capable of operating the sign.

12-3.30C Construction

Not Used

12-3.30D Payment

Not Used

12-3.31 PORTABLE FLASHING BEACONS

12-3.31A General

Section 12-3.31 includes specifications for placing portable flashing beacons.

12-3.31B Materials

Each portable flashing beacon must have:

1. Standard and base
2. Lighting unit
3. Flasher unit
4. Battery power source

The components must be assembled to form a complete, self-contained, flashing beacon that can be delivered to the job site and placed into immediate operation.

The lens for the beacon lighting unit must have a visible diameter of 12 inches. The lens must be glass or plastic complying with ANSI D-10.1 for a yellow traffic signal lens.

The beacon lighting unit must be equipped with a visor and backplate except a visor is not required during hours of darkness. The visor must be at least 8 inches long.

The flasher unit must be capable of flashing from 50 to 60 flashes per minute with a dwell time from 250 to 350 milliseconds.

The standard must be adjustable to allow variable mounting of the lighting unit from 6 to 10 feet, measured from the bottom of the base to the center of the lens, and be capable of being secured at the desired height. The standard must be securely attached to the base and have a length of multiconductor, neoprene-jacketed cable long enough for the full vertical height.

The base must be (1) large enough to accommodate at least two 12 V automotive-type storage batteries and (2) a shape and weight such that the beacon will not roll if struck by a vehicle or pushed over.

The lamp must be rated at 25 W for operation on 12 V battery current.

The flashing beacon must be weatherproof and must be capable of operating a minimum of 150 hours between battery recharging and other routine maintenance.

The standard and base must be finished with 2 applications of commercial-quality enamel matching color no. 12473 of FED-STD-595. The interior of the visor and the front face of the backplate must be finished with 2 applications of commercial-quality, nonreflective black enamel.

12-3.31C Construction

Remove portable flashing beacons from the traveled way at the end of each night's work. You may store the flashing beacon at selected central locations within the highway where designated by the Engineer.

Moving portable flashing beacons from location to location if ordered after initial placement is change order work.

12-3.31D Payment

The payment quantity for flashing beacon (portable) is the number of portable flashing beacon locations with each location counting as 1 measurement unit.

12-3.32 PORTABLE CHANGEABLE MESSAGE SIGNS

12-3.32A General

12-3.32A(1) Summary

Section 12-3.32A includes specifications for placing portable changeable message signs.

12-3.32A(2) Definitions

Reserved

12-3.32A(3) Submittals

If requested, submit a certificate of compliance for each PCMS.

Submit your cell phone number before starting the first activity that requires a PCMS.

12-3.32A(4) Quality Assurance

Reserved

12-3.32B Materials

Each PCMS must have a message board, controller unit, power supply, and a structural support system. The unit must be assembled to form a complete self-contained PCMS that can be delivered to the job site and placed into immediate operation. The sign unit must be capable of operating at an ambient air temperature from -4 to 158 degrees F and must be unaffected by mobile radio transmissions other than those required to control the PCMS.

A PCMS must be permanently mounted on a trailer, truck bed, or truck cab under the manufacturer's instructions. The PCMS must be securely mounted on the support vehicle such that it remains attached during any impact to the vehicle. If it is mounted on a trailer, the trailer must be capable of being leveled and plumbed.

A minimum of 3 feet of retroreflective material must be permanently affixed on all 4 sides of the trailer. The retroreflective material need not be continuous but must be visible on the same plane.

The sign panel must be capable of displaying a 3-line message with at least 7 characters per line. The characters must be at least 18 inches in height where the useable shoulder area is at least 15 feet wide. To prevent encroachment onto the traveled way where the useable shoulder area is less than 15 feet wide, you may use a smaller message panel with at least 12-inch-high characters.

The message displayed on the sign must be visible from a distance of 1,500 feet and legible from a distance of 750 feet at noon on a cloudless day and during the night by persons with 20/20 vision or vision corrected to 20/20.

The characters on a sign panel may be 10 inches in height if:

1. PCMS is mounted on a service patrol truck or other incident response vehicle or used for traffic control operations on a highway facility where the posted speed limit is less than 40 mph
2. Message is legible from a distance of at least 650 feet at noon on a cloudless day and during the night by persons with 20/20 vision or vision corrected to 20/20

A matrix sign must provide a complete alphanumeric selection.

A PCMS must automatically adjust its brightness under varying light conditions to maintain the legibility of the message. The sign must be equipped with an automatic-dimming mode that automatically compensates for the influence of temporary light sources or abnormal lighting conditions. The sign must have 3 or more manual dimming modes of different intensities.

During the hours of darkness, a matrix sign not using lamps must be either internally or externally illuminated.

The controller must be an all solid-state unit containing the necessary circuitry for the storage of at least 5 preprogrammed messages. The controller must be installed at a location that allows the operator to perform all functions from a single position. The controller must have a keyboard entry system that allows the operator to generate an infinite number of additional messages in addition to the preprogrammed stored messages. The keyboard must be equipped with a security lockout feature to prevent unauthorized use of the controller.

The controller must have:

1. Nonvolatile memory that stores keyboard-created messages during periods when the power is not activated
2. Variable display rate that allows the operator to match the information display to the speed of approaching traffic
3. Screen upon which messages may be reviewed before being displayed on the sign

The flashing-off time must be adjustable from within the control cabinet.

12-3.32C Construction

Place a PCMS as far from the traveled way as practicable where it is legible to approaching traffic without encroaching on the traveled way. Where the vertical roadway curvature restricts the sight distance of approaching traffic, place the sign on or before the crest of the curvature where it is most visible to the approaching traffic. Where the horizontal roadway curvature restricts the sight distance of approaching traffic, place the sign at or before the curve where it is most visible to approaching traffic. Where practicable, place the sign behind guardrail or Type K temporary railing.

Make a taper consisting of 9 traffic cones placed 25 feet apart to delineate the location of a PCMS except where the sign is placed behind guardrail or Type K temporary railing.

When in full operation, the bottom of a sign must be at least 7 feet above the roadway in areas where pedestrians are anticipated and 5 feet above the roadway elsewhere, and the top of the sign must be not more than 14.5 feet above the roadway.

Operate the PCMS under the manufacturer's instructions.

Keep the PCMS clean to provide maximum visibility.

If multiple signs are needed, place each sign on the same side of the road at least 1,000 feet apart on freeways and expressways and at least 500 feet apart on other types of highways.

If more than one PCMS is simultaneously visible to traffic, only 1 sign may display a sequential message at any time. Do not use dynamic message displays, such as animation, rapid flashing, dissolving, exploding, scrolling, horizontal movement, or vertical movement of messages. The message must be centered within each line of the display.

You may use an additional PCMS if more than 2 phases are needed to display a message.

Display only messages shown or ordered.

Repeat the entire message continuously in not more than 2 phases of at least 3 seconds per phase. The sum of the display times for both of the phases must be a maximum of 8 seconds. If more than 2 phases are needed to display a message, use an additional PCMS.

You must be available by cell phone during activities that require a sign. Be prepared to immediately change the displayed message if ordered. You may operate the sign with a 24-hour timer control or remote control if authorized.

After the initial placement, move a sign from location to location as ordered.

When a PCMS is not in use, move it to an area at least 15 feet from the edge of the traveled way or remove it from the job site away from traffic.

12-3.32D Payment

Not Used

12-3.33 TEMPORARY SIGNAL SYSTEMS

12-3.33A General

Section 12-3.33 includes specifications for installing temporary signal systems, including installing temporary traffic signals, lighting, and flashing beacons for traffic control.

Temporary signal systems must comply with section 87.

The system must operate on a continuous, 24-hour basis unless traffic is controlled by flaggers.

12-3.33B Materials

12-3.33B(1) General

Reserved

12-3.33B(2) Generators

A generator system to power a temporary signal system must have an operating generator and backup generator.

In the event of a failure to supply voltage for the system, the backup generator must start automatically and transfer the system load upon reaching the operating voltage.

The system must have enough fuel storage to operate when it is unattended.

If a generator to back up commercial power is specified in the special provisions, the generator must have an automatic transfer switch.

Each generator must:

1. Be 120 V(ac) or 120/240 V(ac), 60 Hz, 2.5 kW minimum, continuous-duty type
2. Be powered by a gasoline, LPG, or diesel engine operating at approximately 1,800 rpm with an automatic oil feed
3. Be equipped to provide automatic start-stop operation with a 12 V starting system
4. Have generator output circuits that have overcurrent protection with a maximum setting of 15 A

12-3.33B(3) Automatic Transfer Switches

An automatic transfer switch must provide the following functions:

1. Line voltage monitoring in the event of a power outage that signals the generator to start.
2. Engine start delay, adjustable from 0 to 6 seconds, to prevent starting if the power outage is only momentary and an engine stop delay, adjustable from 0 to 8 minutes, to allow the generator set to run unloaded to cool before shut down.
3. Transfer delay from 0 to 120 seconds to allow the generator to stabilize before connecting to the load and retransfer delay from 0 to 32 minutes to allow the line voltage to stabilize.
4. Load-No Load switch to allow a test with or without load.
5. Normal-Test switch that will start and run the generator in the Test position. Normal position must return the generator to automatic operation.
6. Battery charger powered by the normal line voltage.
7. Generator voltage sensor that signals for a transfer if the generator output is ready.

The automatic transfer switch must be:

1. Rated at 100 A for 120/240 V(ac)
2. 3 wire
3. Single phase
4. Compatible with the generator furnished

The switch must have a mechanical interlock to prevent an application of power to the load from both sources and to prevent backfeeding from the generator to the line.

12-3.33C Construction

12-3.33C(1) General

Use one of the following methods to provide power to the temporary signal system:

1. Commercial power from an existing utility company
2. Generator system

Do not use electrical power from existing highway facilities unless authorized.

Do not use power from private parties to provide power to the temporary signal system.

If the temporary signal system is out of operation, provide flaggers to maintain traffic control until the traffic signals are returned to service.

12-3.33C(2) Commercial Power

Commercial power must be 120 V(ac) or 120/240 V(ac). Make arrangements with the utility company for providing service. Protect the power source in a locked enclosure. Provide keys to all locks to the Engineer.

12-3.33D Payment

Not Used

12-3.34 TEMPORARY FLASHING BEACON SYSTEMS

12-3.34A General

Section 12-3.34 includes specifications for installing temporary flashing beacon systems.

A temporary flashing beacon system must comply with section 87.

12-3.34B Materials

12-3.34B(1) General

Reserved

12-3.34B(2) Generators

A generator system to power a temporary flashing beacon system must comply with section 12-3.33B(2).

12-3.34B(3) Sign Panels

The sign panels installed on a temporary flashing beacon system must be stationary-mounted construction area signs complying with section 12-3.11.

12-3.34C Construction

Relocate each system during the progress of the work such that the systems are located at the ends of the pavement at the end of each work shift.

Use commercial power from an existing utility company or generator system to provide power to the temporary flashing beacon system.

Do not use power from a private party to provide power to a temporary flashing beacon system.

Commercial power must be 120 V(ac) or 120/240 V(ac). Make arrangements with the utility company for providing service. Protect the power source in a locked enclosure. Provide keys to all locks to the Engineer.

12-3.34D Payment

Not Used

12-3.35 AUTOMATED WORK ZONE INFORMATION SYSTEMS

12-3.35A General

12-3.35A(1) Summary

Section 12-3.35 includes specifications for installing automated work zone information systems.

12-3.35A(2) Definitions

Reserved

12-3.35A(3) Submittals

Reserved

12-3.35A(4) Quality Assurance

Assign an on-site system coordinator. The coordinator must be available locally to service, maintain, and relocate system components as necessary. The coordinator must be accessible 24–7 while the system is deployed. If the system fails to perform as specified, perform any necessary remedial work and replace any failed components within 24 hours of notification of a system or component failure.

12-3.35B Materials

12-3.35B(1) General

The AWIS must be a proven system that has been successfully deployed and operated in actual work zones or congested areas.

The system must acquire traffic data throughout the work zone and automatically display predetermined information to motorists without operator intervention after system initialization.

Real-time information must be displayed to motorists using a PCMS. The sign must comply with section 12-3.32.

The system must be controlled either locally or remotely by a dedicated controller or computer.

Authorized users must be able to both locally and remotely override motorist information messages.

Traffic sensors must not require adjustments after the initial deployment.

12-3.35B(2) General System Function Requirements

The general system functions of the AWIS must be capable of:

1. Preventing any unauthorized users or systems from gaining access to the PCMSs through an industry authentication and encryption standard level of security.
2. Providing current operational status locally and remotely. Operational status must include current traffic data and messages, communications system, and power status.

3. Delivering notifications either by telephone, voice, or text messages to alert support staff of trouble conditions.
4. Generating trouble alerts for conditions such as (1) low roadside equipment power or voltage, (2) system communications failure, (3) low speed traffic detected, and (4) excessive delay detected.
5. Adjusting the thresholds of reduced speed and congestion-induced delay at which the system initiates a trouble alert.
6. Allowing programming of the hours during which the trouble condition alerting subsystem initiates notification to authorized users.
7. Measuring periodically and automatically the power levels of all equipment. Alert support staff, locally and remotely via a telephone message, in time to provide supplemental power before the system ceases to operate.
8. Displaying preprogrammed messages based on the time of day and day of week.

12-3.35B(3) Motorist Information Message Requirements

The AWIS must be capable of:

1. Displaying predetermined speed, delay, diversion, and closure messages to motorists when user-adjustable thresholds are exceeded.
2. Updating its speed and delay advisory messages at least once per minute. The actual message updates must be consistent with traffic conditions.
3. Selecting messages for each PCMS independently, based on the traffic conditions downstream of the sign.
4. Recording motorist information messages in a comma-separated values file with time and date stamps, including message overrides with user ID.
5. Displaying default messages when traffic conditions, system algorithms, and user parameters do not dictate that an advisory message should be displayed.
6. Displaying separate, independent, default messages on each PCMS.
7. Analyzing traffic parameters in work zones in which there are multiple speed limits.

The following parameters for the selection and presentation of information messages must be adjustable by the user:

1. Message update frequency
2. Minimum delay necessary to trigger a delay advisory message
3. Persistence of delay before a delay message is displayed
4. Level of delay required to trigger a diversion message
5. Change in delay needed to cause a delay advisory message update
6. Change in downstream speed at which a speed advisory message update occurs

12-3.35B(4) System Communication Requirements

The wireless communications subsystem of the AWIS must:

1. Operate independently of the public cellular phone system for receiving data to ensure reliable communications
2. Communicate independent of the line of sight or distance
3. Incorporate an error detection and correction mechanism to ensure the integrity of all traffic condition data and motorist information messages
4. Configure automatically during system initialization

12-3.35B(5) Traffic Data Acquisition Requirements

The AWIS must collect accurate traffic data using a speed measurement technique with an accuracy of ±5 mph, allowing specific information messages. The system must collect data during reduced visibility conditions, including precipitation, fog, darkness, excessive dust, and road debris.

The system must (1) archive the data with time and date stamps and (2) aggregate the data in operator-definable time increments, accessible 24–7 to the Engineer in a comma-separated values file.

12-3.35B(6) User Interface

The system must have a user interface to control the AWIS PCMS communications. The interface must be (1) software compatible with a Windows environment or (2) a web service accessed by a web browser.

Provide any software on a CD or other Engineer-authorized data-storage device for installation at the Department's Transportation Management Center.

The user interface must, at a minimum, provide the user with a list of AWIS PCMSs in the field, location information for each AWIS PCMS, and a real-time on-board display of the message in the field. Control options must, at a minimum, provide the user the ability to change the on-board messages and flash rate.

12-3.35C Construction

Obtain authorization for the message content and the threshold used for triggering the message before displaying any message on a PCMS.

Provide complete setup and support for the AWIS PCMS communications.

12-3.35D Payment

Not Used

12-3.36 PORTABLE TRANSVERSE RUMBLE STRIPS

Reserved

12-3.37–12-3.40 RESERVED

12-4 MAINTAINING TRAFFIC

12-4.01 GENERAL

12-4.01A General

Section 12-4.01 includes general specifications for maintaining traffic through construction work zones.

If local authorities regulate traffic, notify them at least 5 business days before the start of job site activities. Cooperate with the local authorities to handle traffic through the work zone and to make arrangements to keep the work zone clear of parked vehicles.

12-4.01B Materials

Not Used

12-4.01C Construction

Furnishing and operating pilot cars if ordered is change order work.

12-4.01D Payment

Not Used

12-4.02 TRAFFIC CONTROL SYSTEMS

12-4.02A General

12-4.02A(1) Summary

Section 12-4.02 includes specifications for providing a traffic control system to close traffic lanes, shoulders, ramps, and connectors.

A traffic control system for a closure includes the temporary traffic control devices described as part of the traffic control system. Temporary traffic control devices must comply with section 12-3.

12-4.02A(2) Definitions

Construction Zone Enhanced Enforcement Program (COZEEP): Program that provides California Highway Patrol officers to monitor the movement of traffic within the work zone.

designated holidays: Designated holidays are shown in the following table:

Designated Holidays

Holiday	Date observed
New Year's Day	January 1st
Washington's Birthday	3rd Monday in February
Memorial Day	Last Monday in May
Independence Day	July 4th
Labor Day	1st Monday in September
Veterans Day	November 11th
Thanksgiving Day	4th Thursday in November
Christmas Day	December 25th

If a designated holiday falls on a Sunday, the following Monday is a designated holiday. If November 11th falls on a Saturday, the preceding Friday is a designated holiday.

12-4.02A(3) Submittals

12-4.02A(3)(a) General

Submit a request for a minor deviation from the specified work hours. For a project in District 7, submit the request at least 15 days before the proposed closure date. Your request may be authorized if (1) the Department does not accrue a significant cost increase and (2) the work can be expedited and better serve the traffic.

If a closure is not opened to traffic by the specified time, submit a work plan that ensures that future closures will be opened to traffic by the specified time. Allow 2 business days for review.

Submit closure schedule requests and closure schedule amendments using LCS to show the locations and times of the requested closures.

Submit a traffic break request using LCS to show the location and time of the requested traffic break.

12-4.02A(3)(b) Closure Schedules

Every Monday by noon, submit a closure schedule request for planned closures for the next week.

Except for a project in District 7, the next week is defined as Sunday at noon through the following Sunday at noon.

For a project in District 7, the next week is defined as Friday at noon through the following Friday at noon.

Submit a closure schedule request from 25 days to 125 days before the anticipated start of any job site activity that reduces:

1. Horizontal clearances of traveled ways, including shoulders, to 2 lanes or fewer due to activities such as temporary barrier placement and paving
2. Vertical clearances of traveled ways, including shoulders, due to activities such as pavement overlays, overhead sign installation, or falsework girder erection

Submit closure schedule changes, including additional closures, by noon at least 3 business days before a planned closure.

Cancel closure requests using LCS at least 48 hours before the start time of the closure.

The Department notifies you through LCS of authorized and unauthorized closures and closures that require coordination with other parties as a condition for authorization.

12-4.02A(3)(c) Contingency Plans for Closures

Submit a contingency plan for an activity that could affect a closure if a contingency plan is specified in the special provisions or if a contingency plan is requested.

If a contingency plan is requested, submit the contingency plan within 1 business day of the request.

The contingency plan must identify the activities, equipment, processes, and materials that may cause a delay in the opening of a closure to traffic. The plan must include:

1. List of additional or alternate equipment, materials, or workers necessary to ensure continuing activities and on-time opening of closures if a problem occurs. If the additional or alternate equipment, materials, or workers are not on the job site, specify their location, the method for mobilizing these items, and the required time to complete mobilization.
2. General time-scaled logic diagram displaying the major activities and sequence of the planned activities. For each activity, identify the critical event that will activate the contingency plan.

Submit revisions to a contingency plan at least 3 business days before starting the activity requiring the contingency plan. Allow 2 business days for review.

12-4.02A(3)(d) Traffic Break Schedule

Every Monday by noon, submit a traffic break request for the next week. Support for a traffic break is based on local California Highway Patrol staffing levels and may not be available for the date or time requested.

Traffic break requests are limited to the hours when a shoulder or lane closure is allowed.

Cancel a traffic break request using LCS at least 48 hours before the start time of the traffic break.

The Department notifies you through LCS of authorized and unauthorized traffic breaks.

The Department does not adjust time or payment if (1) a California Highway Patrol officer is unavailable for the requested date or time or (2) your request is not authorized.

12-4.02A(4) Quality Assurance

Reserved

12-4.02B Materials

Not Used

12-4.02C Construction

12-4.02C(1) General

Work that interferes with traffic is limited to the hours when closures are allowed.

Do not reduce an open traffic lane width to less than 10 feet. If traffic cones or delineators are used for temporary edge delineation, the side of the base of the cones or delineators nearest to traffic is considered the edge of the traveled way.

Do not simultaneously close consecutive ramps in the same direction of travel servicing 2 consecutive local streets unless authorized.

Notify the Engineer of delays in your activities caused by the denial of either (1) an authorized closure or (2) a closure schedule request for the specified time frame allowed for closures.

Discuss the contingency plan for any activity that could affect the closure schedule with the Engineer at least 5 business days before starting the activity requiring the plan.

If you do not open a closure to traffic by the specified time, suspend work and submit a work plan. No further closures are allowed until your work plan has been authorized.

If the Engineer orders you to remove a closure before the time designated in the authorized closure schedule, any delay caused by this order is an excusable delay.

The Engineer may reschedule a closure that was canceled due to unsuitable weather.

12-4.02C(2) Lane Closure System

12-4.02C(2)(a) General

The Department provides LCS training. Request the LCS training at least 30 days before submitting the 1st closure request. The Department provides the training within 15 days after your request.

LCS training is web-based or held at a time and location agreed upon by you and the Engineer. For web-based training, the Engineer provides you the website address to access the training.

With 5 business days after completion of the training, the Department provides LCS accounts and user IDs to your assigned, trained representatives.

Each representative must maintain a unique password and current user information in the LCS.

The project is not accessible in LCS after Contract acceptance.

12-4.02C(2)(b) Status Updates for Authorized Closures

Update the status of authorized closures using the LCS Mobile web page.

For a stationary closure on a traffic lane, use code:

1. 10-97 immediately before you place the 1st cone on the traffic lane
2. 10-98 immediately after you remove all of the cones from the traffic lane

For a stationary closure on the shoulder, use code:

1. 10-97 immediately before you place the 1st cone after the last advance warning sign
2. 10-98 immediately after you remove the last cone before the advance warning signs

For a moving closure, use code:

1. 10-97 immediately before the actual start time of the closure
2. 10-98 immediately after the actual end time of the closure

For closures not needed on the authorized date, use code 10-22 within 2 hours after the authorized start time.

If you are unable to access the LCS Mobile web page, immediately notify the Engineer of the closure's status.

12-4.02C(3) Closure Requirements and Charts

12-4.02C(3)(a) General

Where 2 or more lanes in the same direction, including the shoulders, are adjacent to the area where the work is being performed, close the adjacent lane under any of the following conditions:

1. Work is off the traveled way but within 6 feet of the edge of the traveled way, and the approach speed is greater than 45 mph
2. Work is off the traveled way but within 3 feet of the edge of the traveled way, and the approach speed is less than 45 mph

Closure of the adjacent traffic lane is not required during any of the following activities:

1. Work behind a barrier
2. Paving, grinding, or grooving
3. Installation, maintenance, or removal of traffic control devices except for temporary railing

12-4.02C(3)(b) Complete Freeway or Expressway Closure Requirements

Reserved

12-4.02C(3)(c) HOV, Express, and Bus Lane Closure Requirements

Reserved

12-4.02C(3)(d) City Street Closure Requirements

Reserved

12-4.02C(3)(e) Closure Restrictions for Special Events and Venues

Reserved

12-4.02C(3)(f) Closure Restrictions for Designated Holidays and Special Days

Reserved

12-4.02C(3)(g) Freeway or Expressway Lane Requirement Charts

Reserved

12-4.02C(3)(h) Complete Freeway or Expressway Closure Hour Charts

Reserved

12-4.02C(3)(i) Complete Connector Closure Hour Charts and Connector Lane Requirement Charts

Reserved

12-4.02C(3)(j) Complete Ramp Closure Hour Charts and Ramp Lane Requirement Charts

Reserved

12-4.02C(3)(k) Conventional Highway Lane Requirement Charts

Reserved

12-4.02C(3)(l) Complete Conventional Highway Closure Hour Charts

Reserved

12-4.02C(3)(m) City Street Closure Hour Charts and City Street Lane Requirement Charts

Reserved

12-4.02C(3)(n) Concrete Slab and Approach Slab Replacement Closure Hours Table

Reserved

12-4.02C(3)(o)–12-4.02C(3)(s) Reserved

12-4.02C(4)–12.4.02C(6) Reserved

12-4.02C(7) Traffic Control System Requirements

12-4.02C(7)(a) General

Control traffic using stationary closures.

If components of the traffic control system are displaced or cease to operate or function as specified, immediately repair them to their original condition or replace them and place them back in their original locations.

Vehicles equipped with attenuators must comply with section 12-3.23.

Each vehicle used to place, maintain, and remove components of a traffic control system on a multilane highway must have a Type II flashing arrow sign that must operate whenever the vehicle is used for placing, maintaining, or removing the components. For a stationary closure, vehicles with a Type II flashing arrow sign not involved in placing, maintaining, or removing the components must display only the caution display mode. If a flashing arrow sign is required for a closure, activate the sign before the closure is in place.

12-4.02C(7)(b) Stationary Closures

Except for channelizing devices placed along open trenches or excavations adjacent to the traveled way, remove the components of the traffic control system for a stationary closure from the traveled way and shoulders at the end of each work period. You may store the components at authorized locations within the limits of the highway.

If a traffic lane is closed with channelizing devices for excavation work, move the devices to the adjacent edge of the traveled way when not excavating. Space the devices as shown for the lane closure.

12-4.02C(7)(c) Moving Closures

For a moving closure, use a PCMS that complies with section 12-3.32 except the sign must be truck mounted. The full operational height to the bottom of the sign may be less than 7 feet above the ground but must be as high as practicable.

If you use a flashing arrow sign in a moving closure, the sign must be truck mounted. Operate the flashing arrow sign in the caution display mode if it is being used on a 2-lane, two-way highway.

12-4.02C(7)(d) Traffic Breaks

You may request a traffic break for special operations, such as:

1. Installation, removal, or replacement of an overhead power line or other utility cable across the highway
2. Falsework adjustment
3. Installation or removal of traffic control devices in areas without a standard-width shoulder
4. Transportation of large equipment across the highway
5. Access to median areas for workers or equipment

If the Department authorizes the traffic break, the Engineer notifies you and arranges the traffic break with the California Highway Patrol through COZEEP. The duration of a traffic break must not exceed 5 minutes or as authorized.

Two California Highway Patrol officers per vehicle are required for traffic breaks occurring any time from 2200 to 0600 hours.

A minimum of 2 California Highway Patrol vehicles will be assigned to conduct a traffic break.

Place a PCMS approximately 2,000 feet upstream of the work area or as agreed upon by the Engineer. The PCMS must comply with section 12-3.32 except the PCMS must not be trailer mounted. Monitor the traffic during the traffic break. If a queue develops, reposition the PCMS truck far enough upstream of the traffic break to provide real-time notification to motorists before they approach the traffic queue.

12-4.02C(8) Traffic Control System Signs

12-4.02C(8)(a) General

Traffic control system signs must comply with section 12-3.11.

12-4.02C(8)(b) Connector and Ramp Closure Signs

Inform motorists of a temporary closing of a (1) connector or a (2) freeway or expressway entrance or exit ramp using:

1. SC6-3(CA) (Ramp Closed) sign for closures of 1 day or less
2. SC6-4(CA) (Ramp Closed) sign for closures of more than 1 day

SC6-3(CA) and SC6-4(CA) signs must be stationary mounted at the locations shown and must remain in place and visible to motorists during the connector or ramp closure.

Notify the Engineer at least 2 business days before installing the sign and install the sign from 7 to 15 days before the closure.

12-4.02C(9)–12-4.02C(12) Reserved

12-4.02D Payment

The Department pays for change order work for a traffic control system by force account for increased traffic control and uses a force account analysis for decreased traffic control.

The Department does not pay for furnishing, placing, relocating, and removing PCMSs used for a traffic break.

The Department deducts the full cost of COZEEP support provided for the traffic break.

The hourly rate for each California Highway Patrol officer providing COZEEP support is $115. This rate includes full compensation for each hour or portion thereof that the officer provides the support. Markups are not added to any expenses associated with COZEEP support.

The minimum number of hours for an officer is 4 hours, except if a closure is already in place and the Engineer authorizes your request for an on-duty officer to conduct a traffic break, the minimum number of hours for an officer is 1 hour.

For a cancellation less than 48 hours before the scheduled start time of COZEEP support, except for a cancellation due to adverse weather or extenuating circumstances, the Department deducts:

1. Minimum of $50 per California Highway Patrol officer if the officer is notified before the start time
2. Maximum of 4 hours of pay per officer if the officer is not notified before the start time

12-4.03 FALSEWORK OPENINGS

Reserved

12-4.04 TEMPORARY PEDESTRIAN ACCESS ROUTES

12-4.04A General

12-4.04A(1) Summary

Section 12-4.04 includes specifications for providing, maintaining, and removing temporary pedestrian access routes.

A temporary pedestrian access route includes temporary traffic control devices as shown except for Type K temporary railing and temporary crash cushions.

12-4.04A(2) Definitions

Reserved

12-4.04A(3) Submittals

If work activities require the closure of a pedestrian route and a temporary pedestrian access route is not shown, submit a work plan for a temporary pedestrian access route. The work plan must:

1. Describe the activities, processes, equipment, and materials that will be used to provide the temporary access route
2. Show the locations of the routes and the placement of traffic control devices for each stage of work
3. Include a time-scaled logic diagram displaying the sequence and duration of the planned activities for each stage of work
4. Be sealed and signed by an engineer who is registered as a civil engineer in the State

Submit “Temporary Pedestrian Access Route Contractor Compliance Report,” within 2 business days after construction of a temporary pedestrian access route.

Submit “Temporary Pedestrian Access Route Contractor Weekly Report,” within 2 business days of completing a weekly inspection.

12-4.04A(4) Quality Assurance

12-4.04A(4)(a) General

Reserved

12-4.04A(4)(b) Quality Control

Perform a review of the temporary pedestrian access route after it is constructed and document compliance on the “Temporary Pedestrian Access Route Contractor Compliance Report.”

The Department will conduct a verification inspection after receiving the compliance report.

For a temporary pedestrian access route in use perform a weekly review and document compliance on the “Temporary Pedestrian Access Route Contractor Weekly Report.”

12-4.04B Materials

The walkway surface must be slip resistant and surfaced with minor HMA or commercial-quality, bituminous material, commercial-quality concrete, or wood.

A handrail with a circular cross section must have an outer diameter from 1-1/4 to 2 inches. A handrail with a noncircular cross section must have a perimeter from 4 to 6-1/4 inches and a maximum cross-section dimension of 2-1/4 inches.

Fasteners must be rounded to prevent injury to a pedestrian's fingers, hands, and arms and to eliminate sharp edges that could catch on clothing.

A detectable warning surface must be on the Authorized Material List for detectable warning surfaces and match yellow color no. 33538 of FED-STD-595.

Temporary traffic control devices used to channelize pedestrians must:

1. Be free of sharp or rough edges
2. Have a continuous detectable edging at least 6 inches high and at no more than 2 inches above the walkway surface
3. Be at least 32 inches in height
4. Have smooth connection points between devices to allow for a handrail
5. Have a top and bottom surface in the same vertical plane

12-4.04C Construction

Notify the Engineer 5 business days before closing an existing pedestrian route. Do not close the route until authorized.

If work activities require the closure of a pedestrian route and a temporary pedestrian access route is not shown, provide a temporary pedestrian access route near the traveled way. You may route pedestrians using the existing sidewalk or by constructing a temporary access route.

If a bid item for a temporary pedestrian access route is not shown on the Bid Item List, then constructing a temporary pedestrian access route is change order work except, when the closure is a result of your means and methods.

Construct a temporary pedestrian access route such that:

1. Walkway surface is firm and stable and free of irregularities
2. Cross slope of the pedestrian route is at most 50:1 (horizontal:vertical)
3. Longitudinal slope of the pedestrian route is at most 20:1 (horizontal:vertical)
4. Walkway, landings, blended transitions, and curb ramps are at least 60 inches wide except where not feasible, the width must be at least 48 inches wide with a 60-by-60-inch passing space at least every 200 feet
5. Lateral joints or gaps between surfaces are less than 1/2 inch wide
6. Discontinuities in surface heights are less than 1/2 inch and beveled if greater than 1/4 inch with a slope no greater than 2:1 (horizontal:vertical)
7. Ramps have:
    7.1. Longitudinal slope of at most 12:1 (horizontal:vertical)
    7.2. Rise less than 30 inches
    7.3. Protective edging at least 2 inches high on each side and handrails at a height from 34 to 38 inches above the walkway surface if the rise is greater than 6 inches
8. Curb ramps have:
    8.1. Longitudinal slope of at most 12:1 (horizontal:vertical)
    8.2. Protective edging at least 2 inches high on each side if the curb ramp does not have flares and the rise is greater than 6 inches
9. Pedestrians are channelized when routed off existing pedestrian routes

Construct handrails such that they are continuous, smooth and free of sharp or rough edges.

Provide an overhead covering to protect pedestrians from falling objects and drippings from overhead structures.

If the temporary access route is next to traffic or work activities, place a temporary barrier to separate the route from vehicles and equipment.

Install a detectable warning surface at locations where a curb ramp, landing, or blended transition connects to a street. Install the warning surface such that it extends a minimum of 36 inches in the direction of travel and for the full width of the landing, blended transition, or curb ramp, excluding the flares.

Maintain the temporary pedestrian access route clear of obstructions. Do not allow traffic control devices, equipment, or construction materials to protrude into the walkway. Maintain a continuous unobstructed path connecting all pedestrian routes, parking lots, and bus stops located within the project limits.

Remove the temporary pedestrian access route when the Engineer determines it is no longer needed.

Provide a temporary pedestrian access route through falsework under section 16-2.02.

12-4.04D Payment

Not Used

12-4.05 BRIDGE CLEANING AND PAINTING ACTIVITIES

12-4.05A General

Section 12-4.05 includes specifications for maintaining traffic during bridge cleaning and painting activities.

Signs must comply with section 12-3.11.

12-4.05B Materials

Not Used

12-4.05C Construction

For bridge cleaning and painting activities, place the signs shown in the following table in addition to those shown on the plans:

Sign no.	Sign description	Requirement
W20-1	Road Work Ahead	Place portable 30-by-30-inch signs at locations where traffic approaches a bridge with work underway. If the approach speed is greater than 50 mph, the sign must be 48 by 48 inches. The sign panel base material must not be plywood. Attach 2 orange, 16 sq in flags to each sign.
--	Cleaning and Painting Operations	Place a 48-by-48-inch sign near each W20-1 sign. Use 4-inch-high black lettering and include your name, address, and telephone number on an orange background.

The Engineer determines the exact locations of the signs. Do not use signs until needed. Maintain the signs in place during bridge cleaning and painting activities. Remove the signs at the end of each work shift.

After each day's bridge cleaning and painting activities, remove obstructions from the roadway to allow for free passage for traffic. Remove blast cleaning residue from the traveled way before opening the area to traffic.

You may lay supply lines along the top of curbs adjacent to railing posts if the lines do not interfere with traffic. Remove the lines when work is not in progress.

12-4.05D Payment

Not Used

12-4.06 TOLL BRIDGES

Reserved

12-4.07–12-4.10 RESERVED

12-5 RESERVED

12-6 TEMPORARY PAVEMENT DELINEATION

12-6.01 GENERAL

Section 12-6 includes specifications for placing temporary pavement delineation except for delineation on a seal coat project.

Temporary painted traffic stripes and painted pavement markings used for temporary delineation must comply with section 84-2.

Temporary signs for no-passing zones must comply with section 12-3.11.

12-6.02 MATERIALS

12-6.02A General

The following types of temporary pavement delineation must be on the Authorized Material List for signing and delineation materials:

1. Temporary pavement markers for long term day/night use (180 days or less)
2. Temporary pavement markers for short term day/night use (14 days or less)
3. Temporary (removable) striping and pavement marking tape (180 days or less)
4. Permanent traffic striping and pavement marking tape
5. Channelizers

12-6.02B Temporary Pavement Markers

Temporary pavement markers must be the same color as the lane line or centerline markers being replaced.

Temporary pavement markers must be for long-term day or night use, 180 days or less, except you may use temporary pavement markers for short-term day or night use, 14 days or less, if you place the permanent pavement delineation before the end of the 14 days.

12-6.02C Channelizers

Channelizers used for temporary edge line delineation must be orange and surface mounted.

12-6.03 CONSTRUCTION

12-6.03A General

If work activities obliterate pavement delineation, place temporary or permanent pavement delineation before opening the traveled way to traffic. The temporary pavement delineation must consist of a lane line and centerline pavement delineation for traveled ways open to traffic. On multilane roadways, freeways, expressways, and 2-lane roadways with shoulders 4 feet or more in width, the temporary pavement delineation must also include edge line delineation for traveled ways open to traffic.

Establish the alignment for temporary pavement delineation, including the required lines or markers. Surfaces to receive an application of paint or removable traffic tape must be dry and free from dirt and loose material. Do not apply temporary pavement delineation over existing pavement delineation or any other temporary pavement delineation. Maintain temporary pavement delineation until no longer needed or replace it with a new striping detail of temporary or permanent pavement delineation.

When the Engineer determines the temporary pavement delineation is no longer required for the direction of traffic, remove the temporary pavement delineation, including any underlying adhesive for temporary pavement markers, from the final layer of surfacing and from the pavement to remain in place. Remove temporary pavement delineation that conflicts with any subsequent or new traffic pattern for the area.

12-6.03B Temporary Lane Line and Centerline Delineation

If lane lines or centerlines are obliterated and temporary pavement delineation to replace the lines is not shown, the minimum lane line and centerline delineation must consist of temporary pavement markers placed longitudinally at 24-foot maximum intervals.

For temporary lane line or centerline delineation consisting entirely of temporary pavement markers for short-term day or night use, 14 days or less, do not use the markers for more than 14 days on lanes opened to traffic. Place the permanent pavement delineation before the end of the 14 days. If the permanent pavement delineation is not placed within 14 days, replace the temporary pavement markers with additional temporary pavement delineation equivalent to the pattern described for the permanent pavement delineation for the area.

If no-passing centerline pavement delineation is obliterated, install the following temporary no-passing zone signs before opening lanes to traffic:

1. W20-1 (Road Work Ahead) sign from 1,000 to 2,000 feet in advance of the no-passing zone
2. R4-1 (Do Not Pass) sign at the beginning of the no-passing zone and at 2,000-foot maximum intervals within the no-passing zone
3. W7-3a (Next ___ Miles) plaque beneath the W20-1 sign for continuous zones longer than 2 miles

4. R4-2 (Pass With Care) sign at the end of the no-passing zone

The Engineer determines the exact location of temporary no-passing zone signs. Maintain the temporary no-passing zone signs in place until you place the permanent no-passing centerline pavement delineation.

Remove the temporary no-passing zone signs when the Engineer determines they are no longer required for the direction of traffic.

12-6.03C Temporary Edge Line Delineation

On multilane roadways, freeways, expressways, and 2-lane roadways with shoulders 4 feet or more in width open to traffic where edge lines are obliterated and temporary pavement delineation to replace those edge lines is not shown, provide temporary pavement delineation for:

1. Right edge lines consisting of any of the following:
   1.1. Solid 6-inch-wide traffic stripe tape of the same color as the stripe being replaced
   1.2. Traffic cones placed longitudinally at 100-foot maximum intervals
   1.3. Portable delineators or channelizers placed longitudinally at 100-foot maximum intervals
2. Left edge lines consisting of any of the following:
   2.1. Solid 6-inch-wide traffic stripe tape of the same color as the stripe being replaced
   2.2. Traffic cones placed longitudinally at 100-foot maximum intervals
   2.3. Portable delineators or channelizers placed longitudinally at 100-foot maximum intervals
   2.4. Temporary pavement markers placed longitudinally at 6-foot maximum intervals

You may apply temporary traffic stripe paint of the same color as the stripe being replaced instead of solid 6-inch-wide temporary traffic stripe tape where the removal of the temporary traffic stripe is not required.

The Engineer determines the lateral offset for traffic cones, portable delineators, and channelizers used for temporary edge line delineation. If traffic cones or portable delineators are used for temporary edge line delineation, maintain the cones or delineators during the hours of the day when they are in use.

Cement the bases of channelizers used for temporary edge line delineation to the pavement with hot melt bituminous adhesive as specified in section 81-3 for cementing pavement markers to pavement.

12-6.03D Temporary Traffic Stripe, Pavement Marking, and Pavement Markers

12-6.03D(1) General

Reserved

12-6.03D(2) Temporary Traffic Stripe Tape

Except where the temporary traffic stripe is used for 14 days or less, apply temporary removable traffic stripe tape under the manufacturer's instructions and as follows:

1. Slowly roll the tape with a rubber-tired vehicle or roller to ensure complete contact with the pavement surface.
2. Apply the tape straight on a tangent alignment and on a true arc on a curved alignment.
3. Do not apply the tape when the ambient air or pavement temperature is less than 50 degrees F unless otherwise authorized.

For temporary traffic stripe tape used for 14 days or less, apply the temporary removable traffic stripe tape under the manufacturer's instructions.

12-6.03D(3) Temporary Traffic Stripe Paint

Apply temporary traffic stripe paint under section 84-2.03 except you may apply 1 or 2 coats of the temporary traffic stripe paint for new or existing pavement.

You are not required to remove painted temporary traffic stripe that will be covered by paving work.

12-6.03D(4) Temporary Pavement Marking Tape

Apply temporary removable pavement marking tape as specified for applying temporary removable traffic stripe tape in section 12-6.03D(2).

12-6.03D(5) Temporary Pavement Marking Paint

Apply temporary pavement marking paint under section 84-2.03 except you may apply 1 or 2 coats of the temporary pavement marking paint.

You are not required to remove of painted temporary pavement markings that will be covered by paving work.

You may use permanent or temporary removable pavement marking tape instead of temporary pavement marking paint.

12-6.03D(6) Temporary Pavement Markers

Place temporary pavement markers under the manufacturer's instructions. Cement temporary markers to the surfacing with the manufacturer's recommended adhesive except do not use epoxy adhesive in areas where the removal of the pavement markers is required.

You may use retroreflective pavement markers instead of temporary pavement markers for long-term day or night use, 180 days or less, except to simulate patterns of broken traffic stripe. Retroreflective pavement markers used for temporary pavement markers must comply with section 81-3 except the waiting period before placing pavement markers on new asphalt concrete surfacing as specified in section 81-3.03 does not apply. Do not use epoxy adhesive to place pavement markers in areas where the removal of the pavement markers is required.

12-6.04 PAYMENT

The Department does not pay for additional temporary pavement delineation used to replace temporary pavement markers.

Temporary traffic stripe is measured as specified for traffic stripe in section 84.

Temporary pavement marking is measured as specified for pavement marking in section 84.

12-7 TEMPORARY PAVEMENT DELINEATION FOR SEAL COATS

12-7.01 GENERAL

Section 12-7 includes specifications for placing temporary pavement delineation for a seal coat project.

Temporary signs for no-passing zones must comply with section 12-3.11.

12-7.02 MATERIALS

Temporary raised pavement markers for seal coat applications must be temporary pavement markers for short-term day or night use, 14 days or less, on the Authorized Material List for signing and delineation materials.

12-7.03 CONSTRUCTION

Before applying binder that will obliterate existing traffic stripes, place temporary raised pavement markers on the existing traffic stripes except for right edge lines at 24-foot maximum intervals. Place 2 markers side by side on double traffic stripes with 1 marker placed on each stripe longitudinally at 24-foot maximum intervals. Place temporary raised pavement markers under the manufacturer's instructions. Before opening the lanes to uncontrolled traffic, remove the covers from the temporary raised pavement markers.

If you obliterate no-passing centerline pavement delineation, install the following temporary no-passing zone signs before opening lanes to traffic:

1. W20-1 (Road Work Ahead) sign from 1,000 to 2,000 feet in advance of the no-passing zone
2. R4-1 (Do Not Pass) sign at the beginning of the no-passing zone and at 2,000-foot maximum intervals within the no-passing zone
3. W7-3a (Next ___ Miles) plaque beneath the W20-1 sign for continuous zones longer than 2 miles
4. R4-2 (Pass With Care) sign at the end of the no-passing zone

The Engineer determines the exact location of the temporary no-passing zone signs. Maintain the temporary no-passing zone signs in place until you place the permanent no-passing centerline pavement

delineation. Remove the temporary no-passing zone signs when the Engineer determines they are no longer required for the direction of traffic.

Maintain temporary pavement delineation until you replace it with the permanent pavement delineation.

12-7.04 PAYMENT

Not Used

12-8–12-10 RESERVED

13 WATER POLLUTION CONTROL

13-1 GENERAL

13-1.01 GENERAL

13-1.01A Summary

Section 13-1 includes general specifications for preventing, controlling, and abating water pollution within waters of the State.

Information on forms, reports, and other documents is in the following Department manuals:

1. Field Guide to Construction Site Dewatering
2. Stormwater Pollution Prevention Plan (SWPPP) and Water Pollution Control Program (WPCP) Preparation Manual
3. Construction Site Best Management Practices (BMPs) Manual
4. Construction Site Monitoring Program Guidance Manual

You may view these manuals at the Stormwater and Water Pollution Control Information link at the Department's Division of Construction website or purchase them at the Department's Publication Distribution Unit.

A WPCP and a SWPPP must comply with the Department's Stormwater Pollution Prevention Plan (SWPPP) and Water Pollution Control Program (WPCP) Preparation Manual and must be prepared using the latest template posted on the Construction stormwater website.

13-1.01B Definitions

active area: Area where soil-disturbing work activities have occurred at least once within 15 days.

construction phase: Phase that includes (1) the highway construction phase for building roads and structures, (2) the plant establishment, permanent erosion control establishment, and maintenance phase for placing vegetation for final stabilization, and (3) the suspension phase for suspension of work activities or a winter shutdown. The construction phase starts at the start of job site activities and ends at Contract acceptance.

inactive area: Area where soil-disturbing work activities have not occurred within 15 days.

qualifying rain event: Storm that produces at least 0.5 inch of precipitation with a 48-hour or greater period between rain events.

run-on: Water that originates off-site and flows onto the job site.

storm event: Storm that produces or is forecasted to produce at least 0.10 inch of precipitation within a 24-hour period.

13-1.01C Submittals

13-1.01C(1) General

Within 48 hours after (1) the end of a storm event resulting in a discharge, (2) a nonstormwater discharge, or (3) receiving a written notice or an order from the RWQCB or another regulatory agency, submit the following information:

1. Date, time, location, and nature of the activity and the cause of the discharge, notice, or order
2. Type and quantity of the discharge
3. WPC practices in use before the discharge or before receiving the notice or order
4. Description of WPC practices and corrective actions taken to manage the discharge or cause of the notice

13-1.01C(2) Training Records

For all employees and subcontractors who will be working at the job site, submit WPC training records as informational submittals. The records must include the training subjects and dates for the initial training, ongoing training, and tailgate meetings. Submit records for:

1. Existing employees within 5 business days of obtaining the SWPPP or WPCP authorization

2. New employees within 5 business days of receiving the training
3. Subcontractors' employees at least 5 business days before a subcontractor starts work

13-1.01C(3) Contractor-Support Facilities

At least 5 business days before operating any Contractor-support facility, submit:

1. Plan showing the location and associated WPC practices
2. Copy of the notice of intent approved by the RWQCB and the WPCP or SWPPP approved by the RWQCB if you will be operating a batch plant or a crushing plant under the Industrial General Permit
3. Copy of the plans for an offsite drying facility if you will be drying liquid residue from concrete grooving or grinding activities before disposal. The facility may include temporary lined ponds or other measures to prevent the liquid residue from infiltrating the soil. The plans must be sealed and signed by an engineer who is registered as a civil engineer in the State.

13-1.01C(4) Water Quality Monitoring

13-1.01C(4)(a) General

Section 13-1.01C(4) applies if a bid item for a water quality monitoring report is shown on the Bid Item List.

13-1.01C(4)(b) Water Quality Monitor

Within 7 days after Contract approval, submit the name and qualifications of your water quality monitor. Include the monitor's training and experience in collecting and analyzing water quality samples.

13-1.01C(4)(c) Water Quality Monitoring Reports

Whenever work activities occur in water, submit a monthly report of water quality monitoring by the 7th of the month for the monitoring work conducted during the previous month. The report must include:

1. Visual inspection reports for each storm event and nonstormwater discharge. Each visual inspection report must include:
   1.1. Name of personnel performing the inspection, inspection date, and date the inspection report was completed
   1.2. Descriptions of storm and weather conditions
   1.3. Locations and observations
2. Field inspection reports and sampling results, including:
   2.1. Description of the analytical methods used, reporting units, and detection limits
   2.2. Date, location, time of sampling, visual observations, photographs, and measurements
   2.3. Estimate of water flow
   2.4. Calibration logs for field monitoring equipment
3. Visual inspection reports and sampling results for a storm event that generates visible runoff, including:
   3.1. Date, location, and time of visual observations
   3.2. Photographs of the areas disturbed by project activities, including material disposal areas
   3.3. Photographs showing the disturbed soil areas and documenting compliance for erosion control and revegetation measures, including soil stabilization and sediment control
4. Summary of WQO exceedance reports
5. Summary of corrective actions

If a WQO is exceeded during work activities in water, submit a WQO exceedance report within 6 hours. The report must include:

1. Field inspection reports and sampling results, including:
   1.1. Description of the analytical methods used, reporting units, and detection limits
   1.2. Date, location, time of sampling, visual observations, photographs, and measurements
   1.3. Estimate of the water flow
2. Description of WPC practices and corrective actions taken to manage WQO exceedance

13-1.01C(4)(d) Water Quality Annual Reports

Section 13-1.01C(4)(d) applies if a bid item for a water quality annual report is shown on the Bid Item List.

Submit a water quality annual report for each reporting period from July 1st to June 30th. If construction occurs through June 30th, submit the report no later than July 15th for the previous reporting period. If construction ends before June 30th, submit the report within 15 days after Contract acceptance.

The report must be in an authorized format and include:

1. Project's description, location, and receiving waters
2. Water quality monitoring information, such as:
   2.1. Summary and evaluation of sampling and analysis results and laboratory reports
   2.2. Analytical methods, reporting units, and detection limits for analytical parameters
   2.3. Summary of corrective actions
   2.4. Identification of corrective actions or compliance activities that were not implemented
   2.5. Summary of any exceedances
   2.6. Names of individuals performing water quality inspections and sampling
   2.7. Logistical information for inspections and sampling, including the location, date, time, and precipitation
   2.8. Visual observations and sample collection records
3. Photographs documenting Contract compliance for:
   3.1. Disturbed soil areas created by work activities
   3.2. Erosion control and revegetation measures, including soil stabilization and sediment control practices
   3.3. Completed work
4. Records of training and meetings for water quality permit compliance

Submit 2 copies of the water quality annual report. Allow 10 days for review. If revisions are required, the Engineer notifies you of the date the review stopped and provides comments. Submit a revised report within 5 business days of receiving the comments. The Department's review resumes when the complete report is resubmitted.

Submit an electronic copy on a read-only CD, DVD, or other Engineer-authorized data-storage device and 2 printed copies of the authorized water quality annual report. Include the signed certifications from the water quality monitor and the WPC manager.

13-1.01C(5) Disposal Documentation

At least 15 days before starting concrete grooving or grinding activities, submit a copy of one of the following documents from the disposal facility that will receive the grooving or grinding residue:

1. RWQCB permit allowing the facility to manage and dispose of the residue
2. Written approval from the RWQCB authorizing the facility to receive the residue
3. Local, state, or federal permits if the facility is located outside the State

Within 5 business days of completing concrete grooving or grinding activities, submit the disposal receipts and weight tickets as informational submittals.

13-1.01C(6)–13-1.01C(8) Reserved

13-1.01D Quality Assurance

13-1.01D(1) General

Reserved

13-1.01D(2) Regulatory Requirements

Comply with the Department's general permit issued by the SWRCB for Order No. 2012-0011-DWQ, NPDES No. CAS000003, National Pollutant Discharge Elimination System (NPDES) Statewide Storm Water Permit and Waste Discharge Requirements (WDRS) for State of California, Department of Transportation. The Department's general permit governs stormwater and nonstormwater discharges from the Department's properties, facilities, and activities. For the Department's general permit, go to the Caltrans Program link on the Storm Water Program page of the SWRCB website.

Discharges from manufacturing facilities, such as batch plants and crushing plants, must comply with the discharge requirements in the NPDES General Permit for Storm Water Discharges Associated with

Industrial Activities; Order No. 2014-0057-DWQ, CAS000001 (Industrial General Permit), issued by the SWRCB. For the Industrial General Permit, go to the SWRCB website.

For a batch plant and crushing plant outside a job site or within a job site that serves one or more contracts, obtain coverage under the Industrial General Permit before operating a batch plant to manufacture concrete, HMA, or other material or a crushing plant to produce rock or aggregate.

13-1.01D(3) Training

Employees must receive initial WPC training before starting work at the job site.

For your project managers, supervisory personnel, subcontractors, and employees involved in WPC work:

1. Provide stormwater training in the following subjects:
   1.1. WPC rules and regulations
   1.2. Implementation and maintenance of:
      1.2.1. Temporary soil stabilization
      1.2.2. Temporary sediment control
      1.2.3. Tracking control
      1.2.4. Wind erosion control
      1.2.5. Material pollution prevention and control
      1.2.6. Waste management
      1.2.7. Nonstormwater management
2. Conduct weekly training meetings covering:
   2.1. Deficiencies and corrective actions for WPC practices
   2.2. WPC practices required for work activities during the week
   2.3. Spill prevention and control
   2.4. Material delivery, storage, usage, and disposal
   2.5. Waste management
   2.6. Nonstormwater management procedures

Training for personnel who collect water quality samples must include:

1. Review of the sampling and analysis plan and the *Construction Site Monitoring Program Guidance Manual*
2. Health and safety review
3. Sampling simulations

13-1.01D(4) Water Pollution Control Manager

13-1.01D(4)(a) General

Assign a WPC manager to implement the WPCP or SWPPP.

13-1.01D(4)(b) Qualifications

The WPC manager must:

1. Comply with the requirements provided in the Construction General Permit for:
   1.1. QSP if the project requires a WPCP
   1.2. QSD if the project requires a SWPPP
2. Complete the stormwater management training described at the Stormwater and Water Pollution Control Information link at the Department's Division of Construction website

13-1.01D(4)(c) Responsibilities

The WPC manager must:

1. Be the primary contact responsible for WPC work
2. Oversee WPC work, including:
   2.1. Maintenance of WPC practices
   2.2. Inspections of WPC practices identified in the SWPPP or WPCP
   2.3. Inspections and reports for visual monitoring
   2.4. Preparation and implementation of the rain event action plans
   2.5. Sampling and analysis

2.6. Preparation and submittal of:
2.6.1. NAL exceedance reports
2.6.2. Violation reports for the receiving water monitoring trigger
2.6.3. SWPPP annual certification
2.6.4. Annual reports
2.6.5. WPC-practice status reports
3. Oversee and enforce hazardous waste management practices under section 14-11, including spill prevention and control measures
4. Have the authority to:
4.1 Mobilize crews to make immediate repairs to WPC practices
4.2 Stop construction activities damaging WPC practices or causing water pollution
5. Ensure that all employees have current WPC training and provide training if collecting water quality samples is delegated
6. Implement the authorized SWPPP or WPCP
7. Revise the SWPPP or WPCP if required
8. Be at the job site within 2 hours of being contacted

13-1.01D(5) Quality Control

13-1.01D(5)(a) General

Section 13-1.01D(5) applies if a bid item for a water quality monitoring report is shown on the Bid Item List.

Project-specific WQOs for work activities in water are specified in the special provisions.

Assign a water quality monitor to collect water samples and record water quality data. The water quality monitor must have the same qualifications as the WPC manager, including the requirements for a QSP, and must have training and experience in collecting and analyzing water quality samples. The water quality monitor may be the same person as the WPC manager.

The water quality monitor must be responsible for generating and submitting water quality reports.

The water quality monitor must notify the Engineer within 6 hours of an unauthorized discharge.

The water quality monitor must inspect the job site and receiving waters after each storm event and nonstormwater discharge. The inspection of a nonstormwater discharge must include observation of:

1. Receiving waters:
1.1. 24 hours before starting work in water, including the installation of any clear-water diversion
1.2. At least 4 times daily whenever work occurs in water, including the installation, operation, and removal of any clear water diversion
1.3. For the presence of floating and suspended materials, sheen on the surface, discoloration, turbidity, and odors.
2. Job site for the presence of authorized and unauthorized nonstormwater discharges and their sources. Unauthorized discharges to surface waters include:
2.1. Soil, silt, and sand
2.2. Bark, sawdust, and slash
2.3. Rubbish and debris
2.4. Cement, concrete, and concrete washings
2.5. Oil and petroleum products
2.6. Welding slag
2.7. Other organic or earthen materials

Retain each visual inspection report at the job site.

13-1.01D(5)(b) Water Quality Sampling and Analysis

Take water quality samples each day a construction activity has the potential to mobilize sediment or alter background conditions within waters of the State. Take water quality samples of surface water when:

1. Conducting in-water work
2. Work activities result in materials reaching receiving waters
3. Work activities result in the creation of a visible plume in receiving waters

Comply with the equipment manufacturer's instructions for sample collection, analysis methods, and equipment calibration.

At least 24 hours before starting in-water work:

1. Establish locations for water quality sampling:
   1.1. Upstream of the effluent discharge point or location of in-water work by no more than 50 feet
   1.2. At the effluent discharge point, including the location of in-water work
   1.3. Downstream of the effluent discharge point or location of in-water work between 35 and 50 feet
2. Take water quality samples to document background conditions for upstream, effluent, and downstream locations. Test for each water quality objective shown in the table titled "Water Quality Objectives."
3. Estimate water flow.

During in-water work, including the installation of a clear water diversion, take water quality samples:

1. At least 4 times daily for each water quality objective
2. At upstream, effluent, and downstream locations

If a water quality objective is exceeded, the water quality monitor must notify the Engineer by phone or electronic media within 30 minutes and:

1. Conduct water quality sampling every hour until measurements comply with water quality objectives.
2. Measure the distance from the effluent location to the downstream extent of the exceedance.
3. Obtain photographs of the tributary upstream, downstream, and at the location of in-water work.
4. If WPC practices are installed, repaired, or modified to control the source of the exceedance, monitor the activity and document with samples, photographs, and a brief summary.

You are not required to collect samples:

1. During dangerous weather conditions, such as flooding or electrical storms
2. Outside of normal working hours

If downstream samples show levels outside of the acceptable range and indicate a possible water quality objective exceedance, assess the WPC practices, site conditions, and surrounding influences to determine the probable cause for the increase.

Retain calibration logs, water quality sampling documentation, and analytical results at the job site.

13-1.01D(5)(c) Reserved

13-1.03D(6)–13-1.01D(8) Reserved

13-1.02 MATERIALS

Not Used

13-1.03 CONSTRUCTION

13-1.03A General

Monitor the NWS's forecast daily at its website.

Install facilities and devices used for WPC practices before performing other job site activities. Install soil stabilization and sediment control materials for WPC practices in all active areas or before any storm event.

Repair or replace facilities and devices used for WPC practices within 24 hours of discovering any damage.

You may request or the Engineer may order changes to the WPC work. Changes may include additional or new WPC practices. Additional WPC work is change order work.

Retain a printed copy of the authorized WPCP or SWPPP at the job site.

13-1.03B Contractor-Support Facilities

Use WPC practices to protect stormwater systems or receiving waters from the discharge of potential pollutants from any Contractor-support facility.

Contractor-support facilities include:

1. Staging areas
2. Storage yards for equipment and materials
3. Mobile operations
4. Batch plants for concrete and HMA
5. Crushing plants for rock and aggregate
6. Other facilities installed for your convenience, such as haul roads
7. Offsite drying facilities for drying wastes before disposal

If you obtain or dispose of material at a noncommercially operated borrow or disposal site, prevent water pollution due to erosion at the site during and after completion of your activities. Upon completion of your work, leave the site in a condition such that water will not collect or stand in it.

13-1.03C Inspections

Use the Stormwater Site Inspection Report form for documenting inspections.

Inspect WPC practices identified in the SWPPP or WPCP:

1. Before a forecasted storm event
2. After a qualifying rain event that produces runoff
3. At 24-hour intervals during extended storm events
4. On a predetermined schedule of at least once a week

Inspect the following work activities and areas daily:

1. Storage areas for hazardous materials and waste as specified in section 14-11
2. Hazardous waste disposal and transporting activities as specified in section 14-11
3. Hazardous material delivery and storage activities
4. Demolition sites within 50 feet of storm drain systems and receiving waters

Inspect vehicles and equipment at the job site daily for leaks and spills. Verify that operators are inspecting vehicles and equipment each day of use.

Inspect the following work activities and areas daily if the activity occurs daily or weekly if the activity occurs weekly:

1. Vehicle and equipment cleaning facilities
2. Vehicle and equipment maintenance and fueling areas
3. Pile driving areas for leaks and spills
4. Temporary concrete washouts
5. Paved roads at job site access points for street sweeping
6. Dewatering work
7. Temporary ATS
8. Work over water

13-1.03D Deficiencies

If the Engineer or you identify a deficiency in the implementation of the authorized WPCP or SWPPP, immediately correct the deficiency unless a later date is authorized, but before precipitation occurs.

The Department may correct the deficiency if you fail to correct it immediately, by the agreed date, or before the onset of precipitation. The cost of this work is deducted.

13-1.03E–13-1.03H Reserved

13-1.04 PAYMENT

The Department does not pay for the cleanup, repair, removal, disposal, or replacement of WPC practices due to improper installation or your negligence.

The Department does not pay for WPC practices at Contractor-support facilities and noncommercially operated borrow or disposal sites.

13-2 WATER POLLUTION CONTROL PROGRAM

13-2.01 GENERAL

13-2.01A Summary

Section 13-2 includes specifications for preparing a water pollution control program.

Preparing a water pollution control program includes developing and implementing the WPCP, providing a WPC manager, conducting WPC training, and monitoring, inspecting and correcting WPC practices.

If the Department determines that the project qualifies for an erosivity waiver, the conditions for the waiver are specified in the special provisions. The erosivity waiver and R-factor are described in the NPDES General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ, NPDES No. CAS000002).

13-2.01B Definitions

Reserved

13-2.01C Submittals

Within 7 days after Contract approval, submit 2 copies of your WPCP. You may assign a QSP other than the WPC manager to develop the WPCP.

The WPCP must:

1. Show the location of disturbed soil areas, water bodies, and water conveyances
2. Describe the work involved in the installation, maintenance, repair, and removal of temporary WPC practices
3. Show the locations and types of WPC practices that will be used for:
   - 3.1. Stormwater and nonstormwater in Contractor-support facilities outside the job site but related to work activities, including:
     - 3.1.1. Staging areas
     - 3.1.2. Storage yards
     - 3.1.3. Access roads
   - 3.2. Activities or mobile activities related to all NPDES permits
4. Show the locations and types of temporary WPC practices that will be used in the work for each type of construction phase
5. Show the locations and types of WPC practices that will be installed permanently under the Contract
6. Include a schedule showing when:
   - 6.1. Work activities will be performed that could cause the discharge of pollutants into stormwater
   - 6.2. WPC practices, including soil stabilization and sediment control, associated with each construction phase will be implemented
7. Include a copy of each permit obtained by the Department, such as the Department of Fish and Game permits, US Army Corps of Engineers permits, RWQCB 401 certifications, Docket No. ESPO-SMA 15/16-001 Soil Management Agreement for Aerially Deposited Lead-Contaminated Soils with the DTSC (ADL Agreement), ADL Agreement notification, and RWQCB waste discharge requirements for reuse of aerially deposited lead

Allow 5 business days for review.

After the Engineer authorizes the WPCP, submit an electronic copy on a read-only CD, DVD, or other Engineer-authorized data storage device and 3 printed copies of the authorized WPCP.

If a RWQCB requires review of the authorized WPCP, the review is specified in the special provisions and the Engineer submits the authorized WPCP to the RWQCB for review and comment.

If the Engineer orders changes to the WPCP based on the RWQCB's comments, submit a revised WPCP within 3 business days.

Do not start job site activities until the WPCP is authorized.

Submit a revised WPCP if:

1. Changes in work activities could affect the discharge of pollutants
2. WPC practices are added as change order work
3. WPC practices are added at your discretion
4. Changes in the quantity of disturbed soil are substantial
5. Objectives for reducing or eliminating pollutants in stormwater discharges have not been achieved
6. Project receives a written notice or order from the RWQCB or any other regulatory agency

13-2.01D Quality Assurance

Reserved

13-2.02 MATERIALS

Not Used

13-2.03 CONSTRUCTION

Manage work activities such that you reduce the discharge of pollutants to surface waters, groundwaters, and municipal-separate storm sewer systems.

Monitor and inspect WPC practices at the job site.

Notify the Engineer within 6 hours whenever you:

1. Identify discharges into receiving waters or drainage systems that are causing or could cause water pollution
2. Receive a written notice or order for the project from the RWQCB or any other regulatory agency

Continue WPCP implementation during any suspension of work activities.

You must submit a SWPPP and pay all associated costs if you do any of the following:

1. Disturb 1 ac or more of soil on a project without an erosivity waiver
2. Disturb more than 5 ac of soil on a project with an erosivity waiver
3. Fail to comply with the schedule for soil-disturbing activities for a project with an erosivity waiver and the delay voids the erosivity waiver

13-2.04 PAYMENT

The Department pays you for prepare water pollution control program as follows:

1. Total of 75 percent of the item total upon authorization of the WPCP
2. Total of 100 percent of the item total upon Contract acceptance

13-3 STORMWATER POLLUTION PREVENTION PLAN

13-3.01 GENERAL

13-3.01A Summary

Section 13-3 includes specifications for preparing a stormwater pollution prevention plan for projects that will disturb 1 ac or more of soil.

Preparing a stormwater pollution prevention plan includes developing and implementing the plan, providing a WPC manager, conducting WPC training, and monitoring, inspecting, and correcting WPC practices.

Except for projects in the Lake Tahoe Hydrologic Unit or on federal or tribal lands, the Department establishes an environmental risk level for each project. The project's risk level is specified in the special provisions.

13-3.01B Definitions

Reserved

13-3.01C Submittals

13-3.01C(1) General

Submit the documents shown with an *X* in the following table:

Submittal Requirements

Document	Risk level 1	Risk level 2	Risk level 3	EPA	Lake Tahoe Hydrologic Unit
SWPPP	X	X	X	X	X
Construction Site Monitoring Program	X	X	X	X	X[a]
Job site monitoring reports	X	X	X	X	X
Sampling and analysis plan	X	X	X	X	X
Sampling and analysis plan for nonvisible pollutants	X	X	X	X	X
Sampling and analysis plan for pH and turbidity	--	X	X	--	X
NAL reports	--	X	X	--	X
Receiving water monitoring trigger reports	--	--	X	--	--
Rain Event Action Plan	--	X	X	--	X
Annual Certification	X	X	X	X	X
Stormwater Annual Report	X	X	X	X	X

[a]For a project in the Lake Tahoe Hydrologic Unit, this program is referred to as the Construction Site Monitoring and Reporting Program

13-3.01C(2) Stormwater Pollution Prevention Plan

13-3.01C(2)(a) General

Within 15 days of Contract approval, submit 3 copies of your SWPPP. You may assign a QSD other than the WPC manager to develop the SWPPP.

The SWPPP must:

1. Describe the work involved in the installation, maintenance, repair, and removal of temporary and permanent WPC practices
2. Include maps showing:
   - 2.1. Locations of disturbed-soil areas
   - 2.2. Water bodies and conveyances
   - 2.3. Locations and types of WPC practices that will be used for each Contractor-support facility
   - 2.4. Locations and types of temporary WPC practices that will be used in the work for each construction phase
   - 2.5. Locations and types of WPC practices that will be installed permanently under the Contract
   - 2.6. Water quality sampling locations
   - 2.7. Locations planned for the storage and use of potential nonvisible pollutants
   - 2.8. Receiving-water sampling locations
3. Include a Construction Site Monitoring Program or Construction Site Monitoring and Reporting Program as applicable
4. Include a schedule showing when:
   - 4.1. Work activities will be performed that could cause the discharge of pollutants into stormwater
   - 4.2. WPC practices, including soil stabilization and sediment control, associated with each construction phase will be implemented
5. Include a copy of each permit obtained by the Department, such as the Department of Fish and Game permits, US Army Corps of Engineers permits, RWQCB 401 certifications, Docket No. ESPO-SMA 15/16-001 Soil Management Agreement for Aerially Deposited Lead-Contaminated Soils with the DTSC (ADL Agreement), ADL Agreement notification, and RWQCB waste discharge requirements for aerially deposited lead reuse
6. Include training records for project personnel

If revisions are required, the Engineer notifies you of the date when the review stopped and provides comments. Submit a revised SWPPP within 15 days of receiving the comments. The Department's review resumes when a complete SWPPP has been resubmitted.

Submit an electronic copy on a read-only CD, DVD, or other Engineer-authorized data storage device and 4 printed copies of the authorized SWPPP.

If the RWQCB requires review of the authorized SWPPP, the Engineer submits it to the RWQCB for review and comment. If the Engineer orders changes to the SWPPP based on the RWQCB's comments, submit a revised SWPPP within 10 days.

Do not start job site activities until (1) the SWPPP is authorized and (2) a waste discharge ID number is issued.

Submit a revised SWPPP annually before July 15th and any time:

1. Changes in work activities could affect the discharge of pollutants
2. WPC practices are added as change order work
3. WPC practices are added at your discretion
4. Changes in the quantity of disturbed soil are substantial
5. Objectives for reducing or eliminating pollutants in stormwater discharges have not been achieved
6. You receive a written notice of a permit violation for the project from the RWQCB or any other regulatory agency

13-3.01C(2)(b) Construction Site Monitoring Program

13-3.01C(2)(b)(i) General

Submit a construction site monitoring program with your SWPPP. The program must be prepared by a QSD.

For all projects, submit:

1. Visual monitoring procedures
2. Sampling and analysis plan for nonvisible pollutants
3. Sampling and analysis plan for nonstormwater discharges
4. Sampling and analysis plan for monitoring required by the RWQCB

For a risk level 2 project, also submit a sampling and analysis plan for pH and turbidity.

For a risk level 3 project, also submit:

1. Sampling and analysis plan for pH and turbidity
2. Sampling and analysis plan for receiving-water monitoring
3. Sampling and analysis plan for any temporary ATS

For a project in the Lake Tahoe Hydrologic Unit, the program must include all of the requirements for a risk level 3 project and:

1. Watershed monitoring option
2. QC procedures
3. Reporting requirements and record retention
4. Noncompliance reporting
5. Annual report
6. Final report

Change the program as needed to reflect the current job site activities.

13-3.01C(2)(b)(ii) Site Inspection Reports

Submit a Stormwater Site Inspection Report as an informational submittal within 24 hours of completing a weekly inspection. The WPC manager must oversee the preparation of this report. The report must include the location and quantity of installed WPC practices and disturbed soil.

13-3.01C(2)(b)(iii) Visual Monitoring Reports

Submit a copy of the visual monitoring report on a Stormwater Site Inspection Report form for each storm event and nonstormwater discharges. The visual monitoring report must include:

1. Name of personnel performing the inspection, inspection date, and date the inspection report is completed
2. Storm and weather conditions
3. Location of any of the following:
   3.1. Floating and suspended material, sheen on the surface, discoloration, turbidity, odor, and source of observed pollutants for flowing and contained stormwater systems
   3.2. Nonstormwater discharges and their sources
4. Corrective action taken

For each storm event, the monitoring report must include:

1. Date, time, and rain gauge reading
2. Visual observations:
   2.1. Within 2 business days before the predicted storm for:
      2.1.1. Spills, leaks, or uncontrolled pollutants in drainage areas
      2.1.2. Proper implementation of WPC practices
      2.1.3. Leaks and adequate freeboard in storage areas
   2.2. Every 24 hours during the storm event for:
      2.2.1. Effectiveness of WPC practices
      2.2.2. WPC practices needing maintenance and repair
   2.3. Within 2 business days after a qualifying rain event for:
      2.3.1. Stormwater discharge locations
      2.3.2. Evaluation of design, implementation, effectiveness, and locations of WPC practices, including locations where additional WPC practices may be needed

For nonstormwater discharges, the monitoring report must cover each of the following periods:

1. January through March
2. April through June
3. July through September
4. October through December

Retain a copy of the visual monitoring reports at the job site as part of the SWPPP.

13-3.01C(2)(b)(iv) Sampling and Analysis Plan

Submit a sampling and analysis plan that complies with the Department's *Construction Site Monitoring Program Guidance Manual*.

The sampling and analysis plan must describe:

1. Sampling equipment and sample containers.
2. Preparation of samples.
3. Collection and holding times.
4. Field measurement methods.
5. Analytical methods.
6. Quality assurance and quality control.
7. Sample preservation and labeling.
8. Collection documentation, including the names of personnel collecting samples and their training.
9. Shipment of samples.
10. Chain of custody.
11. Data management and reporting.
12. Precautions from the construction site health and safety plan, including procedures for collecting samples during precipitation. List the conditions under which you are not required to collect samples, such as:
    12.1. Dangerous weather
    12.2. Flooding or electrical storms

12.3. Times outside of normal working hours
13. Procedures for collecting and analyzing at least 3 samples for each day of each qualifying rain event for a risk level 2 or risk level 3 project.
14. Procedures for collecting effluent samples at all locations where the stormwater is discharged off the job site.

The sampling and analysis plan must identify the State-certified laboratory that will perform the analyses. For a list of State-certified laboratories, go to the SWRCB's website.

Submit a revised plan if discharges or sampling locations change because of changed work activities or knowledge of site conditions.

13-3.01C(2)(b)(v) Sampling and Analysis Plan for Nonvisible Pollutants

Submit a sampling and analysis plan for monitoring nonvisible pollutants.

The sampling and analysis plan must identify potential nonvisible pollutants present at the job site associated with any of the following:

1. Construction materials and wastes
2. Existing contamination due to historical site usage
3. Application of soil amendments, including soil stabilization materials, with the potential to change pH or contribute toxic pollutants to stormwater

The sampling and analysis plan for nonvisible pollutants must include sampling procedures for the following conditions if observed during a stormwater visual inspection. Include a procedure for collecting at least 1 sample for each storm event for:

1. Materials or wastes containing potential nonvisible pollutants not stored under watertight conditions
2. Materials or wastes containing potential nonvisible pollutants stored under watertight conditions at locations where a breach, leak, malfunction, or spill occurred and was not cleaned up before the precipitation
3. Chemical applications occurring within 24 hours before precipitation or during precipitation that could discharge pollutants to surface waters or drainage systems, including applications of fertilizer, pesticide, herbicide, methyl methacrylate concrete sealant, or nonpigmented curing compound
4. Applied soil amendments, including soil stabilization materials that could change pH levels or contribute toxic pollutants to stormwater runoff and discharge pollutants to surface waters or drainage systems, unless independent test data is available to indicate acceptable concentrations of nonvisible pollutants in the material
5. Stormwater runoff from an area contaminated by the historical usage of the site that could discharge pollutants to surface waters or drainage systems

The sampling and analysis plan for nonvisible pollutants must:

1. Include sampling procedures and a schedule for:
   1.1. Sample collection during the first 2 hours of rain events that generate runoff
   1.2. Each nonvisible pollutant source
   1.3. Uncontaminated control sample
2. Identify the locations for sampling downstream and collecting control samples and the reasons for selecting those locations. Select locations for control samples where the sample does not come in contact with materials, wastes, or areas associated with potential nonvisible pollutants or disturbed soil areas.

13-3.01C(2)(b)(vi) Sampling and Analysis Reports

13-3.01C(2)(b)(vi)(A) General

Submit an electronic copy on a read-only CD, DVD, or other Engineer-authorized data storage device and a printed copy of water quality analysis results and the QC report within 48 hours of field sampling and within 30 days of laboratory analysis.

The QC report must include an evaluation of whether the downstream samples show levels of the tested parameter that are higher than the control sample. The evaluation must include:

1. Sample ID number
2. Contract number
3. Constituent
4. Reported value
5. Analytical method
6. Method detection limit
7. Reported limit

Retain a copy of the water quality sampling and analysis results with the SWPPP at the job site.

13-3.01C(2)(b)(vi)(B) Numeric Action Level Exceedance Reports

If a NAL is exceeded, notify the Engineer and submit an exceedance report within 48 hours after the conclusion of a storm event. The report must include:

1. Field sampling results and inspections, including:
   1.1. Analytical methods, reporting units, and detection limits
   1.2. Date, location, time of sampling, visual observations, and measurements
   1.3. Quantity of precipitation from the storm event
2. Description of WPC practices and corrective actions taken to manage exceedance of the NAL

13-3.01C(2)(b)(vi)(C) Receiving-Water Monitoring Trigger Reports

If a receiving-water monitoring trigger is exceeded, notify the Engineer and submit a monitoring trigger report within 48 hours after the conclusion of a storm event. The report must include:

1. Field sampling results and inspections, including:
   1.1. Analytical methods, reporting units, and detection limits
   1.2. Date, location, time of sampling, visual observations, and measurements
   1.3 Quantity of precipitation from the storm event
2. Description of the WPC practices and corrective actions

13-3.01C(2)(b)(vi)(D)–13-3.01C(2)(b)(vi)(F) Reserved

13-3.01C(2)(b)(vii)–13-3.01C(2)(b)(x) Reserved

13-3.01C(3) Rain Event Action Plan

For a risk level 2 or risk level 3 project, submit a rain event action plan at least 48 hours before a forecasted storm event if the NWS predicts a storm event with at least a 50 percent probability of precipitation within 72 hours.

For a project in the Lake Tahoe Hydrologic Unit, submit a rain event action plan at least 24 hours before a forecasted storm event if the NWS predicts a storm event with at least a 30 percent probability of precipitation in the project area within 72 hours for construction activities occurring:

1. From May 1 through October 15
2. During periods when construction is conducted under a variance to the land disturbance prohibition of the permit

The rain event action plan must include:

1. Site location
2. Project risk level
3. Contact information, including 24-hour emergency phone numbers for:
   3.1. WPC manager
   3.2. Erosion and sediment control providers or subcontractors
   3.3. Stormwater sampling providers or subcontractors
4. Storm information
5. Description of:
   5.1. Construction phase, including active and inactive areas
   5.2. Active areas and activities
   5.3. Subcontractors and trades on the job site
   5.4. Prestorm activities, including:
      5.4.1. Responsibilities of the WPC manager

5.4.2. Responsibilities of the crew and crew size
5.4.3. Stabilization for active and inactive areas
5.4.4. Stockpile management
5.4.5. Corrective actions taken for deficiencies identified during prestorm visual inspections
5.5. Activities to be performed during storm events, including:
5.5.1. Responsibilities of the WPC manager
5.5.2. Responsibilities of the crew and crew size
5.5.3. WPC practices for maintenance and repair
6. Flood contingency measures

Have the rain event action plan at the job site at least 24 hours before a forecasted storm event. Retain a printed copy of each rain event action plan at the job site as part of the SWPPP.

13-3.01C(4) Stormwater Annual Report

Submit 2 copies of a stormwater annual report before July 15th for the preceding construction period from July 1st through June 30th or within 15 days after Contract acceptance if construction ends before June 30th.

For a project in the Lake Tahoe Hydrologic Unit, submit the stormwater annual report before October 31st for the preceding construction period from October 16th through October 15th or within 15 days after Contract acceptance if construction ends before October 15th.

The stormwater annual report must include:

1. Project information, such as a description of the project and work locations
2. Stormwater monitoring information, including:
   2.1. Summary and evaluation of sampling and analysis results and laboratory reports
   2.2. Analytical methods, reporting units, and detections limits for analytical parameters
   2.3. Summary of the corrective actions taken
   2.4. Identification of the corrective actions taken and compliance activities not implemented
   2.5. Summary of violations
   2.6. Names of the individuals performing stormwater inspections and sampling
   2.7. Logistical information for inspections and sampling, including location, date, time, and precipitation
   2.8. Visual observations and sample collection records
3. Documentation of training for individuals responsible for:
   3.1. Permit compliance
   3.2. Installation, inspection, maintenance, and repair of WPC practices
   3.3. Development and revision of the SWPPP

Allow 10 days for review. If revisions are required, the Engineer notifies you of the date the review stopped and provides comments.

Submit a revised report within 5 business days of receiving the comments. The Department's review resumes when a complete report has been resubmitted.

Submit an electronic copy on a read-only CD, DVD, or other Engineer-authorized data storage device and 2 printed copies of the authorized stormwater annual report signed by the WPC manager.

13-3.01C(5) Annual Certification

Submit an annual certification of compliance as described in the Department's *Stormwater Pollution Prevention Plan (SWPPP) and Water Pollution Control Program (WPCP) Preparation Manual* before July 15th of each year.

13-3.01D Quality Assurance

13-3.01D(1) General

Reserved

13-3.01D(2) Regulatory Requirements

Except for a project in the Lake Tahoe Hydrologic Unit or on federal or tribal lands, discharges of stormwater from the project must comply with NPDES General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ, NPDES No. CAS000002) referred to herein as *Permit*.

For a project in the Lake Tahoe Hydrologic Unit, discharges of stormwater from the project must comply with the NPDES General Permit for General Waste Discharge Requirements and National Pollutant Discharge Elimination System General Permit for Storm Water Discharges Associated with Construction Activity in the Lake Tahoe Hydrologic Unit, Counties of Alpine, El Dorado, and Placer, (Order No. R6T-2016-0010 and NPDES No. CAG616002). You may view the General Permit for the Lake Tahoe Hydrologic Unit at the Construction Storm Water Program page of the SWRCB website.

A project on federal or tribal lands must comply with the permit issued by the US EPA for National Pollutant Discharge Elimination System General Permit for Discharges from Construction Activities. This permit governs stormwater and nonstormwater discharges from work activities at the job site. This permit may be viewed at the US EPA website.

13-3.01D(3) Water Quality

13-3.01D(3)(a) General

Assign trained personnel to collect water quality samples. The personnel must comply with the equipment manufacturer's instructions for the collection of samples, analytical methods, and equipment calibration.

Samples taken for laboratory analysis must comply with water quality sampling procedures and be analyzed by a State-certified laboratory under 40 CFR part 136, *Guidelines Establishing Test Procedures for the Analysis of Pollutants*.

For a risk level 2 or risk level 3 project, take samples for pH and turbidity from representative and accessible locations upstream and downstream of the discharge point. For multiple discharge points, obtain samples from a single upstream and a single downstream location.

If the receiving water monitoring trigger for turbidity is exceeded for a risk level 3 project, take samples and analyze the suspended sediment concentration under ASTM D3977 at a minimum detection limit of 5 mg/L.

13-3.01D(3)(b) Numeric Action Levels

For a risk level 2 or risk level 3 project, test the receiving water under the test methods and at the detection limits for the NALs shown in the following table:

Quality characteristic	Test method	Detection limit (min)	NAL
Turbidity (max, NTU)	Field test with calibrated portable instrument	1	250
pH	Field test with calibrated portable instrument	0.2	6.5–8.5

For a project in the Lake Tahoe Hydrologic Unit, test the receiving water under the test method and at the detection limits for the NALs shown in the following table:

Quality characteristic	Test method	Detection limit (min)	NAL
pH	Field test with calibrated portable instrument	0.2	6.0–9.0

The daily average sampling limits must be within the specified range.

13-3.01D(3)(c) Receiving-Water Monitoring Triggers

For a risk level 3 project, test the receiving water under the test methods and at the detection limits for the monitoring triggers shown in the following table:

Quality characteristic	Test method	Detection limit (min)	Monitoring trigger
Turbidity (max, NTU)	Field test with calibrated portable instrument	1	500
pH	Field test with calibrated portable instrument	0.2	6.0–9.0

The storm event daily average for storms up to the 5-year, 24-hour storm must not exceed the receiving-water monitoring trigger for turbidity.

The daily average sampling results must not exceed the receiving-water monitoring trigger for pH.

13-3.01D(3)(d) Numeric Effluent Limitations

For a project in the Lake Tahoe Hydrologic Unit, test the receiving water under the test methods and at the detection limits for the NALs shown in the following table:

Quality characteristic	Test method	Detection limit (min)	NEL
Turbidity (max, NTU)	Field test with calibrated portable instrument	1	20

The storm event daily average for storms up to the 20-year, 1-hour storm must not exceed the NEL for turbidity.

13-3.01D(4) Water Quality Control

For a risk level 2 or risk level 3 project, collect water samples:

1. During a storm event for:
   1.1. Each nonvisible pollutant source and a corresponding uncontaminated control sample
   1.2. All locations identified on the rain event action plan
2. During a qualifying rain event for:
   2.1. Each nonvisible pollutant source and a corresponding uncontaminated control sample
   2.2. Turbidity, pH, and other constituents as required
   2.3. All locations identified on the rain event action plan

Collect at least 3 samples for each day of a qualifying rain event.

Collect samples during (1) normal working hours and (2) the first 2 hours of each storm event.

Collect receiving water samples for a risk level 3 project and if a direct discharge to receiving waters occurs.

If a downstream sample shows an increased level of turbidity, pH, or other constituent, assess WPC practices, site conditions, and surrounding influences to determine the probable cause for the increase.

You may request or the Engineer may order laboratory analysis of stormwater samples. If ordered, laboratory analysis of stormwater samples is change order work.

13-3.01D(5)–13-3.01D(6) Reserved

13-3.02 MATERIALS

Not Used

13-3.03 CONSTRUCTION

Post a sign or other notice at a safe, publicly accessible location close to the job site. The notice must include the NPDES tracking number and a contact name and phone number for obtaining additional project information. Locate the sign or notice such that it is visible from the part of the highway nearest the work activities.

Obtain, install, and maintain a rain gauge at the job site. Observe and record precipitation daily.

For a project that requires a rain event action plan, implement the plan, including crew mobilization, at least 24 hours before precipitation occurs.

Continue SWPPP implementation during any suspension of work activities.

13-3.04 PAYMENT

For a project with 60 original working days or less, the Department pays for prepare stormwater pollution prevention plan as follows:

1. Total of 75 percent of the item total upon authorization of the SWPPP
2. Total of 100 percent of the item total upon Contract acceptance

For a project with more than 60 original working days, the Department pays for prepare stormwater pollution prevention plan as follows:

1. Total of 50 percent of the item total upon authorization of the SWPPP
2. Total of 90 percent of the item total upon work completion
3. Total of 100 percent of the item total upon Contract acceptance

The Department does not pay for the preparation, collection, laboratory analysis, and reporting of stormwater samples for nonvisible pollutants if WPC practices are not implemented before precipitation or if you fail to correct a WPC practice before precipitation.

The Department pays:

1. $500 for each authorized rain event action plan
2. $2,000 for each authorized stormwater annual report

The Department does not adjust the unit price for an increase or decrease in the quantity of:

1. Rain event action plan
2. Storm water sampling and analysis day
3. Storm water annual report

13-4 JOB SITE MANAGEMENT

13-4.01 GENERAL

13-4.01A Summary

Section 13-4 includes specifications for performing job site management work.

Job site management work includes spill prevention and control, material management, waste management, nonstormwater management, and dewatering activities.

Temporary linear sediment barriers must comply with section 13-10.

13-4.01B Definitions

minor spill: Spill of oil, gasoline, paint, or other materials in such small quantities that can easily be controlled by a first responder upon discovery of the spill.

semisignificant spill: Spill of oil, gasoline, paint, or other materials in quantities that can be controlled by a first responder with help from other personnel.

significant or hazardous spill: Spill of oil, gasoline, paint, or other materials in quantities that cannot be controlled by job site personnel.

13-4.01C Submittals

At least 15 days before the start of dewatering activities, submit a dewatering and discharge work plan. The dewatering and discharge work plan must include:

1. Title sheet and table of contents
2. Description of dewatering and discharge activities detailing the locations, quantity of water, equipment, and discharge point
3. Estimated schedule for dewatering and the discharge start and end dates of intermittent and continuous activities
4. Discharge alternatives, such as dust control or percolation

5. Visual monitoring procedures with inspection log
6. Copy of the approval to discharge into a sanitary sewer system

For material used or stored within the job site, submit the following documents as informational submittals:

1. SDS at least 5 business days before material is used or stored
2. Monthly inventory records

Submit approval from the local health agency, city, county, and sewer district before discharging from a sanitary or septic system directly into a sanitary sewer system.

Submit a discharge notification upon discovery of a spill or discharge of materials into a body of water.

13-4.01D Quality Assurance

Reserved

13-4.02 MATERIALS

Not Used

13-4.03 CONSTRUCTION

13-4.03A General

Implement effective housekeeping practices for handling, storing, using, and disposing of materials to prevent pollution. Limit potential pollutants at their source before they come in contact with stormwater.

13-4.03B Spill Prevention and Control

13-4.03B(1) General

Keep material or waste storage areas clean, well organized, and equipped with enough cleanup supplies for the material being stored.

Implement spill and leak prevention procedures for chemicals and hazardous substances stored on the job site. If you spill or your equipment or materials leak chemicals or hazardous substances at the job site, you are responsible for all associated cleanup costs and related liability.

Prevent spills from entering stormwater runoff before and during cleanup activities. Do not bury the spill or wash it with water.

Immediately report spills to the WPC manager.

As soon as it is safe, contain and clean up spills of petroleum materials and sanitary and septic waste substances listed in 40 CFR, parts 110, 117, and 302. Comply with section 14-11 for a spill or leak that produces hazardous waste.

13-4.03B(2) Minor Spills

Clean up a minor spill as follows:

1. Contain the spread of the spill.
2. Recover the spilled material using absorbents.
3. Clean the contaminated area.
4. Promptly dispose of the contaminated material and absorbents.

13-4.03B(3) Semisignificant Spills

Immediately clean up a semisignificant spill as follows:

1. Contain the spread of the spill.
2. On a paved or other impervious surface, encircle and recover the spilled material with absorbents.
3. On soil, construct an earthen dike and dig up the contaminated soil for disposal.
4. During precipitation, cover the spill with 10-mil plastic sheeting or other material to prevent contamination of the runoff.
5. Promptly dispose of the contaminated material and absorbents.

13-4.03B(4) Significant or Hazardous Spills

Immediately notify the Engineer and qualified personnel of a significant or hazardous spill. Handle the spill as follows:

1. Do not attempt to clean up the spill until qualified personnel have arrived.
2. Obtain the immediate services of a spill contractor or hazardous material team.
3. Notify local emergency response teams by dialing 911 and county officials by using the emergency phone numbers retained at the job site.
4. Notify the California State Warning Center at (800) 852-7550.
5. Notify the National Response Center at (800) 424-8802 regarding spills of Federal reportable quantities under 40 CFR 110, 117, and 302.
6. Notify other agencies as appropriate, including:
   6.1. Fire department
   6.2. Public works department
   6.3. US Coast Guard
   6.4. California Highway Patrol
   6.5. City police or county sheriff's department
   6.6. DTSC
   6.7. Department of Conservation, Division of Oil, Gas, and Geothermal Resources
   6.8. Cal/OSHA
   6.9. RWQCB

13-4.03B(5)–13-4.03B(6) Reserved

13-4.03C Material Management

13-4.03C(1) General

Minimize or eliminate discharge of material into the air, storm drain systems, and receiving waters while taking delivery of, using, or storing the following materials:

1. Hazardous chemicals, including acids, lime, glues, adhesives, paints, solvents, and curing compounds
2. Soil stabilizers and binders
3. Fertilizers
4. Detergents
5. Plaster
6. Petroleum materials, including fuel, oil, and grease
7. Asphalt and concrete components
8. Pesticides and herbicides

Employees trained in emergency spill cleanup procedures must be present during the unloading of hazardous materials or chemicals.

Minimize the use of hazardous materials if practicable.

Perform each of the following activities at least 100 feet from a concentrated flow of stormwater, a drainage course, or an inlet wherever it is performed (1) within the floodplain or (2) at least 50 feet outside the floodplain:

1. Stockpiling materials
2. Storing pile-driving equipment and liquid waste containers
3. Washing vehicles and equipment in outside areas
4. Fueling and maintaining vehicles and equipment

13-4.03C(2) Material Storage

Store materials in their original containers with the original labels maintained in legible condition. Immediately replace damaged or illegible labels.

Comply with section 14-11.03 for the storage of liquids, petroleum materials, and substances listed in 40 CFR 110, 117, and 302.

Store bagged or boxed material on pallets. Protect bagged or boxed material from wind and rain during non–working days and whenever precipitation is forecasted.

13-4.03C(3) Stockpile Management

Minimize stockpiling of materials at the job site.

Do not allow soil, sediment, or other debris from stockpiles to enter storm drains, open drainages, or watercourses.

Manage stockpiles by implementing WPC practices on:

1. Active stockpiles before a forecasted storm event
2. Inactive stockpiles according to the WPCP or SWPPP schedule

Cover active and inactive soil stockpiles with soil stabilization material or a temporary cover and surround them with a linear sediment barrier.

Cover stockpiles of concrete and asphalt concrete rubble, HMA, AB, or AS with a temporary cover and surround them with a linear sediment barrier.

Place stockpiles of pressure-treated wood on pallets and cover them with an impermeable material.

Place stockpiles of cold mix asphalt concrete on an impervious surface and cover them with an impermeable material. Protect the stockpile from stormwater run-on and runoff.

Repair or replace linear sediment barriers and covers as needed to keep them functioning properly. If sediment accumulates to 1/3 of the linear sediment barrier's height, remove the accumulated sediment.

13-4.03C(4)–13-4.03C(6) Reserved

13-4.03D Waste Management

13-4.03D(1) General

Manage solid waste under section 14-10.

Manage hazardous waste under section 14-11.

13-4.03D(2) Paint Waste

Clean water-based and oil-based paint from brushes or equipment within a contained area to prevent contamination of soil, receiving waters, or storm drain systems. Handle and dispose of paints, thinners, solvents, residues, and sludges that cannot be recycled or reused as hazardous waste under section 14-11. When thoroughly dry, dispose of dry latex paint, paint cans, used brushes, rags, absorbent materials, and drop cloths as solid waste under section 14-10.

13-4.03D(3) Concrete Waste

Prevent the discharge of concrete and asphalt concrete waste into storm drain systems and receiving waters.

Collect concrete waste simultaneously with the waste-producing activity. Concrete waste includes grout, dust, debris, residue, and slurry from demolition, saw cutting, coring, grooving, or grinding activities.

Dispose of liquid residue from concrete grooving or grinding activities at an appropriately permitted disposal facility.

If authorized, you may transport liquid grooving or grinding residue to a contractor-support facility for drying.

13-4.03D(4) Sanitary and Septic Waste

Do not bury or discharge wastewater from a sanitary or septic system within the highway. A sanitary facility discharging into a sanitary sewer system must be properly connected and free from leaks. Place a portable sanitary facility at least 50 feet away from storm drains, receiving waters, and flow lines.

Comply with local health agency regulations if using an on-site disposal system.

13-4.03D(5) Liquid Waste

Prevent job-site liquid waste from entering storm drain systems and receiving waters. Liquid wastes include:

1. Drilling slurries or fluids
2. Grease- and oil-free wastewater and rinse water
3. Dredgings, including liquid waste from cleaning drainage systems
4. Liquid waste running off a surface, including wash and rinse water
5. Other nonstormwater liquids not covered by separate permits

Store liquid waste in structurally sound, leak-proof containers, such as roll-off bins or portable tanks.

Provide enough liquid waste containers with enough volume to prevent overflow, spills, and leaks.

Store containers at least 50 feet from moving vehicles and equipment.

Remove and dispose of deposited solids from sediment traps under section 14-10 unless another method is authorized.

Liquid waste may require testing to determine hazardous material content before disposal.

Dispose of drilling fluids and residue.

If an authorized location is available within the job site, fluids and residue exempt under 23 CA Code of Regs § 2511(g) may be dried by evaporation in a leak-proof container. Dispose of the remaining solid waste under section 14-10.

13-4.03D(6)–13-4.03D(8) Reserved

13-4.03E Nonstormwater Management

13-4.03E(1) General

Use water for work activities such that erosion and the discharge of pollutants into storm drain systems and receiving waters are prevented. Obtain authorization before washing anything at the job site with water that could discharge into a storm drain system or receiving waters. Immediately report discharges.

Sweep and vacuum paved areas. Do not wash paved areas with water.

Direct runoff water, including water from the repair of a water line, from the job site to areas where it can infiltrate into the ground. Do not allow spilled water to escape the areas used to fill water trucks. Manage run-on to minimize contact with job site water.

13-4.03E(2) Illicit Connection and Illegal Discharge Detection and Reporting

Before starting work and daily thereafter, inspect the job site and its perimeter for the following evidence of illicit connections, illegal discharges, and dumping:

1. Debris or trash piles
2. Staining or discoloration on pavement or soils
3. Pungent odors coming from drainage systems
4. Discoloration or an oily sheen on water
5. Stains and residue in ditches, channels, or drain boxes
6. Abnormal water flow during dry weather
7. Excessive sediment deposits
8. Nonstandard drainage junction structures
9. Broken concrete or other disturbances at or near junction structures

If evidence of an illegal connection, discharge, or dumping is discovered, immediately notify the Engineer. Do not take further action unless ordered. Assume that unlabeled or unidentifiable material is hazardous.

13-4.03E(3) Vehicle and Equipment Cleaning

Limit vehicle and equipment cleaning or washing at the job site except for the safety and protection of the equipment and as needed to comply with PLACs. Notify the Engineer before cleaning vehicles and equipment at the job site with soap, solvents, or steam. Contain and recycle or dispose of resulting waste

under section 14-11 or section 13-4.03D(5), whichever is applicable. Do not use diesel to clean vehicles or equipment. Minimize the use of solvents.

Clean or wash vehicles and equipment in a structure equipped with disposal facilities. You may wash vehicles in an outside area if the area is:

1. Paved with concrete or asphalt concrete
2. Surrounded by a containment berm
3. Equipped with a sump to collect and dispose of wash water

Use as little water as practicable when washing vehicles and equipment. Hoses must be equipped with a positive shutoff valve.

Discharge the liquid from wash racks to a recycling system or to another authorized system. Remove liquids and sediment as necessary.

13-4.03E(4) Vehicle and Equipment Fueling and Maintenance

If practicable, perform maintenance on vehicles and equipment off-site.

If fueling or maintenance must be performed at the job site, obtain authorization for an assigned area or areas for these activities before using them. Minimize mobile fueling and maintenance activities. Perform fueling and maintenance activities on level ground in areas protected from stormwater run-on and runoff.

Use containment berms or dikes around fueling and maintenance areas. Keep enough absorbents and spill kits in the fueling or maintenance area and on fueling trucks to handle potential spills. Dispose of spill-cleanup material and kits immediately after use. Use drip pans or absorbent pads during fueling or maintenance.

Do not leave fueling or maintenance areas unattended during fueling and maintenance activities. Fueling nozzles must be equipped with (1) an automatic shutoff control and (2) vapor recovery where required by the Air Quality Management District. Secure nozzles in an upright position when not in use. Do not top off fuel tanks.

Recycle or properly dispose of used batteries and tires.

If leaks cannot be repaired immediately, remove the vehicle or equipment from the job site.

13-4.03E(5) Material and Equipment Used Over Water

Place drip pans and absorbent pads under vehicles and equipment used over water. Keep enough spill-cleanup material with the vehicles and equipment to handle potential spills. Place drip pans or plastic sheeting under vehicles and equipment on docks, barges, or other surfaces over water whenever the vehicles or equipment will be idle for more than 1 hour.

Install watertight curbs or toe boards on barges, platforms, docks, or other surfaces over water to contain material, debris, and tools. Secure any material or debris to prevent spills or discharge into the water due to wind.

Report discharges to receiving waters immediately upon discovery.

13-4.03E(6) Structure Removal Over or Adjacent to Water

Do not allow demolished material to enter storm drain systems and receiving waters. Use authorized covers and platforms to collect debris. Use attachments on equipment to catch debris during small demolition activities. Empty debris-catching devices daily and handle debris under section 13-4.03D.

13-4.03E(7) Paving, Sealing, Saw Cutting, Grooving, and Grinding Activities

Prevent the following materials from entering storm drain systems and receiving waters:

1. Cementitious material
2. Asphaltic material
3. Aggregate or screenings
4. Saw cutting, grooving, and grinding residue
5. Pavement chunks
6. Shoulder backing

7. Methacrylate resin
8. Sandblasting residue

Cover drainage inlets and use linear sediment barriers to protect downhill receiving waters until paving, saw cutting, grooving, and grinding activities are completed and excess material has been removed. Cover drainage inlets and manholes during the application of seal coat, tack coat, slurry seal, or fog seal.

Whenever precipitation is forecasted, limit paving, saw cutting, and grinding to places where runoff can be captured.

Do not start seal coat, tack coat, slurry seal, or fog seal activities when precipitation is forecasted during the application and curing period.

Do not grind or groove pavement during precipitation.

Use a vacuum to remove slurry immediately after it is produced. Do not allow the slurry to run onto lanes open to traffic or off the pavement.

Collect the residue from grooving and grinding activities with a vacuum attachment on the grinding machine. Do not leave the residue on the pavement or allow it to flow across the pavement.

You may stockpile material removed from existing roadways under section 13-4.03C(3) if authorized.

Do not coat asphalt trucks and equipment with substances that contain soap, foaming agents, or toxic chemicals.

When paving equipment is not in use, park the paving equipment over drip pans or plastic sheeting with absorbent material to catch drips.

13-4.03E(8) Thermoplastic Striping and Pavement Markers

Do not preheat, transfer, or load thermoplastic within 50 feet of drainage inlets or receiving waters.

Do not unload, transfer, or load bituminous material for pavement markers within 50 feet of drainage inlets or receiving waters.

Collect and dispose of bituminous material from the roadway after removing markers.

13-4.03E(9) Pile Driving

Keep spill kits and cleanup materials at pile driving locations. Park pile driving equipment over drip pans, absorbent pads, or plastic sheeting with absorbent material. Protect pile driving equipment by parking it on plywood and covering it with plastic if precipitation is forecasted.

Store pile driving equipment on level ground and protect it from stormwater run-on when not in use. Use vegetable oil instead of hydraulic fluid if practicable.

13-4.03E(10) Concrete Curing

Do not overspray chemical curing compounds. Minimize the drift by spraying as close to the concrete as practicable. Do not allow runoff of curing compounds. Cover drainage inlets before applying the curing compound.

Minimize the use and discharge of water by using wet blankets or similar methods to maintain moisture when concrete is curing.

13-4.03E(11) Concrete Finishing

Collect and dispose of (1) water and solid waste from high-pressure water blasting and (2) sand and solid waste from sandblasting. Before sandblasting, cover drainage inlets within 50 feet of the sandblasting. Minimize the drift of dust and blast material by keeping the nozzle close to the surface of the concrete. If the character of the blast residue is unknown, test for hazardous materials and dispose of it.

Inspect the containment structures for concrete-finishing waste for damage before each day of use and before forecasted precipitation. Remove the liquid and solid waste from the containment structures after each work shift.

13-4.03E(12)–13-4.03E(15) Reserved

13-4.03F Sweeping

Sweep by hand or mechanical methods, such as vacuuming. Do not use mechanical kick brooms.

Sweep paved roads at construction entrance and exit locations and paved areas within the job site:

1. During clearing and grubbing activities
2. During earthwork activities
3. During trenching activities
4. During pavement-structure construction activities
5. When vehicles are entering and leaving the job site
6. After soil-disturbing activities
7. After observing off-site tracking of material

Monitor paved areas and roadways within the project. Sweep within:

1. 1 hour if sediment or debris is observed during activities requiring sweeping
2. 24 hours if sediment or debris is observed during activities not requiring sweeping

Remove collected material, including sediment, from paved shoulders, drain inlets, curbs and dikes, and other drainage areas. You may stockpile collected material at the job site. Dispose of collected material at least once per week if stockpiled.

You may dispose of sediment within the job site collected during sweeping activities. Protect the disposal areas against erosion.

Keep dust to a minimum during street sweeping activities. Use water or a vacuum whenever dust generation is excessive or sediment pickup is ineffective.

13-4.03G Dewatering

Dewatering consists of discharging accumulated stormwater, groundwater, or surface water from excavations or temporary containment facilities.

Perform dewatering work as specified for the work items involved, such as a temporary ATS or dewatering and discharge.

If dewatering and discharging activities are not specified for a work item and you perform dewatering activities:

1. Conduct dewatering activities under the Department's *Field Guide for Construction Site Dewatering*.
2. Ensure any dewatering discharge does not cause erosion, scour, or sedimentary deposits that could impact natural bedding materials.
3. Discharge the water within the project limits. Dispose of the water if it cannot be discharged within project limits due to site constraints or contamination.
4. Do not discharge stormwater or nonstormwater that has an odor, discoloration other than sediment, an oily sheen, or foam on the surface. Immediately notify the Engineer upon discovering any such condition.

13-4.03H–13-4.03J Reserved

13-4.04 PAYMENT

Not Used

13-5 TEMPORARY SOIL STABILIZATION

13-5.01 GENERAL

Section 13-5 includes specifications for placing temporary soil stabilization materials.

Move-in and move-out for temporary erosion control includes:

1. Moving onto the job site when the Engineer determines an area is ready to receive temporary soil stabilization materials
2. Setting up all required personnel and equipment

3. Moving out all personnel and equipment when work in that area is complete

13-5.02 MATERIALS

13-5.02A General

Tackifier, fiber, seed, and straw must comply with the specifications for the same materials in section 21-2.02 except section 21-2.01 does not apply.

Fiber for temporary hydraulic mulch, tacked straw, and hydroseed must be at least 50 percent wood fiber. The remaining percentage must be cellulose fiber, alternate fiber, or a combination of these fibers.

13-5.02B Erosion Control Blankets

An erosion control blanket must comply with the specifications for RECPs in section 21-2.02O except section 21-2.01 does not apply.

An erosion control blanket classified as long-term and nondegradable must be Class 8 RSP fabric.

13-5.02C Temporary Mulch

Temporary mulch must comply with the specifications for wood mulch in section 20.

13-5.02D Cementitious Binder

Cementitious binder must be:

1. Calcium sulfate hemihydrate
2. At least 85 percent pure
3. Functional for at least 365 days
4. Miscible with water and fiber
5. Nontoxic to aquatic organisms
6. Free from growth or germination-inhibiting factors
7. Nonflammable

13-5.02E Soil Binder

Soil binder must comply with the material specifications for tackifier.

13-5.02F Temporary Covers

A temporary cover must be a geosynthetic temporary cover, plastic sheeting, or a combination of both.

Plastic sheeting must be a 10-mil-thick, single-ply geomembrane material complying with ASTM D2103.

Restrainers for securing the cover fabric or plastic sheeting to a slope's surface must be one of the following types:

1. Gravel-filled bags roped together and spaced not more than 6 feet apart.
2. Wooden board and steel restrainer. The wooden board must be 2 by 4 inches, 8 feet long, and made from fir or pine. Steel reinforcing bars must be spaced not more than 4 feet apart along the wooden board.
3. Other authorized type.

Rope must be at least 3/8 inch in diameter and be biodegradable or nondegradable. Biodegradable rope must be made from sisal, manila, or other natural fiber. Nondegradable rope must be made from nylon, polypropylene, or other geosynthetic fiber.

The linear sediment barrier must comply with section 13-10.

13-5.02G Gravel-Filled Bags

A gravel-filled bag must:

1. Be a geosynthetic bag
2. Have inside dimensions from 24 to 32 inches long and from 16 to 20 inches wide
3. Have a bound opening sewn with yarn, bound with wire, or secured with a closure device
4. Weigh from 30 to 50 pounds when filled with gravel

Gravel for a gravel-filled bag must be from 3/8 to 3/4 inch in diameter and must be clean and free of clay balls, organic matter, and other deleterious materials.

13-5.02H–13-5.02J Reserved

13-5.03 CONSTRUCTION

13-5.03A General

The Engineer authorizes the areas to receive soil stabilization materials by approving the placement of stakes or other suitable markers in increments of 1 ac or less.

Place temporary soil stabilization material within 24 hours after an area is ready to receive the material or before a forecasted storm event. Do not use a hydraulically applied material whenever:

1. Precipitation occurs
2. Water is standing on or moving across the soil surface
3. Soil is frozen
4. Air temperature is below 40 degrees F during the tackifier's curing period unless allowed under the tackifier manufacturer's instructions and authorized

13-5.03B Temporary Erosion Control Blankets

Place a temporary erosion control blanket as specified for RECPs in section 21-2.03O.

13-5.03C Temporary Mulch

Spread temporary mulch as specified for spreading wood mulch in section 20.

If an application rate is not shown, spread mulch to a uniform thickness of 2 inches.

13-5.03D Temporary Hydraulic Mulch

Apply temporary hydraulic mulch as specified for hydromulch in section 21-2.03D.

If application rates are not shown, apply temporary hydraulic mulch at the following rates:

1. Fiber at 2,000 lb/ac
2. Tackifier under the manufacturer's instructions for the slope, soil, and wind conditions

13-5.03E Temporary Bonded Fiber Matrix Hydraulic Mulch

Apply temporary bonded fiber matrix hydraulic mulch as specified for bonded fiber matrix in section 21-2.03H.

If an application rate is not shown, apply temporary bonded fiber matrix hydraulic mulch at the rate of 3,500 lb/ac.

13-5.03F Reserved

13-5.03G Temporary Cementitious Binder Hydraulic Mulch

Apply temporary cementitious binder hydraulic mulch as specified for hydromulch in section 21-2.03D.

If application rates are not shown, apply temporary cementitious binder hydraulic mulch at the following rates:

1. Fiber at 2,000 lb/ac
2. Cementitious binder at 4,000 lb/ac

13-5.03H Temporary Tacked Straw

Apply temporary tacked straw as specified for straw in section 21-2.03G.

If application rates are not shown, apply temporary tacked straw at the following rates:

1. Straw at 2.0 tons/ac
2. Fiber at 2,000 lb/ac
3. Tackifier at the manufacturer's instructed rate for the slope, soil, and wind conditions

13-5.03I Temporary Hydroseed

Apply temporary hydroseed as specified for hydroseed in section 21-2.03D.

If application rates are not shown for fiber and tackifier, apply temporary hydroseed at the following rates:

1. Seed at the rate shown
2. Fiber at 2,000 lb/ac
3. Tackifier at the manufacturer's instructed rate for the slope, soil, and wind conditions

13-5.03J Temporary Soil Binder

Apply temporary soil binder as specified for hydromulch in section 21-2.03D.

If application rates are not shown, apply temporary soil binder at the manufacturer's instructed rate for the slope, soil, and wind conditions.

13-5.03K Temporary Covers

Install temporary-cover fabric as follows:

1. Place the fabric:
   1.1. Loosely on the slope with the longitudinal edges perpendicular to the slope contours
   1.2. On the upper portion of the slope to overlap the fabric on the lower portion of the slope
   1.3. On the side facing the prevailing wind to overlap the fabric on the downwind side of the slope
2. Anchor the perimeter edge of the fabric in key trenches.
3. Overlap the edges of the fabric by at least 2 feet.
4. Place restrainers at the overlap area and along the toe of the slope. Space the restrainers a maximum of 8 feet on center between the overlaps.
5. If anchor restraints are used, ensure that the leg of the steel reinforcing bar pierces the fabric and holds the wooden lath firmly against the surface of the slope.

Install a temporary linear sediment barrier to protect excavation and embankment slopes from run-on and concentrated flows of stormwater. Place the barrier parallel with the slope contour at the toe of the slope. Angle the last 6 feet of the barrier upslope at the downhill end of the run.

If you remove a temporary cover to perform other work, replace and resecure it within 1 hour of stopping work.

Maintain a temporary cover to minimize the exposure of slopes and prevent material movement beyond the linear sediment barrier.

Relocate and secure restrainers to keep the temporary cover in place. If a temporary cover breaks free, immediately resecure it.

Repair or replace a temporary cover if any of the following occurs:

1. Covered area becomes exposed or exhibits visible erosion
2. Erosion occurs between the joints or beneath the linear sediment barrier
3. Temporary cover becomes detached, torn, or unraveled

13-5.03L–13-5.03N Reserved

13-5.04 PAYMENT

The payment quantity for temporary soil stabilization bid items paid for by the area is the area measured parallel with the ground surface not including the additional quantity used for overlaps.

The Department determines the cost for maintaining soil stabilization measures under section 9-1.04 and pays you 1/2 of that cost.

13-6 TEMPORARY SEDIMENT CONTROL

13-6.01 GENERAL

Section 13-6 includes specifications for installing temporary sediment control.

Temporary linear sediment barriers must comply with section 13-10.

13-6.02 MATERIALS

13-6.02A General

An erosion control blanket must comply with section 21-2.02O(4) except section 21-2.01 does not apply.

Fiber rolls, rope, stakes, gravel-filled bags, and foam barriers must comply with section 13-10.02.

13-6.02B Rigid Plastic Barriers

A rigid plastic barrier must:

1. Have an integrated filter
2. Have a formed outer jacket of perforated HDPE or polyethylene terephthalate
3. Have a flattened tubular-shaped cross section
4. Be made from virgin or recycled materials
5. Be free of biodegradable filler materials that degrade the physical or chemical characteristics of the completed filter core or outer jacket
6. Have a length of at least 4 feet per unit
7. Have the ability to interlock separate units into a long barrier such that water does not flow between the units
8. Comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Grab tensile strength of outer jacket material (min, lb/sq in each direction)	ASTM D4632[a]	4,000
Break strength of outer jacket (lb/sq in)	ASTM D4632[a]	1,300
Permittivity of filter core (min, 1/sec)	ASTM D4491	0.38
Flow rate of filter core (gpm per sq ft)	ASTM D4491	100–200
Filter core aperture size (max, microns)	--	425
UV stability of outer jacket and filter core (min, percent tensile strength after 500 hours, xenon-arc lamp and water spray weathering method)	ASTM D4355	90

[a]You may use other appropriate test method for the specific polymer.

For an inlet with a curb opening but no grate, the rigid plastic barrier must be sized to fit the opening and have:

1. Horizontal flap of at least 6 inches with an under-seal gasket to prevent underflows
2. High-flow bypass
3. Vertical height of at least 7 inches after installation

For a grated inlet without a curb opening, the rigid plastic barrier must be sized to fit the inlet and:

1. Cover the grate by at least 2 inches on each side and have an under-seal gasket to prevent underflows
2. Have a high-flow bypass
3. Have a vertical height of at least 1.5 inches after installation

For a grated inlet with a curb opening, the rigid plastic barrier must be sized to fit and have:

1. Horizontal flap that covers the grate by at least 2 inches on the 3 sides away from the curb opening and must have an under-seal gasket to prevent underflows
2. High-flow bypass
3. Section that covers at least 5 inches vertically above the flow line of the curb opening after installation

13-6.02C Sediment Filter Bags

Each sediment filter bag must be sized to fit the catch basin or drainage inlet and have a high-flow bypass.

A sediment filter bag may include a metal frame. If the sediment filter bag does not have a metal frame and is deeper than 18 inches, it must include lifting loops, dump straps, and a restraint cord to keep the sides of the bag away from the walls of the catch basin.

13-6.02D–13-6.02F Reserved

13-6.03 CONSTRUCTION

13-6.03A General

Remove sediment deposits if the sediment exceeds 1 inch in depth from the surface of an erosion control blanket.

Remove sediment from a Type 2 sediment trap of a temporary inlet if the volume has been reduced by approximately 1/2.

Remove sediment from a sediment filter bag if it becomes full or if the restraint cords are no longer visible. Empty a sediment filter bag:

1. Without a metal frame by placing no. 8 steel reinforcing bars through the lifting loops and lifting the filled bag from the drainage inlet
2. With a metal frame by lifting the metal frame from the drainage inlet

Rinse the sediment filter bag before replacing it at the drainage inlet. Do not allow the rinse water to enter a drainage inlet or waterway.

If you place the removed sediment within the job site, stabilize the sediment deposits to prevent erosion.

13-6.03B Temporary Check Dams

Before placing a temporary check dam, remove obstructions, including rocks, clods, and debris greater than 1 inch in diameter from the ground.

If a temporary check dam is to be placed in the same area as an erosion control blanket, install the blanket before placing the dam.

Place a temporary check dam approximately perpendicular to the centerline of the ditch or drainage line. Install the dam with enough spillway depth to prevent flanking of a concentrated flow around its ends. Install a Type 1 or Type 2 dam if the ditch is unlined and a Type 2 dam if the ditch is lined with concrete or asphalt concrete.

For a Type 1 temporary check dam:

1. Secure the fiber rolls with rope and notched wood stakes.
2. Drive the stakes into the soil until the notch is even with the top of the fiber roll.
3. Lace rope between the stakes and over the fiber roll. Knot the rope at each stake.
4. Tighten by driving the stakes further into the soil and forcing the fiber roll against the surface of the ditch or drainage line.

Place a Type 2 temporary check dam as a single layer of gravel-filled bags, placed end-to-end to eliminate gaps. If you need to increase the height of the dam, add more layers of gravel-filled bags. Stack the bags in the upper row to overlap the joints in the lower row. Stabilize the rows by adding more rows of bags in the lower layers.

13-6.03C Temporary Drainage Inlet Protection

Provide temporary drainage inlet protection around drainage inlets as changing conditions require. The drainage inlet protection must be Type 1, Type 2, Type 3A, Type 3B, Type 4A, Type 4B, Type 5, Type 6A, Type 6B, or a combination of these as needed for the surrounding conditions.

For drainage inlet protection in paved or unpaved areas:

1. Prevent runoff ponds from encroaching onto the traveled way or overtopping the curb or dike. Use a linear sediment barrier to redirect runoff and control ponding.
2. Clear the area around each drainage inlet of obstructions, including rocks, clods, and debris greater than 1 inch in diameter, before installing the drainage inlet protection.

3. Install the linear sediment barrier upslope of the existing drainage inlet and parallel with the curb, dike, or flow line to prevent sediment from entering the drainage inlet.

If gravel-filled bags are used for Type 3A and Type 3B temporary drainage inlet protection, place the gravel-filled bags end-to-end to eliminate gaps. Stack the bags such that the upper row overlaps joints in the lower row. Arrange the bags to create a spillway by removing 1 or more gravel-filled bags from the upper layer.

Place fiber rolls over the erosion control blanket for Type 4A temporary drainage inlet protection.

Place the barrier to provide a tight joint with the curb or dike. Cut the cover fabric or jacket to ensure a tight fit.

If a rigid sediment barrier is used for Type 6A or Type 6B temporary drainage inlet protection at a grated inlet without a curb opening, place the barrier using a gasket to prevent runoff from flowing under the barrier. Secure the barrier to the pavement with nails and adhesive, gravel-filled bags, or a combination of both.

Install a sediment filter bag for Type 5 temporary drainage inlet protection as follows:

1. Remove the drainage inlet grate.
2. Place the sediment filter bag in the opening.
3. Replace the grate to secure the sediment filter bag in place.

13-6.03D Reserved

13-6.03E Temporary Fiber Rolls

Install a temporary fiber roll as specified for installing fiber rolls in section 21-2.03P.

13-6.03F Temporary Gravel Bag Berms

Install a temporary gravel bag berm under section 13-10.03C.

13-6.03G Rigid Plastic Barriers

Secure a rigid plastic barrier to:

1. Pavement with 1-inch concrete nails with 1-inch washers and solvent-free adhesive, gravel-filled bags, or a combination of both
2. Soil with 6-inch nails with 1-inch washers and wood stakes

13-6.03H–13-6.03J Reserved

13-6.04 PAYMENT

The payment quantity for temporary sediment control bid items paid for by the length is the length measured along the centerline of the installed material.

The payment quantity for temporary fiber roll does not include the additional quantity used for overlaps.

The Department does not pay for the relocation of temporary drainage inlet protection during work progress.

The Department determines the cost for maintaining sediment control measures under section 9-1.04 and pays you 1/2 of that cost.

13-7 TEMPORARY TRACKING CONTROL

13-7.01 GENERAL

13-7.01A General

Section 13-7 includes specifications for limiting and removing sediment and debris tracked onto roadway surfacing.

13-7.01B Materials

Not Used

13-7.01C Construction

Do not allow soil, sediment, or other debris that is tracked onto the surfacing to enter storm drains, open drainage facilities, and watercourses. Remove any material tracked onto the surfacing within 6 hours.

13-7.01D Payment

Not Used

13-7.02 STREET SWEEPING

13-7.02A General

13-7.02A(1) Summary

Section 13-7.02 includes specifications for sweeping streets.

13-7.02A(2) Definitions

Reserved

13-7.02A(3) Submittals

At least 5 business days before starting clearing and grubbing, earthwork, or any other activity with the potential for tracking sediment or debris, submit the number and type of street sweepers that will be used on the project for each activity.

Keep and submit records of street sweeping activities, including sweeping times, sweeping locations, and the quantity of collected material.

13-7.02A(4) Quality Assurance

Reserved

13-7.02B Materials

Not Used

13-7.02C Construction

Use one of the following types of street sweepers:

1. Mechanical sweeper followed by a vacuum-assisted sweeper
2. Vacuum-assisted, dry, waterless, sweeper
3. Regenerative-air sweeper

Street sweeping does not void the requirements for residue collection included in other work activities, such as grooving, grinding, or asphalt concrete planing.

Sweep streets as specified for sweeping in section 13-4.03F except use a street sweeper.

At least 1 street sweeper must be at the job site at all times when street sweeping work is required. The street sweeper must be in good working order.

13-7.02D Payment

Not Used

13-7.03 TEMPORARY CONSTRUCTION ROADWAYS AND ENTRANCES

13-7.03A General

13-7.03A(1) Summary

Section 13-7.03 includes specifications for constructing temporary construction roadways and entrances.

13-7.03A(2) Definitions

Reserved

13-7.03A(3) Submittals

For a construction entrance, submit details for alternatives at least 5 business days before installation. You may propose alternatives for the sump and corrugated steel panels or eliminate the sump if authorized.

13-7.03A(4) Quality Assurance

Reserved

13-7.03B Materials

13-7.03B(1) General

Fabric for a temporary construction entrance must be Class 8 RSP fabric.

Fabric for temporary construction roadway must be Class 10 RSP fabric.

13-7.03B(2) Rock

Use Type A rock for a Type 1 temporary construction entrance.

Type A rock must comply with:

1. Quality characteristics for rock material in section 72-2.02
2. Sizes shown in the following table:

Square screen size (inches)	Percentage passing	Percentage retained
6	100	0
3	0	100

Use Type B rock for a Type 2 temporary construction entrance.

Type B rock must be no. 25 railway ballast complying with the *AREMA Manual for Railway Engineering*. Do not use blast furnace slag.

Use Type A or Type B rock for a temporary construction roadway.

13-7.03B(3) Corrugated Steel Panels

Each corrugated steel panel must:

1. Be pressed or shop welded
2. Have a slot or hook for connecting the panels together

13-7.03C Construction

Prepare the location for a temporary construction entrance or roadway as follows:

1. Remove vegetation to the ground level and clear away debris.
2. Grade the ground to a uniform plane.
3. Grade the ground surface to drain.
4. Remove sharp objects that could damage the fabric.
5. Compact the top 1.5 feet of the soil to at least a 90 percent relative compaction.

Construct a temporary construction entrance or roadway as follows:

1. Position the fabric along the length of the entrance or roadway.
2. Overlap the sides and ends of the fabric by at least 12 inches.
3. Spread rock over the fabric in the direction of traffic.
4. Cover the fabric with rock within 24 hours.
5. Keep a 6-inch layer of rock over the fabric to prevent damage from the spreading equipment.

Do not drive on the fabric until the rock is spread.

Repair fabric damaged during rock spreading by placing new fabric over the damaged area. The new fabric must be large enough to cover the damaged area and provide at least an 18-inch overlap on all edges.

Maintain a temporary construction entrance or roadway to minimize the generation of dust and tracking of soil and sediment onto public roads. Place additional rock if dust or sediment tracking increases.

Repair a temporary construction entrance or roadway if:

1. Fabric is exposed
2. Depressions develop in the surface
3. Rock is displaced

For a Type 2 temporary construction entrance, place rock under the corrugated steel panels. Use at least 6 corrugated steel panels for each entrance. Couple the panels together to prevent movement.

If using a sump, install the sump within 20 feet of each temporary construction entrance.

13-7.03D Payment

The Department determines the cost for maintaining a temporary construction entrance or roadway under section 9-1.04 and pays you 1/2 of that cost.

The Department does not pay for the relocation of temporary construction entrances or roadways during work progress.

13-8 TEMPORARY ACTIVE TREATMENT SYSTEMS

13-8.01 GENERAL

13-8.01A Summary

Section 13-8 includes specifications for providing a temporary active treatment system for the treatment and discharge of uncontaminated groundwater and accumulated stormwater from excavations or other areas requiring dewatering.

You may discharge into a publicly owned treatment works instead of using a temporary active treatment system. If uncontaminated groundwater, stormwater, or both are discharged to a publicly owned treatment works, obtain a municipal batch discharge permit. The Department does not pay for obtaining the municipal batch discharge permit or for discharging the water.

13-8.01B Definitions

Reserved

13-8.01C Submittals

13-8.01C(1) General

Submit records for the delivery and removal of ATS components.

13-8.01C(2) Active Treatment System Plan

Within 20 days of Contract approval, submit 3 copies of the ATS plan. The plan must include:

1. Title sheet.
2. Table of contents.
3. Certification and approval sheet described in the Department's *Stormwater Prevention Plan (SWPPP) and Water Pollution Control Program (WPCP) Preparation Manual.*
4. Amendment log and format described in the Department's *Stormwater Prevention Plan (SWPPP) and Water Pollution Control Program (WPCP) Preparation Manual.*
5. Description and schedule of the discharge activities.
6. Discharge alternatives, including:
   - 6.1. Reuse of treated water for job site activities, such as dust control, irrigation, fill compaction, or concrete batch plant activities
   - 6.2. Percolation
   - 6.3. Discharge into storm sewers
   - 6.4. Discharge into surface waters
7. Treatment system description and components.
8. Anticipated flow rates.
9. Operation and maintenance manual for the equipment.
10. Monitoring, sampling, and reporting plan, including QA and QC.
11. Health and safety plan.
12. Spill prevention plan.
13. Field-recorded data, visual inspection, calibration procedures, and examples of logs.
14. Descriptions of measuring equipment.
15. Shop drawings showing:

15.1. Section and plan views of stormwater effluent treatment systems
15.2. Location of sampling points for water quality measurements
15.3. Flow path and placement of pipes, hoses, pumps, holding tanks, and other equipment used to convey water
15.4. General position of treatment components relative to excavations or other areas requiring dewatering
15.5. Point of stormwater discharge
16. Daily inspection report form.
17. Municipal batch discharge permit from a publicly owned treatment works if required.
18. Coagulant-handling work plan if you use chemical coagulants, in-line flocculants, or both in the treatment system. The coagulant-handling work plan must include:
18.1. Description of WPC practices to prevent accidental spillage, overfeeding into the treatment system, or other mishandling of coagulant agents
18.2. Monitoring plan for all coagulants, flocculants, or both
18.3. Description of the coagulation and flocculating agents, including chemical and trade names
18.4. Determination of acute or chronic toxicity for aquatic organisms conforming to EPA methods for the agents
18.5. Monitoring plan to detect a residual agent at concentrations at or below the established acute toxicity levels for freshwater and marine conditions for that agent

Allow 20 days for review. If revisions are required, the Engineer notifies you of the date the review stopped and provides comments. Submit a revised ATS plan within 15 days of receiving the comments. The Department's review resumes when a complete plan has been resubmitted.

Submit an electronic copy on a read-only CD, DVD, or other Engineer-authorized data storage device and 4 printed copies of the authorized ATS plan. Allow 15 days for the Engineer to submit the plan to the SWRCB and the RWQCB. If the Engineer requests revisions based on comments from the SWRCB or RWQCB, submit a revised plan within 5 business days.

13-8.01C(3) Inspection Reports

If the ATS discharges treated effluent, submit a daily inspection report within 24 hours. The daily inspection report must include:

1. Discharge volumes
2. Water quality monitoring records
3. Discharge point information that includes:
3.1. Date and time
3.2. Weather conditions, including wind direction and velocity
3.3. Presence or absence of water fowl or aquatic wildlife
3.4. Color and clarity of the effluent discharge
3.5. Erosion or ponding downstream of the discharge point
3.6. Photographs labeled with the time, date, and location

13-8.01C(4) Notice of Discharge Reports

If observations and measurements confirm that a residual chemical or water quality standard is exceeded, submit the notice of discharge within 48 hours after exceeding the limits. The notice of discharge must include documentation of the reasons for exceeding the water quality standard and any corrective work performed to prevent a recurrence.

13-8.01C(5) Numeric Effluent Limitation Violation Reports

If a NEL is exceeded for a risk level 3 project, notify the Engineer and submit a violation report within 6 hours. The report must include:

1. Field sampling results and inspections, including:
1.1. Parameters, analytical methods, reporting units, and detection limits
1.2. Date, location, time of sampling, visual observations, and measurements
1.3. Quantity of precipitation of the storm event
2. Description of WPC practices and corrective actions taken to manage NEL exceedance

For a project in the Lake Tahoe Hydrologic Unit, the NEL violation report must be submitted within 2 hours. The analytical results less than the method detection limits must be reported as *less than the method detection limits.*

13-8.01C(6)–13-8.01C(8) Reserved

13-8.01D Quality Assurance

13-8.01D(1) General

Reserved

13-8.01D(2) Regulatory Requirements

The design, installation, operation, and monitoring of the temporary ATS and monitoring of the treated effluent must comply with Attachment F of NPDES General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ, NPDES No. CAS000002).

For a project within the Lake Tahoe Hydrologic Unit, the design, installation, operation, and monitoring of the temporary ATS and monitoring of the treated effluent must comply with Attachment E of the NPDES General Permit for General Waste Discharge Requirements and National Pollutant Discharge Elimination System General Permit for Storm Water Discharges Associated with Construction Activity in the Lake Tahoe Hydrologic Unit, Counties of Alpine, El Dorado, and Placer, (Order No. R6T-2016-0010 and NPDES No. CAG616002). You may view the General Permit for the Lake Tahoe Hydrologic Unit at the Construction Storm Water Program page of the SWRCB website.

For a project within the Lake Tahoe Hydrologic Unit, the discharger must perform toxicity testing that complies with the following if operating a temporary ATS in batch-treatment mode:

1. Discharger must initiate acute toxicity testing on effluent samples from each batch before discharge. Send bioassays to a laboratory certified by the Department of Public Health ELAP. The laboratory must test for whole effluent toxicity under test E113.
2. Conduct acute toxicity tests as outlined for a 96-hour acute test in Methods for Measuring the Acute Toxicity of Effluents and Receiving Water to Freshwater and Marine Organisms, USEPA-841-R-02-012 for fathead minnow, Pimephales promelas. The acute toxicity for rainbow trout, Oncorhynchus mykiss, may be used as a substitute for testing fathead minnows.
3. Toxicity tests must comply with QA criteria and test acceptability criteria in the most recent versions of the EPA test method for whole effluent toxicity.

13-8.01D(3) Training

Provide training to each ATS operator. The training must:

1. Be specific to the operation of the ATS and liquid coagulants for stormwater discharges in the State, including:
   1.1. Coagulation basics, including chemistry and physical processes
   1.2. System design and operating principles
   1.3. Control systems
   1.4. Coagulant selection, such as jar testing and dose determination
   1.5. Handling and safety measures for the toxicity of coagulants
   1.6. Monitoring, sampling, and analysis
   1.7. Reporting and recordkeeping
   1.8. Emergency response
2. Consist of a formal class with a certificate, testing, and certificate renewal requirements
3. Provide a minimum of 8 hours of classroom and 32 hours of field training

13-8.01D(4) Equipment Calibration

Calibrate the flow meter and devices for taking water quality measurements under the manufacturer's instructions and in the presence of the Engineer.

13-8.01D(5) Quality Control

Water discharged from a temporary ATS must comply with the NELs for discharge effluents and the receiving waters.

Test the water discharged from an ATS under the test methods shown in the following table:

Numeric Effluent Limitations

Quality characteristic	Test method	Detection limit (min)	Requirement
Turbidity (min, NTU)	EPA 0180.1 or field test with calibrated portable instrument	1	10 for daily flow-weighted average 20 for any single sample
pH	Field test with calibrated portable instrument	0.2	Lower NEL = 6.0 Upper NEL = 9.0

The residual chemical for the coagulant must be less than 10 percent of the maximum allowable threshold concentration for the most sensitive species.

Take water quality measurements to verify the limit requirements for the receiving waters and discharge effluent for:

1. Discharges of water lasting more than 4 hours within a 24-hour period as follows:
   - 1.1. If the discharge could affect the receiving body of water in a stormwater drainage system, take measurements at the background and receiving-water sampling locations not more than 1 hour before discharging the treated water.
   - 1.2. Perform startup-phase sampling 10 to 30 minutes after measurable runoff occurs during a storm. Startup-phase sampling includes stormwater runoff, background, and receiving water measurements taken during the first 3 days of discharge. Take samples at regular intervals during the storm. Take at least 4 samples for each discharge lasting 4 hours or more. The time between sampling must not exceed 4 hours.
   - 1.3. Take regular-phase samples at least twice daily. Regular-phase sampling includes effluent, background, and receiving water measurements that occur after the 3rd day of activities. Take samples at regular intervals.
   - 1.4. If the receiving body of water noticeably changes in color or clarity, take additional effluent, background, and downstream measurements.
   - 1.5. If an initial measurement shows that the water quality limits have been exceeded, take an additional measurement from 15 minutes to 1 hour after the initial measurement.
   - 1.6. If the 2nd test confirms the limits were exceeded, revert to the startup-phase sampling requirements before resuming regular-phase sampling.
   - 1.7. For cofferdam maintenance dewatering, you may discontinue regular-phase monitoring after 10 days if the effluent and receiving water measurements are consistently below the water quality limits.
2. Discharges of water lasting 4 hours or less within a 24-hour period as follows:
   - 2.1. If the discharge could affect the receiving body of water in a stormwater drainage system, take measurements at the background and receiving water-sampling locations not more than 1 hour before discharging the treated water.
   - 2.2. Take effluent, background, and receiving water measurements from 10 to 30 minutes after initiating the discharge. Continue to take measurements every hour.
   - 2.3. If an initial measurement shows that the water quality limits have been exceeded, take an additional measurement not more than 15 minutes after the initial measurement.
   - 2.4. If the receiving body of water noticeably changes in color or clarity, take additional effluent, background, and downstream measurements.
3. All other discharges of water as follows:
   - 3.1. Measure the stormwater effluent turbidity and pH at the end of the outfall or in-line sampling port.
   - 3.2. Measure the receiving water turbidity, pH, and dissolved oxygen at (1) a point within the mixing zone and (2) a point within 15 feet downstream of the discharge point.
   - 3.3. Measure the natural background turbidity, dissolved oxygen, and pH at a location that is from 9 to 15 feet upstream of the discharge point. If another job site activity is being performed, measure at least 150 feet upstream of the discharge point.
   - 3.4. If the discharge is made into a surface body of water or into a stormwater drainage system that produces an observable effect on a surface body of water, monitor the receiving water.

For receiving water deeper than 3 feet, take depth-averaged measurements by taking samples from 3 points within the water column and averaging the following 3 measurements:

1. 12 inches below the surface
2. Mid depth
3. 12 inches above the bottom

For receiving water less than 3 feet deep, take the measurement 12 inches below the surface.

13-8.02 MATERIALS

13-8.02A General

An ATS must be designed for the site conditions and anticipated flow rate and must include (1) a treatment system, (2) a collection and conveyance system, and (3) a discharge method and location.

The ATS must be capable of capturing and treating within a 72-hour period a volume equal to the runoff from a 10-year, 24-hour storm event using a watershed coefficient of 1.0.

Monitoring equipment must be interfaced with the control system of the ATS to provide shutoff or recirculation whenever effluent readings do not comply with the turbidity and pH limits.

The control system must default to recirculation or shutoff during a power failure or catastrophic event.

The control system must control the amount of the coagulant, flocculant, or both to prevent overdosing.

13-8.02B Treatment System

The treatment system must be capable of removing sediment and turbidity-producing suspended solids. Primary and secondary treatment may be required, or the design of the treatment system may require combined use of the various treatment components in series to achieve effective treatment. The treatment system must have components to:

1. Remove sediment and turbidity-producing suspended solids. Components may include desilting basins, settling tanks, sediment traps, gravity bag filters, sand media filters, pressurized bag filters, cartridge filters, chemical coagulants and in-line flocculants, temporary holding tanks, or any combination necessary to provide primary and secondary treatment.
2. Adjust the pH or dissolved oxygen by:
    2.1. Addition of sulfuric, phosphoric, citric, or nitric acid under the supplier's specifications for the treatment of water with high pH. You may use hydrochloric acid if the water is dechlorinated before discharge.
    2.2. Filtration through a limestone bed or the addition of sodium hydroxide for the treatment of water with a low pH.
    2.3. Aeration for the treatment of water with low dissolved oxygen.

13-8.02C Collection and Conveyance System

The collection and conveyance system must include pumps and piping to convey the water from the point of dewatering or stormwater capture to the treatment system and to the point of discharge. Pumps and piping must comply with section 74-2.

13-8.02D Monitoring Equipment

Monitoring equipment for the ATS must record data at least once every 15 minutes and cumulative flow data daily. The recording system must have the capacity to record a minimum of 7 days of continuous data.

13-8.03 CONSTRUCTION

13-8.03A General

Discharge treated water:

1. To control dust in an active area
2. To land where the grade allows sheet flow and the soil allows infiltration
3. Such that it does not:
    3.1. Cause erosion and scour. If scour occurs, repair the damage and install an energy dissipater.
    3.2. Impact the natural bedding and aquatic life.

Maintain the ATS to provide proper functioning and prevent leaks. Repair or replace the any component of the dewatering equipment that is not functioning properly.

Remove sediment from the storage or treatment cells as necessary to ensure the cells maintain their required water storage capability.

Sediments removed from the uncontaminated areas during maintenance of the treatment system must be dried, distributed uniformly, and stabilized at a location within the project limits where authorized.

Relocate the ATS as needed.

13-8.03B Monitoring

13-8.03B(1) General

While operating the ATS, monitor:

1. Influent and effluent turbidity
2. Influent and effluent pH
3. Residual chemical
4. Effluent flow rate and flow volume

Use a flow meter to measure all discharges from treatment activities.

13-8.03B(2) Corrective Measures

If observations and measurements determine the water quality limits are exceeded, immediately stop the discharge, notify the Engineer, and start corrective measures to change, repair, or replace the equipment and procedures used to treat the water.

After the Engineer inspects and authorizes your corrective measures, resume treatment and discharge activities under the startup-phase sampling requirements before resuming regular-phase sampling.

13-8.04 PAYMENT

Not Used

13-9 TEMPORARY CONCRETE WASHOUTS

13-9.01 GENERAL

13-9.01A Summary

Section 13-9 includes specifications for installing temporary concrete washouts.

You may use any of the following systems for a temporary concrete washout:

1. Temporary concrete washout facility
2. Portable temporary concrete washout
3. Temporary concrete washout bin

13-9.01B Definitions

Reserved

13-9.01C Submittals

At least 5 business days before starting concrete activities, submit an informational submittal that includes:

1. Location of each concrete washout
2. Name and location of the off-site disposal site to receive the concrete waste
3. Copy of the permit issued by the RWQCB for the off-site commercial disposal site
4. Copy of the permit issued by the state or local agency with jurisdiction over a disposal site located outside of the State

Retain and submit tracking records for the disposal of concrete waste as an informational submittal.

Submit a certificate of compliance for (1) the fabric bag for gravel-filled bags and (2) the plastic liner.

13-9.01D Quality Assurance

Reserved

13-9.02 MATERIALS

13-9.02A General

The sign for a concrete washout must comply with section 12-3.11B(3) except the sign panel may be plywood. The sign panel must be at least 4 by 2 feet. The sign legend must read Concrete Washout in at least 6-inch-high black letters on a white background.

13-9.02B Temporary Concrete Washout Facilities

Stakes for a temporary concrete washout facility must comply with section 13-10.02C.

Straw bales for a temporary concrete washout facility must comply with section 13-10.02H.

Gravel-filled bags for a temporary concrete washout facility must comply with section 13-5.02G.

The plastic liner for a temporary concrete washout facility must be:

1. New single-ply polyethylene sheeting without seams or overlapping joints
2. At least 10 mils thick
3. Free of holes, punctures, tears, or other defects

13-9.02C Portable Temporary Concrete Washouts

A portable temporary concrete washout must be a commercially available, watertight container with enough capacity to contain all liquid and concrete waste generated by washout activities without seepage or spills and be:

1. At least 55 gallons in capacity.
2. Labeled for exclusive use as a concrete waste and washout facility. *Concrete Washout* must be stenciled in 3-inch-high black letters on a white background with the top of the letters placed 12 inches from the top of the container.

13-9.02D Temporary Concrete Washout Bins

A temporary concrete washout bin must be a commercially available, watertight container with enough capacity to contain all liquid and concrete waste generated by washout activities without seepage or spills and be:

1. At least 5 cubic yards in capacity
2. Roll-off type with or without folding steel ramps
3. Labeled for exclusive use as a concrete waste and washout facility

13-9.02E–13-9.02G Reserved

13-9.03 CONSTRUCTION

Place a concrete washout at the job site:

1. Before starting concrete placement activities
2. In the immediate area of concrete work where authorized
3. No closer than 50 feet from any storm drain inlet, open drainage facility, ESA, or watercourse
4. Away from traffic or public access areas

Install a concrete washout sign adjacent to each concrete washout location.

Use a concrete washout to collect:

1. Washout from concrete delivery trucks
2. Slurries containing concrete or asphalt from saw cutting, coring, grinding, grooving, and hydrodemolition
3. Concrete waste from mortar mixing stations

Do not fill a concrete washout higher than 6 inches below the upper rim.

Dispose of concrete waste within 2 business days after a concrete washout becomes full. Dispose of concrete waste from a concrete washout at a plant licensed to receive solid concrete waste, liquid concrete waste, or both.

Relocate a portable temporary concrete washout or bin as needed for concrete work. The Department does not pay for relocating a portable temporary concrete washout or bin.

Secure a portable temporary concrete washout or bin to prevent spilling concrete waste when relocating or transporting it within the job site. If you spill concrete waste, clean up the spilled material and place it back into the concrete washout unit.

13-9.04 PAYMENT

Not Used

13-10 TEMPORARY LINEAR SEDIMENT BARRIERS

13-10.01 GENERAL

13-10.01A Summary

Section 13-10 includes specifications for installing temporary linear sediment barriers.

13-10.01B Definitions

Reserved

13-10.01C Submittals

Submit a certificate of compliance for:

1. Fiber rolls
2. Silt fence fabrics
3. Sediment filter bags
4. Foam barriers
5. Fabric for gravel-filled bags

If you substitute steel wire staples with an alternative attachment device, submit a sample of the device at least 5 business days before its installation.

13-10.01D Quality Assurance

Reserved

13-10.02 MATERIALS

13-10.02A General

Stakes, ropes, and staples must comply with section 21-2.02R except section 21-2.01 does not apply.

13-10.02B Fiber Rolls

A fiber roll must comply with section 21-2.02P except a fiber roll for a large sediment barrier must:

1. Have a diameter from 18 to 22 inches
2. Be at least 8 feet long
3. Weigh at least 6.5 lb/ft

13-10.02C Posts

Each post must comply with the specifications for a post for a temporary high-visibility fence except:

1. Post length must be at least 4 feet except for a temporary reinforced silt fence that must have a post length of at least:
   1.1. 6 feet for a Type 1 installation
   1.2. 5 feet for a Type 2 installation
2. Steel is not allowed for a post for a temporary large sediment barrier

13-10.02D High-Visibility Fabric

The high-visibility fabric must comply with the specifications for fabric for a temporary high-visibility fence.

13-10.02E Wire Mesh

Wire mesh for a temporary reinforced silt fence must:

1. Comply with section 80-2.02E
2. Be fabricated from at least 14-gauge horizontal and vertical wires welded at each intersection
3. Have a maximum opening of 2 inches wide by 4 inches high
4. Be supplied in 50-foot rolls

13-10.02F Wire

Wire for guy wires and tie wires for a temporary reinforced silt fence must be 16-gauge iron or steel.

13-10.02G Anchors

Anchors for a temporary reinforced silt fence must be fabricated from no. 4 steel reinforcing bar.

13-10.02H Straw Bales

Straw for a straw bale must comply with section 21-2.02H.

A straw bale must be:

1. At least 14 inches wide, 18 inches high, 36 inches long, and weigh at least 50 lb.
2. Composed entirely of vegetative matter except for the binding material.
3. Bound by wire, nylon, or polypropylene string. Do not use jute or cotton binding. Baling wire must be at least 16 gauge. Nylon or polypropylene string must be approximately 0.08 inch in diameter with 80 lb of breaking strength.

13-10.02I Foam Barriers

A foam barrier must have:

1. Urethane foam-filled core
2. Geosynthetic fabric cover and flap
3. Triangular, circular, or square cross section
4. Vertical height of at least 5 inches after installation
5. Horizontal flap at least 8 inches in width
6. Length of at least 4 feet per unit
7. Ability to interlock separate units into a long barrier such that water will not flow between units

The geosynthetic fabric cover and flap for a foam barrier must comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Grab breaking load in each direction, 1-inch grip (min, lb)	ASTM D4632	200
Apparent elongation in each direction (min, %)	ASTM D4632	15
Water flow rate (average roll value, gpm/sq ft)	ASTM D4491	100–150
Permittivity (min, 1/sec)	ASTM D4491	0.05
Apparent opening size (max average roll value, US standard sieve size)	ASTM D4751	40
UV resistance (min, percent retained grab breaking load at 500 hours)	ASTM D4355	70

13-10.02J Gravel-filled Bags

Gravel-filled bags for a temporary gravel bag berm must comply with section 13-5.02G.

13-10.02K–13-10.02M Reserved

13-10.03 CONSTRUCTION

13-10.03A General

Before installing a temporary linear sediment barrier, remove obstructions, including rocks, clods, and debris greater than 1 inch in diameter, from the ground.

Maintain a temporary linear sediment barrier to provide sediment-holding capacity and to reduce concentrated flow velocities.

Repair or adjust the barrier if rills or other evidence of concentrated runoff occur beneath the barrier.

Repair or replace split, torn, or unraveled material. Add or replace posts, stakes, or fasteners as needed to prevent sagging or slumping.

Reattach any barrier that becomes detached or dislodged from the pavement.

Repair a split or torn rigid plastic barrier with 16-gauge galvanized steel wire or UV-stabilized cable ties from 5 to 7 inches in length.

Remove sediment deposits, trash, and other debris as needed or ordered.

Remove sediment deposits if the sediment exceeds 1/3 of the height above the ground behind a barrier.

If you place the removed sediment deposits within the job site, stabilize the sediment deposits to prevent erosion.

Place gravel-filled bags behind Type K temporary railing if used within a shoulder area.

13-10.03B Temporary Fiber Rolls

Install temporary fiber rolls as specified for installing fiber rolls in section 21-2.03P.

13-10.03C Temporary Gravel Bag Berms

Place gravel-filled bags end-to-end to eliminate gaps in a temporary gravel bag berm. Place the bags approximately parallel with the slope contour. Angle the last 6 feet upslope at the downhill end of the run. Stack the bags such that the upper row overlaps the joints in the lower row.

Add layers of gravel-filled bags to increase the height of a temporary gravel bag berm if needed. Stack the bags in the upper row to overlap the joints in the lower row. Stabilize the rows by adding rows of bags in the lower layers.

13-10.03D Temporary Large Sediment Barriers

Install a temporary large sediment barrier as follows:

1. Place a single row of fiber rolls end-to-end, approximately parallel with the slope contour. For any 20-foot section of fiber roll, do not allow the fiber roll to vary by more than 5 percent from level.
2. Place the fiber rolls in a furrow that is from 6 to 8 inches deep.
3. Secure the fiber rolls with wood stakes 4 feet apart.
4. Place a stake 18 inches from each end of each fiber roll.
5. Drive the stakes into the soil such that the top of the stakes are less than 2 inches above the top of the fiber rolls.
6. Angle the last 6 feet upslope at the downhill end of the run.

13-10.03E Temporary Reinforced Silt Fences

Place a temporary reinforced silt fence parallel with the slope contour. For any 50-foot section of reinforced silt fence, do not allow the elevation at the base of the fence to vary by more than 1/3 of the fence height.

Install a temporary reinforced silt fence as follows:

1. Dig a 6-inch-deep trench.
2. Place the wire mesh and the bottom of the silt fence fabric in the trench.
3. Place posts on the downhill side of the fabric and wire mesh.
4. Attach the silt fence fabric to the wire mesh with tie wires or locking plastic fasteners along the length of the fence at not more than 3-foot horizontal spacing and from top to bottom at not more than 8-inch vertical spacing.
5. Backfill the trench with soil by hand or mechanical tamping to secure the silt fence fabric and the wire mesh in the trench.
6. Attach guy wires and anchors at each post. Install at least 2 anchors and guy wires at angle points and end posts.

Connect sections of temporary reinforced silt fence as follows:

1. Join separate sections to form reaches not more than 500 feet without openings.
2. Secure the end posts of each section by wrapping the tops of the posts with at least 2 wraps of 16-gauge tie wire.

If temporary reinforced silt fence Type 1 is shown, attach high-visibility fabric to the steel posts with tie wires or locking plastic fasteners.

13-10.03F Temporary Silt Fences

Construct a temporary silt fence with silt fence fabric, posts, and fasteners assembled at the job site or with prefabricated silt fence.

If prefabricated silt fence is used, attach the fabric to the posts by inserting the posts into the sewn pockets. If the fence is assembled at the job site:

1. Fasten the fabric to the posts with staples or nails if wood posts are used
2. Fasten the fabric to the posts with tie wires or locking plastic fasteners if steel posts are used
3. Space the fasteners no more than 8 inches apart

Place a temporary silt fence parallel with the slope contour. For any 50-foot section of temporary silt fence, do not allow the base elevation of the fence to vary by more than 1/3 of the height of the fence above the ground.

Install a temporary silt fence as follows:

1. Place the bottom of the fabric in a 6-inch-deep trench.
2. Secure it with the posts placed on the downhill side of the fabric.
3. Backfill the trench with soil and compact by hand or mechanical methods to secure the fabric in the trench.

Connect sections of a temporary silt fence as follows:

1. Join separate sections to form reaches not more than 500 feet without openings.
2. Secure the end posts of each section by wrapping the tops of the posts with at least 2 wraps of 16-gauge tie wire.

You may install the silt fence by mechanically pushing the silt fence fabric vertically into the soil. Mechanically installed fabric must not slip out of the soil or allow sediment to pass under it.

13-10.03G Temporary Straw Bale Barriers

Install a temporary straw bale barrier as follows:

1. Place a single row of straw bales end-to-end and parallel with the slope contour. For any 20-foot section of straw bale barrier, do not allow it to vary by more than 5 percent from level.
2. Place straw bales in a trench or key them into the slope. Place the bales such that the binding wire or string does not come in contact with the soil. Use wood or metal posts as stakes.
3. Secure each straw bale with 2 stakes. The 1st stake in each bale must be driven toward the previously laid bale to force the bales together.
4. Drive the stakes into the soil such that the top of the stake is less than 2 inches above the top of the straw bale.
5. Angle the last 6 feet upslope at the downhill end of the run.

13-10.03H Temporary Foam Barriers

Secure a foam barrier to:

1. Pavement with (1) 1-inch concrete nails, 1-inch washers, and solvent-free adhesive, (2) gravel-filled bags, or (3) a combination of both
2. Soil with 6-inch nails and 1-inch washers

Secure the barrier with 2 nails at the connection points where barriers overlap. Do not pierce the barrier's core with nails.

13-10.03I Temporary Earthen Berms

Construct a temporary earthen berm with native soil or selected material at least 8 inches high by 36 inches wide. Compact it by hand or mechanical methods.

13-10.03J–13-10.03L Reserved

13-10.04 PAYMENT

Not Used

13-11 RESERVED

13-12 TEMPORARY CREEK DIVERSION SYSTEMS

Reserved

13-13–13-15 RESERVED

14 ENVIRONMENTAL STEWARDSHIP

14-1 GENERAL

14-1.01 GENERAL

Section 14 includes specifications relating to environmental compliance and environmental resource management.

14-1.02 ENVIRONMENTALLY SENSITIVE AREA

If an ESA is shown, the boundaries shown are approximate. The Department marks the exact boundaries on the ground.

Do not enter an ESA unless authorized.

If an ESA is breached, immediately:

1. Stop all work within 60 feet of the ESA boundary
2. Secure the area
3. Notify the Engineer

If an ESA is damaged, the Department determines the necessary remediation and the party to perform the work. The Department deducts the cost for this work.

14-1.03–14.1.06 RESERVED

14-2 CULTURAL RESOURCES

14-2.01 GENERAL

Section 14-2 includes specifications relating to cultural resources.

14-2.02 DEFINITIONS

archaeological monitoring area: Area within or near construction limits where access is allowed but work is subject to archaeological monitoring.

archaeological resources: Remains of past human activity, including historic and prehistoric material such as tools and tool fragments, hearth and food remains, structural remains, and human remains.

14-2.03 ARCHAEOLOGICAL RESOURCES

14-2.03A General

If archaeological resources are discovered within or near construction limits, do not disturb the resources and immediately:

1. Stop all work within a 60-foot radius of the discovery
2. Secure the area
3. Notify the Engineer

The Department investigates the discovery. Do not move archaeological resources or take them from the job site. Do not resume work within the radius of discovery until authorized.

If ordered, furnish resources to assist in the investigation or recovery of archaeological resources. This work is change order work.

14-2.03B Archaeological Monitoring Area

If an archaeological monitoring area is shown within, near, or straddling the job site, the boundaries shown are approximate.

The Department assigns an archaeological monitor to observe work activities within the archaeological monitoring area. Do not work within the area unless the archaeological monitor is present.

The Engineer and the archaeological monitor will conduct a field review with you at least 5 business days before the start of job site activities. The Department marks the exact boundaries of the archaeological monitoring area on the ground.

If a high-visibility fence is shown, install it or other authorized enclosure to protect the area and define its

boundaries before starting other job site activities.

Submit a schedule showing the days and hours that work will be performed in an archaeological monitoring area at least 5 business days before starting work in the monitoring area. Submit an updated schedule at least 5 business days before any changed work day.

14-2.04 HISTORIC STRUCTURES

Reserved

14-2.05–14-2.10 RESERVED

14-3 COMMUNITY IMPACTS AND ENVIRONMENTAL JUSTICE

Reserved

14-4 NATIVE AMERICAN CONCERNS

Reserved

14-5 AESTHETICS

Reserved

14-6 BIOLOGICAL RESOURCES

14-6.01 GENERAL

Section 14-6 includes specifications relating to biological resources.

14-6.02 DEFINITIONS

biological resource incident: Take of a regulated species or violation of a biological resource PLAC.

invasive species: Species whose presence in the environment causes economic or environmental harm or harm to human health.

listed species: Species listed as threatened or endangered under (1) the federal Endangered Species Act of 1973, 16 USC § 1531 et seq., (2) California Endangered Species Act, Fish & Game Code §§ 2050–2115.5, or (3) both.

listed salmonid: Salmon, steelhead, or trout that are listed as a threatened or endangered species under the federal Endangered Species Act or listed or proposed as a threatened or endangered species under the California Endangered Species Act.

nongame birds: Birds identified in the Fish and Game Code as nongame birds.

permitted biological activities: Monitoring, surveying, or other practices that require a take permit and project-specific permission from the US Fish and Wildlife Service or NOAA Fisheries or a take permit or memorandum of understanding from the Department of Fish and Wildlife.

protective radius: Minimum distance between construction activities and a regulated species.

regulated species: Species protected by one or a combination of the following:

1. Federal Endangered Species Act of 1973, 16 USC § 1531 et seq.
2. California Endangered Species Act, Fish & Game Code §§ 2050–2115.5
3. Fish & Game Code §§ 1600–1616
4. National Environmental Policy Act, 42 USC § 4321 et seq.
5. California Environmental Quality Act, Pub Res Code § 21000 et seq.
6. Other law or regulation governing activities that affect species or their habitats

routine biological activities: Biological monitoring, surveying, or other activity that does not require a take permit from the US Fish and Wildlife Service or NOAA Fisheries or a take permit or memorandum of understanding from the Department of Fish and Wildlife.

service-approved biologist: Biologist whose activities must be approved by a state or federal agency as provided in PLACs.

take: Legal definition regarding harm to listed species as defined in 16 USC § 1532 and Fish & Game Code § 86.

take permit: Permit granted by the US Fish and Wildlife Service or the NOAA Fisheries that allows take of federal-listed species under 16 USC § 1539 or by the Department of Fish and Wildlife that allows take of state-listed species under Fish & Game Code § 2081.

temporary wetland protection mat: Device placed temporarily on a wetland to minimize damage to the soils and habitat.

14-6.03 SPECIES PROTECTION

14-6.03A General

Section 14-6.03A applies if species protection areas and requirements are specified in the special provisions. Protect regulated species and their habitat that occur within or near the job site.

Upon discovery of a regulated species, immediately:

1. Stop all work within a 100-foot radius of the discovery
2. Notify the Engineer

14-6.03B Bird Protection

Protect migratory and nongame birds, their occupied nests, and their eggs.

The Department anticipates nesting or attempted nesting from February 1 to September 30.

The federal Migratory Bird Treaty Act, 16 USC § 703–711, 50 CFR 10, and Fish & Game Code §§ 3503, 3513, and 3800 protect migratory and nongame birds, their occupied nests, and their eggs.

The federal Endangered Species Act of 1973, 16 USC § 1531 and § 1543, and the California Endangered Species Act, Fish & Game Code §§ 2050–2115.5, prohibit the take of listed species and protect occupied and unoccupied nests of threatened and endangered bird species.

The Bald and Golden Eagle Protection Act, 16 USC § 668, prohibits the destruction of bald and golden eagles and their occupied and unoccupied nests.

If you find an injured or dead bird or discover migratory or nongame bird nests that may be adversely affected by construction activities, immediately:

1. Stop all work within a 100-foot radius of the discovery
2. Notify the Engineer

The Department investigates the discovery. Do not resume work within the radius of the discovery until authorized.

If ordered, perform one or a combination of the following protection measures:

1. Install exclusion devices
2. Use nesting-prevention measures
3. Remove and dispose of partially constructed and unoccupied nests of migratory or nongame birds on a regular basis to prevent their occupation

These protection measures are change order work.

Prevent nest materials from falling into waterways.

14-6.03C Fish Protection

Protect all life stages of regulated fish in streams and conduct work activities to allow free passage of migratory fish.

Ensure work activities do not produce sound in streams that causes unauthorized take of regulated species.

Pump screens must comply with the *Juvenile Fish Screen Criteria for Pump Intakes* developed by the NOAA Fisheries.

Electrofishing for salmonids must comply with *Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act* published by the NOAA Fisheries.

14-6.03D Contractor-Supplied Biologist

14-6.03D(1) General

Section 14-6.03D(1) applies if a bid item for a Contractor-supplied biologist is shown on the Bid Item List. The Contractor-supplied biologist monitors work activities for the protection of regulated species.

The Contractor-supplied biologist must:

1. Monitor regulated species within the project area
2. Ensure that construction activities do not result in the take of regulated species
3. Ensure that construction activities comply with PLACs
4. Immediately notify the Engineer of any take of regulated species or violation of a biological resource PLAC
5. Prepare, submit, and sign notifications and reports

All reports must include:

1. Description of the implementation of PLAC requirements
2. Names of the biologists conducting biological activity
3. Dates and times of monitoring
4. Locations and activities monitored
5. Representative photographs
6. Findings
7. Recommended protective measures if regulated species are observed
8. Name of the biologist who prepared the report
9. Signature of the biologist certifying the accuracy of the report
10. Details of any take of regulated species or violation of a biological resource PLAC

Submit the name, resume, and statement of qualifications for a Contractor-supplied biologist within 7 days after Contract approval. If required under PLACs, the Department sends the biologist's statement of qualifications to regulatory agencies for review and approval before hiring. Allow 30 days for the regulatory agencies' review. If the submittal is incomplete, the Department provides comments. Submit a revised statement of qualifications within 7 days of receiving comments.

Biologists who perform specialized activities must have field experience working with the regulated species or performing the specialized task. All project-specific authorizations must be current and valid from start of work until work completion.

Do not start work until the Contractor-supplied biologist is approved by regulatory agencies authorized.

14-6.03D(2) Natural Resource Protection Plan

Section 14-6.03D(2) applies if a bid item for a natural resource protection plan is shown on the Bid Item List. The plan must describe your measures for protecting biological resources and complying with environmental laws, regulations, and PLACs.

The plan must be prepared and signed by a Contractor-supplied biologist knowledgeable of the regulated species and their habitats.

Submit your plan within 7 days after Contract approval. If the submittal is incomplete, the Department provides comments. Submit a revised plan within 7 days of receiving comments.

The natural resource protection plan must include:

1. List of species and habitats addressed in the plan
2. List of protocols for species protection surveys with full protocols in an appendix
3. Protection measures for regulated species expected at the job site
4. Protective radii for encounters with regulated species

5. Implementation plan and monitoring schedule for protection measures
6. Monitoring duties
7. Justification for each instance where protection measures and an implementation plan are not necessary for a regulated species
8. Schedule for inspecting protection measures
9. Schedule for maintaining protection measures
10. Schedule for submittal of monitoring reports
11. Response plan for encounters with regulated species
12. Content and schedule for the biological resource information program
13. Location and schedule of fence installation and removal, including identification of the species or habitats to be protected within each ESA or species protection area
14. Protection measures required within each species protection area

14-6.03D(3) Biological Resource Information Program

Reserved

14-6.04 WETLAND PROTECTION

Prevent permanent damage and minimize temporary damage to wetlands when any motorized equipment or vehicles cross the wetlands.

You may use temporary wetland protection mats to cross wetlands if allowed by regulatory agencies.

14-6.05–14-6.10 RESERVED

14-7 PALEONTOLOGICAL RESOURCES

14-7.01 GENERAL

Section 14-7 includes specifications relating to paleontological resources.

14-7.02 DEFINITIONS

paleontological resources: Fossils and the deposits they are found in. Fossils are evidence of ancient life preserved in sediments and rock. Examples of paleontological resources are the remains of (1) animals, (2) animal tracks, (3) plants, and (4) other organisms. Archaeological resources are not paleontological resources. Fossils found within an archaeological resource are generally considered archaeological not paleontological resources.

paleontological resources mitigation: Monitoring for fossils and salvage or in-place stabilization if fossils are found.

14-7.03 DISCOVERY OF UNANTICIPATED PALEONTOLOGICAL RESOURCES

If unanticipated paleontological resources are discovered at the job site, do not disturb the resources and immediately:

1. Stop all work within a 60-foot radius of the discovery
2. Secure the area
3. Notify the Engineer

The Department investigates the discovery and modifies the dimensions of the secured area if needed. Do not move paleontological resources or take them from the job site. Do not resume work within the radius of discovery until authorized.

14-7.04 PALEONTOLOGICAL RESOURCES MITIGATION

Reserved

14-7.05–14.7.08 RESERVED

14-8 NOISE AND VIBRATION

14-8.01 GENERAL

Section 14-8 includes specifications for controlling noise and vibration.

14-8.02 NOISE CONTROL

Control and monitor noise resulting from work activities.

Do not exceed 86 dBA Lmax at 50 feet from the job site from 9:00 p.m. to 6:00 a.m.

14-8.03–14.8.06 RESERVED

14-9 AIR QUALITY

14-9.01 GENERAL

Section 14-9 includes specifications relating to air quality.

14-9.02 AIR POLLUTION CONTROL

Comply with air-pollution-control rules, regulations, ordinances, and statutes that apply to work performed under the Contract, including those provided in Govt Code § 11017 (Pub Cont Code § 10231).

Do not dispose of material by burning.

14-9.03 AIR MONITORING

Reserved

14-9.04–14-9.10 RESERVED

14-10 SOLID WASTE DISPOSAL AND RECYCLING

14-10.01 GENERAL

Section 14-10 includes specifications for managing solid waste.

Dispose of or recycle solid waste from the job site.

Do not allow litter, trash, or debris to accumulate anywhere on the site, including storm drain grates, trash racks, and ditch lines. Pick up and remove litter, trash, and debris from the job site at least once a week. Do not perform solid waste management in the median area unless there is construction activity present. Perform solid waste management monthly during the plant establishment period. The WPC manager must monitor solid waste storage and disposal procedures.

If practicable, recycle nonhazardous waste and excess material. If recycling is not practicable, dispose of the material.

Furnish enough closed-lid dumpsters of sufficient size to contain the solid waste generated by work activities. When waste reaches the fill line, empty the dumpsters. Dumpsters must be watertight. Do not wash out dumpsters at the job site. Furnish additional containers and more frequent pickup during the demolition phase of construction.

Solid waste includes:

1. Brick
2. Mortar
3. Timber
4. Metal scraps
5. Sawdust
6. Pipe
7. Electrical cuttings
8. Nonhazardous equipment parts
9. Styrofoam and other packaging materials
10. Vegetative material and plant containers from highway planting
11. Litter and smoking material, including litter generated by the public
12. Other trash and debris

Furnish and use trash containers in the job-site yard, field trailers, and locations where workers gather for lunch and breaks.

14-10.02 SOLID WASTE DISPOSAL AND RECYCLING REPORT

Submit a solid waste disposal and recycling report between January 1 and 15 for each year work is performed under the Contract at any time during the previous calendar year. Show the types and amounts of project-generated solid waste taken to or diverted from landfills or reused on the project from January 1 to December 31 of the previous calendar year.

Submit a final solid waste disposal and recycling report within 5 business days after Contract acceptance. Show the types and amounts of project-generated solid waste taken to or diverted from landfills or reused on the project from January 1 to Contract acceptance.

For each failure to submit a completed report, the Department deducts $10,000.

14-10.03–14-10.05 RESERVED

14-11 HAZARDOUS WASTE AND CONTAMINATION

14-11.01 GENERAL

Section 14-11 includes specifications relating to hazardous waste and contamination.

If hazardous waste is or will be generated on the job site, the WPC manager must be knowledgeable of proper handling and emergency procedures for hazardous waste as demonstrated by submitting a training certificate which indicates completion of training required under 22 CA Code of Regs § 66265.16.

The WPC manager must:

1. Oversee and enforce hazardous waste management practices
2. Inspect hazardous waste storage areas daily, including temporary containment facilities and satellite collection locations
3. Oversee hazardous waste transportation activities on the job site

14-11.02 DISCOVERY OF UNANTICIPATED ASBESTOS AND HAZARDOUS SUBSTANCES

Upon discovery of unanticipated asbestos or a hazardous substance, immediately stop working in the area of discovery and notify the Engineer if:

1. You reasonably believe the substance is asbestos as defined in Labor Code § 6501.7 or a hazardous substance as defined in Health & Safety Code § 25316 and § 25317.
2. Its presence is not described in the Contract.
3. The substance has not been made harmless.

14-11.03 HAZARDOUS WASTE MANAGEMENT

Handle, store, and dispose of hazardous waste under 22 CA Code of Regs Div 4.5.

Use the following storage procedures:

1. Store hazardous waste and potentially hazardous waste separately from nonhazardous waste at the job site.
2. Store hazardous waste using metal containers approved by the US Department of Transportation for the transportation and temporary storage of hazardous waste.
3. Store hazardous waste in sealed, covered containers labeled with the contents and accumulation start date under 22 CA Code of Regs Div 4.5. Labels must comply with the provisions of 22 CA Code of Regs Div 4.5.§ 66262.31 and § 66262.32. Immediately replace damaged or illegible labels.
4. Handle the containers such that no hazardous waste is spilled.
5. Store hazardous waste away from storm drains, watercourses, moving vehicles, and equipment.
6. Furnish containers with enough storage volume at convenient satellite locations for collection of hazardous waste. When full or no longer needed, immediately move the containers to secure, temporary containment facilities.
7. Store hazardous waste and potentially hazardous waste in secure, temporary containment enclosures within secondary containment facilities. The secondary containment facilities must be impervious to the stored materials for a minimum contact time of 72 hours. Locate the temporary enclosures away from public access. Acceptable secure enclosures include a locked, chain-link-fenced area or a lockable shipping container located on the job site until disposal as authorized.
8. Design and construct secondary containment facilities with the capacity to contain the greater of:
    8.1. Precipitation from a 24-hour-long, 25-year storm and 10 percent of the aggregate volume of all containers
    8.2. Entire volume of the largest container within the facility
9. Cover secondary containment facilities during non–working days and if a storm event is predicted. Secondary containment facilities must be adequately ventilated.

10. Keep secondary containment facilities free of accumulated rainwater or spills. After a storm event or a spill or leak, collect the accumulated liquid and place it into storage drums within 24 hours. Handle these liquids as hazardous waste unless testing determines them to be nonhazardous.
11. Do not store incompatible wastes such as chlorine and ammonia in the same secondary containment facility.
12. Provide enough separation between storage containers to allow for cleanup of spills or emergency-response access. Keep storage areas clean, organized, and equipped with supplies appropriate for cleaning up the hazardous wastes being stored.
13. Inspect storage areas at least daily and before and after a storm event.
14. Repair or replace perimeter controls, containment structures, covers, and liners as needed.

Do not:

1. Overfill storage containers
2. Spill hazardous waste or potentially hazardous waste
3. Mix hazardous wastes
4. Allow hazardous waste or potentially hazardous waste to accumulate on the ground

Dispose of hazardous waste within 90 days of the start of generation. Use a hazardous waste manifest and a transporter registered with the DTSC to transport the waste to an appropriately permitted hazardous waste management facility. The transporter must have completed the California Highway Patrol's Basic Inspection of Terminals Program with a satisfactory rating.

14-11.04 DUST CONTROL

Excavation, transportation, and handling of material containing hazardous waste or contamination must result in no visible dust migration. When clearing, grubbing, and performing earthwork operations in areas containing hazardous waste or contamination, provide a water truck or tank on the job site.

14-11.05 STOCKPILING

14-11.05A General

Do not stockpile material containing hazardous waste or contamination unless ordered. Stockpiles containing hazardous waste or contamination must not be placed where affected by surface run-on or run-off. Cover stockpiles with a minimum 12-mils-thick plastic sheeting or 1 foot of nonhazardous material. Do not place stockpiles in ESAs. Stockpiled material must not enter storm drains, inlets, or waters of the State.

14-11.05B Liner

Reserved

14-11.06 CONTRACTOR-GENERATED HAZARDOUS WASTE

14-11.06A General

You are the generator of hazardous waste produced from materials you bring to the job site. Manage this waste as hazardous waste under section 14-11.03 if it is produced from the following substances:

1. Petroleum materials
2. Asphalt materials
3. Concrete curing compound
4. Pesticides
5. Acids
6. Paints
7. Stains
8. Solvents
9. Wood preservatives
10. Roofing tar
11. Road flares
12. Lime
13. Glues and adhesives
14. Materials classified as hazardous waste under 22 CA Code of Regs Div 4.5

If concentrations of hazardous waste constituents are unknown, use a laboratory certified by the SWRCB's ELAP to analyze a minimum of 4 discrete, representative samples of the waste. Determine (1) whether it is a hazardous waste and (2) the safe and lawful methods for storage and disposal. Perform sampling and analysis under US EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846) and 22 CA Code of Regs Div 4.5.

Use your own generator's EPA Identification Number and sign hazardous waste manifests for the hazardous waste you generate.

Within 24 hours of transporting Contractor-generated hazardous waste, submit a copy of the Uniform Hazardous Waste Manifest.

14-11.06B Contractor-Generated Contaminated Soil

Identify contaminated soil resulting from spills or leaks by looking for discoloration or differences in soil properties. Immediately notify the Engineer of spills or leaks. Clean spills and leaks as ordered. Sample soil with evidence of contamination and send the samples for analysis to a laboratory certified by the SWRCB's ELAP.

You are the generator of hazardous waste produced by spills and leaks that you cause. If the soil is determined to be a hazardous waste, handle and dispose of it under section 14-11.03.

Prevent the flow of water, including groundwater, from mixing with contaminated soil by using one or a combination of the following measures:

1. Berms
2. Cofferdams
3. Grout curtains
4. Freeze walls
5. Concrete seal course

If water mixes with contaminated soil and becomes contaminated, sample the water and send the samples for analysis to a laboratory certified by the SWRCB's ELAP. If analysis demonstrates that the water is a hazardous waste, manage and dispose of it under section 14-11.03.

14-11.07 DEPARTMENT-GENERATED HAZARDOUS WASTE

14-11.07A General

If the Department is the generator of hazardous waste produced from work activities, manage this hazardous waste under section 14-11.03.

14-11.07B Storage of Department-Generated Hazardous Waste

Labels on storage containers must comply with 22 CA Code of Regs § 66262.31 and § 66262.32. Mark labels with:

1. Date the hazardous waste was generated
2. *Hazardous Waste*
3. Composition and physical state of the hazardous waste (e.g., asphalt grindings with thermoplastic or paint)
4. *Toxic*
5. Name, address, and telephone number of the Engineer
6. Contract number
7. Name of the contractor or subcontractor

Handle the storage containers such that no hazardous waste is spilled. You are the generator of hazardous waste produced from your spills of Department-generated hazardous waste.

14-11.07C Transport and Disposal of Department-Generated Hazardous Waste

Dispose of hazardous waste at a California disposal site operating under a DTSC permit.

The Engineer provides the Department's EPA Identification Number for hazardous waste disposal.

The Engineer signs the hazardous waste manifests. Notify the Engineer 5 business days before the manifests are to be signed.

The Department does not consider you the generator of hazardous waste and you are not obligated for further cleanup, removal, or remedial action for Department-generated hazardous waste handled and disposed of under:

1. Section 14-11
2. State and federal laws and regulations governing hazardous waste
3. County and municipal ordinances and regulations governing hazardous waste

Within 5 business days of transporting Department-generated hazardous waste, submit documentation of proper disposal from the receiving landfill.

14-11.08 REGULATED MATERIAL CONTAINING AERIALLY DEPOSITED LEAD

Reserved

14-11.09 MINIMAL DISTURBANCE OF REGULATED MATERIAL CONTAINING AERIALLY DEPOSITED LEAD

Reserved

14-11.10 NATURALLY OCCURRING ASBESTOS

Reserved

14-11.11 DEPARTMENT-GENERATED CONTAMINATED SOIL

Reserved

14-11.12 REMOVAL OF YELLOW TRAFFIC STRIPE AND PAVEMENT MARKING WITH HAZARDOUS WASTE RESIDUE

14-11.12A General

Section 14-11.12 applies if the removal of existing yellow thermoplastic and yellow painted traffic stripe and pavement marking that will produce hazardous waste residue is specified in the special provisions. Section 14-11.12 includes specifications for removing, handling, and disposing of yellow thermoplastic and yellow painted traffic stripe and pavement marking. The residue from the removal of this material is a Department-generated hazardous waste.

Residue from the removal of yellow thermoplastic and yellow painted traffic stripe and pavement marking contains lead chromate. The average lead concentration is at least 5 mg/l soluble lead or 1,000 mg/kg total lead. When applied to the roadway, the yellow thermoplastic and yellow painted traffic stripe and pavement marking contained as much as 2.6 percent lead. Residue produced from the removal of this yellow thermoplastic and yellow painted traffic stripe and pavement marking contains heavy metals in concentrations that exceed thresholds established by the Health & Safety Code and 22 CA Code of Regs. For bidding purposes, assume the residue is not regulated under the Federal Resource Conservation and Recovery Act, 42 USC § 6901 et seq.

The work associated with the disposal of hazardous waste residue identified by test results to be regulated under the Resource Conservation and Recovery Act is change order work.

Removal of existing yellow thermoplastic and yellow painted traffic stripe and pavement marking exposes workers to health hazards that must be addressed in your lead compliance plan. Yellow thermoplastic and yellow paint may produce toxic fumes when heated.

14-11.12B Submittals

14-11.12B(1) General

Reserved

14-11.12B(2) Work Plan

Submit a work plan for the removal, containment, storage, and disposal of yellow thermoplastic and yellow painted traffic stripe and pavement marking. The work plan must include:

1. Objective of the operation

2. List of removal equipment
3. Procedures for the removal and collection of yellow thermoplastic and yellow painted traffic stripe and pavement marking residue, including dust
4. Type of hazardous-waste storage containers
5. Description of storage location and how it will be secured
6. Hazardous waste sampling protocol and QA requirements and procedures
7. Qualifications of sampling personnel
8. Name and address of the analytical test laboratory certified by the SWRCB's ELAP for all analyses to be performed
9. Name of the hazardous waste transporter and the transporter's:
   9.1 DTSC registration certificate
   9.2 Proof of compliance with the California Highway Patrol Biennial Inspection of Terminals Program
10. Name and address of the disposal site that will accept the hazardous waste residue

If ordered, submit a revised work plan within 5 business days of notification.

14-11.12B(3) Analytical Test Results

Submit analytical test results of the residue and chain of custody documentation before:

1. Requesting the Engineer's signature on the waste profile document for the disposal facility
2. Requesting the generator's EPA Identification Number for disposal from the Engineer
3. Removing the residue from the job site

14-11.12B(4) Disposal Documentation

Submit documentation of proper disposal from the receiving landfill within 5 business days of transporting residue from the job site.

14-11.12C Removal

When grinding or other authorized methods are used to remove yellow thermoplastic and yellow painted traffic stripe and pavement marking that produces a hazardous waste residue:

1. Immediately contain and collect the residue, including dust
2. Use a HEPA filter-equipped vacuum attachment operated concurrently with the removal operations or other equivalent approved method for collection of the residue

14-11.12D Sampling and Testing of Residue

Hazardous waste residue from the removal of yellow thermoplastic and yellow painted traffic stripe and pavement marking must be tested as required by the disposal facility and including:

1. Total lead by US EPA Method 6010B
2. Total chromium by US EPA Method 6010B
3. Soluble lead by the California Waste Extraction Test
4. Soluble chromium by the California Waste Extraction Test
5. Soluble lead by the Toxicity Characteristic Leaching Procedure
6. Soluble chromium by the Toxicity Characteristic Leaching Procedure

From the first 220 gal of hazardous waste or portion thereof, if less than 220 gal are produced, a minimum of 4 randomly selected samples must be taken and analyzed individually. Samples must not be composited. From each additional 880 gal of hazardous waste or portion thereof, if less than 880 gal are produced, a minimum of 1 additional random sample must be taken and analyzed.

Use chain of custody procedures consistent with chapter 9 of US EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846) while transporting samples from the job site to the analytical laboratory.

Before performing the analyses, the laboratory must homogenize each sample. The homogenization process must not include grinding of the samples. The aliquot taken from the sample must be:

1. Obtained in an amount large enough for all analyses to be performed

2. Homogenized a 2nd time
3. Used for the total and soluble analyses after the 2nd homogenization

14-11.12E Transport and Disposal of Residue

Request the generator's EPA Identification Number when the Engineer accepts waste characterization test results documenting that the residue is a hazardous waste.

The Engineer signs the manifests as the hazardous waste generator within 5 business days of 1) receiving and accepting the analytical test results and 2) receiving your request for the generator's EPA Identification Number.

If test results demonstrate that the residue is a nonhazardous waste and the Engineer accepts this determination, dispose of the residue at an appropriately permitted CA Class II or CA Class III facility.

The Department does not adjust payment for the disposal of nonhazardous residue at CA Class II or Class III facility.

14-11.13 DISTURBANCE OF EXISTING PAINT SYSTEMS ON BRIDGES

14-11.13A General

Section 14-11.13 applies if disturbance of the existing paint system on a bridge is specified in the special provisions. Section 14-11.13 includes specifications relating to the disturbance of an existing paint system on a bridge.

Any work that disturbs the existing paint system produces debris containing heavy metals in amounts that exceed the established thresholds in 8 CA Code of Regs and exposes workers to health hazards which must be addressed in your lead compliance plan. Welding, cutting, or heating the surfaces coated by the existing paint system produces toxic fumes and must be done in compliance with 8 CA Code of Regs § 1537.

Any work that disturbs the existing paint system produces debris containing heavy metals in amounts that exceed the thresholds established in 22 CA Code of Regs. This debris is a Department-generated hazardous waste.

Grime and detritus already on the bridge before the start of work may also contain lead. Consider the grime and detritus part of the existing paint system. The Department is the hazardous waste generator if the Engineer accepts waste characterization test results demonstrating that the debris is a hazardous waste.

Contain all debris produced when the existing paint system is disturbed. If containment measures are inadequate to contain and collect debris produced when the existing paint system is disturbed, stop work until:

1. Revised debris containment and collection plan has been authorized
2. Released material has been collected and contained

In areas without exposed soil, the concentrations of heavy metals in the work area must not increase when the existing paint system is disturbed. Any visible increase in the concentrations of heavy metals must be removed.

Handle, store, transport, and dispose of debris produced when the existing paint system is disturbed under applicable federal, state, and local hazardous waste laws.

14-11.13B Submittals

14-11.13B(1) General

Reserved

14-11.13B(2) Debris Containment and Collection Plan

Submit a debris containment and collection plan. The plan must:

1. Identify materials, equipment, and methods to be used when the existing paint system is disturbed
2. Include shop drawings of:

2.1. Containment systems complying with section 59-2.01C(2)
2.2. Components that provide ventilation, air movement, and visibility for worker safety
3. Include the name and location of the analytical laboratory that will perform the analyses
4. Identify the hazardous waste transporter that will haul the debris and provide documentation of:
4.1. Current DTSC registration
4.2. Compliance with the California Highway Patrol's Biennial Inspection of Terminals Program
5. Include the name and location of the disposal facility that will accept the hazardous waste

Allow 20 days for review. If required, submit a revised debris containment and collection plan.

14-11.13B(3) Air Monitoring Reports

Reserved

14-11.13B(4) Soil Sampling Results for Debris Containment Verification

Reserved

14-11.13B(5) Waste Characterization Test Results

Submit waste characterization test results and chain of custody documentation for the debris before:

1. Requesting the Engineer's signature on the waste profile document for the disposal facility
2. Requesting the generator's EPA Identification Number for disposal
3. Removing the debris from the job site

14-11.13B(6) Disposal Documentation

Submit documentation from the receiving landfill or recycling facility confirming proper disposal within 5 business days of transporting debris from the project.

14-11.13C Safety and Health Protection Measures

Comply with 8 CA Code of Regs including §1532.1.

Supply clean protective work clothing for 5 Department personnel:

1. Whenever there is possible exposure to heavy metals or silica dust
2. During application of paint undercoats

Replace protective work clothing as needed.

Do not start any work activities with the potential for lead exposure until the Engineer inspects and authorizes protective work clothing and washing facilities.

Protective work clothing remains your property upon completion of the Contract.

14-11.13D Work Area Monitoring

Reserved

14-11.13E Debris Storage

Debris produced when the existing paint system is disturbed must not be temporarily stored on the ground. Before the end of each work shift, remove accumulated debris from the containment system. Store the debris as hazardous waste.

14-11.13F Debris Waste Characterization

Perform waste characterization testing on the debris as required by Department and the disposal facility. From the first 220 gal of hazardous waste or portion thereof, if less than 220 gal are produced, a minimum of 4 randomly selected samples must be taken and analyzed individually. Samples must not be composited. From each additional 880 gal of hazardous waste or portion thereof, if less than 880 gal are produced, a minimum of 1 additional random sample must be taken and analyzed.

Use chain of custody procedures consistent with chapter 9 of US EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846) while transporting samples from the job site to the analytical laboratory. The laboratory must be certified by the SWRCB's ELAP for all analyses to be performed.

Before performing the analyses, the laboratory must homogenize each sample. The homogenization process must not include grinding of the samples. A sample aliquot must be:

1. Obtained in an amount large enough for all analyses to be performed
2. Homogenized a 2nd time
3. Used for the total and soluble analyses after the 2nd homogenization

14-11.13G Debris Transport and Disposal

14-11.13G(1) General

For bidding purposes, assume the debris is a CA hazardous waste. Assume the debris is not regulated under the Federal Resource Conservation and Recovery Act, 42 USC § 6901 et seq. Disposal of hazardous waste debris identified by test results to be regulated under the Resource Conservation and Recovery Act is change order work.

14-11.13G(2) Hazardous Waste Debris

Request the generator's EPA Identification Number when the Engineer accepts waste characterization test results documenting that the debris is a hazardous waste.

Use a hazardous waste manifest and a transporter whose vehicles have current DTSC registration certificates when transporting hazardous waste. The Engineer provides the generator's EPA Identification Number and signs the manifests as the hazardous waste generator within 5 business days of accepting the waste characterization test results and receiving your request for the generator's EPA Identification Number.

14-11.13G(3) Nonhazardous Waste Debris

If waste characterization test results demonstrate that the debris is a nonhazardous waste and the Engineer accepts the results, dispose of the debris at an appropriately permitted CA Class II or CA Class III facility or recycle it. Make all arrangements with the operator of the disposal facility and comply with the facility's requirements.

You may dispose of nonhazardous debris at a facility equipped to recycle the debris if you make all arrangements with the recycling facility's operator and perform any facility-required testing of the debris.

The Department does not adjust payment for disposal of nonhazardous debris at a recycling facility.

14-11.14 TREATED WOOD WASTE

14-11.14A General

Section 14-11.14 applies if treated wood waste is shown on the Bid Item List.

Section 14-11.14 includes specifications for handling, storing, transporting, and disposing of treated wood waste. Manage treated wood waste under 22 CA Code of Regs Div 4.5 Ch 34.

14-11.14B Submittals

Within 5 business days of disposing of treated wood waste, submit as an informational submittal a copy of each completed shipping record and weight receipt.

14-11.14C Training

Provide training to personnel who handle or may come in contact with treated wood waste. Training must include:

1. Requirements of 8 CA Code of Regs
2. Procedures for identifying and segregating treated wood waste
3. Safe handling practices
4. Requirements of 22 CA Code of Regs Div 4.5 Ch 34
5. Proper disposal methods

Maintain training records for 3 years.

14-11.14D Storage of Treated Wood Waste

Until disposal, store treated wood waste using the following methods:

1. Raise the waste on blocks above a foreseeable run-on elevation and protect it from precipitation for no more than 90 days.
2. Place the waste on a containment surface or pad protected from run-on and precipitation for no more than 180 days.
3. Place the waste in water-resistant containers designed for shipping or solid waste collection for no more than 1 year.
4. Place the waste in a storage building as defined in 22 CA Code of Regs Div 4.5 Ch 34 § 67386.6(a)(2)(C).

Prevent unauthorized access to treated wood waste using a secure enclosure such as a locked chain-link-fenced area or a lockable shipping container located within the job site.

Resize and segregate treated wood waste at a location where debris including sawdust and chips can be contained. Collect and manage the debris as treated wood waste.

Identify treated wood waste and accumulation areas using water-resistant labels that comply with 22 CA Code of Regs, Div 4.5 Ch 34 § 67386.5. Labels must include:

1. The words *Caltrans District* and the district number
2. The words *Construction Contract* and the contract number
3. District office address
4. Engineer's name, address, and telephone number
5. Contractor's contact name, address, and telephone number
6. Date placed in storage

14-11.14E Transport and Disposal of Treated Wood Waste

Dispose of treated wood waste within:

1. 90 days of generation if stored on blocks
2. 180 days of generation if stored on a containment surface or pad
3. 1 year of generation if stored in a water-resistant container or within 90 days after the container is full, whichever is shorter
4. 1 year of generation if stored in a storage building as defined in 22 CA Code of Regs, Div 4.5, Ch 34, § 67386.6(a)(2)(C)

Before transporting treated wood waste, obtain agreement from the receiving facility that it will accept the waste. Protect shipments of the waste from loss and exposure to precipitation. For projects generating 10,000 lb or more of treated wood waste, request a generator's EPA Identification Number from the Engineer at least 5 business days before the 1st shipment. Each shipment must be accompanied by a shipping record such as a bill of lading or invoice that includes:

1. The words *Caltrans District* and the district number
2. The words *Construction Contract* and the contract number
3. District office address
4. Engineer's name, address, and telephone number
5. Contractor's name, contact person, and telephone number
6. Receiving facility's name and address
7. Description of the waste (e.g., treated wood waste with preservative type if known or unknown/mixture)
8. Project location
9. Estimated weight or volume of the shipment
10. Date of transport
11. Date of receipt by the treated wood waste facility
12. Weight of shipment measured by the receiving facility
13. Generator's US EPA Identification Number for projects generating 10,000 lb or more of treated wood waste

The shipping record must be 8-1/2 by 11 inches and a 4-part carbon or carbonless form to provide copies for the Engineer, transporter, and treated wood waste facility.

Dispose of treated wood waste at an approved California disposal site operating under a RWQCB permit that includes acceptance of treated wood waste.

14-11.15 DISPOSAL OF ELECTRICAL EQUIPMENT REQUIRING SPECIAL HANDLING

Reserved

14–11.16 ASBESTOS-CONTAINING CONSTRUCTION MATERIALS IN BRIDGES

Reserved

14-11.17–14-11.20 RESERVED

14-12 OTHER AGENCY REGULATORY REQUIREMENTS

14-12.01 GENERAL

Section 14-12 includes specifications relating to other agencies' environmental regulations and PLACs.

14-12.02 STATE PARKS

Section 14-12.02 includes specifications for working in areas under the jurisdiction of State Parks.

Comply with the State Parks' regulations and PLACs.

Protect natural and cultural features within the park.

14-12.03 STATE RECLAMATION BOARD

Section 14-12.03 includes specifications for working in areas under the jurisdiction of the State Reclamation Board.

Comply with the State Reclamation Board's regulations and PLACs.

Submit proposed changes to the PLAC requirements for transmittal to the State Reclamation Board. Do not implement these changes until the Engineer receives written approval from the State Reclamation Board.

14-12.04–14.12.08 RESERVED

15 EXISTING FACILITIES

15-1.01 GENERAL

Section 15 includes general specifications for performing work on existing facilities.

Performing work on existing facilities includes abandoning, adjusting, modifying, obliterating, reconstructing, relaying, relocating, remodeling, removing, repairing, resetting, or salvaging a facility.

Do not perform work on an existing facility until the facility is no longer needed.

Reconstructed facilities must comply with the design of and be equal to the best parts of the existing facilities.

Reconstruction work must comply with the specifications for new work of similar character.

15-1.02 MATERIALS

Materials for adjusting facilities to grade must be similar in character to the existing materials.

15-1.03 CONSTRUCTION

15-1.03A General

Backfill trenches, holes, depressions, and pits caused by performing work on an existing facility. In an unsurfaced area, backfill with embankment material under section 19. In a surfaced area, backfill with material equal to or better than the surrounding material. Grade backfilled areas to drain and blend in with the surrounding area.

Clean earth and other foreign material, including concrete, from material to be salvaged or incorporated into the work.

Dispose of removed facilities not to be salvaged or incorporated into the work.

If you damage a facility or a portion of a facility to remain in place, repair or replace it. The repair or replacement must be equal or better in quality than the original portion.

Repair or replace materials to be salvaged or incorporated into the work that are lost or damaged during work activities. The repair or replacement must be equal or better in quality than the original portion. Instead of this repair or replacement, the Department may deduct the repair or replacement cost.

Replace material from existing facilities described to be reused in the work if the Engineer determines the material is unsuitable. Furnishing the replacement material is change order work.

If you damage a part of a loop conductor specified to remain in place, including the part leading to the adjacent pull box, replace the entire loop detector and any adjacent loops damaged during the replacement.

Break the floors of structures within the roadway that are not required to be removed such that water will not be entrapped.

Where abrasive blasting is performed within 10 feet of a lane open to traffic, remove residue with a vacuum attachment operating concurrently with the blast cleaning equipment.

15-1.03B Removing Concrete

Where concrete is described to be removed, remove the concrete to a depth of at least 3 feet below finished grade.

Concrete removal includes removal of any steel embedded in the concrete.

Before removing a portion of a monolithic concrete element, make a 1-inch-deep saw cut to a true line along the limits of removal on faces of the element that will be visible in the completed work.

Protect existing reinforcement to be incorporated into the new work from damage.

Where new concrete is to join existing concrete, remove enough concrete to allow splicing of new reinforcement.

Thoroughly remove all material adhering to the existing reinforcement before embedding it in new concrete.

Instead of disposing of removed concrete, you may:

1. Incorporate it in adjacent embankments if it is:
   1.1. Broken into parts at most 10 inches in greatest dimension
   1.2. Buried at least 3 feet below the finished grade and slope lines
   1.3. Buried at least 10 feet from trees or highway facilities
   1.4. Not buried where piling is to be constructed
2. Place it at authorized locations such that it will not present an unsightly appearance from the highway

15-1.03C Salvaging Facilities

Tag the bundles, packages, and individually salvaged material. Show the following information on the tags:

1. Name or description of the material
2. Type or model number
3. Dimensions
4. Quantity if more than 1

Haul salvaged material directly to the location specified in the special provisions and stockpile it. If authorized, you may temporarily stockpile salvaged material at the job site. Replace any salvaged material that is lost before it is stockpiled at the location specified in the special provisions.

15-1.03D–15-1.03K Reserved

15-1.04 PAYMENT

Not Used

16 TEMPORARY FACILITIES

16-1 GENERAL

16-1.01 GENERAL

Section 16-1 includes general specifications for constructing temporary facilities.

Constructing temporary facilities includes placing temporary devices.

16-1.02 MATERIALS

You may use used materials for temporary facilities if the used materials comply with the specifications for new materials.

16-1.03 CONSTRUCTION

Maintain temporary facilities until they are no longer needed.

Excavate and backfill as necessary to remove temporary facilities. Backfill with materials of equal or better quality and to a comparable density of the surrounding materials and grade the surface to match the existing grade and cross slope.

Dispose of temporary facilities when they are no longer needed.

16-1.04 PAYMENT

Not Used

16-2 MISCELLANEOUS TEMPORARY FACILITIES

16-2.01 GENERAL

16-2.01A General

Section 16-2 includes specifications for constructing miscellaneous temporary facilities.

Miscellaneous temporary facilities include temporary facilities that apply to multiple sections or are not closely associated with other sections.

16-2.01B Materials

Not Used

16-2.01C Construction

Not Used

16-2.01D Payment

Not Used

16-2.02 TEMPORARY PEDESTRIAN FACILITIES

16-2.02A General

16-2.02A(1) Summary

Section 16-2.02 includes specifications for constructing temporary pedestrian facilities.

Temporary pedestrian facilities must comply with the *California MUTCD*, Part 6, Chapter 6D, "Pedestrian and Worker Safety."

Lighting must comply with the specifications for falsework lighting in section 48.

16-2.02A(2) Definitions

Reserved

16-2.02A(3) Submittals

Submit shop drawings and supporting calculations for temporary pedestrian facilities with a protective overhead covering. Shop drawings and calculations must be signed by an engineer who is registered as a civil engineer in the State.

16-2.02A(4) Quality Assurance

Reserved

16-2.02B Materials

16-2.02B(1) General

The walkway must be surfaced with asphalt concrete, commercial-quality concrete, or wood. The surface must be skid resistant and free of irregularities.

Hand railings must be S4S lumber and painted white.

The protective overhead covering of a temporary pedestrian facility must be plywood at least 3/4 inch thick or wood planking with a nominal minimum thickness of 2 inches.

16-2.02B(2) Design Requirements

Design a temporary pedestrian facility with a protective overhead covering to support all imposed loads.

The design load and maximum allowable stresses for a temporary pedestrian facility with protective overhead covering must comply with section 48-2.02B. The minimum design live load for a temporary pedestrian facility with a protective overhead covering must be 150 psf for the entire structure.

16-2.02C Construction

Construct handrails on each side of a temporary pedestrian facility as necessary to protect pedestrian traffic from hazards due to work activities or adjacent vehicular traffic.

The minimum width between the inside face of the handrails must be 60 inches. The clear height of the facility measured from the floor surface to the canopy overhead must be at least 8 feet. Provide adequate lighting at all times.

Extend overhead protection for pedestrians at least 4 feet beyond the edge of the bridge deck. Illuminate all pedestrian openings through falsework.

Maintain a temporary pedestrian facility in good condition and keep it clear of obstructions.

16-2.02D Payment

Not Used

16-2.03 TEMPORARY HIGH-VISIBILITY FENCES

16-2.03A General

16-2.03A(1) Summary

Section 16-2.03 includes specifications for constructing temporary high-visibility fences.

Constructing a temporary high-visibility fence includes the installation of any signs specified in the special provisions.

16-2.03A(2) Definitions

Reserved

16-2.03A(3) Submittals

Submit a certificate of compliance for the high-visibility fabric.

16-2.03A(4) Quality Assurance

Reserved

16-2.03B Materials

High-visibility fabric must be manufactured from polypropylene, polyethylene, or a combination of both.

Identify, store, and handle the fabric under ASTM D4873.

The fabric must be orange, contain UV inhibitors, and have a width of at least 48 inches and openings from a minimum 1 by 1 inch to a maximum 2 by 4 inches.

The minimum roll weight for a 4-by-100-foot roll of fabric must be 12 lb.

Posts must be either wood or steel.

Each wood post must:

1. Be untreated fir, redwood, cedar, or pine and cut from sound timber
2. Be straight and free from loose or unsound knots or other defects that would make it unfit for use
3. Have a cross section of at least 2 by 2 inches
4. Have a length of at least 6 feet
5. Have a pointed bottom end

Each steel post must have:

1. *U*, *T*, *L*, or other cross-sectional shape that resists failure from lateral loads.
2. Weight of at least 3/4 lb/ft.
3. Length of at least 6 feet.
4. Pointed bottom end.
5. Safety cap attached to the exposed end. The cap must be orange or red plastic and fit snugly to the post.

16-2.03C Construction

Install posts at a maximum 8-foot center-to-center spacing.

Embed each post in the ground at least 16 inches.

Attach fabric to wood posts with nails or staples.

Attach fabric to steel posts with tie wires or locking plastic fasteners at a maximum spacing of 8 inches.

Maintain posts in a vertical position.

Reattach any detached fabric.

Replace any damaged fabric.

16-2.03D Payment

Not Used

16-2.04 TEMPORARY CONSTRUCTION MATS

16-2.04A General

16-2.04A(1) General

16-2.04A(1)(a) Summary

Section 16-2.04A includes general specifications for constructing temporary construction mats.

16-2.04A(1)(b) Definitions

Reserved

16-2.04A(1)(c) Submittals

Submit a schedule for the placement and removal of the mats. Include the location, mat type, and placement and removal dates for each location. Describe the method of installing and removing the mats.

16-2.04A(1)(d) Quality Assurance

Reserved

16-2.04A(2) Materials

A temporary construction mat must be manufactured (1) for use as a temporary roadway, (2) to protect the ground without ground preparation, and (3) to prevent permanent damage and minimize temporary damage to a wetland.

16-2.04A(3) Construction

The mats must provide a continuous cover over the wetlands. Seal openings around any columns or other obstacles. Obtain authorization for the seals.

Mats must be free from soil, seeds, or other organic or hazardous material before entering the work area.

Conduct temporary installation activities on the mats or outside of wetlands.

Do not install mats whenever the National Weather Service predicts at least a 50 percent probability of precipitation within 72 hours.

Clean debris from the mats daily. Inspect the mats and immediately replace or repair damaged or broken mats.

When no longer needed, move mats to a washout location and clean them before removing them from the job site. The washout location must be outside of wetlands and ESAs and inside the cleared work area where wash water and other material will not enter any wetlands, streams, or ESAs.

16-2.04A(4) Payment

Not Used

16-2.04B HDPE Mats

16-2.04B(1) General

Section 16-2.04B includes specifications for constructing HDPE temporary construction mats.

16-2.04B(2) Materials

An HDPE mat must:

1. Be made of HDPE
2. Be at least 4 feet wide by 8 feet long and 1/2 inch thick
3. Have a load-bearing capacity of at least 60 tons

16-2.04B(3) Construction

Not Used

16-2.04B(4) Payment

Not Used

16-2.04C–16-2.04G Reserved

16-2.05 JOB SITE WATER CONTROL

16-2.05A General

16-2.05A(1) General

Section 16-2.05 includes specifications for controlling water to provide a dry working area at the job site.

16-2.05A(2) Materials

Not Used

16-2.05A(3) Construction

Not Used

16-2.05A(4) Payment

Not Used

16-2.05B Water-Filled Cofferdam

Reserved

16-2.05C–16-2.05G Reserved

16-3–16-10 RESERVED

DIVISION III EARTHWORK AND LANDSCAPE

17 GENERAL

17-1 GENERAL

17-1.01 GENERAL

Section 17 includes general specifications for grading.

17-1.02 MATERIALS

Not Used

17-1.03 CONSTRUCTION

Not Used

17-1.04 PAYMENT

Not Used

17-2 CLEARING AND GRUBBING

17-2.01 GENERAL

Section 17-2 includes specifications for clearing and grubbing.

Clearing and grubbing consists of removing objectionable material from the following construction areas:

1. Highways
2. Bridges and other structures
3. Roads, road approaches, streets, and ramps
4. Material sites
5. Ditches and channels
6. Areas enclosed by interchange loops and ramps
7. Other described areas

The Department may salvage materials from improvements before the bid opening date.

17-2.02 MATERIALS

Not Used

17-2.03 CONSTRUCTION

17-2.03A General

Complete the work specified in section 20-10.02C(2) before clearing and grubbing.

Clear and grub before performing earthwork in an area.

Do not injure standing trees, plants, and improvements shown to be protected.

Clear and grub the entire length of the job site to the following widths:

1. 5 feet outside of excavation and embankment slope lines where slopes are not rounded
2. Outside limits of slopes where slopes are rounded
3. 5 feet outside of structures
4. 2 feet outside of slope lines for ditches and channels with a bottom width of less than 12 feet
5. 5 feet outside of slope lines for ditches and channels with a bottom width of 12 feet or more

If the construction area includes an orchard, vineyard, or other cultivated area, remove all orchard trees, vines, and other vegetation in the entire highway to right-of-way lines.

17-2.03B Clearing

Clear all construction areas above original ground of (1) all vegetation such as trees, logs, upturned stumps, roots of downed trees, brush, grass, and weeds and (2) other objectionable material including concrete, masonry, and debris.

Cut tree branches that extend over the roadway and hang within 20 feet of finished grade. Cut other branches to give each tree a balanced appearance. Cut off branches close to the trunk under section 20-3.01C(2).

17-2.03C Grubbing

Grub all construction areas to a depth necessary to remove all trees, existing stumps, roots, buried logs, and other objectionable material, except embankment areas where the grading plane is 2 feet or more above original ground.

In embankment areas where the grading plane is 2 feet or more above original ground, cut off trees, stumps, and roots not more than 1 foot above original ground, except remove trees, stumps, and roots completely where work includes any of the following:

1. Structure construction
2. Pile construction
3. Subdrainage trench excavation
4. Removal of unsuitable material
5. Cutting into slopes of original hillsides, old or new fill

17-2.03D Disposal of Materials

Dispose of objectionable materials resulting from clearing and grubbing activities, unless (1) the Contract includes a bid item for duff as specified in section 21-1.02C or (2) you reduce combustible material to chips with a 1/2-inch maximum thickness and spread them in areas enclosed by interchange loops and ramps or between slope lines and right-of-way lines. Bury the chips or distribute them uniformly by mixing with underlying soil to prevent combustion.

Do not leave objectionable material in or under embankments, including dikes.

Accumulation of flammable material is not allowed.

17-2.04 PAYMENT

Not Used

17-3–17-10 RESERVED

18 DUST PALLIATIVES

18-1.01 GENERAL

18-1.01A Summary

Section 18 includes specifications for applying dust palliatives.

A dust palliative must be any of the following:

1. Water
2. Dust suppressant
3. Dust control binder

18-1.01B Definitions

Reserved

18-1.01C Submittals

If a dust suppressant or dust control binder is to be used, submit a dust treatment plan at least 15 days before starting job site activities. The dust treatment plan must include:

1. Product name and type
2. Manufacturer's name
3. Polymer emulsion type if a synthetic polymer emulsion is used, including identification of:
   - 3.1. Individual components greater than 5 percent by volume in blends of polymers with different compositions
   - 3.2. Additives greater than 2 percent by volume
4. SDS
5. Proposed methods for applying products
6. Application rate per pass, total application rate, and residual application rate
7. Required weather conditions for application, including ambient and surface temperatures, wind conditions, and allowable period before expected precipitation
8. Drying time or curing time required before traffic is allowed on the treated surface

Submit the manufacturer's instructions for the material to be used.

Submit a certificate of compliance for the dust suppressant, dust control binders, and fibers.

For a dust suppressant, include with the certificate of compliance:

1. Test results verifying compliance with the quality characteristic requirements in section 18-1.01D. The results must be from a test conducted within 12 months before the date of the certificate of compliance.
2. Test results from a test conducted within 12 months before the date of the certificate of compliance verifying compliance with the following environmental requirements:
   - 2.1. Maximum constituent concentration levels
   - 2.2. Organic and inorganic requirements for:
     - 2.2.1. VOCs
     - 2.2.2. Semi-VOCs
     - 2.2.3. Synthetic precipitation leaching procedure
   - 2.3. Aquatic toxicity

18-1.01D Quality Assurance

A dust suppressant or dust control binder must comply with US EPA requirements and RWQCB requirements for soil stabilizers.

A dust suppressant must be tested by either an ASTM- or AMRL-AASHTO-accredited laboratory for compliance with the specified quality characteristic requirements.

A dust suppressant must be tested by an EPA-accredited laboratory for environmental requirements. Liquid chemical treatments must be tested before dilution. Solid products must be mixed with water to a 25 percent concentration before testing. The constituent concentration for each dust suppressant must not exceed the maximum levels shown in the following table:

Maximum Constituent Concentration Levels

Constituent	Test method	Requirement maximum level (ppm)
Arsenic	EPA Method 200.7	5.0
Barium		100.0
Cadmium		0.2
Chromium		1.0
Copper		1.0
Lead		1.0
Mercury	EPA Method 245.1	0.05
Selenium	EPA Method 200.7	5.0
Zinc		10.0
Phosphorus	EPA Method 365.4	2500.0
Cyanide	EPA Method 335.4	0.2

A dust suppressant must comply with the requirements shown in the following table:

Organic and Inorganic Requirements

Quality characteristic	Test method	Requirement
VOCs	EPA Method 8260	Set by the CalEPA Air Resources Board and local air district
Semi-VOCs	EPA Method 8270	US EPA Target Compound List and Contract-required quantitation limits
Synthetic precipitation leaching procedure	EPA Method 1312	Set by the RWQCB

A dust suppressant must comply with the aquatic toxicity requirements shown in the following table:

Aquatic Toxicity Requirements

Quality characteristic	Test method	Requirement
Aquatic toxicity[a] (LC50 min, ppm)	ASTM E729 or EPA Method 600/4-90/027F and EPA Method 600/4-91/002	10
Aquatic toxicity[a] (rating)	ASTM E729 or EPA Method 600/4-90/027F and EPA Method 600/4-91/002	slightly toxic or better
Renewal toxicity[b] (LC50 min, ppm)	ASTM E1295	10
Renewal toxicity[b] (rating)	ASTM E1295	slightly toxic or better

[a]Using *Ceriodaphnia dubia* (water flea), *Oncorhynchus mykiss* (rainbow trout), *Pimephales promelas* (fathead minnow), and *Americamysis bahia* (mysid shrimp)
[b]Using *Ceriodaphnia dubia* (water flea)

18-1.02 MATERIALS

18-1.02A General

A dust suppressant or a control binder must be either (1) miscible in water or (2) a material that is directly applied to the surface without mixing with water.

18-1.02B Dust Suppressants

18-1.02B(1) General

A dust suppressant must be one of the following:

1. Petroleum-based organic product
2. Nonpetroleum-based organic product
3. Hygroscopic product
4. Synthetic polymer emulsion

18-1.02B(2) Petroleum-Based Organic Products

A petroleum-based organic dust suppressant must be an asphalt emulsion, petroleum resin, base oil, mineral oil, or synthetic fluid.

An asphalt emulsion must be Grade SS1h.

A petroleum resin must comply with the requirements shown in the following table:

Petroleum Resin Requirements

Quality characteristic	Test method	Requirement
Residue (min, %)	ASTM D6934	60
pH	ASTM D1429	4.0–7.0
sp gr at 16 °C (min)	ASTM D1298	1.00
Kinematic visc at 25 °C (min, Saybolt Furol seconds[a])	ASTM D2170	188
Flash point (min °C)	ASTM D92	205
Particle charge test	ASTM D7402	Positive

[a]Use ASTM D2161 to convert the mm^2/s value to Saybolt Furol seconds

A base or mineral oil must comply with the requirements shown in the following table:

Base and Mineral Oils Requirements

Quality characteristic	Test method	Requirement
Base and mineral oil content (min, %)	--	75
sp gr at 16 °C (min)	ASTM D1298	0.85–0.90
Brookfield absolute visc at 20 °C (max, cP)	ASTM D2196	250
Flash point (min, °C)	ASTM D93	150

A synthetic fluid must comply with 40 CFR 35 and the requirements shown in the following table:

Synthetic Fluids Requirements

Quality characteristic	Test method	Requirement
Synthetic fluid content (min, %)	--	75
sp gr at 16 °C (min)	ASTM D1298	0.85–0.90
Brookfield absolute visc at 20 °C (max, cP)	ASTM D2196	250
Flash point (min, °C)	ASTM D93	140

18-1.02B(3) Nonpetroleum-Based Organic Products

A nonpetroleum-based organic dust suppressant must be lignosulfonate, plant oil, or tall oil pitch rosin.

A lignosulfonate must comply with the requirements shown in the following table:

Lignosulfonate Requirements

Quality characteristic	Test method	Requirement
Lignin sulfonate content ready to use (min, %)	ASTM D4900	25
Residue total solids content (min %)	ASTM D4903 or D2834	52
Lignin sulfonate content of residue (min, %)	--	50
Reducing sugars content of residue (min, %)	ASTM D5896 or D6406	25
pH	ASTM D1293	6.0–9.0
sp gr (min)	ASTM D1429	1.20
Brookfield absolute visc at 25 °C (max, cP)	ASTM D2196	1,000

A plant oil must comply with the requirements shown in the following table:

Plant Oil Requirements

Quality characteristic	Test method	Requirement
Residue active solids content (min, %)	ASTM D4903	50
sp gr (min)	ASTM D1429	0.93
Brookfield absolute visc 25 °C (cP)	ASTM D2196	50–200
Flash point (min, °C)	ASTM D93	288

A tall oil pitch rosin must comply with the requirements shown in the following table:

Tall Oil Pitch Rosin Requirements

Quality characteristic	Test method	Requirement
Rosin acid content (min, %)	ASTM D1240	10
Residue active solids content (min, %)	ASTM D2834	45
pH	ASTM D1293	3.0–9.0
sp gr (min)	ASTM D1429	1.00
Brookfield absolute visc at 25 °C (cP)	ASTM D2196	50–200

18-1.02B(4) Hygroscopic Products

A hygroscopic dust suppressant must be calcium chloride, calcium chloride flake, or magnesium chloride.

Calcium chloride must comply with the requirements shown in the following table:

Calcium Chloride[a] Requirements

Quality characteristic	Test method	Requirement
Calcium chloride content (%)	ASTM E449	28–42
Total magnesium chloride (max, %)	ASTM E449	6.0
Total alkali chlorides as sodium chloride (max, %)	ASTM E449	6.0
Calcium hydroxide content (max, %)	ASTM E449	0.2
pH with 5 percent solution	ASTM D1293	7.0–9.0
sp gr	ASTM D1429	1.28–1.44

[a]ASTM D98 or AASHTO M144

Calcium chloride flake must comply with the requirements shown in the following table:

Calcium Chloride Flake[a] Requirements

Quality characteristic	Test method	Requirement
Calcium chloride content (min, %)	ASTM E449	75
Total magnesium as $MgCl_2$ (max, %)	ASTM E449	6.0
Total alkali chlorides as sodium chloride (max, %)	ASTM E449	6.0
Calcium hydroxide content (max, %)	ASTM E449	0.2
pH with 5 percent solution	ASTM D1293	7.0–9.0
Gradation percent passing		
3/8–inch sieve	ASTM C136	100
No. 4 sieve		80–100
No. 30 sieve		0–5

[a]ASTM D98 or AASHTO M144

Magnesium chloride must comply with the requirements shown in the following table:

Magnesium Chloride Requirements

Quality characteristic	Test method	Requirement
Magnesium chloride content (%)	ASTM D4691 or ASTM D511[a]	28–33
Sulfate content as magnesium sulfate (max, %)	ASTM D4691[a]	4.0
Potassium content as potassium chloride (max, %)	ASTM E449	0.5
Sodium chloride content (max, %)	ASTM E449	1.0
pH with 5% solution	ASTM D1293	7.0–9.0
sp gr	ASTM D1429	1.31 ± 0.02

[a]You may use another appropriate atomic absorption spectrophotometry method such as that in *Standard Methods for the Examination of Water and Waste Water* by APHA-AWWA-WPCF.

18-1.02B(5) Synthetic Polymer Emulsions

A synthetic polymer emulsion must comply with the requirements shown in the following table:

Synthetic Polymer Emulsion Requirements

Quality characteristic	Test method	Requirement
Residue active solids content (min, %)	ASTM D2834	40
pH	ASTM D1429	4.0–9.5
sp gr at 16 °C	ASTM D1298	1.00–1.15
Brookfield absolute visc (max, cP)	ASTM D2196	1,000
Polymer film tensile strength – dry (psi)	ASTM D412	500
Retained coagulum on no. 100 sieve (max, %)	ASTM D1417	0.1
Ash content (max, %)	ASTM D5040	2

18-1.02C Dust Control Binders

A dust control binder must comply with the specifications for a tackifier in section 21-2.02E except section 21-2.01 does not apply.

Fibers must comply with section 21-2.02D except section 21-2.01 does not apply.

18-1.03 CONSTRUCTION

18-1.03A General

Monitor dust conditions and apply a dust palliative for dust control as described and as ordered. Reapply the dust palliative at any time to control dust.

Apply a dust suppressant to:

1. Temporary haul roads
2. Construction staging, material storage, and layout areas
3. Compacted soil or AB roads or driveways
4. Paved surfaces

Apply a dust control binder to:

1. Rough-graded soils
2. Completed slopes
3. Soil stockpiles unless another practice is already used

Do not use a dust suppressant or dust control binder within 100 feet of a wetland or body of water.

18-1.03B Equipment

Apply dust suppressants that are miscible in water with either (1) a pressure-type water distributor truck equipped with a spray system or (2) a pressure-type asphalt distributor truck as specified in section 37-1.03B.

Apply dust suppressant flakes to the surface using a spreader or spinner disk.

Apply dust control binders with either (1) a pressure-type water distributor truck equipped with a spray system or (2) hydraulic spray equipment as specified for applying hydromulch in section 21-2.03D.

18-1.03C Mixing and Application Rates

Use the mix proportions and application rate for the corresponding dust suppressant as shown in the following table:

Dust Suppressant Application

Dust suppressant	Mix proportions	Application rate
Asphaltic emulsion, Grade SS1H	5 parts water to 1 part emulsion	0.20–1.0 gal/sq yd
Petroleum resin emulsion	5 parts water to 1 part emulsion	0.20–1.0 gal/sq yd
Base and mineral oil	Apply undiluted	0.30–0.35 gal/sq yd
Lignosulfonate	1 part water to 1 part concentrate	1.0 gal/sq yd
Plant oil	Apply undiluted	0.25–0.50 gal/sq yd
Tall oil pitch rosin	5 parts water to 1 part emulsion for clayey soil and 10 parts water to 1 part emulsion for sandy soil	0.30–1.0 gal/sq yd
Calcium chloride solution (hygroscopic)	Apply undiluted	0.20–0.35 gal/sq yd
Calcium chloride flakes (hygroscopic)	--	1.0–1.5 lb/sq yd
Magnesium chloride (hygroscopic)	Apply undiluted	0.30–0.50 gal/sq yd
Synthetic polymer emulsion	9 parts water to 1 part concentrate	0.50 gal/sq yd

Apply hygroscopic dust suppressants under the manufacturer's instructions.

Apply calcium chloride flakes to a moist surface.

Allow surfaces treated with a dust suppressant to cure before opening them to traffic. Adequate cure occurs when moisture is evaporated, sheen is gone, and tracking is nonextant.

Use the mix proportions and application rate for the corresponding dust control binder as shown in the following table:

Dust Control Binder Application

Dust control binder	Mix proportions	Application rate
Guar	11 to 15 lb per 1,000 gal of water	44–59 lb/acre
Psyllium	Enough water to allow for uniform slurry flow	80–200 lb/acre
Starch	Manufacturer's recommended mix proportions with water	150 lb/acre
Liquid acrylic copolymers and polymers[a]	10 parts water to 1 part polymer	1,175 gal/acre
Liquid methacrylate and acrylate polymers	Manufacturer's recommended mix proportions with water	20 gal/acre
Copolymers of sodium acrylates and acrylamides	Manufacturer's recommended mix proportions with water	3–10 lb/acre
Polyacrylamide and copolymer of acrylamide	10 lb per 1,000 gal of water	5 lb/acre
Hydro-colloid polymers	Manufacturer's recommended mix proportions with water	54–64 lb/acre

[a]Mix and handle the polymeric compound in a manner that will not cause foaming. You may add an antifoaming agent.

Do not allow stormwater runoff from polyacrylamide treated soils unless water passes through:

1. Sediment basin if the total drainage area is greater than or equal to 5 acres.
2. Sediment trap or a series of check dams if the total drainage area is less than 5 acres. Maximize the number of check dams used and space them evenly in the drainage channel such that sediment settlement is maximized.

You may add fibers to dust control binders at a rate of 2,000 lb/acre.

You may reapply dust palliatives at a reduced application rate if authorized.

18-1.04 PAYMENT

Not Used

19 EARTHWORK

19-1 GENERAL

19-1.01 GENERAL

19-1.01A Summary

Section 19-1 includes general specifications for performing earthwork activities.

Performing earthwork activities includes removal of unsuitable material or a buried man-made object if the removal is described.

If paleontological resources mitigation is specified in the special provisions under section 14-7.04, performing earthwork activities includes:

1. Paleontological resources training for your staff and subcontractors
2. Submittals of your schedule of subsurface-disturbing activities and updated schedules
3. Coordination and work with the Department's mitigation team

Complete work specified in section 20-10.02C(2) before starting earthwork activities.

19-1.01B Definitions

Reserved

19-1.01C Submittals

Reserved

19-1.01D Quality Assurance

Reserved

19-1.02 MATERIALS

Not Used

19-1.03 CONSTRUCTION

19-1.03A General

Unless the material resulting from the excavation is hazardous, construct embankments and dikes or backfill structures with it. If the quantity of excavated material is not sufficient to construct embankments, obtain the material under section 19-7.

19-1.03B Unsuitable Material

Excavate and dispose of unsuitable material encountered below the natural ground surface in embankment areas or below the grading plane in excavation areas as ordered.

Notify the Engineer before removing the unsuitable material if:

1. Removal is not otherwise described
2. You request payment for removal as change order work

Backfill the space resulting from excavating unsuitable material with material suitable for the planned use. Place and compact suitable material under section 19-5.

19-1.03C Grade Tolerance

Immediately before placing subsequent layers of material, prepare the grading plane such that the grading plane:

1. Does not vary more than 0.05 foot above or below the grade established by the Engineer where HMA is to be placed.
2. Does not extend above the grade established by the Engineer where concrete base or pavement is to be placed.
3. Beneath structural approach slabs or the thickened portion of sleeper slabs do no extend above the grade established by the Engineer.
4. At any point is within 0.05 foot above the grade established by the Engineer if the material to be placed on the grading plane is paid by the cubic yard.

5. At any point is within 0.10 foot above the grade established by the Engineer if subbase or base material to be placed on the grading plane is paid by the ton.

19-1.03D Buried Man-Made Objects

Remove and dispose of a buried man-made object encountered in an excavation as part of the excavation work.

Notify the Engineer before removing the buried man-made object if:

1. Removal of the object is not otherwise described
2. Object could not have been determined by visual inspection
3. You request payment for removal of the object as change order work

19-1.04 PAYMENT

Not Used

19-2 ROADWAY EXCAVATION

19-2.01 GENERAL

19-2.01A Summary

Section 19-2 includes specifications for performing roadway excavation.

Roadway excavation consists of all excavation involved in the grading and construction of the roadway except structure excavation and any excavation paid for as a separate bid item.

Roadway excavation includes:

1. Excavating and stockpiling the selected material
2. Removing the stockpiled material and placing it in its final position
3. Removing surcharge material
4. Performing the removal of a slide or slipout which is paid for as the type of roadway excavation involved

19-2.01B Definitions

selected material: Specific material excavated from a described location on the job site. Selected material includes topsoil.

19-2.01C Submittals

Reserved

19-2.01D Quality Assurance

Reserved

19-2.02 MATERIALS

Not Used

19-2.03 CONSTRUCTION

19-2.03A General

Excavate to the described or authorized grade. If you overexcavate, backfill with an authorized material and compact it.

Remove pavement within the limits of roadway excavation. Pavement removal must comply with section 39 and 41.

Compaction must comply with section 19-5.

Construct embankments under section 19-6.

19-2.03B Surplus Material

If a quantity of surplus material is shown, the quantity is approximate.

Ensure enough material is available to complete the embankments before placing the material at other locations on the job site or disposing of it.

Obtain authorization before disposing of surplus material or using it for any of the following:

1. Widening embankments uniformly
2. Flattening slopes
3. Placing along the roadway or at other locations

If you cannot use surplus material within the highway, dispose of it.

If you dispose of any surplus material prematurely and later find a material shortage, replace the surplus material with an authorized material.

If an ordered change increases the quantity of excavation or decreases the quantity of embankment such that surplus material must be disposed of, disposing of this material is change order work.

19-2.03C Deficiency Material

If the quantity of acceptable material from excavation is not enough to construct the embankments, the quantity of material needed to complete the embankments must consist of local or imported borrow.

Obtain local or imported borrow under section 19-7.

If a bid item for imported borrow is not shown on the Bid Item List, obtaining imported borrow is change order work.

19-2.03D Selected Material

19-2.03D(1) General

If selected material is not used for a specified layer, place the selected material in the roadway prism as embankment or structure backfill.

If selected material is used as a specified layer, spread and compact it under section 25.

If practicable and unless processing of material is required, haul selected material directly from the excavation to its final position in the roadway prism and compact it in place.

Selected material must remain in place until it can be placed in its final position unless stockpiling of selected material is ordered.

If stockpiling of selected material is ordered, excavate and stockpile the selected material until the stockpiled material is to be placed in its final position in the roadway prism. This work is change order work.

19-2.03D(2) Topsoil

Reserved

19-2.03E Blasting

The Department does not allow excessive blasting.

Remove material outside the planned cross section that is shattered or loosened due to blasting.

Suspend blasting activities if any of the following conditions occurs:

1. Any sign of overshooting
2. Endangerment to the public
3. Destruction of property or natural features

19-2.03F Slides and Slipouts

Excavate and remove material:

1. Outside the planned roadway or ditch slope that is unstable and constitutes a potential slide
2. From a slide that has come into the roadway or ditch
3. Slipped out of new or existing embankments

Excavate to the designated lines or slopes either by benching or as ordered.

Use removed material to construct embankments unless otherwise ordered.

Before removal activities if removal of a slide or a slipout is not described, you may request the removal to be change order work.

If you complete a slope and are ordered to remove unstable or stable material and reslope the area, the removal and resloping is change order work.

Repair any damage to the completed work resulting from a slide or slipout as ordered.

Repairing damage to the completed work due to a slide or slipout is paid for as the type of work involved unless otherwise ordered as change order work.

If a slide or slipout is caused by your activities or negligence, remove the slide or slipout material and restore the slope.

19-2.03G Slopes

Construct slopes to the lines and grades established by the Engineer. Slope tolerances are measured perpendicular to the planned slope.

Any point on the completed excavation slope must be within 0.5 foot of the planned slope, unless the excavation is in rock, in which case, any point on the completed slope must be within 2 feet of the planned slope.

Slopes or portions of slopes must not encroach on the roadbed.

Round the tops of excavation slopes and ends of excavations.

Any point on the completed embankment slope must be within 0.5 foot of the planned slope for slopes within 4 feet of the shoulder grade. Slopes below 4 feet must be within 1 foot of the planned slope.

If an embankment is constructed of large rock and the size of rocks make it impracticable to construct slopes within 1 foot, the Engineer may authorize you to construct slopes more than 4 feet below shoulder grade to within 2 feet of the planned slope.

For median and side slopes with a 6:1 (horizontal:vertical) or flatter slope:

1. Completed slopes must be within 0.2 foot from the grade established by the Engineer
2. Flowlines must be graded to drain and must be within 0.1 foot from the grade established by the Engineer

If the slope is to be cultivated or straw is to be incorporated into the surface, remove loose rocks larger than 2-1/2 inches in maximum dimension, roots, and other debris on the surface of the slope before cultivation or incorporation of straw.

Maintain completed slopes. Repair any slope damage caused by erosion.

19-2.03H Ditch Excavation

Excavate ditches including channels for changing the course of streams.

Avoid excavating below the grade for the bottom of the ditch or water channel. If you excavate below grade, backfill with suitable material and compact it.

19-2.04 PAYMENT

The payment quantity for roadway excavation is the volume of roadway excavation material, including volume of material involved in:

1. Embankment construction unless a separate bid item for constructing embankments is shown on the Bid Item List
2. Ditch or channel excavation if the bottom width of the ditch or channel is 12 feet or more
3. Local borrow excavation

The volume of material for roadway excavation is determined from the average end areas and the distances between them.

If changed conditions or nature of a particular operation make determining the quantities of roadway excavation based on average end areas impractical, the payment quantity is the volume determined using a method best suited to obtain an accurate quantity.

If the quantities of roadway excavation are determined from average end areas and centerline distances, a correction for curvature is not applied to quantities within the roadway prism. In determining the quantity of material outside the original roadway prism, where the roadway centerline is used as a base, a correction is made for curvature if the centerline radius is 1,000 feet or less.

The volume of material removed from a stockpile is determined from measurements of the stockpile before removal.

If the bottom of a ditch or channel is less than 12 feet wide, the payment quantity for ditch excavation is the volume determined from average areas and the distances between them.

19-3 STRUCTURE EXCAVATION AND BACKFILL

19-3.01 GENERAL

19-3.01A Summary

Section 19-3 includes specifications for performing structure excavation and backfill.

Structure excavation includes:

1. Excavating foundations for structures, including trenches for culverts, pipes, rods, deadmen, cutoff walls, and other facilities
2. Placing structure backfill where compaction of the structure backfill is not required.
3. Control and removal of water
4. Installation and removal of facilities required to complete the work unless specified or allowed to remain in place

Structure excavation (Type A) includes excavation for footings where seal courses are shown.

Structure excavation (bridge) includes structure excavation not shown on the Bid Item List or plans as any other type of structure excavation.

Structure backfill (bridge) includes structure backfill not shown on the Bid Item List or plans as any other type of structure backfill.

Structure excavation (bridge) or structure backfill (bridge) includes structure excavation or structure backfill for bridges not described by type.

19-3.01B Definitions

Reserved

19-3.01C Submittals

19-3.01C(1) General

Reserved

19-3.01C(2) Cofferdams

Submit shop drawings for cofferdam construction. Include construction methods and calculations with the shop drawings. Shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer in the State.

For cofferdams on or affecting railroad property, allow 85 days for review.

19-3.01C(3) Soldier Pile Walls

Submit shop drawings for soldier pile wall construction. Shop drawings must include:

1. Construction sequence

2. Traffic control
3. Method of soldier pile installation
4. Method of placing lagging
5. Excavation lift limits
6. Drilling and excavation equipment
7. Calculations showing soil stability at all stages of construction

Shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer in the State.

Allow 10 days for review.

19-3.01C(4) Ground Anchor and Soil Nail Walls

Submit shop drawings for earthwork for each ground anchor wall and soil nail wall to OSD, Documents Unit. Notify the Engineer of the submittal. Include in the notification the date and a description of the contents of the submittal. The shop drawings must include:

1. Wall construction schedule with construction sequence
2. Measures to ensure wall and slope stability during construction
3. Provisions for installing verification and proof test nails
4. Methods of excavation for the staged lifts and types of excavation equipment
5. Excavation lift height and maximum duration of exposure for each wall zone, including supporting calculations and provisions to stabilize the exposed excavated face
6. Details for measuring the movement of the excavated face and the wall during stability testing and construction
7. Space requirements for installation equipment
8. Dewatering plan to divert, control, and dispose of surface and groundwater during construction
9. Provisions for discontinuous rows of soil nails

Shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer in the State.

Submit 5 copies of shop drawings for initial review. Allow 30 days for review.

Submit from 6 to 12 copies of final shop drawings as requested by the Engineer for final authorization.

19-3.01C(5) Test Results

Submit test results of any stability testing performed for ground anchor walls and soil nail walls as an action submittal.

19-3.01C(6) Controlled Low-Strength Material

If you propose using controlled low-strength material, submit a mix design. Include test data before excavating the trench where controlled low-strength material is to be used.

19-3.01D Quality Assurance

19-3.01D(1) General

Reserved

19-3.01D(2) Stability Test for Ground Anchor and Soil Nail Walls

For soil nail walls, wall zones are specified in the special provisions.

For ground anchor walls, a wall zone is the entire wall.

If you use an excavation lift height greater than 5 feet or an exposure duration longer than 1 work shift, perform stability testing. Perform the testing before roadway excavation.

Perform at least 1 stability test within the limits of each wall zone.

Excavate a neat face at most 3 feet in front of the final wall face alignment. The excavated face must:

1. Have the height shown in the authorized shop drawings.

2. Be 20 feet long and parallel to the wall alignment with a constant height. You may excavate ramps outside the 20-foot section for construction access.
3. Be left open for the proposed exposure time shown in the authorized shop drawings.
4. Maintain its integrity without raveling, sloughing, or measurable displacement throughout the proposed exposure time.

After authorization of the test results, you may use the proposed excavation height within the tested wall zone for the observed exposure time.

If the Engineer determines the exposed excavated face is not maintaining its integrity, you must immediately stabilize the excavated face and perform additional stability testing.

Stability testing does not apply to ground-anchored soldier pile walls.

19-3.02 MATERIALS

19-3.02A General

Reserved

19-3.02B Cofferdam

Interior dimensions of cofferdams must provide enough space inside the wales for (1) form construction, (2) pile driving, and (3) pumping of water from outside the foundation forms.

No shoring is allowed in cofferdams that would induce stress, shock, or vibration in the permanent structure.

19-3.02C Structure Backfill

Structure backfill must be free of organic or other unsatisfactory material.

The impervious backfill material must be an authorized earthy material. The sand equivalent requirement does not apply.

Structure backfill compacted to a relative compaction of at least 95 percent and material placed behind retaining walls must have a sand equivalent value of at least 20 and comply with the gradation requirements shown in the following table:

Sieve size	Percentage passing
3"	100
No. 4	35–100
No. 30	20–100

Except for material placed behind retaining walls, structure backfill compacted to a relative compaction of at least 90 percent must comply with the gradation requirements shown in the following table:

Sieve size	Percentage passing
3"	100

Structure backfill for crib walls must comply with the requirements shown in the following tables:

Wall height (feet)	Type of backfill material	Thickness of each layer of material before compaction (feet)
<10	C, D, or E	1
10–25	D or E	2
>25	E	4

Backfill material type	Gradation		Sand equivalent (min)	Relative compaction (min, %)
	Sieve size	Percentage passing		
C	3"	100	--	90
D	3"	100	30	90
	No. 4	35–100		
E	3"	100	--	90
	No. 4	25–70		
	No. 50	5–20		
	No. 200	0–5		

Material from structure excavation not suitable for use as structure backfill may be used to replace imported borrow or other excavated material.

19-3.02D Pervious Backfill Material

Pervious backfill material must consist of one or any combination of the following materials:

1. Gravel
2. Crushed gravel
3. Crushed rock
4. Natural sand
5. Manufactured sand

Pervious backfill material must comply with the gradation requirements shown in the following table:

Sieve size	Percentage passing
2"	100
No. 50	0–100
No. 100	0–8
No. 200	0–4

The gradation for sacked pervious backfill material behind wall drain outlets must comply with the gradation specified for 1-1/2-by-3/4 inch primary aggregate in section 90-1.02C(4)(b).

A weep hole and geocomposite drain alternative must comply with section 68-7.

19-3.02E Slurry Cement Backfill

Slurry cement backfill must be a fluid workable mixture of aggregate, cement, and water.

The aggregate must be one of the following:

1. Commercial-quality concrete sand
2. Excavated or imported material in any combination, free of organic material and other deleterious substances and complying with the gradation requirements shown in the following table:

Sieve size	Percentage passing
1-1/2"	100
1"	80–100
3/4"	60–100
3/8"	50–100
No. 4	40–80
No. 100	10–40

The cement must comply with section 90-1.02B(2) except testing is not required.

The water must be free from oils, salts, and other impurities that adversely affect the backfill.

Proportion slurry cement backfill by weight or volume. The backfill must contain at least 188 pounds of cement per cubic yard and enough water to produce a fluid workable mix that flows and can be pumped without segregation during placement.

Mix materials thoroughly by machine. Use a pugmill, rotary drum, or other authorized mixer. Mix until cement and water are thoroughly dispersed.

You may use slurry cement backfill as structure backfill only for pipe culverts.

19-3.02F Culvert Beddings

19-3.02F(1) General

Culvert beddings must be shaped bedding, sand bedding, or soil cement bedding.

If more than 1 type of bedding is allowed, use the same bedding for the entire length of the culvert.

19-3.02F(2) Sand Beddings

Sand bedding must consist of sand:

1. Free of clay or organic material
2. Suitable for the purpose intended
3. Complying with the gradation requirements shown in the following table:

Sieve size	Percentage passing
No. 4	90–100
No. 200	0–5

19-3.02F(3) Soil Cement Beddings

Material and mixing requirements for soil cement bedding must comply with the specifications for slurry cement backfill in section 19-3.02E except:

1. It must contain at least 282 pounds of cement per cubic yard
2. Aggregate must not be commercial-quality concrete sand

19-3.02G Controlled Low-Strength Material

If authorized, controlled low-strength material may be used as structure backfill for pipe culverts unless the culvert has a diameter or span of more than 20 feet.

Controlled low-strength material must be a fluid workable mixture of aggregate, cement, and water.

Cement must be one of the following:

1. Cement complying with ASTM C150
2. Blended hydraulic cement complying with either of the following:
   2.1. ASTM C595
   2.2. Physical requirements in ASTM C1157

When tested under ASTM D4832, the controlled low-strength material must have a 28-day compressive strength:

1. From 50 to 100 psi for pipe culverts with 20 feet or less in height of cover
2. Of at least 100 psi for pipe culverts with over 20 feet in height of cover

Water must be free of oil, salts, and other impurities that adversely affect the backfill.

Aggregate must be one of the following:

1. Commercial-quality concrete sand
2. Excavated or imported material in any combination, free of organic material and other deleterious substances and complying with the gradation requirements shown in the following table:

Sieve size	Percentage passing
1-1/2"	100
1"	80–100
3/4"	60–100
3/8"	50–100
No. 4	40–80
No. 100	10–40

Mix materials thoroughly by machine. A pugmill rotary drum or other authorized mixer must be used. Mix until cement and water are thoroughly dispersed.

Wherever controlled low-strength material is placed within the travelled way or covered by paving or embankment materials, the controlled low-strength material must achieve a maximum indentation diameter of 3 inches when tested under ASTM D6024 before covering and opening to traffic.

19-3.02H Concrete Backfill

Concrete backfill encasing steel soldier piles below the lagging must comply with section 90-1 and contain at least 505 pounds of cementitious material per cubic yard.

19-3.02I Lean Concrete Backfill

Lean concrete backfill must comply with the specifications for slurry cement backfill in section 19-3.02E except the aggregate must be commercial-quality concrete sand.

19-3.02J Filter Fabric

Filter fabric must be Class A.

19-3.03 CONSTRUCTION

19-3.03A General

Reserved

19-3.03B Structure Excavation

19-3.03B(1) General

Remove any material that comes into an excavation from outside the described limits.

Obtain the Engineer's acceptance of the completed structure excavation before placing any concrete or masonry.

When embankments must be constructed before culverts are placed, construct embankments to the specified height and for a distance on each side of the culvert location 5 times the culvert diameter or height before excavating for and installing culverts. Where embankments are constructed on a steep slope or at a difficult location, the Engineer may modify embankment heights before culverts are installed.

Change order work includes:

1. If structure excavation is more than 0.5 foot from the depth shown and you request an adjustment for the increased depth
2. The Engineer orders an adjustment for a decreased depth

19-3.03B(2) Soldier Pile Walls

Excavate for and construct soldier pile walls in lifts from the top down.

Excavate in a way that minimizes voids requiring backfill behind the lagging.

Do not excavate more than 3 feet below any level of ground anchors that have not been stressed and grouted.

The Engineer determines whether boulders or portions of boulders that interfere with lagging must be removed. Perform any additional earthwork ordered. The additional earthwork is change order work.

Complete placing lagging to the full height of the exposed excavation face by the end of the work shift.

19-3.03B(3) Pier Column Excavation

Reserved

19-3.03B(4) Cofferdams

Cofferdams for foundation construction must be (1) carried below the bottom of footings, (2) braced, and (3) made as watertight as practicable.

You may construct the cofferdam large enough to provide clearance to perform the work.

Right or enlarge a cofferdam tilted or moved out of position during sinking to provide the required clearance and proper pier location.

In tidal waters or in streams that may flood, vent cofferdam walls at low water elevation to ensure equal hydrostatic head inside and outside the cofferdam when placing and setting seals.

Cross struts or bracing may extend through foundation concrete if authorized. Struts or bracing below low water may remain in place except in navigable streams or when specified to be removed. Remove struts or bracing above low water. Fill resulting spaces with the same type of concrete as the surrounding concrete.

Remove cofferdams to at least 2 feet below the streambed after completing substructure construction. Do not disturb or mar the finished concrete or masonry.

19-3.03B(5) Water Control and Foundation Treatment

Select the method to remove and control water at excavations where seal courses are not shown. Methods may include well point systems, pumping sumps, cofferdams, or concrete seal courses. If you construct a seal course comply with section 51-1.03D(3) except:

1. Seal course thickness requirement does not apply for a spread footing
2. Curing requirements do not apply for a pile footing

Where concrete seal courses are shown, use a cofferdam, concrete seal course, and dewatering pumps. Place seal course concrete under section 51-1.03D(3).

If no piles are used and footing concrete, culverts, or other structures are placed on an excavated surface other than rock:

1. Perform excavation without disturbing foundation material. Dewater the excavation if groundwater is encountered and no seal course is used. Continue dewatering activities before and during subsequent excavation. Foundations must be free of water when footing concrete or pipes are placed. Continue dewatering activities as required to prevent damage to the work.
2. If foundation material is disturbed by excavation activities, damaged by water, or removed for your convenience in dewatering, restore the foundation to a condition at least equal to the undisturbed foundation. To replace damaged or removed foundation material for culverts, use Class 2 AB that complies with section 26. Compact the base as specified for structure backfill in section 19-3.03E.

If the Engineer determines the undisturbed original material of the excavation is unsuitable, correct it as ordered. This work is change order work.

If footing concrete or masonry is placed on rock, fully uncover the rock and remove the surface to sound rock. Level or cut the rock to steps and then roughen it.

Pressure grout or treat seams in rock as ordered. This work is change order work.

If you encounter solid rock or other unyielding material when excavating for a culvert other than an arch culvert, remove 1 to 5 feet of the material below the bottom of the culvert not to exceed a depth of 1/24 of the height of the embankment above the top of the culvert.

Backfill the resulting space below the culvert using structure backfill under section 19-3.03E. Excavating and backfilling below the planned elevation of the bottom of the culvert is change order work.

For footings on piles, excavate to the bottom of footings before driving piles or drilling for piling. If swell or subsidence results from pile driving, excavate or backfill the footing area to the grade of the bottom of the

footing. If the material under footings would mix with footing concrete or would not support the weight of wet concrete, replace the material with suitable material, install soffit forms, or provide a platform using authorized means on which to cast the footing.

19-3.03C–19-3.03D Reserved

19-3.03E Structure Backfill

19-3.03E(1) General

Place structure backfill in uniform layers. Bring backfill up uniformly on all sides of structures. Backfill layers must be at most 0.67 foot thick before compacting the thickness must be at most 4 feet when compaction is performed by ponding or jetting.

Do not use compaction equipment or methods that may cause excessive displacement or damage structures.

Do not place structure backfill until footings or other parts of the structure or facility are inspected by the Engineer and authorized for backfilling. Do not place backfill against the back of abutments, retaining walls, or outside walls of CIP concrete structures until the concrete has attained a compressive strength of at least 2,500 psi or the concrete has been in place for 28 days.

Place backfill inside bridge wingwalls and abutments before railings on wingwalls are constructed.

Compaction by ponding and jetting may be authorized under the following conditions:

1. Backfill material is self-draining when compacted
2. Foundation materials will not soften or be damaged by water
3. Structures will not be damaged by hydrostatic pressure

Ponding and jetting of the upper 4 feet below finished grade is not allowed. Perform work without damaging the structure or embankment and such that water is not collected and confined. Supplement ponding and jetting with vibratory or other compaction equipment.

Compact structure backfill to a relative compaction of at least 95 percent except you may compact structure backfill to a relative compaction of at least 90 percent at the following locations:

1. Overside drains
2. Footings for slope protection, slope paving, and aprons
3. Headwalls, endwalls, and culvert wingwalls
4. Retaining walls, except for portions under any surfacing
5. Inlets in median areas or in traffic interchange loops
6. Footings and pumping plants not beneath surfacing

At locations where ordered, place a compacted impervious backfill material for:

1. Outer 2-foot portion of structure backfill adjacent to inlets and outlets for pipes and culverts
2. Structure backfill placed within 2 feet of finished grade at abutments, abutment wingwalls, retaining walls, and other portions of structures

Structure backfill placed at bridge supports in waterways and water channels not beneath any embankment, pavement, or slope protection:

1. Does not need to be compacted
2. Must be placed to the level of original ground or finished grade shown

Any material you place outside the excavation pay limits material must comply with the material and compaction requirements of the adjacent structure backfill.

If imported borrow is shown on the Bid Item List, you may use imported borrow as structure backfill if it complies with the specifications for structure backfill.

Place material from structure excavation not used as structure backfill in roadway embankments under section 19-6 or disposed of it under section 19-2.03B.

19-3.03E(2) Crib Walls

Backfill (1) cells formed by crib members of a crib wall and (2) the space between a crib wall and structure excavation face.

Structure backfill for crib walls must not sift or flow through the openings in the walls.

Backfill crib walls simultaneously during wall erection. Place material in uniform layers before compacting. Compact material by hand tamping, mechanical compaction, or other authorized compaction methods.

19-3.03E(3) Soldier Pile Walls

Compact structure backfill behind lagging of soldier pile walls by hand tamping, mechanical compaction, or other authorized compaction method.

In fill areas behind the lagging, key the structure backfill into the existing or excavated back slope.

Place and compact the backfill behind the lagging at least 5 feet above the level of ground anchors before drilling for the anchors. Place and compact the remaining backfill behind the lagging after the anchors are grouted.

If filter fabric is shown behind the lagging:

1. Immediately before placing the filter fabric, remove any loose or extraneous material and sharp objects from the surface to receive the filter fabric.
2. Handle and place the filter fabric under the manufacturer's instructions. Stretch, align, and place the fabric without wrinkling.
3. Stitch the adjacent borders of filter fabric or overlap the adjacent borders by 12 to 18 inches. If stitching the border, use yarn of a (1) contrasting color and (2) a size and composition complying with fabric manufacturer's instructions. Use from 5 to 7 stitches per inch of seam.
4. Repair any damaged filter fabric by (1) placing a piece of filter fabric large enough to cover the damaged area and (2) complying with the overlapping or stitching requirements.

19-3.03F Slurry Cement Backfill

Place slurry cement backfill within 1 hour of mixing. Place it in a uniform manner that prevents (1) voids or segregation of the backfill and (2) floating or shifting of the culverts. Remove foreign material that falls into trenches.

Do not backfill over or place material over slurry cement backfill until at least 4 hours after placement. When concrete sand is used as aggregate and the in-place material is free draining, you may start backfilling as soon as the surface water is gone.

If slurry cement backfill is used for structure backfill, you may reduce the excavation width such that the clear distance between the outside of the pipe and the side of the excavation on each side of the pipe is at least (1) 6 inches for pipes 42 inches or less in diameter or span and (2) 1 foot for pipes over 42 inches in diameter or span.

Place slurry cement backfill only for that portion of structure backfill (1) below the original ground or grading plane or (2) below the top of the embankment placed before excavating for the culvert pipe. Compact earth plugs at each end of the pipe before placing the backfill to completely contain slurry in the pipe trench.

19-3.03G Pervious Backfill Material

Place pervious backfill material in layers along with and by the same methods specified for structure backfill. Pervious backfill material at the same location must have approximately the same gradation. Cover pervious backfill material at locations exposed to erosion with a 1-foot layer of an authorized earthen material.

19-3.03H Culvert Bedding

Shape trench beds to fit the bottom of the culvert and to provide uniform support along the entire culvert length. You may excavate the trench below the bottom of the culvert and construct shaped bedding by backfilling and compacting the backfill material. Shape beds using a template conforming to the outside shape of the culvert and guided by headers set parallel to the culvert grade. Headers may be left in place.

Place soil cement bedding as specified for slurry cement backfill in section 19-3.03F except do not backfill over soil cement bedding until 8 hours after placement.

19-3.03I Controlled Low-Strength Material

If a controlled low-strength material l is used for structure backfill, you may reduce the excavation width such that the clear distance between the outside of the pipe culvert and the side of the excavation on each side of the pipe culvert is at least:

1. 6 inches for pipe culverts with either of the following conditions:
   1.1. 20 feet or less in height of cover
   1.2 42 inches or less of diameter or span
2. 1 foot for pipe culverts with either of the following conditions:
   2.1. Over 20 feet in height of cover
   2.2 Over 42 inches in diameter or span

Place controlled low-strength material only for that portion of structure backfill (1) below the original ground or grading plane or (2) below the top of the embankment that is placed before excavating for the pipe. Compact earth plugs at each end of the pipe culvert before placing the backfill to completely contain slurry in the pipe culvert trench.

For trenches in existing pavement, place controlled low-strength material no higher than the bottom of the existing pavement's permeable drainage layer. Where a drainage layer does not exist, place the material no higher than 1 inch below the bottom of the existing asphalt concrete surfacing or no higher than the top of the base below the existing concrete pavement.

For rigid pipe culverts, the minimum height of controlled low-strength material relative to the pipe culvert invert must be 0.5 times the pipe culvert diameter or height.

For flexible pipe culverts, the minimum height of controlled low-strength material must be 0.7 times the pipe culvert diameter or height.

19-3.03J Soldier Pile Walls

Where necessary to install lagging, remove lean concrete backfill from drilled holes and in front of pile..

19-3.03K Ground Anchor and Soil Nail Walls

For ground anchor and soil nail walls excavate in lifts from the top down.

Clean the excavated face of loose materials, mud, rebound, and other materials that prevent or reduce the shotcrete from bonding to the excavated face and soil nails.

Remove cobbles, boulders, portions of boulders, and debris at the final wall alignment that protrude more than 2 inches from the excavated face.

If stability testing is not performed, apply the shotcrete facing during the same work shift that the excavation is performed. You may delay placing the shotcrete facing up to 24 hours if you demonstrate the integrity of the excavated face is maintained.

Notify the Engineer immediately if raveling or instability of the excavated face occurs or the wall face moves horizontally more than 0.4 percent of the excavated wall height.

Immediately stabilize unstable areas by buttressing the excavated face with an earth berm or other authorized methods. Stop construction in unstable areas. Take authorized remedial measures to stablilize the areas.

Replace any damaged soil nails and ground anchors.

If your excavation and installation methods result in a discontinuous wall along any soil nail row, the ends of the structurally completed wall section must extend beyond the ends of the next lower excavation lift by a distance equal to twice the lift height. Maintain temporary slopes at the ends of each wall section to ensure slope stability.

Do not excavate to the next underlying excavation lift until the following conditions have been met for the portion of the soil nail or ground anchor wall in the current excavation lift:

1. Soil nails or ground anchors are installed and grouted.
2. Reinforced shotcrete facing is constructed.
3. Grout and shotcrete have cured for at least 72 hours.
4. Soil nail facing anchorages are attached or ground anchors are locked off.

Do not excavate beyond the horizontal limits of the overlying completed wall section. At the end of each excavation lift, maintain temporary slopes flatter than 2:1 (horizontal: vertical) to ensure slope stability.

19-3.04 PAYMENT

The Department does not adjust the payment quantity of imported borrow placed as structure backfill if replacement material for the imported borrow is provided.

For structures other than culverts, if the pay limits are not shown, the payment quantities for structure excavation and structure backfill are computed as follows:

1. Horizontal limits are vertical planes 1 foot outside the neat lines of the footings or structures without footings.
2. Upper limit for structure excavation is the original ground surface. Where structure excavation is performed within a roadway excavation or a ditch excavation area, the upper limit is the plane of the bottom and side slopes of the excavated area. In new embankments, the upper limit is the plane of the new embankment at the specified elevation.
3. Upper limit for structure backfill is the finished grading plane or the finished slope lines.
4. Lower limit is a plane at the bottom of the completed footings or structures or the lower outside surface of rods or deadmen.

Except for culverts, the Department does not adjust the unit price of structure excavation for an increase in depth of up to 2 feet or an increase in width of up to 3 times the outside width of the footing. For excavation to greater depths or widths, the Department does not adjust the unit price of structure excavation outside the limits unless before removal activities, (1) the Engineer authorizes the excavation outside the limits to be change order work or (2) you request the excavation outside the limits to be change order work. When the pay limits of structure excavation are so increased, the pay limits for structure backfill are similarly increased. The Department does not adjust the unit price of structure backfill.

If the depth of the structure excavation is reduced due to a reduction or elimination of the seal course, the Department does not decrease the payment quantity for structure excavation (Type A).

The payment quantity for structure backfill does not include:

1. Volume of pervious backfill material within the limits of the structure backfill
2. Volume occupied by the new structure

For culverts:

1. Depth of structure excavation is the vertical distance between original ground and the bottom of the culvert trench.
2. Increased depth due to unsuitable material or rock or other unyielding material below the planned grade as specified in section 19-3.03H is not considered in determining the depth of structure excavation.
3. Structure excavation more than 0.5 foot from the depth shown is a work-character change if you request an adjustment for an increased depth or the Engineer orders an adjustment for a decreased depth.

19-4 ROCK EXCAVATION

19-4.01 GENERAL

19-4.01A General

19-4.01A(1) Summary

Section 19-4 include general specifications for performing rock excavation.

19-4.01A(2) Definitions

flyrock: Rock that becomes airborne due to blasting.

near-field blasting: Blasting within 30 feet of a building, highway facility, or utilities.

19-4.01A(3) Submittals

Reserved

19-4.01A(4) Quality Assurance

Reserved

19-4.01B Materials

Not Used

19-4.01C Construction

Excavate rock by blasting, controlled blasting, using chemical expanders or hydraulic splitters, or another authorized method.

19-4.01D Payment

The payment quantity for any type of rock excavation is measured as specified for roadway excavation.

19-4.02 PRESPLITTING

19-4.02A General

19-4.02A(1) Summary

Section 19-4.02 includes specifications for presplitting rock to form rock excavation slopes in conjunction with blasting or controlled blasting.

19-4.02A(2) Definitions

presplitting: Establishing a free surface or shear plane in rock along the specified excavation slope by the controlled use of explosives and blasting accessories in appropriately aligned and spaced drilled holes.

19-4.02A(3) Submittals

Submit a copy of the explosive manufacturer's instructions as an informational submittal before using any column-type explosive for presplitting.

19-4.02A(4) Quality Assurance

Reserved

19-4.02B Materials

The maximum diameter of explosive used in a presplit hole must not be greater than 50 percent of the diameter of the presplit hole.

Standard cartridge explosives prepared and packaged by explosive manufacturing firms must be used in the presplit holes. The explosives must consist of one of the following:

1. Fractional portions of standard cartridges to be affixed to a detonating cord in the field
2. Solid column explosives joined and affixed to a detonating cord in the field

Stemming materials must be dry, free-running material complying with the gradation requirements shown in the following table when tested under California Test 202:

Sieve size	Percentage passing
3/8"	100
No. 8	10

19-4.02C Construction

Presplit the rock to form rock excavation slopes.

Before drilling the presplitting holes, remove overburden soil and weathered rock along the top of the excavation for a distance of at least 50 feet beyond the production hole drilling limits or to the end of the excavation. Expose fresh rock to an elevation equal to the bottom of the adjacent lift of the presplitting holes being drilled.

Drill slope holes for presplitting along the line of the planned slope. The drilled holes must be from 2-1/2 to 3 inches in diameter. Use the proper drilling equipment and techniques to ensure that no hole deviates (1) from the plane of the planned slope by more than 12 inches or (2) from parallel to an adjacent hole by more than 67 percent of the planned horizontal spacing between holes.

The Department does not pay for drilling more than 3 feet below finished grade unless additional drilling is ordered. The additional drilling is change order work.

The length of presplit holes for an individual lift must not exceed 20 feet, unless you can demonstrate to the Engineer that you can stay within the specified tolerances and produce a uniform slope. The length of holes may then be increased to a maximum of 60 feet if authorized.

Space the presplit holes a maximum of 3 feet on centers. Adjust the spacing to produce a uniform shear face between holes.

The Engineer may order you to drill auxiliary holes along the presplit line. These holes must not be loaded or stemmed. Except for spacing, the auxiliary drill holes must comply with the specifications for presplit holes. This work is change order work.

Place the adjacent line of production holes inside the presplit lines such that you avoid damage to the presplit face.

If necessary to reduce shatter and overbreak of the presplit surface, drill the 1st line of production holes parallel to the slope line at the top of the cut and at each bench level thereafter. Immediately stop blasting activities if the presplit surface is damaged.

Do not drill production holes within 8 feet of a presplit plane unless authorized. The bottom of the production holes must not be lower than the bottom of the presplit holes.

You may use a construction working bench offset by 24 inches from the bottom of each lift to drill the next lower presplitting pattern.

Adjust the drilling to compensate for any drift of previous levels and for the offset at the start of new levels to maintain the specified slope plane.

If the drilling and blasting methods do not produce a uniform slope and shear face without overbreak and within the specified tolerances, drill, blast, and excavate in short sections, up to 100 feet, until you achieve the desired results.

If you use a fractional portion of a standard explosive cartridge, firmly affix the cartridge to a length of detonating cord equal to the depth of the drill hole. Ensure the cartridge does not slip down the detonating cord or cock across the hole and bridge the flow of stemming material. Space the cartridges along the length of the detonating cord at a maximum of 30 inches on center. Adjust the spacing as needed to achieve the desired results.

If you use a solid column-type explosive, assemble and affix the column to the detonating cord under the explosive manufacturer's instructions.

The bottom charge of a presplit hole may be larger than the line charges but must not cause overbreak. Place the top charge of the presplitting hole far enough below the collar to avoid overbreaking the surface.

Before placing the charge, clear the hole of any obstructions for the hole's entire depth. Ensure that placing of the charge does not cause caving of material from the walls of the holes.

The Engineer may order the use of stemming materials as necessary to achieve a satisfactory presplit face. Stemmed presplit holes must be completely filled to the collar.

Simultaneously detonate charges in each presplitting pattern.

The tolerances specified in section 19-2.03G do not apply to presplit surfaces of excavation slopes where presplitting is required. The presplit face must not deviate more than 1 foot from the plane passing through adjacent drill holes, except where the character of the rock is such that irregularities are unavoidable. The average plane of the completed slopes must not deviate more than 1 foot from the plan slopes. These tolerances are measured perpendicular to the plane of the slope. No portion of the slope may encroach on the roadbed.

If equally satisfactory presplit slopes are obtained, you may either presplit the slope face before drilling for production blasting or presplit the slope face and production blast at the same time, provided that the presplitting drill holes are fired with zero delay. Detonation of the production holes must be delayed from the detonation of the presplit line and must start at the row of holes farthest from the new slope line and progressing in steps to the row of holes nearest the presplit line. Detonation of the production holes must result in a minimum 50 ms delay between detonation of the presplit holes and detonation of the row of production holes nearest the presplit line. The presplitting holes must extend either to the end of the excavation or for a distance of not less than 50 feet beyond the limits of the production holes to be detonated.

19-4.02D Payment

The payment quantity for drill hole (presplitting) is the theoretical slope length determined from the elevation taken before detonating each lift and a plane 3 feet below finished grade. For holes that comply with the specified slope and tolerances, except alignment within the plane of the slope, the payment quantity is 75 percent of the theoretical slope length.

The Department does not pay for holes that do not show a hole trace for approximately 50 percent of the drilled length.

19-4.03 BLASTING

19-4.03A General

19-4.03A(1) Summary

Section 19-4.03 includes specifications for excavating rock by blasting.

Blasting activities must comply with federal, State, and local blasting regulations, including 8 CA Code of Regs Ch 4, Subchapter 7, Group 18, "Explosive Materials."

19-4.03A(2) Definitions

Reserved

19-4.03A(3) Submittals

Submit 3 copies of your blasting safety plan. The plan must include:

1. References to applicable federal, State, and local codes and regulations
2. Copies of permits required for blasting activities
3. Business name, contractor license number, address, and telephone number of the blasting subcontractor
4. Proof of current liability insurance and bonding
5. Name, address, telephone number, copies of applicable licenses, and resume of:
   - 5.1. Blaster-in-charge
   - 5.2. Personnel responsible for blast design, loading, and conducting blasting operations
   - 5.3. Safety officer for the blasting subcontractor
6. Name, address, and telephone number of the local fire station and law enforcement agencies
7. Detailed description of:
   - 7.1. Location where explosives will be stored
   - 7.2. Security measures to protect and limit access to the explosives
   - 7.3. Means for transporting explosives
   - 7.4. List of personnel allowed to handle the explosives
8. Exclusion zone and limited-entry zone for nonblast-related operations and personnel surrounding loading and blasting operations
9. Details of warning signals used to alert employees on the job site of an impending blast and to indicate the blast is completed and the area is safe to enter
10. Procedures for conducting blasting operations

11. Measures to protect blasting operations and personnel from lightning
12. Emergency evacuation procedures for areas where explosives may be present
13. Methods for recognizing, handling, and resolving misfires, including:
    13.1. Who will be notified
    13.2. How the blast zone will be secured until the misfire is resolved
    13.3. Identification of equipment that may be needed to resolve misfires
14. Details of signs to be used around blasting zones, including:
    14.1. Timing of when signs will be posted for a specific blast
    14.2. Name and telephone number of the person responsible for placing the signs
    14.3. Roadway signs for compliance with the *California MUTCD*, Chapter 6H, Typical Application 2
15. Traffic control details for:
    15.1. Loading and blasting operations
    15.2. Misfire event or other blast-related phenomenon that causes a transportation corridor to remain closed to the public
16. Description of the possible generation of noxious gas and details of the safeguards to be used to protect employees, work zones adjacent to the shot, private property, and the public
17. Procedure to report and resolve complaints for blast-related accidents
18. Copies of each SDS and manufacturer data sheets of explosives, caps, primers, initiators, and other compounds

If the plan requires revisions, the Department provides comments. Submit a revised plan after receiving the comments. Submit 3 copies of the revised blasting safety plan after authorization.

19-4.03A(4) Quality Assurance

Reserved

19-4.03B Materials

Not Used

19-4.03C Construction

You may use hydraulic splitters, pneumatic hammers, blasting, or another authorized roadway excavation method to fracture rock and construct stable final rock cut faces.

19-4.03D Payment

Not Used

19-4.04 CONTROLLED BLASTING

19-4.04A General

19-4.04A(1) Summary

Section 19-4.04 includes specifications for excavating rock by controlled blasting.

Blasting activities must comply with federal, State, and local blasting regulations, including 8 CA Code of Regs Ch 4, Subchapter 7, Group 18, "Explosives and Pyrotechnics," and 22 CA Code of Regs, Division 4.5, Ch 33, "Best Management Practices for Perchlorate Materials."

19-4.04A(2) Definitions

controlled blasting: Using explosives and blasting accessories in predetermined spaced and aligned drilled holes.

19-4.04A(3) Submittals

19-4.04A(3)(a) General

Reserved

19-4.04A(3)(b) Blasting Safety Plan

Submit 3 copies of your blasting safety plan. The plan must include:

1. References to applicable federal, State, and local codes and regulations
2. Copies of permits required for blasting activities

3. Business name, contractor license number, address, and telephone number of the blasting subcontractor
4. Proof of current liability insurance and bonding
5. Name, address, telephone number, copies of applicable licenses, and resume of:
   5.1. Blaster-in-charge.
   5.2. Personnel responsible for blast design, loading, and conducting blasting operations.
   5.3. Safety officer for the blasting subcontractor.
   5.4 Blast monitoring consultant.
   5.5 Blasting consultant if the project involves near-field blasting activities. Include a list of controlled blasting projects worked on by the blasting consultant.
6. Name, address, and telephone number of the local fire station and law enforcement agencies
7. Detailed description of:
   7.1. Location where explosives will be stored
   7.2. Security measures to protect and limit access to the explosives
   7.3. Means for transporting explosives
   7.4. List of personnel allowed to handle the explosives
8. Exclusion zone and limited-entry zone for nonblast-related operations and personnel surrounding loading and blasting operations
9. Details of warning signals used to alert employees on the job site of an impending blast and to indicate the blast is completed and the area is safe to enter
10. Procedures for conducting blasting operations
11. Measures to protect blasting operations and personnel from lightning
12. Emergency evacuation procedures for areas where explosives may be present
13. Methods for recognizing, handling, and resolving misfires, including:
    13.1. Who will be notified
    13.2. How the blast zone will be secured until the misfire is resolved
    13.3. Identification of equipment that may be needed to resolve misfires
14. Details of signs to be used around blasting zones, including:
    14.1. Timing of when signs will be posted for a specific blast
    14.2. Name and telephone number of the person responsible for placing the signs
    14.3. Roadway signs for compliance with the *California MUTCD*, Chapter 6H, Typical Application 2
15. Traffic control details for:
    15.1. Loading and blasting operations
    15.2. Misfire event or other blast-related phenomenon that causes a transportation corridor to remain closed to the public
16. Description of the possible generation of noxious gas and details of the safeguards to be used to protect employees, work zones adjacent to the shot, private property, and the public
17. Procedure to report and resolve complaints for blast-related accidents
18. Copies of each SDS and manufacturer data sheets of explosives, caps, primers, initiators, and other compounds

If the blasting safety plan requires revisions, the Department provides comments. Submit a revised plan after receiving comments. Submit 3 copies of the revised plan after authorization.

19-4.04A(3)(c) Controlled Blasting Plan

Submit 3 copies of your controlled blasting plan for each blast. The plan must include details on how each blast will be controlled and the following:

1. Blast identification by numerical and chronological sequence
2. Location, referenced to stationing, offset distance, date, and time of the blast
3. Drawings showing drill hole pattern, spacing, burden, and initiation sequence
4. Typical cross-sections through the zone to be blasted
5. Groundwater level, if present, within the prism to be blasted
6. Initiation-sequence diagram showing the actual firing time of each delay
7. Type of material to be blasted
8. Number of drill holes
9. Diameter, depth, and spacing of holes
10. Height or length of stemming

11. Types and characteristics of explosives, including the explosive's density, relative strength, and date of manufacture
12. Type of caps and delay periods and their date of manufacture
13. Total amount of explosives to be used
14. Total amount of explosives detonating within any 8 ms period
15. Powder factor (pounds of explosive per cubic yard of material blasted)
16. Method of firing
17. Direction and distance to nearest building or structure
18. Type of instrumentation and method for monitoring vibration and noise from the blasting activities
19. Location and placement of the instrumentation
20. Measures to limit noise and flyrock
21. Measures to limit overbreak
22. Name of the blasting subcontractor
23. Name and signature of the blaster-in-charge
24. Drawings showing the spacing and proximity of shot guards relative to the blast location

If you revise the controlled blasting plan to adjust for site conditions or the Department provides comments, submit a revised plan before starting controlled blasting. Submit 3 copies of the revised plan after authorization.

19-4.04A(3)(d) Preblast and Postblast Surveys

Submit a preblast survey of all structures, including buildings, within 330 feet of controlled blasting locations at least 15 days before starting the blasting activities. Submit the preblast survey with the controlled blasting plan.

The preblast survey must include:

1. Written report, sketches, and photographs or video with the date and time displayed on the image
2. Name of the person who performed the survey
3. Names of the property owner and occupants
4. Property address
5. Date and time of the inspection
6. Description of the structure or other improvements, including culverts and bridges
7. Detailed description of the existing condition of the walls, ceiling, and floor of each interior room, including any attic or basement
8. Detailed description of the existing condition of the foundations, exterior walls, roofs, doors, windows, and porches
9. Detailed description of the existing condition of garages, outbuildings, sidewalks, driveways, and swimming pools
10. Detailed listing of highway sign posts, light fixtures, and overhead power lines
11. Survey of wells or other private water supplies, including the total depth and existing water surface levels
12. Identification of sites conducting procedures, processes, or operations that may be sensitive to blasting activities
13. Scaled map or aerial photo showing the location of the structures and properties surveyed and the location of all proposed blasting sites

If blasting activities are suspended for 45 days or more, perform another preblast survey and submit the survey at least 15 days before resuming blasting activities.

Submit a postblast survey of the same buildings and other structures as in the preblast survey within 15 days after completing blasting activities. The postblast survey must include all items included in the preblast survey.

19-4.04A(3)(e) Vibration and Noise Monitoring Report

Submit a vibration and noise monitoring report for each controlled blast shot. The report must include:

1. Identification of the blasting seismograph used to record each blast shot
2. Name of the blast monitoring consultant
3. Distance and direction of the recording stations from the blast area

4. Type of ground at the recording station and type of material on which the instrumentation sits
5. Maximum particle velocity in each component and the resultant peak particle velocity of each shot
6. Copy of the seismograph readings with the date and signature of the blast monitoring consultant
7. Noise levels recorded in dB (C-network or Linear network) units

19-4.04A(3)(f) Video Recording

Submit a video recording of each controlled blast on a DVD or other Engineer-authorized data-storage device. Identify each video or section of the video with an index to identify each blast.

19-4.04A(3)(g) Blasting Complaint Report

Submit a report for each blasting complaint, including:

1. Name and address of the complainant
2. Date, time, and nature of the complaint
3. Dated photo or videotape of the physical damage
4. Name of the person who received the complaint
5. Record of the complaint investigation
6. Resolution of the complaint

19-4.04A(3)(h) Postblast Report

Submit a postblast report within 48 hours of a controlled blast. The report must include all data required in the controlled blasting plan for that shot and the following information:

1. Description of site conditions, loading, and time of blast
2. Description of weather conditions at time of blast including wind direction and cloud cover
3. Drillers boring record
4. Copy of vibration and noise monitoring report
5. Copy of documented complaints arising from the blast

19-4.04A(4) Quality Assurance

19-4.04A(4)(a) General

Reserved

19-4.04A(4)(b) Blaster-In-Charge for Controlled Blasting

Assign a blaster-in-charge to supervise all controlled blasting activities. The blaster-in-charge must have at least 10 years of experience in performing or supervising similar blasting activities and must be a licensed blaster.

19-4.04A(4)(c) Blast Monitoring Consultant for Controlled Blasting

Assign a blast monitoring consultant to monitor blasting-generated vibrations and noise near buildings and other structures that may be subject to damage. The monitoring consultant must be responsible for collecting and interpreting the vibration and noise data. The blast monitoring consultant must:

1. Not be employed by the blasting contractor or other subcontractor on the project
2. Have a minimum 2-year associate's degree in science or engineering
3. Have at least 5 years of documented experience in collecting and interpreting ground vibrations and noise data

19-4.04A(4)(d) Blasting Consultant for Controlled Blasting

Assign a blasting consultant to oversee near-field blasting activities. The blasting consultant must:

1. Be an engineering geologist or civil engineer who is licensed in the State
2. Have at least 10 years of experience providing specialized blasting services in near-field blasting
3. Not be employed by the blasting contractor, explosive manufacturer, or explosive distributor

19-4.04B Materials

Each seismograph used to record controlled blasting activities must be capable of:

1. Recording particle velocities for 3 mutually perpendicular components of vibration and an instantaneous resultant peak vector sum in the range generally found for controlled blasting
2. Continuously measuring, recording, and reporting vibrations along 3 primary axes
3. Measuring and recording vibration frequencies ranging from 2 to 300 Hz
4. Providing a printed record of each event showing a plot of peak particle velocity versus vibration frequencies
5. Measuring and recording airblast noise levels

The seismograph's noise transducer must be detachable from the main unit to allow its placement at elevations with a clear line of sight between the transducer and the blast.

19-4.04C Construction

19-4.04C(1) General

At least 7 days before starting or resuming controlled blasting activities, provide written notification to the occupants of the buildings within 330 feet of the blasting. Notify the occupants of pending blasting activities on the day of blasting.

Do not perform blasts within 1,200 feet of concrete placed within the previous 72 hours.

Before firing any blast, confirm that the groundwater conditions are consistent with the shot design and explosive type to be used.

Before firing any blast in areas where flyrock may result in personal injury or damage to property or the work, cover the rock to be blasted with blasting mats, soil, or other equally serviceable material to prevent flyrock.

If blasting causes flyrock, suspend blasting activities. The blasting consultant must review the job site to determine the cause of the flyrock problem and submit a revised controlled blasting plan that prevents flyrock.

Do not use drill cuttings as stemming in controlled blasting activities.

Keep vibration levels below a peak particle velocity of 2 inches per second at the nearest building, highway facility, or utility.

Limit noise from airblast overpressure levels to below 128 dB (C-scale or linear network) at the nearest building.

Control ground vibrations and noise created from blasting by using properly designed delay sequencing and charge weights for shots.

Provide 3 seismographs to record controlled blasting activities. Record each blast shot using the seismographs. Video record each blast from a safe location with a clear view of the blast area, activities, and progression.

Notify the Engineer no later than the start of the next day's work shift of any blasting complaint received.

19-4.04D Payment

Not Used

19-4.05–19-4.08 RESERVED

19-5 COMPACTION

19-5.01 GENERAL

Section 19-5 includes specifications for compacting all earthwork except structure backfill.

19-5.02 MATERIALS

Not Used

19-5.03 CONSTRUCTION

19-5.03A General

Relative compaction specifications apply to material whether in an excavation or an embankment.

The moisture content of material to be compacted to at least 95 percent must be such that the specified relative compaction is attained and the embankment is in a firm and stable condition.

Do not compact material that contains excessive moisture until the material is dry enough.

19-5.03B Relative Compaction (95 Percent)

Compact earthwork to a relative compaction of at least 95 percent for at least a depth of:

1. 0.5 foot below the grading plane for the width between the outer edges of shoulders
2. 2.5 feet below the finished grade for the width of the traveled way plus 3 feet on each side

Except for the outer 5 feet measured horizontally from the embankment side slope, compact the full width and depth of the embankment within 150 feet of each bridge abutment to at least 95 percent relative compaction. The 150-foot limit is measured horizontally from the bridge abutment and either parallel or concentric with the roadway centerline.

Compact earthwork to a relative compaction of at least 95 percent for embankments under retaining wall footings without pile foundations:

1. For the full depth of the embankment
2. Within the limits established by inclined planes sloping 1.5:1 (horizontal: vertical) out and down from lines 1 foot outside the bottom edges of the footing

19-5.03C Relative Compaction (90 Percent)

Compact earthwork to a relative compaction of at least 90 percent in embankment areas not required to be compacted to 95 percent.

19-5.03D Foundation Preparation

You are responsible for preparing the foundation to receive material.

You may excavate and replace basement material to facilitate compaction. Before you replace the basement material, if ordered, compact a layer below the excavated material to a depth, width, and degree of compaction ordered. The ordered work is change order work.

19-5.04 PAYMENT

If basement material is (1) placed in the embankment or used in other planned or authorized work and (2) replaced with planned excavated material or imported borrow, the replaced material is paid for at the item bid price for the type of excavation or imported borrow involved.

19-6 EMBANKMENT CONSTRUCTION

19-6.01 GENERAL

19-6.01A Summary

Section 19-6 includes specifications for constructing embankments.

Constructing embankments includes:

1. Preparing areas to receive embankment material
2. Placing and compacting embankment material including:
   2.1. Suitable material within roadway areas where unsuitable material has been removed
   2.2. Material in holes, pits, and other depressions within the roadway area
3. Constructing a temporary surcharge embankment above the grading plane
4. Constructing dikes

19-6.01B Definitions

Reserved

19-6.01C Submittals

For geosynthetic reinforced embankment, if you request the use of backfill with a gradation larger than the specified size submit test results for installation damage-reduction factors for each type of geosynthetic reinforcement under FHWA-NHI-00-044, section 5.1 with your LTDS calculations.

19-6.01D Quality Assurance

Reserved

19-6.02 MATERIALS

19-6.02A General

Embankment material must be excavated material from excavations or from local or imported borrow.

Material for embankment areas where piles are to be placed or driven, must not contain rocks, broken concrete, or other solid materials larger than 4 inches in greatest dimension.

Do not place borrow or excavation material having a sand equivalent value less than 10 within 2.5 feet of finished grade.

19-6.02B Geosynthetic Reinforced Embankment

Each geosynthetic reinforcement roll must be labeled with:

1. Manufacturer's name
2. Production identification
3. Roll dimensions
4. Lot number
5. Date of manufacture

The backfill for geosynthetic reinforced embankment must be free from:

1. Organic material
2. Shale, soft, or poor-durability particles
3. Recycled materials such as glass, shredded tires, concrete rubble, or other unsuitable materials
4. Loose or extraneous material and sharp objects that may come in contact with the geosynthetic reinforcement

The backfill must comply with the gradation requirements shown in the following table:

Sieve size	Percent passing
1-1/2"	100
3/4"	75–100
No. 4	20–100
No. 40	0–60
No. 200	0–50

The backfill must comply with the quality characteristics shown in the following table:

Quality characteristic	Test method	Requirement
Plasticity index (max)	California Test 204	20
pH	California Test 643	5–9

If authorized, you may backfill with a gradation larger than the specified size up to a 4 inch maximum.

19-6.03 CONSTRUCTION

19-6.03A General

Compact embankment under section 19-5.

Construct embankment slopes under section 19-2.03G.

Scarify, water, grade, and roll the existing roadbed before placing new material if you construct an embankment on an existing roadway.

If you construct an embankment against a slope, prepare original ground or embankment slopes by cutting into it at least 6 feet horizontally as you place the new embankment in layers. Compact the cut material along with the new embankment material.

For bridge footings constructed in an embankment, construct the embankment to the grading plane elevation and extend the finished slope to the grading plane before:

1. Excavating for footings
2. Driving piles or drilling holes for CIP piles

The grading plane of embankments beneath structure approach slabs and beneath the thickened portion of sleeper slabs must not project above the grade established by the Engineer.

Grade trenches, holes, depressions, and pits outside of areas where embankments are to be constructed to provide a presentable and well-drained area.

19-6.03B Subsidence

If there is a bid item for embankment or imported borrow, you may compact the ground surface on which an embankment is to be constructed before placing embankment material.

If the compaction results in an average subsidence exceeding 0.25 foot, the Engineer measures the ground surface after compaction. Allow time for the measurements before placing the embankment material.

The Engineer determines the additional quantity of material for embankment work due to subsidence by the average end areas from the original measurement and the final measurements.

If a quantity is specified for either embankment or imported borrow for the anticipated effect of subsidence and you do not agree with this specified quantity, you may submit a plan for measuring the subsidence. The plan must include complete details of the measuring devices and their installation.

If your plan for measuring subsidence is authorized, install and maintain the subsidence-measuring devices.

The Engineer takes readings as needed to determine the progress of subsidence. Help the Engineer as ordered.

If the Engineer finds a damaged device, that device is not used for determining subsidence in the area the device represents. The subsidence for that area is considered zero regardless of the subsidence measured at other areas.

Subsidence is considered zero at:

1. Intersection of the side slope and end slope at structures with the ground line as established by the original cross sections
2. Points on the cross sections 50 feet beyond the start and end of the area equipped with subsidence-measuring devices unless the Engineer agrees otherwise

After final measurements are made, remove the detachable elements of the subsidence-measuring devices.

The additional payment quantity of material for embankment work due to subsidence is the volume determined by the average end areas from the original measurement and the final measurements, including zero subsidence at specific areas.

19-6.03C Placing and Compacting

Do not construct embankments when material is frozen or a blanket of snow prevents proper compaction.

Construct embankment in layers. The loose thickness of each layer must not exceed 8 inches.

Break up clods or hard lumps of earth that are over 8 inches in greatest dimension before compacting material in the embankment, unless material such as hardpan or cemented gravel, cannot be broken readily in which case:

1. Distribute the material throughout the embankment
2. Place enough earth or other fine material around the larger material as you deposit it to fill the interstices and produce a dense, compact embankment

If embankment material contains rock, the loose thickness of each layer of embankment material before compaction below a plane 3 feet below finished grade must comply with the following requirements:

1. If embankment material contains over 50 percent by volume of rock larger than 8 inches in greatest dimension, the loose thickness of each layer must not exceed the maximum size of rock in the material.
2. If embankment material contains from 25 to 50 percent by volume of rock larger than 8 inches in greatest dimension, the loose thickness of each layer must not exceed the maximum size of rock or 3 feet, whichever is less.
3. If embankment material contains less than 25 percent by volume of rock larger than 8 inches in greatest dimension, the loose thickness of each layer must not exceed 8 inches in the area between the rocks larger than 8 inches.

Reinforcement or metal attached to reinforced concrete rubble placed in embankments must not protrude above the grading plane. Trim reinforcement or metal to less than 3/4 inch from the face of the reinforced concrete rubble material before placing the material within 2 feet below the grading plane.

In a sidehill embankment where the width, including bench cuts for bonding existing and new embankments, is too narrow to accommodate mobile power-compacting equipment, you may place the material by end dumping if authorized.

If end dumping is allowed for constructing an embankment against existing slopes or 1/2 the embankment width at a time, plow or cut the slopes of the original ground or embankment before starting end dumping.

Where embankments are constructed across low, swampy ground that cannot support the weight of hauling equipment, you may construct the lower part of the embankment by dumping successive loads in a uniformly distributed layer that can support the equipment for placing subsequent layers.

Construct embankments such that each layer has a cross fall of less than 5 percent.

At locations where it is impractical to use mobile power-compacting equipment, compact the embankment layers by any method that attains the specified compaction.

19-6.03D Settlement Periods and Surcharges

If an embankment settlement period is specified, construct the embankment to at least the grading plane and to the limits described for:

1. Distance of at least 150 feet measured parallel to the centerline of the roadway from each bridge abutment
2. Entire length of a retaining wall and a width of at least 30 feet from the face of the wall

If a surcharge is specified, place the surcharge in uniform layers. Compact the surcharge by routing the grading equipment across the full width.

Prevent the embankment and any surcharge from encroaching upon the traveled way or existing improvements.

The settlement period starts after the embankment and any specified surcharge construction is complete.

If ordered, install settlement platforms. The installation is change order work.

The surcharge must remain in place until the end of the specified settlement period or as ordered.

Before the end of the settlement period, do not:

1. Excavate for abutments, bent footings, wingwalls, or retaining wall footings
2. Drive or drill holes for foundation piles

Remove any surcharge material.

Remove surcharge material above the grading plane. Compact the embankment below the grading plane before placing the subsequent layers of subbase or base.

19-6.03E Geosynthetic Reinforced Embankment

Place geosynthetic reinforcement within 3 inches of the design elevations.

Place at least 3 inches of compacted backfill between the layers of reinforcement shown.

Geosynthetic reinforcement must be:

1. Secured with staples, pins, or small piles of backfill
2. Placed without wrinkles
3. Aligned with the primary strength direction perpendicular to slope contours
4. Spliced under the manufacturer's instructions
5. Butted edge-to-edge for straight slope contours
6. Butted edge-to-edge at the slope face and fanned out or overlapped into the backfill for curved slope contours

Cover the geosynthetic reinforcement with backfill within the same work shift.

Place at least 6 inches of backfill on the reinforcement before operating or driving equipment or vehicles over it, except, you may drive equipment or vehicles for spreading backfill directly on the reinforcement if you:

1. Comply with the manufacturer's instructions
2. Use rubber-tire vehicles
3. Minimize traffic repetitions
4. Maintain a speed less than 5 mph
5. Avoid sudden braking and sharp turning

Where guardrail posts will be placed at the top crest of a geosynthetic-reinforced embankment and the geosynthetic reinforcement interferes with the placement of posts, you may precut the affected layers of the reinforcement into cross-shaped patterns. The precutting dimensions must not exceed the post dimensions by more than 12 inches.

Do not extend geosynthetic reinforcement into the pavement structure.

Repair any damaged reinforcement by placing additional reinforcement to cover the damaged area as follows:

1. For reinforcement placed parallel to slope contours, overlap 5 aperture openings or 8 inches whichever is greater
2. For reinforcement placed perpendicular to slope contours, splice the edges under the manufacturer's instructions

Grade and compact the backfill to ensure the reinforcement remains taut.

Compact the backfill to a relative compaction of at least 90 percent. If hand-operated equipment is used, do not place more than 6 inches of backfill before compaction.

Use hand-operated equipment to compact areas within 3 feet of:

1. Slope contours
2. Underground structures

Do not disk or plow in the reinforced area.

19-6.04 PAYMENT

If ordered to cut into a slope more than 6 feet, the excavated material in excess of 6 feet is paid for as roadway excavation.

If there is a bid item for embankment shown on the Bid Item List, the payment quantity for embankment is the volume determined from the planned or authorized cross sections and the measured ground surface.

The Department does not increase the embankment quantity if subsidence or consolidation occurs after you start placing the embankment material.

19-7 BORROW MATERIAL

19-7.01 GENERAL

19-7.01A Summary

Section 19-7 includes specifications for obtaining local and imported borrow material for embankment construction.

The payment quantity for imported borrow does not include aggregate base placed to fill low areas.

19-7.01B Definitions

Reserved

19-7.01C Submittals

Reserved

19-7.01D Quality Assurance

Notify the Engineer before opening any imported borrow material site so that the Department may test the material.

19-7.02 MATERIALS

19-7.02A General

Borrow material must be:

1. Suitable for the purpose intended
2. Free of unsuitable material including organic matter

19-7.02B Local Borrow

Reserved

19-7.02C Imported Borrow

Imported borrow must be free of man-made refuse, such as:

1. Concrete
2. Asphalt concrete
3. Residue from grooving and grinding operations
4. Metal
5. Rubber
6. Mixed debris
7. Rubble

19-7.03 CONSTRUCTION

19-7.03A General

Clear, grub, and strip borrow sites if necessary.

Excavate, load, and if necessary haul borrow material.

Construct embankments under section 19-6.

19-7.03B Local Borrow

Obtain local borrow such that no scar or unsightly appearance is generated.

19-7.03C Imported Borrow

Before placing imported borrow in embankments, ensure enough space is available in embankment locations for placing planned or designated excavated material from the job site.

19-7.04 PAYMENT

The payment quantity for imported borrow paid by theoretical volume basis is the volume determined from the planned or authorized cross section for embankments and the measured ground surface adjusted by subtracting the theoretical quantities of material from excavations.

The theoretical quantity of materials from excavations used in embankments is determined by summing the quantities for roadway excavation, structure excavation, and ditch excavation and then by multiplying the quantities by the grading factor.

The grading factor used for excavated materials for determining payment quantity for imported borrow is 1.0.

If import borrow site is only being used for 1 project, you may request that import borrow be measured and paid based on borrow site cross sections and the following:

1. Notify the engineer before opening any imported borrow material site so the Department may take cross-section elevations and measurements of the ground surface after clearing, grubbing and any stripping.
2. The payment quantity for imported borrow paid by the cubic yard is the volume determined from the average areas and the distances between them.
3. Areas and distances used to determine the volume are those from the material site before and after the imported borrow is excavated.

19-8 RESERVED

19-9 SHOULDER BACKING

19-9.01 GENERAL

Section 19-9 includes specifications for constructing shoulder backing adjacent to the edge of new pavement surfacing.

19-9.02 MATERIALS

Shoulder backing must be clean and consist of one or any combination of the following materials:

1. Broken stone
2. Crushed gravel
3. Natural rough surfaced gravel
4. Sand
5. RAP
6. Concrete
7. LCB
8. CTB

Shoulder backing must be graded within the percentage passing limits shown in the following table:

Sieve size	Percentage passing
2"	100
1"	75–100
3/4"	65–100
No. 4	35–60
No. 30	10–35
No. 200	5–15

If 100 percent RAP is used, shoulder backing must be graded within the percentage passing limits shown in the following table:

Sieve size	Percentage passing
1-1/2"	100
3/4"	70–100
No. 4	30–80

Shoulder backing must comply with the sand equivalent requirements shown in the following table:

Quality characteristics	Test method	Requirement
Sand Equivalent		
Single type of material except RAP	California Test 217	10-35
Combination of all type of materials including RAP		10-35
Combination of all type of materials excluding RAP		10-30
100% RAP (min)		10

If a combination of broken stone, crushed gravel, natural rough-surfaced gravel, and sand is used, shoulder backing must comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Percentage crushed particles (min, %)[a]	California Test 205	
1 fractured face		75
2 fractured faces		50
Durability index	California Test 229	25

[a]Applies to material retained on no. 4 sieve only

When tested under California Test 212 using the rodding method, the minimum unit weight of shoulder backing must be 105 lb/cu ft, except if shoulder backing consists of 100 percent RAP this requirement does not apply.

19-9.03 CONSTRUCTION

Do not place shoulder backing containing RAP within 100 feet measured horizontally from a culvert, watercourse, or bridge.

Remove weeds, grass, and debris from the area to receive shoulder backing.

Scarify the basement material to receive shoulder backing at least 0.25 foot deep and water immediately before placing the shoulder backing.

Place and spread shoulder backing directly on the basement material. After placing the shoulder backing, water and compact it with a minimum of 2 passes with a steel-tired roller weighing at least 8 tons. Wherever the total thickness of shoulder backing is more than 6 inches, place the backing under sections 19-5 and 19-6. Form smooth and uniform cross sections and slopes.

Do not deposit shoulder backing on new pavement.

Complete shoulder backing within 5 days after placement of adjacent new surfacing except complete shoulder backing within 15 days wherever edge treatment under section 39-2.01C(5) is placed.

Before opening a lane adjacent to uncompleted shoulder backing, place portable delineators and W8-9, Low Shoulder, signs off of and adjacent to the new pavement surfacing.

Portable delineators and signs must comply with section 12 except the signs may be set on temporary portable supports or on barricades.

Place portable delineators at the beginning and along the drop-off of the edge of pavement in the direction of travel, at maximum intervals of 500 feet on tangents and 200 feet on curves.

Place the W8-9 signs at the beginning and along the drop-off of the edge of pavement in the direction of travel, at maximum intervals of 2,000 feet.

Remove portable delineators and W8-9 signs when the shoulder backing is complete in that area.

19-9.04 PAYMENT

Not Used

19-10 SUBGRADE ENHANCEMENT GEOSYNTHETIC

19-10.01 GENERAL

Section 19-10 includes specifications for placing subgrade enhancement geosynthetic between the subgrade and pavement structure.

Subgrade enhancement geosynthetic includes subgrade enhancement geogrid and subgrade enhancement geotextile.

19-10.02 MATERIALS

Subgrade enhancement geogrid must be biaxial geogrid.

A polyester geotextile must not be used for subgrade enhancement geotextile within 4 inches of recycled concrete.

19-10.03 CONSTRUCTION

19-10.03A General

Before placing subgrade enhancement geosynthetic, remove loose or extraneous material and sharp objects that may come in contact with the geosynthetic.

Place the geosynthetic:

1. Under manufacturer's instructions
2. Longitudinally along the roadway alignment
3. Without wrinkles

Overlap the adjacent edges of the rolls at least 2 feet. Overlap the ends of rolls at least 2 feet in the direction you spread the material covering the subgrade enhancement geosysnthetic.

You may fold or cut the geosysnthetic to conform to curves. Overlap any cut material at least 2 feet. Hold the overlap in place with staples, pins, or small piles of material placed on the subgrade enhancement material.

Make any repairs by placing a new piece of material over the damaged area with at least 3 feet of overlap from the edges of the damaged area.

Compact the AB with either a (1) smooth wheeled roller with no vibrations or (2) rubber tire roller

Do not stockpile material on the geosynthetic or place more geosynthetic than can be covered within 72 hours.

Do not operate equipment or vehicles directly on geosynthetic, except you may operate vehicles and equipment on geogrid if one of the following conditions is met:

1. Vehicles and equipment are:
   1.1. Equipped with rubber tires
   1.2 Operated under 10 mph
   1.3 Operated in a manner to avoid sudden braking and sharp turns
2. At least 0.35 feet of AB has been placed, spread, and compacted on the geogrid

19-10.03B Subgrade Enhancement Geotextile

Do not:

1. Compact it with a sheepsfoot or other nonsmooth roller
2 Turn vehicles on material placed directly over geotextile

Before operating equipment on areas where geotextile has been placed, spread and compact 0.5 feet of material on the geotextile.

19-10.04 PAYMENT

The payment quantity for subgrade enhancement geogrid and subgrade enhancement geotextile is the area measured parallel to the surface, not including the additional quantity used for overlaps.

19-11–19-30 RESERVED

20 LANDSCAPE

20-1 GENERAL

20-1.01 GENERAL

20-1.01A Summary

Section 20 includes general specifications for performing landscaping work.

Perform roadside clearing:

1. As required to prepare the job site for construction work
2. Until the start of the plant establishment work or Contract acceptance, whichever comes first

Check for plant deficiencies under section 20-10.03A(4) before installing any irrigation system in an existing planting area to be maintained.

Unless a supply line is shown through plant holes, relocate any plant hole to clear a supply line.

Do not install supply lines, control and neutral conductors, and electrical conduits in common trenches above each other.

20-1.01B Definitions

Reserved

20-1.01C Submittals

At least 15 days before applying any pesticide, submit a copy of the pest control adviser's recommendation.

At the end of each week, submit a Report of Chemical Spray Operations form as an informational submittal documenting the application of all pesticides.

Before mixing a pesticide, submit a copy of the registered label for the pesticide as an informational submittal. If you are unable to copy the label, allow the Engineer to read the label on the container.

20-1.01D Quality Assurance

20-1.01D(1) General

Obtain a recommendation for the use of all pesticides under the Food & Agri Code from a pest control adviser who is licensed as an agricultural pest control adviser in the State. The recommendation must include the pesticides to be used, rates of application, methods of application, and application areas.

The pesticide applicator must have an active and valid qualified applicator license or certificate from the Department of Pesticide Regulation.

20-1.01D(2) Progress Inspections

The Engineer performs progress inspections:

1. After marking plant locations
2. Before cultivating work starts
3. Before pressure testing of irrigation pipe on the supply side of control valves
4. Before testing of low voltage control and neutral conductors
5. During irrigation system functional tests
6. Before planting the plants
7. Before completion of planting work
8. Before the start of plant establishment work
9. Once a month during the plant establishment period

Notify the Engineer at least 4 business days before each inspection is required. Allow at least 3 business days for the Engineer's inspection.

Do not proceed with the next construction activity until the inspection has been completed and any required corrective work has been performed and authorized.

20-1.02 MATERIALS

20-1.02A General

Reserved

20-1.02B Water

Unless there is a bid item for irrigation water service charges, the Department furnishes water if it is available from an existing Department-owned facility within the project limits or an irrigation system to be installed under the Contract.

If water is not available from one of these sources, make arrangements for supplying water. Water must be of a quality that promotes plant growth.

20-1.02C Pesticides

Pesticides must comply with the regulations of the Department of Pesticide Regulation.

Insecticide must be imidacloprid.

Rodenticides must be brodifacoum, bromadiolone, or diphacinone.

Do not use pelleted forms of pesticides for weed control.

For weed control, use a pesticide with a photosensitive dye that produces a contrasting color when sprayed on the ground. The color must disappear within 2 to 3 days after being applied. The dye must not stain surfaces or injure plants or wildlife when applied at the manufacturer's recommended application rate.

20-1.02D–20-1.02H Reserved

20-1.03 CONSTRUCTION

20-1.03A General

Take precautions to prevent irrigation water from:

1. Wetting vehicles, pedestrians, and pavement
2. Eroding soil
3. Causing excess runoff

If water use calculations are provided as supplemental project information, water plants under the Model Water Efficient Landscape Ordinance, 23 CA Code of Regs § 490 et seq., and local water agency provisions.

Water plants at night unless otherwise authorized.

Dispose of removed, pruned, and damaged vegetative material.

You may reduce removed vegetative material to chips with a maximum thickness of 1/2 inch and spread it within the job site at locations determined by the Engineer. Do not substitute chipped material for wood mulch or place it in areas to receive wood mulch.

20-1.03B Pesticides

Notify the Engineer of pesticide application times at least 24 hours before each application.

Mix and apply pesticides under the regulations of the Department of Pesticide Regulation and the instructions on the pesticide product label.

Do not apply pesticides:

1. On Saturdays and holidays unless authorized
2. Whenever weather and wind conditions are unsuitable for application
3. Within the plant basin
4. On the foliage and woody parts of the plant

Any granular preemergent must be covered with mulch on the same work day. Do not apply granular preemergent in plant basins.

Do not apply preemergents:

1. To groundcover plants within 3 days after planting
2. Within 18 inches of trees, shrubs, and seeded areas
3. Before plants have been thoroughly watered

20-1.03C Roadside Clearing

20-1.03C(1) General

Roadside clearing includes:

1. Removing existing plants described to be removed
2. Controlling rodents, insects, and weeds

Control rodents by using rodenticides or traps.

20-1.03C(2) Remove Existing Plants

Removal of existing plants includes removing their stumps and roots 2 inches or larger in diameter to a minimum depth of 12 inches below finished grade. Backfill holes resulting from stump removal to the finished grade with material obtained from adjacent areas.

If a plant is to be planted within an existing groundcover area, remove the existing groundcover from within an area 6 feet in diameter centered at each plant location.

20-1.03C(3) Weed Control

Control weeds by the use of pesticides, hand-pulling, or mowing.

If pesticides are used to control weeds, apply pesticides before the weeds reach the seed stage of growth or exceed 4 inches in length, whichever occurs first. Do not use pesticides at cutting plant locations.

Where cuttings are to be planted, control weeds by hand-pulling within an area 2 feet in diameter centered at each plant location.

If weeds are to be controlled by hand-pulling, hand-pull weeds before they reach the seed stage of growth or exceed 4 inches in length, whichever occurs first.

Where liner, plug, or seedling plants are to be planted 10 feet or more apart, control weeds by the use of pesticides or hand-pulling within an area 2 feet in diameter centered at each plant location. Where liner, plug, or seedling plants are to be planted less than 10 feet apart, control weeds by the use of pesticides within the entire area.

Control weeds by mowing outside of mulched areas, plant basins, groundcover areas, and within areas to be seeded. Mowing must extend to the edges of pavement, dikes, curbs, sidewalks, walls, and fences.

If mowing is to be performed within areas to be seeded, perform mowing as needed until the start of the seeding activity.

Perform mowing before the weeds reach the seed stage of growth or exceed 6 inches in length, whichever occurs first. Mow weeds to a height of 3 inches.

20-1.03C(4) Disposal of Removed Groundcover, Weeds, and Mowed Material

Dispose of hand-pulled weeds the same day they are pulled. Dispose of removed groundcover within 3 days.

Dispose of mowed material from the initial mowing. Disposal of material from subsequent mowing is not required.

20-1.03D Cultivation

Cultivation must be by mechanical methods and performed until the soil is in a loose condition to a minimum depth of 6 inches. Soil clods must not be larger than 2 inches in maximum dimension after cultivation.

The areas to be cultivated must extend 12 inches beyond the outer limit of each planting area requiring cultivation.

After initial cultivation, place soil amendment and fertilizer at specified rates.

Recultivate to thoroughly mix native soil and amendments.

Do not drive on cultivated areas after cultivation.

Planting areas that have been cultivated and become compacted must be recultivated.

Rocks and debris encountered during soil preparation in planting areas must be brought to the ground surface.

Remove rocks and debris as ordered. This work is change order work.

20-1.03E Weed Germination

Reserved

20-1.03F–20-1.03K Reserved

20-1.04 PAYMENT

The payment quantity for landscape bid items paid for by the area is the area measured parallel to the ground surface.

The payment quantity for cultivation includes the area not cultivated within the cultivation area shown.

20-2 IRRIGATION

20-2.01 GENERAL

20-2.01A General

20-2.01A(1) Summary

Section 20-2.01 includes general specifications for installing irrigation systems.

The irrigation systems shown are diagrammatic.

20-2.01A(2) Definitions

Reserved

20-2.01A(3) Submittals

20-2.01A(3)(a) General

Submit shop drawings for the electrical components of the irrigation system except electric service (irrigation) 30 days before installation. The drawings must:

1. Include schematic wiring diagrams showing wire sizes and routes between electrical components
2. Show conduit sizes
3. Bear the written approval of the controller manufacturer or the manufacturer's authorized agent
4. Be accompanied by:
   4.1. Colored wire and splice samples
   4.2. Manufacturer's descriptive and technical literature

20-2.01A(3)(b) Manufacturer's Instructions

Submit the manufacturer's installation instructions as an informational submittal at least 15 days before installing:

1. Couplings for conduits used for irrigation conduits
2. Plastic pipe and fittings
3. Solvent cement for plastic pipe and flexible hose
4. Sprinklers
5. Flow sensors
6. Rain sensors
7. Remote control valves
8. Backflow preventers

20-2.01A(4) Quality Assurance

20-2.01A(4)(a) General

Reserved

20-2.01A(4)(b) Pressure Testing

20-2.01A(4)(b)(i) General

Perform pressure testing for leakage on irrigation supply lines:

1. In the Engineer's presence
2. On business days from 8 a.m. to 5 p.m. unless authorized
3. Before backfilling supply line trenches
4. With irrigation system gate valves open
5. With open ends of the supply line and fittings plugged or capped

Notify the Engineer at least 48 hours before performing a pressure test.

Perform pressure testing using Method A or B to test supply lines installed by trenching and backfilling and supply lines that are completely visible after installation.

Perform pressure testing using Method A to test all other supply lines, including those installed in the ground by methods other than trenching and backfilling.

Test irrigation supply line in conduit by Method A with the testing period modified to 0.5 hour and no allowable pressure drop.

20-2.01A(4)(b)(ii) Method A

For Method A pressure testing for leakage:

1. Calibrate the pressure gauge from 0 to 200 psi in 5 psi increments. Pressure gauge must be accurate to within a tolerance of 2 psi.
2. Fill the supply line with water and connect the line to a pressure gauge. Place the pipeline under a pressure of 125 psi. Remove the source of pressure and leave the line under the required pressure.
3. Test the supply line under the required pressure for a period of 1 hour. The pressure gauge must remain in place until each test period is complete.
4. Leaks that develop in the tested portion of the system must be located and repair after each test period if a drop of more than 5 psi is indicated by the pressure gauge. After the leaks have been repaired, repeat the 1-hour pressure test until the drop in pressure is 5 psi or less.

For a system consisting of a new supply line connected to an existing line, the new supply line must be isolated from the existing line and tested.

20-2.01A(4)(b)(iii) Method B

For Method B pressure testing for leakage:

1. Turn on the water and maintain at full pressure from the water source for a period not less than 8 consecutive hours after all the air has been expelled from the line for the portion of the supply line on the upstream side of the control valve to be backfilled. Perform the same test for a period not less than 1 hour for the portion of the supply on the downstream side of the control valve to be backfilled.
2. Repair leaks that develop in the tested portion of the system. After the leaks have been repaired, repeat the pressure test until no leaks occur.

20-2.01A(4)(c) Sprinkler Coverage Check

After installation of the sprinklers, check and adjust the entire sprinkler system for proper orientation and uniform coverage.

20-2.01A(4)(d) Irrigation System Functional Tests

The functional tests for each irrigation controller or group of controllers and associated irrigation system served by a single electric service point must consist of at least 1 complete cycle of operation. The Engineer determines the length of the cycle.

Perform a functional test for each irrigation system:

1. Before planting the plants
2. After planting the plants
3. Before the start of the plant establishment work

20-2.01A(4)(e) Final Irrigation System Check

Perform the final check of the existing and new irrigation system 20 to 30 days before Contract acceptance. The Engineer determines the length of the cycle.

Remote control valves connected to existing and new irrigation controllers must be checked for automatic operation when the controllers are in automatic mode.

20-2.01B Materials

20-2.01B(1) General

Concrete for replacing concrete facilities must be minor concrete.

HMA for replacing asphalt concrete surfacing and facilities must comply with section 39 except you may use minor HMA only if authorized.

20-2.01B(2) Garden Valves

Each garden valve must:

1. Be the inverted nose type and of brass or bronze construction with a female thread inlet
2. Have a replaceable seat washer, a rising valve stem within a protective collar, and a male thread hose outlet
3. Have a loose key handle

20-2.01B(3) Recycled Water Identification

Irrigation components used for recycled water must be manufactured or painted purple. Recycled water irrigation pipe and tubing must have a permanent label with the wording *CAUTION: RECYCLED WATER* every 24 inches in 2 rows spaced approximately 180 degrees apart in the longitudinal direction of the pipe or tubing.

The recycled water warning sign must be a decal or a decal attached to a 1/16-inch-thick aluminum plate or tag.

Each warning sign decal must:

1. Show the phrase *Recycled Water, Do Not Drink* and the drinking-glass graphic symbol
2. Be UV fade and weather resistant and manufactured from flexible vinyl with or without mylar
3. Have a purple background, black text, and self-adhesive backing

Each warning tag must:

1. Show the phrase *RECYCLED WATER* and the drinking-glass graphic symbol
2. Be UV fade and weather resistant
3. Be purple, double-sided, and manufactured from polyurethane
4. Have an integral neck attachment and attachment hole capable of withstanding 178 lb of pull-out resistance
5. Have hot-stamped black lettering

Posts and hardware for the warning signs must comply with section 82-3.

Concrete sprinkler protectors used with recycled water must be painted purple.

20-2.01B(4) Location Markers

Location markers must be schedule 40 white PVC plastic pipe.

20-2.01B(5) Pull Boxes

Pull boxes must comply with section 86 and be no. 5 or larger. Pull boxes for low voltage conductors must not have side openings.

Pull box covers used solely for irrigation electrical service must be marked *IRRIGATION*.

20-2.01B(6) Unions

Unions must be brass or malleable iron capable of withstanding the maximum required working pressure.

20-2.01B(7) Valve Boxes and Covers

Valve boxes must be precast concrete.

Covers must be:

1. Concrete, steel, or cast iron
2. Marked *WATER* in cast-in letters not less than 1 inch high unless shown
3. 1 piece, except 2 pieces are required if the weight of the valve box cover exceeds 35 lb

Valve box covers must be labeled. Labels must:

1. Be predrilled plate plastic consisting of 2 layers of contrasting color
2. Be at least 1/8 inch thick
3. Have mechanically engraved inscriptions at least 1 inch high

Covers for valve boxes that contain remote control valves must be labeled with the controller and station.

Covers for valve boxes that contain irrigation equipment must be labeled with the standard abbreviation for that equipment

20-2.01B(8) Wye Strainers

Wye strainers, except those used for drip valve assemblies, must:

1. Have a cast iron or all bronze body
2. Have a removable stainless steel strainer screen with 40-mesh woven wire
3. Have a 20-mesh woven wire screen or perforated sheet with 0.045-inch-diameter holes when on a backflow preventer assembly
4. Be capable of withstanding a working pressure of 150 psi
5. Be equipped with a garden valve at the outlet

20-2.01C Construction

20-2.01C(1) General

Immediately shut off water to broken pressurized irrigation components. Repair irrigation systems within 24 hours after a malfunction or damage occurs.

Connect underground metallic pipes, valves, or fittings made of dissimilar metals through a dielectric coupling or bushing.

You may install conduits, conductors, and supply lines by methods other than trenching provided that they are not damaged and are installed at the depths described.

20-2.01C(2) Trenching and Backfilling

For a project with multiple water service points, excavate and backfill the trenches 1 service point at a time.

Remove rocks and debris encountered during trenching activity. The removal of rocks and debris is change order work.

Backfill each trench with material that is excavated from the trench. Each trench must have a uniform bearing throughout the entire length and must be free of jagged rubble, rock, broken concrete, asphalt concrete and sharp objects greater than 2 inches in greatest dimension.

Compact the backfill in the trench to a minimum relative compaction of 90 percent. If the trench backfill settles, place additional material and compact until the backfill is level with the surrounding grade.

Ensure conduit, supply line, and joints are not moved or damaged by backfill activity.

If trenching requires the removal of:

1. Plants:
   1.1. Remove plants as necessary under section 20-1.03C.
   1.2. If plants are to remain, adjust the trench alignment to minimize damage.
   1.3. If the supply line location interferes with the excavation of plant holes, relocate the plant hole away from the supply line.
   1.4. Where authorized by the Engineer, prune trees and shrubs as necessary to complete the trenching work.
2. Turf:
   2.1. Do not remove a width of more than 12 inches.
   2.2. Replace with sod under section 20-3.02C(3)(e).
3. Groundcover:
   3.1. Do not remove a width of more than 6 feet.
   3.2. Replace groundcover with plants from flats and plant at 12 inches on center under section 20-3.02C.
   3.3. You may rototill existing *Carpobrotus* and *Delosperma.* Backfill for the trenches must not contain plants longer than 6 inches. No replacement of *Carpobrotus* and *Delosperma* is required if removed by rototilling.
4. Existing surface:
   4.1. Make a minimum 2-inch-deep saw cut along neat lines around the perimeter of the pavement to be removed at locations determined by the Engineer.
   4.2. Place a minimum of 2 inches of sand bedding under and on top of supply lines and conduits.
   4.3. Compact the backfill under the replacement surfacing to a minimum relative compaction of 95 percent.
   4.4. Replace the structural section to match the removed materials. The surface must have the same uniform smoothness, color, and texture as the adjacent surface.

If trenching in areas to receive new surfacing:

1. Place a minimum of 2 inches of sand bedding under and on top of supply lines and conduits.
2. Compact the backfill under the new surfacing to a minimum relative compaction of 95 percent.

20-2.01C(3) Pull Boxes

Install pull boxes under section 87 at the following locations:

1. At all conductor splices except splices made in valve boxes
2. Within 5 feet of irrigation controllers
3. At ends of electrical conduits
4. At other locations shown

20-2.01C(4) Valve Boxes and Covers

In walkways and paved areas, install the top of the valve box flush with the surrounding finished grade.

20-2.01C(5) Recycled Water Warning Signs

Install recycled water warning signs on irrigation facilities that use recycled water.

Install sign decals directly to clean, smooth surfaces. Clean the surface with alcohol or an equivalent cleaner before applying the decal.

Install a 4-by-4-inch warning sign decal to each:

1. Backflow preventer assembly
2. Irrigation controller enclosure cabinet door

Install a 2-by-2-inch warning tag to each remote control valve and valve box cover.

Install a 2-1/2-by-3-inch sign decal to each sprinkler riser.

Under local regulations, install a 12-by-12-inch warning sign decal on an aluminum plate and attach to gates, fences, and walls located in the vicinity of a recycled water irrigation system. On gates and fences, install signs with S hooks and C clips or 14-gauge galvanized steel wire. On concrete walls or other rough surfaces, install signs with a silicon-based adhesive. In open areas, install signs on metal posts under section 82-3.

20-2.01C(6) Garden Valves

Furnish 3 keys before Contract acceptance.

20-2.01D Payment

Not Used

20-2.02 BACKFLOW PREVENTER ASSEMBLIES

20-2.02A General

20-2.02A(1) Summary

Section 20-2.02 includes specifications for installing backflow preventer assemblies.

20-2.02A(2) Definitions

Reserved

20-2.02A(3) Submittals

Reserved

20-2.02A(4) Quality Assurance

Each backflow preventer assembly must be certified by a backflow preventer tester. The tester must have an active and valid certification from the water purveyor having jurisdiction.

If the local water purveyor does not have a certification program, the tester must be certified by AWWA or a nearby county with a certification program.

Notify the Engineer at least 5 business days before certifying the backflow preventer assembly.

Certify each backflow preventer assembly annually and within 10 days of Contract acceptance.

20-2.02B Materials

20-2.02B(1) General

Each backflow preventer assembly must include:

1. Backflow preventer including gate valve, wye strainer, brass or malleable iron unions, fittings, and supports
2. Blanket
3. Enclosure
4. Concrete pad

Concrete for the pad must be minor concrete, except the cementitious material content of the concrete must be at least 463 lb/cu yd. Hand mixing of the concrete is allowed.

20-2.02B(2) Backflow Preventers

Each backflow preventer must:

1. Be reduced-pressure principle type.
2. Comply with the specifications of the water purveyor that has jurisdiction.
3. Be factory assembled with:
   - 3.1. 2 check valves.
   - 3.2. 1 pressure differential relief valve.
   - 3.3. 4 test cocks.
   - 3.4. 2 shut-off valves manufactured from iron or bronze. Shut-off valves must be one of the following:

3.4.1. Resilient-wedge gate valves.
3.4.2. Resilient-seated and fully-ported ball valves.
3.4.3. Resilient-seated butterfly valves.

Backflow preventer components must be capable of withstanding a working pressure of 150 psi.

20-2.02B(3) Backflow Preventer Blankets

Each backflow preventer blanket must:

1. Be polyester fabric coated with vinyl or polymeric resin
2. Be resistant to UV light, water, mildew, and fire
3. Have an R-value from R-30 to R-38

Blankets must have a securing mechanism that includes zippers, hook-pile tape, grommets, snaps, buttons, or any combination of these. Wherever the backflow preventer is not in an enclosure, the securing mechanism must be capable of accepting a padlock.

20-2.02B(4) Backflow Preventer Enclosures

Each backflow preventer enclosure must:

1. Be Type 304 stainless steel
2. Have expanded metal side, end, and top panels fabricated from 9-gauge minimum-thickness sheet with openings of approximately 3/4 by 1-3/4 inches
3. Have expanded metal panels attached to the 3/16-inch-thick frame by a series of welds not less than 1/4 inch in length and spaced not more than 4 inches on center, along the edges of the enclosure
4. Have lock guards with a minimum thickness of 12 gauge
5. Have hexagonal nuts and lock-type washers
6. Have padlock-clasp or latch-and-lock mechanism

20-2.02C Construction

Finish exposed top surface of concrete pad with a medium broom finish applied parallel to the long dimension of the pad.

Install the hold-downs for the backflow preventer assembly enclosure when the concrete is still plastic.

20-2.02D Payment

Not Used

20-2.03 CAM COUPLER ASSEMBLIES

20-2.03A General

Section 20-2.03 includes specifications for installing cam coupler assemblies.

20-2.03B Materials

Each cam coupler assembly must consist of a cam coupler, dust cap, check valve, pipes, fittings, concrete thrust block, and valve box with woven wire cloth and gravel.

Cam couplers must be manufactured of brass or bronze and be able to withstand a working pressure of 150 psi.

20-2.03C Construction

Install cam coupler assemblies in valve boxes.

20-2.03D Payment

Not Used

20-2.04 CONTROL AND NEUTRAL CONDUCTORS

20-2.04A General

20-2.04A(1) Summary

Section 20-2.04 includes specifications for installing or extending 24 V(ac) control and neutral conductors between irrigation controllers and valve solenoids.

20-2.04A(2) Definitions

Reserved

20-2.04A(3) Submittals

Reserved

20-2.04A(4) Quality Assurance

Perform conductors test. The test must comply with the specifications in section 87.

Where the conductors are installed by trenching and backfilling, perform the test after a minimum of 6 inches of backfill material has been placed and compacted over the conductors.

20-2.04B Materials

Control and neutral conductors must comply with the provisions for conductors and cables in section 86.

Electrical conduit and fittings must comply with section 86.

Conductors must include a control conductor for each valve and a common neutral.

Conductor insulation color, except for the stripes, must be continuous throughout. The color of the conductors must be consistent from the controller to each valve. Neutral conductors must be white. Do not use white for control conductors. Do not use conductors with green insulation except as allowed by the NEC.

Conductors must be:

1. Of the size recommended by the manufacturer of the controllers to be installed
2. Rated for 36 V or 600 V for armor-clad
3. Rated for direct burial
4. Underground feeder cable Type UF and TWU
5. Solid, uncoated copper for armor-clad
6. Not less than 90 percent of the AWG diameter required

No. 10 and smaller conductors must be insulated with a minimum of 56 mils of PVC or a minimum of 41 mils of polyethylene. No. 8 and larger conductors must be insulated with a minimum of 70 mils of PVC.

No. 10 and smaller armor-clad conductors must be insulated with a minimum of 41 mils of polyethylene. No. 8 and larger armor-clad conductors must be insulated with 54 to 60 mils of PVC.

Armor-clad conductors must include:

1. Stainless steel tape armor, Type 304, helically wrapped with a 33 percent minimum overlap. The tape must be 0.5 inch wide and at least 0.005 inch thick.
2. UV-resistant PVC outer conductor jacket complying with ICEA S-61-402, NEMA standard WC5 and UL listing 1263. The jacket nominal thickness must be from 24 to 30 mils.

20-2.04C Construction

20-2.04C(1) General

Reserved

20-2.04C(2) Conductors in Open Trenches

Do not install control and neutral conductors above each other in an open trench. Wrap conductors together with electrical tape at 10 foot intervals.

Tie a 24-inch loop of wire at all changes of direction that are greater than 45 degrees. Untie the loops after all the connections are made.

Where conductors are installed in the same trench as the supply line, install at the same depth as the line. At other locations, install conductors not less than 12 inches below finished grade.

Where conductors are not in a supply line trench, install conductors at least 4 feet from curbs, dikes, and paved shoulders.

20-2.04C(3) Conductors in Conduits

Install conductors in electrical conduit if conductors are to be:

1. Surface mounted
2. Installed in or on structures
3. Installed under paved areas
4. Installed in irrigation conduits
5. Placed in concrete

20-2.04C(4) Splicing

Splice low voltage control and neutral conductors under section 87, except do not use Method B.

Leave at least 2 feet of slack for each conductor at each:

1. Pull box
2. Valve box for each conductor that is connected to other facilities within the box or spliced within the box

Do not splice conductors in irrigation controller cabinets.

Permanent splice connections must be made with freshly cut and skinned conductors. Do not use temporary splices made for testing valve circuits as permanent splices.

20-2.04C(5) Marking

Mark control and neutral conductors in pull boxes, valve boxes, at irrigation control terminals, and at splices.

Mark conductor terminations and splices with adhesive cloth wrap-around markers. Seal markers with clear, heat-shrinkable sleeves.

Mark nonspliced conductors with clip-on, C-shaped, white extruded PVC sleeves. Sleeves must have black indented legends of uniform depth with transparent overlays over the legends and chevron cuts for the alignment of 2 or more sleeves.

Identify markers for the control conductors with the appropriate irrigation controller and station number.

20-2.04D Payment

Not Used

20-2.05 FLOW SENSORS

20-2.05A General

Section 20-2.05 includes specifications for installing flow sensors.

20-2.05B Materials

Each flow sensor must be an in-line type with a nonmagnetic spinning impeller as the only moving part.

The electronics housing must:

1. Be schedule 80 PVC or cast 85-5-5-5 bronze
2. Include glass-filled polyphenylene sulfide
3. Be easily removable from the meter body and include 2 ethylene-propylene O-rings

The impeller must be glass reinforced nylon on a tungsten carbide shaft.

The electronics must be rated to withstand prolonged water immersion conditions and include two 48-inch-long single-conductor 18 AWG leads.

The insulation must be direct burial UF type colored red for the positive lead and black for the negative lead.

The flow sensor must be capable of withstanding:

1. 100- to 400-psi operating pressure depending on sensor size shown
2. Liquid temperatures up to 220 degrees F
3. Flows from 1/2 to 15 ft/sec

20-2.05C Construction

Not Used

20-2.05D Payment

Not Used

20-2.06 IRRIGATION CONTROLLERS

20-2.06A General

20-2.06A(1) Summary

Section 20-2.06 includes specifications for installing irrigation controllers.

20-2.06A(2) Definitions

base station: Designated computer that collects data from a series of satellite controllers through a centralized server.

centralized server: Designated server that collects data from all base stations.

network communication: Identified means through which satellite controllers, base stations, and a centralized server communicate to one another, such as fiber optics, spread spectrum, and phone lines.

remote access device: Wireless device, such as an FCC-compliant radio remote, web-enabled smart phone, or wireless computer or tablet, used to communicate with satellite controllers from a remote location.

remote irrigation control system: Centralized water-management system that consists of:

1. Base station
2. Centralized server or web-based application
3. Satellite controllers
4. Remote access device

satellite controller: Irrigation controller that communicates directly to a base station or centralized server.

smart controller: Irrigation controller that estimates or measures depletion of available plant soil moisture to operate an irrigation system, replenishing water as needed while minimizing excess water use.

web-based application: Encrypted managing software that is coded in a browser-supported language and is executable via a common Internet web browser, such as Internet Explorer, Firefox, and Safari.

20-2.06A(3) Submittals

Submit a complete manufacturer's maintenance and operations manual for each type of installed controller as an informational submittal.

After the work is complete, submit 3 copies of the as-built shop drawings, including any wire modifications for each controller installed.

For each controller, laminate and place in an envelope 1 copy of:

1. As-built schematic wiring diagram, including wiring modifications
2. 11-by-17-inch as-built irrigation plan

The laminate must be clear, mat-finished plastic that is at least 10 mils thick. The envelope must be heavy-duty plastic.

Attach the envelope to the inside of the controller enclosure or cabinet door. If the door is not large enough to secure the envelope, submit the envelope and its contents.

20-2.06A(4) Quality Assurance

Provide training by a qualified person on the use and adjustment of the installed irrigation controllers at least 30 days before Contract acceptance.

Modifications to electrical components must be done by the manufacturer before shipment to the job site.

The installation date and expiration date of the manufacturer's guarantee for the controllers must be permanently marked on the inside face of the controller.

20-2.06B Materials

20-2.06B(1) General

Conventional AC-powered irrigation controllers must operate on 120 V(ac), 60 Hz, and supply from 24 to 30 V(ac), 60 Hz for operating electrical remote control valves.

Concrete for the pad and foundation must be minor concrete except the cementitious material content of the concrete must be at least 463 lb/cu yd. Hand mixing of the concrete is allowed.

20-2.06B(2) Irrigation Controllers

20-2.06B(2)(a) General

The irrigation controllers must:

1. Be a smart controller from a single manufacturer.
2. Be fully automatic and capable of operating a complete 30-day or longer irrigation program.
3. Have a switch or button on the face of the irrigation control panel showing that the irrigation controller can be turned on or off and provide for automatic or manual operation. Manual operation must allow cycle start at the desired station and allow for the minimum activation of a single station or have the option to operate multiple stations in sequential or simultaneous operation modes.
4. Have nonvolatile memory.
5. Have a watering time display on the face of the control panel.
6. Have a panel and circuit board connected to the low voltage control and neutral conductors by means of a plug and receptacle connectors located within the cabinet enclosure.
7. Have a variable or incremental timing adjustment ranging from 1 to 360 minutes per station.
8. Be capable of operating at least 3 program schedules.
9. Be capable of having at least 4 start times per program schedule.
10. Have an output that can energize a pump start circuit or a remote control master valve.
11. Be protected by fuses and circuit breakers.
12. Display a program and station affected by a sensory alert without changing other watering schedules not affected by the alert.
13. Be capable of global manual and automatic seasonal adjustments to all valves in any given program.
14. Automatically change watering schedule based on evapotranspiration data provided by a local weather station or have an internal programmed default of historical evapotranspiration data for a given region.
15. Support a flow sensor, and a rain sensor or access to a weather station, and have automatic shut-off capability.
16. Be capable of communicating with the remote access device.

If the irrigation controller is installed in an enclosure cabinet, the cabinet must be stainless steel and must comply with section 20-2.06B(3).

Irrigation controllers not installed in enclosure cabinets must be weatherproof, constructed of fiberglass or metal, and have a door lock with 2 keys provided.

Remote irrigation systems must comply with the specifications for irrigation controllers and be accessible only through a secured and encrypted server that is password- and firewall-protected by the Department, or through a firewall-secured remote server that is independent from any Department servers. The Department will set up and manage the network communication.

20-2.06B(2)(b) Battery Powered Irrigation Controllers

Reserved

20-2.06B(2)(c) Solar Powered Irrigation Controllers

Reserved

20-2.06B(2)(d) Two-wire Irrigation Controllers

Reserved

20-2.06B(3) Irrigation Controller Enclosure Cabinets

The irrigation controller enclosure cabinet must comply with section 86 and:

1. Be minimum 14-gauge Type 304 stainless steel.
2. Include a mounting panel. Fabricate mounting panels using any of the following materials:
   2.1. 3/4-inch exterior AC grade veneer plywood. Paint panels with 1 application of an exterior, latex based, wood primer and 2 applications of an exterior, vinyl acrylic enamel, white in color. Paint panels on all sides and edges before installation of the panels in the cabinets and the equipment on the panels.
   2.2. 3/16-inch-thick aluminum sheets.
   2.3. 10-gauge cold-rolled steel sheets.
   2.4. 0.157-inch stainless steel metal sheets.
3. Provide cross ventilation, roof ventilation, or a combination of both. Ventilation must not compromise the weather resistance properties of the cabinet and must be fabricated by the cabinet manufacturer.
4. Include protection against lightning damage.
5. Have an area inside the cabinet doors for storage of the as-built schematic wiring diagram and irrigation plans.
6. Have padlock clasp or latch and lock mechanism.

20-2.06B(4) Rain Sensors

Rain sensor units must be a solid-state, automatic shut-off type, and compatible with the irrigation controller. The rain sensor unit must automatically interrupt the master remote control valves if approximately 1/8 inch of rain has fallen. The irrigation controller must automatically be enabled again when the accumulated rainfall evaporates from the rain sensor unit collection cup.

Rain sensor units must be one of the following:

1. Rated from 24 to 30 V(ac)
2. Wireless and FCC compliant

20-2.06C Construction

Finish the exposed top surface of concrete pad with a medium broom finish applied parallel to the long dimension.

Install electrical components for automatic irrigation systems under section 87.

Install irrigation controllers under the manufacturer's instructions.

If 2 or more irrigation controllers operate the same remote master control valve, install an isolation relay under the controller manufacturer's instructions.

Where direct burial conductors are to be connected to the terminal strip, connect the conductors with the open-end-crimp-on wire terminals. Exposed wire must not extend beyond the crimp of the terminal and the wires must be parallel on the terminal strip.

Install rain sensor units for irrigation controllers on the irrigation controller enclosure cabinets. Provide protection against lightning damage.

20-2.06D Payment

Payment for 120-volt or higher electrical service is not included in the payment for any type of irrigation controller.

20-2.07 IRRIGATION CONDUIT

20-2.07A General

20-2.07A(1) Summary

Section 20-2.07 includes specifications for installing irrigation conduit.

Before performing work on irrigation systems, locate existing irrigation conduits shown to be incorporated into the new work.

Before removing or disturbing existing pavement markers that show the location of the existing irrigation conduit, mark the location of the existing conduit on the pavement.

20-2.07A(2) Definitions

Reserved

20-2.07A(3) Submittals

Reserved

20-2.07A(4) Quality Assurance

Demonstrate that the irrigation conduits are free from obstructions after placement of base and surfacing.

Before and after extending the irrigation supply line in an irrigation conduit, pressure test the supply line under section 20-2.01A(4)(b).

After conductors are installed in an irrigation conduit, test the conductors under section 20-2.04A(4).

Assign a technical representative to direct and control the directional bore activities. The representative must be present during directional bore activities. Unless otherwise authorized, perform directional bore activities in the presence of the Engineer.

20-2.07B Materials

20-2.07B(1) General

Reserved

20-2.07B(2) ABS Composite Pipe Conduit

ABS composite pipe and couplings must comply with ASTM D2680. Couplings must be solvent cement type.

20-2.07B(3) Corrugated HDPE Pipe Conduit

Corrugated HDPE pipe must comply with ASTM F405 and ASTM F667 or be Type S complying with AASHTO M252 and AASHTO M294. Couplings and fittings must be as recommended by the pipe manufacturer.

20-2.07B(4) Corrugated Steel Pipe Conduit

Corrugated pipe conduit must comply with section 66. The nominal thickness of metal sheets for pipe must be 0.064 inch for corrugated steel pipe and 0.060 inch for corrugated aluminum pipe. Coupling bands and hardware must comply with section 66.

20-2.07B(5) PVC Pipe Conduit Sleeve

PVC pipe conduit sleeves must be schedule 40 complying with ASTM D1785.

Fittings must be schedule 80.

20-2.07B(6) Welded Steel Pipe Conduit

Welded steel pipe must comply with ASTM A53. Pipe must be black and have either welded or threaded joints.

The wall thickness for the various sizes of welded steel pipe must have the thickness shown in the following table:

Nominal pipe size (inches)	Minimum wall thickness (inch)
3	0.216
4	0.237
6	0.280
8	0.277
10	0.279
12	0.330

20-2.07C Construction

20-2.07C(1) General

If existing irrigation conduits are to be incorporated into new work, excavate exploratory holes for locating existing conduits at the locations indicated by existing markers or as directed. Excavate and backfill exploratory holes to a maximum size of 2-1/2 feet in width, 5 feet in depth, and 5 feet on each side of the marker or directed location parallel to the roadway. If the conduit is not found and if ordered, increase the size of the exploratory holes beyond the dimensions specified. The additional excavation and backfill is change order work.

If extending an existing conduit, remove the existing conductors from the conduit.

Use a coupling band if the new conduit matches the existing conduit diameter; otherwise overlap the conduit at least 12 inches.

After extending the existing conduits, install conductors that match the color and size of the existing conductors without splices. Splice conductors in adjacent pull boxes.

If installing a control and neutral conductor and electrical conduit through the irrigation conduit, install a no. 5 pull box at each end.

Remove any debris found in the conduit before performing other work. Removing debris located more than 3 feet from the ends of the conduits is change order work.

Extend conduit 2 feet beyond all paving.

Cap the ends of unused conduit.

Place Type G pavement markers with retroreflective face facing away from the oncoming traffic under section 81-3 on paved shoulders or dikes at irrigation conduit locations where authorized.

20-2.07C(2) Welded Steel Pipe Conduit

20-2.07C(2)(a) General

Install welded steel pipe by directional boring or jack and drill.

20-2.07C(2)(b) Directional Boring

Notify the Engineer at least 2 business days before starting directional bore activities.

The diameter of the boring tool for directional boring must be only as large as necessary to install the conduit.

Mineral slurry or wetting solution may be used to lubricate the boring tool and to stabilize the soil surrounding the boring path. The mineral slurry or wetting solution must be water based.

The directional bore equipment must have directional control of the boring tool and have an electronic boring tool location detection system. During operation, the directional bore equipment must be able to determine the location of the tool both horizontally and vertically.

20-2.07C(2)(c) Jack and Drill

Notify the Engineer at least 2 business days before starting jack and drill activities.

Jacking or drilling pits must be no closer than 2 feet from the pavement edge whenever possible.

If authorized, small holes may be cut in the pavement to locate or remove obstructions.

Do not use excessive water that will soften the subgrade or undermine the pavement.

20-2.07C(3) PVC Pipe Conduit Sleeve

Where PVC pipe conduit sleeves 2 inches or less in outside diameter are installed under surfacing, you may install by directional boring under section 20-2.07C(2)(b).

Cap ends of conduit until used.

20-2.07D Payment

Not Used

20-2.08 IRRIGATION SUPPLY LINE

20-2.08A General

20-2.08A(1) Summary

Section 20-2.08 includes specifications for installing irrigation supply line.

20-2.08A(2) Definitions

Reserved

20-2.08A(3) Submittals

Submit a certificate of compliance for polyethylene pipe and plastic pipe supply line.

20-2.08A(4) Quality Assurance

Solvent cement must comply with local air quality management district provisions.

20-2.08B Materials

20-2.08B(1) General

Concrete for thrust blocks must be produced from commercial-quality aggregates. The concrete must contain at least 295 pounds of cementitious material per cubic yard.

20-2.08B(2) Copper Pipe Supply Line

Copper pipe must be Type K rigid pipe complying with ASTM B88. Fittings must be wrought copper or cast bronze either soldered or threaded.

Solder must be 95 percent tin and 5 percent antimony.

20-2.08B(3) Galvanized Steel Pipe Supply Line

Galvanized steel pipe supply line and couplings must be standard weight complying with ASTM A53, except that the zinc coating must not be less than 90 percent of the specified quantity. Except for couplings, the fittings must be galvanized malleable iron, banded and threaded, and comply with ANSI B16.3, Class 150.

Joint compound must be nonhardening and noncorrosive. Do not use pipe thread sealant tape.

20-2.08B(4) Drip Irrigation Tubing

Drip irrigation tubing must be virgin polyethylene plastic complying with ASTM D2737.

The drip irrigation tubing must be distribution tubing with preinstalled in-line emitters.

If preinstalled in-line drip irrigation tubing is not shown, you may install emitters that match the distribution specifications shown. The emitters must be barbed or threaded-type outlet devices with dual silicone diaphragms.

When tested under ASTM D2122, the wall thickness of polyethylene tubing must have the thickness shown in the following table:

Nominal pipe size (inch)	Minimum wall thickness (inch)	Maximum wall thickness (inch)
1/2	0.050	0.070
5/8	0.055	0.075
3/4	0.060	0.080

The polyethylene tubing fittings must be leak-free, compression type and have female sockets with an internal barb to provide a positive pipe-to-fitting connection that will not separate at the designed pressure.

20-2.08B(5) Plastic Pipe Supply Line

Plastic pipe supply line must be PVC pipe that is NSF approved.

Schedule 40 plastic pipe supply line must comply with ASTM D1785.

Class 315 plastic pipe supply line must comply with ASTM D2241.

PVC gasketed bell joints must comply with ASTM D2672, ASTM D2241, ASTM D3139, and ASTM F477.

For solvent-cemented type joints, the primer and solvent cement must be made by the same manufacturer. The primer color must contrast with the color of the pipe and fittings.

Solvent-cemented fittings for schedule 40 plastic pipe supply line must be injection molded PVC, schedule 40, and comply with ASTM D2466.

Solvent-cemented fittings for class 315 plastic pipe supply line must be injection molded PVC, schedule 80, and comply with ASTM D1784 and ASTM D2467.

Fittings for a supply line placed in an irrigation conduit must be schedule 80.

Fittings for a plastic pipe supply line larger than 4 inches must be ductile iron complying with section 20-2.13C(2)(b).

If UV-resistant plastic pipe supply line is required, the pipe must be homogeneous, a uniform color, and manufactured of:

1. At least 80 percent vinyl chloride resin with UV stabilizers
2. Non-PVC resin modifiers and coloring ingredients
3. Coloring ingredients with UV stabilizers

20-2.08C Construction

20-2.08C(1) General

Cut pipe straight and true. After cutting, ream out the ends to the full inside diameter of the pipe.

Prevent foreign material from entering the irrigation system during installation. Immediately before assembling, clean all pipes, valves, and fittings. Flush lines before attaching sprinklers, emitters, and other terminal fittings. Reuse water from waterline flushing for landscape irrigation if practicable.

Pipe supply lines installed between the water meter and backflow preventer assembly must be installed at least 18 inches below finished grade measured to the top of the pipe.

Where a connection is made to existing supply lines, belled and gasketed fittings or compression fittings may be used.

Install a thrust block at each change in direction on the main supply line, terminus run, and at other locations shown.

Where supply lines cross paved ditches more than 3 feet deep at their flow line, install galvanized steel pipe for the entire span of the ditch.

20-2.08C(2) Galvanized Steel Pipe Supply Line

Coat male pipe threads on galvanized steel under the manufacturer's instructions.

20-2.08C(3) Drip Irrigation Tubing

Install drip irrigation tubing on grade and under manufacturer's instructions.

If preinstalled in-line drip irrigation tubing is not shown, install emitters under manufacturer's instructions.

Install a flush valve and an air-relief valve if recommended by the drip valve assembly manufacturer.

20-2.08C(4) Plastic Pipe Supply Line

For PVC pipe 1-1/2 inches in diameter or smaller, cut the pipe with PVC cutters.

For solvent-cemented type joints, apply primer and solvent-cement separately under the manufacturer's instructions.

Wrap the male portion of each threaded plastic pipe fitting with at least 2 layers of pipe thread sealant tape.

20-2.08D Payment

The payment quantity for any type of supply line pipe or drip irrigation tubing is the length measured along the slope.

20-2.09 SPRINKLER ASSEMBLIES

20-2.09A General

Section 20-2.09 includes specifications for installing sprinkler assemblies.

20-2.09B Materials

20-2.09B(1) General

Swing joints must match the inlet connection size of the riser.

Where shown, a sprinkler assembly must include a check valve.

Threaded nipples for swing joints and risers must be schedule 80, PVC 1120 or PVC 1220 pipe, and comply with ASTM D1785. Risers for sprinkler assemblies must be UV resistant.

Fittings for sprinkler assemblies must be injection-molded PVC, schedule 40, and comply with ASTM D2466.

Flexible hose for sprinkler assemblies must be leak-free, non-rigid and comply with ASTM D2287, cell Type 6564500. The hose must comply with ASTM D2122 and have the thickness shown in the following table:

Nominal hose diameter (inch)	Minimum wall thickness (inch)
1/2	0.127
3/4	0.154
1	0.179

Solvent cement and fittings for flexible hose must comply with section 20-2.08B(5).

20-2.09B(2) Pop-Up Sprinkler Assemblies

Each pop-up sprinkler assembly must include a body, nozzle, swing joint, pressure reducing device, fittings, and sprinkler protector where shown.

20-2.09B(3) Riser Sprinkler Assemblies

Each riser sprinkler assembly must include a body, flexible hose, threaded nipple, nozzle, swing joint (except for a Type V riser), pressure reducing device, fittings, and riser support where shown.

20-2.09B(4) Tree Well Sprinkler Assemblies

Each tree well sprinkler assembly must include a threaded nipple, nozzle, swing joint, fittings, perforated drainpipe, and drain grate.

The perforated drainpipe must be commercial-grade, rigid PVC pipe with holes spaced not more than 6 inches on center on 1 side of the pipe.

The drain grate must be a commercially-available, 1-piece, injection-molded grate manufactured from structural foam polyolefins with UV light inhibitors. Drain grate must be black.

Gravel for filling the drainpipe must be graded such that 100 percent passes the 3/4-inch sieve and 100 percent is retained on the 1/2-inch sieve. The gravel must be clean, washed, dry, and free from clay or organic material.

20-2.09C Construction

Where shown, install a flow shut-off device under the manufacturer's instructions, unless you use equipment with a preinstalled flow shut-off device.

Where shown, install a pressure reducing device under the manufacturer's instructions, unless you use equipment with a preinstalled pressure reducing device.

Install pop-up and riser sprinkler assembly:

1. From 6-1/2 to 8 feet from curbs, dikes, and sidewalks
2. At least 10 feet from paved shoulders
3. At least 3 feet from fences and walls

If sprinkler assembly cannot be installed within these limits, the location will be determined by the Engineer.

Set sprinkler assembly riser on slopes perpendicular to the plane of the slope.

20-2.09D Payment

Not Used

20-2.10 VALVES

20-2.10A General

Section 20-2.10 includes specifications for installing valves.

20-2.10B Materials

20-2.10B(1) General

Not Used

20-2.10B(2) Ball Valves

Each ball valve must be a 2-piece brass or bronze body with a minimum nonshock working pressure of 400 psi. The seats and O-ring seals must be PTFE.

20-2.10B(3) Check Valves

Each check valve must be one of the following:

1. Schedule 80 PVC with a factory setting to withstand a minimum 7-foot head on risers
2. Class 200 PVC if used on a nonpressurized plastic irrigation supply line
3. Internal to the sprinkler body with a factory setting to withstand a minimum 7-foot head

20-2.10B(4) Drip Valve Assemblies

Each drip valve assembly must include:

1. Remote control valve
2. Wye filter with:
    2.1. Filter housing that:
        2.1.1. Can withstand a working pressure of 150 psi
        2.1.2. Is manufactured of reinforced polypropylene plastic
    2.2. Reusable stainless steel filter cartridge with a 200 mesh size filtration
3. Schedule 80 PVC pipes and fittings
4. Pressure regulator

20-2.10B(5) Garden Valve Assemblies

Each garden valve assembly must have:

1. Garden valve
2. Location marker

20-2.10B(6) Gate Valves

Each gate valve must be:

1. Flanged or threaded type
2. Iron or bronze body
3. Bronze trimmed with one of the following:
   3.1. Female thread rising stem
   3.2. Non-rising stem
4. Able to withstand a working pressure of 150 psi

Gate valves smaller than 3 inches must have a cross handle.

Gate valves 3 inches or larger must be flanged type with a square nut.

Gate valves attached to the outlets of a wye strainer must have PTFE seating rings on the discharge side of the gate valves. Valve wedges must be driven obliquely by cam action into the seating rings.

20-2.10B(7) Pressure Regulating Valves

Each pressure regulating valve must be:

1. Flanged or threaded type
2. Brass, bronze, cast iron, or plastic body
3. Spring diaphragm type
4. Pilot controlled

Pressure regulating valve must have no internal filter screens.

20-2.10B(8) Pressure Relief Valves

Each pressure relief valve must have:

1. Brass or bronze body
2. Stainless steel springs
3. Bronze nickel chrome seats
4. Composition seat discs
5. Female bottom inlets
6. Female side outlets

20-2.10B(9) Quick Coupling Valves

Each quick coupling valve must be 3/4-inch double slotted with a self-closing cap, 3/4-inch brass key and 3/4-inch brass hose swivel. Except for the cap, quick coupling valve must be brass or bronze construction.

20-2.10B(10) Remote Control Valves

20-2.10B(10)(a) General

Each remote control valve must:

1. Be normally closed type.
2. Be glass-filled nylon, brass, or bronze.
3. Be completely serviceable from the top without removing the valve body from the system.
4. Be equipped with a device that regulates and adjusts the flow of water and be provided with a manual shut-off. The manual shut-off for valves larger than 3/4 inch must be operated by a cross handle.
5. Have solenoids compatible with the irrigation controller.
6. Have a manual bleed device.

7. Be capable of withstanding a pressure of 200 psi.
8. Have replaceable compression discs or diaphragms.
9. Have threaded fittings for inlets and outlets.
10. Have DC latching solenoids if used with solar or battery controllers. Solenoids must operate on 3.5 V.
11. Be bottom, angled, or straight inlet configuration.

20-2.10B(10)(b) Remote Control Valves with Flow Sensor

Reserved

20-2.10B(10)(c) Remote Control Valves with Pressure Regulator

Each remote control valve with pressure regulator must be factory assembled as 1 unit.

20-2.10C Construction

20-2.10C(1) General

All valves must be installed in a valve box with a cover except:

1. Check valves
2. Garden valves
3. Pressure regulating valves installed on backflow preventers

20-2.10C(2) Control Valves

Install control valves:

1. From 6-1/2 to 8 feet from curbs, dikes, and sidewalks
2. At least 10 feet from paved shoulders
3. At least 3 feet from fences, walls, or both

If a control valve cannot be installed within these limits, the location will be determined by the Engineer.

20-2.10C(3) Check Valves

Install check valves as necessary to prevent low-head drainage.

20-2.10C(4) Garden Valve Assemblies

Install a location marker from 8 to 10 inches from the back of each garden valve assembly.

20-2.10C(5) Gate Valves

Furnish 3 long shank keys before Contract acceptance.

20-2.10C(6) Pressure Regulating Valves

Install pressure regulating valves with threaded connections and a union on the inlet side of the valves.

20-2.10C(7) Quick Coupling Valves

Furnish 3 loose quick coupling brass keys and brass hose swivels before Contract acceptance.

20-2.10D Payment

Not Used

20-2.11 WYE STRAINER ASSEMBLIES

20-2.11A General

Section 20-2.11 includes specifications for installing wye strainer assemblies

20-2.11B Materials

Each wye strainer assembly must include:

1. Wye strainer
2. Valve box and cover

20-2.11C Construction

Install wye strainer assembly on the upstream side of the remote control valves.

Install garden valve such that the discharge sprays out of the valve box when the system is flushed.

20-2.11D Payment

Not Used

20-2.12 RESERVED

20-2.13 SUPPLY LINE ON STRUCTURES

20-2.13A General

20-2.13A(1) General

20-2.13A(1)(a) Summary

Section 20-13A includes general specifications for installing water supply lines through bridges and on the exterior of concrete structures.

20-2.13A(1)(b) Definitions

Reserved

20-2.13A(1)(c) Submittals

Submit a work plan for the temporary casing support at the abutments as an informational submittal.

20-2.13A(1)(d) Quality Assurance

20-2.13A(1)(d)(i) General

Before installing seismic expansion assemblies or expansion assemblies, the Engineer must authorize the extension setting.

20-2.13A(1)(d)(ii) Regulatory Requirements

Piping materials must bear the label, stamp, or other markings of the specified standards.

20-2.13A(1)(d)(iii) Quality Control

Test water supply lines before:

1. Backfilling
2. Starting work on box girder cell decks
3. Otherwise covering the water supply lines

Furnish pipe anchorages to resist thrust forces occurring during testing.

Test the water supply lines as 1 unit. The limits of the unit must be 5 feet beyond the casing at each end of the bridge.

Cap each end of the water supply lines before testing. Caps must be rated for the test pressure.

Test water supply lines under section 20-2.01A(4)(b), except that the testing period must be 4 hours with no pressure drop.

Place water supply lines 4 inches and larger under a pressure of at least 120 psi during testing. Air relief valves must not be subjected to pressure testing.

If water supply lines fail testing, retest the lines after repair.

20-2.13A(2) Materials

20-2.13A(2)(a) General

Protect stored piping from moisture and dirt. Elevate piping above grade. Support piping to prevent sagging and bending.

Protect flanges, fittings, and assemblies from moisture and dirt.

20-2.13A(2)(b) Air Release Valve Assemblies

Each air release valve assembly must include an air release valve, ball valve, tank vent, nipples, and pipe saddle.

Air release valves must have a cast iron body with stainless steel trim and float, 1-inch NPT inlet, 1/2-inch NPT outlet, and 3/16-inch orifice.

Ball valves must have a 2-piece bronze body with chrome plated or brass ball and 1-inch full-size port and be rated for at least 400 psi.

Tank vents must have a 1/2-inch NPT inlet and downward-facing double openings with screened covers.

Nipples must be schedule 40 galvanized steel pipe.

Pipe saddle must be rated for at least 150 psi and be compatible with the water supply line. Pipe saddle for water supply lines smaller than 4 inches must be a single strap pipe saddle. Pipe saddle for water supply lines 4 inches and larger must be a double strap pipe saddle. You may use a tee fitting for galvanized steel water supply lines.

20-2.13A(2)(c) Casings

Casings must be welded steel pipe casing and comply with section 70-7.

20-2.13A(2)(d) Pipe Wrap Tape

Pipe wrap tape must be pressure sensitive tape made from PVC or polyethylene. Pipe wrap tape must be at least 50 mils thick and not wider than 2 inches.

20-2.13A(2)(e) Pipe Hangers

Pipe hangers must comply with section 70-7.02C.

The pipe hanger must be rated for the water supply line. If casings are shown, include the weight of the casing.

20-2.13A(2)(f) Epoxy Adhesives

Epoxy used for anchoring concrete pipe supports must comply with section 70-7.02D.

20-2.13A(2)(g) Concrete Pipe Supports

Concrete pipe supports must comply with section 70-7.02D.

20-2.13A(2)(h) Pipe Clamps and Anchors

Metal clamps must be commercial-quality steel and comply with section 75-2. Anchors must comply with the specifications for concrete anchorage devices in section 75-3.02C.

20-2.13A(2)(i) Pull Boxes

Each pull box and cover must comply with section 20-2.01B(5).

20-2.13A(3) Construction

20-2.13A(3)(a) General

Support water supply lines as described.

Where water supply lines penetrate bridge superstructure concrete, either form or install pipe sleeves at least 2 pipe sizes larger than the pipe.

20-2.13A(3)(b) Preparation

Clean the interior of the pipe before installation. Cap or plug openings as pipe is installed to prevent the entrance of foreign material. Leave caps or plugs in place until the adjacent pipe section is installed.

20-2.13A(3)(c) Installation

20-2.13A(3)(c)(i) General

Reserved

20-2.13A(3)(c)(ii) Casings

Install each casing under section 70-7.03.

Seal casing end with 8 inches of polyurethane foam at dirt stop or pipe end seal.

20-2.13A(3)(c)(iii) Wrapping Water Supply Line

Wrap damaged supply line coatings with pipe wrap tape. Wrap field joints and fittings that are in contact with the earth.

Wrapping must be clean. Prime the area as recommended by the tape manufacturer. Tightly wrap the tape with 1/2 uniform overlap, free from wrinkles and voids, and provide not less than a 100 mil thickness. The tape must conform to the joint or fitting contours. Extend the tape at least 6 inches over adjacent pipe.

20-2.13A(3)(c)(iv) Pipe Clamps and Anchors

Install water supply lines on the exterior surfaces of bridges or other concrete structures with metal clamps and anchors.

Drill holes for anchors to the manufacturer's recommended depth. Drilling tools must be authorized. Do not drill holes closer than 6 inches from the edge of a concrete structure. Relocate holes if reinforcing steel is encountered. Fill abandoned holes with mortar. Mortar must comply with section 51-1.02F.

Where water supply lines are mounted vertically for more than 2 feet, install clamps and anchors within 6 inches of the elbows.

Where water supply lines are mounted vertically for more than 10 feet, install additional clamps and anchors at 10-foot maximum centers.

20-2.13A(3)(d) Sequences of Operation

If the bridge superstructure is to be prestressed, do not place mortar around casings in abutments and hinges until bridge superstructure prestressing has been completed.

20-2.13A(4) Payment

The payment quantity for a supply line on structures is the length measured from end to end along the centerline.

The Department does not pay for failed tests.

20-2.13B Supply Line on Structures, Less than 4 Inches

20-2.13B(1) General

20-2.13B(1)(a) Summary

Section 20-2.13B includes specifications for installing water supply lines smaller than 4 inches on structures.

20-2.13B(1)(b) Definitions

Reserved

20-2.13B(1)(c) Submittals

Product data for materials includes catalog cuts, performance data, and installation instructions.

Submit product data for:

1. Water supply line
2. Expansion assemblies
3. Casing insulators
4. Pipe end seals
5. Pipe anchorages
6. Air release valve assemblies
7. Casings
8. Pipe hangers
9. Epoxy adhesives
10. Concrete pipe supports

20-2.13B(1)(d) Quality Assurance

Reserved

20-2.13B(2) Materials

20-2.13B(2)(a) General

Reserved

20-2.13B(2)(b) Water Supply Line

Water supply line must comply with section 20-2.08.

20-2.13B(2)(c) Expansion Assemblies

Each expansion assembly must consist of a hose with ends, insulated flange connections, and elbows. Each expansion assembly must have the same nominal inside diameter as the water supply line. Working pressure must be at least 150 psi.

Hose must be medium or heavy weight, crush and kink resistant, and rated for at least 150 psi. Cover must be flexible, oil-resistant rubber or synthetic, and reinforced with at least 2-ply synthetic yarn or steel wire. The inner tube must comply with FDA and USDA standards for potable water. Hose ends must be stainless steel flanged connections with stainless steel crimped bands or swaged end connectors. Do not use barbed ends with band clamps.

Elbows must be 45-degree standard-weight galvanized steel fittings.

20-2.13B(2)(d) Casing Insulators

Each casing insulator must be:

1. 2-piece, high-density, injection-molded polyethylene and must have a nonconductive inner liner with cadmium-plated nuts and bolts.
2. Factory-constructed to ensure the water supply line is centered in the casing. The insulator must not allow any contact between the pipe and casing and have at least 2 runners seated on the bottom of the casing.
3. Sized for the casing and water supply line shown.

20-2.13B(2)(e) Pipe Anchorages

Each pipe anchorage must consist of an I-beam, U-bolts, anchors, and double nuts.

Use concrete anchorage devices for anchors on existing bridges. Use L-anchor bolts for anchors on new bridges.

Fabricate the I-beam from 1/2-inch steel plate. Steel plate, U-bolts, L-anchors, and nuts must comply with section 75-2. Concrete anchorage devices must comply with section 75-3.02C.

20-2.13B(2)(f) Pipe End Seals

Each pipe end seal must consist of a pipe end seal, stainless steel bands, and polyurethane foam.

Pipe end seal must be factory-constructed from seamless neoprene and sized for the casing and water supply line shown. Neoprene must be at least 1/8 inch thick. Stainless steel bands must be crimped.

Polyurethane foam must be expanding foam spray that is water resistant and moisture cured.

20-2.13B(3) Construction

Locate pipe anchorage halfway between expansion assemblies.

Pipe end seal must be pulled onto the casing during pipe installation. Do not use wrap-around type end seals.

20-2.13B(4) Payment

Not Used

20-2.13C Supply Line on Structures, 4 Inches and Larger

20-2.13C(1) General

20-2.13C(1)(a) Summary

Section 20-2.13C includes specifications for installing 4-inch and larger water supply lines on structures.

20-2.13C(1)(b) Definitions

Reserved

20-2.13C(1)(c) Submittals

Product data for materials includes catalog cuts, performance data, and installation instructions.

Submit product data for:

1. Water supply line
2. Expansion assemblies
3. Flange insulating gaskets
4. Casing insulators
5. Seismic expansion assemblies
6. Lateral restraint assemblies
7. Air release valve assemblies
8. Casings
9. Pipe hangers
10. Epoxy adhesives
11. Concrete pipe supports

Submit the maximum range and preset dimension for each expansion assembly or seismic expansion assembly as an informational submittal.

Submit at least 5 sets of product data to OSD, Documents Unit. Each set must be bound together and include an index stating equipment names, manufacturers, and model numbers. Two sets will be returned. Notify the Engineer of the submittal. Include in the notification the date and contents of the submittal.

20-2.13C(1)(d) Quality Assurance

Reserved

20-2.13C(2) Materials

20-2.13C(2)(a) General

Reserved

20-2.13C(2)(b) Water Supply Line

Water supply lines must consist of ductile iron pipe and fittings. Pipe must comply with ANSI/AWWA C151/A21.51, Class 350. Fittings must comply with ANSI/AWWA C110/A21.10 and be rated for a working pressure of 350 psi.

Ductile iron pipe connections to expansion assemblies must be a flanged joint complying with ANSI/AWWA C115/A21.15. Flange gaskets must be rated for a working pressure of 350 psi. Fasteners must comply with section 75-2, except that stainless steel fasteners must not be used.

All other ductile iron pipe and fitting joints must be push-on, restrained type complying with ANSI/AWWA C111/A21.11. Push-on, restrained type joints may use proprietary dimensions and restrained joint locking systems.

Ductile iron pipe and fittings must have an asphaltic coating complying with ANSI/AWWA C151/A21.51 and a cement mortar lining complying with ANSI/AWWA C104/A21.4.

20-2.13C(2)(c) Expansion Assemblies

Each expansion assembly must be a sleeve type expansion joint. The expansion assembly must have:

1. Ductile iron body complying with ANSI/AWWA C153/A21.53
2. Flanged ends complying with ANSI/AWWA C110/A21.10
3. Fusion-bonded epoxy internal lining complying with ANSI/AWWA C213 with a minimum thickness of 15 mils
4. Internal expansion-sleeve limiting-stop collars and be pressure balanced
5. Working pressure of at least 350 psi for sizes 24 inches and smaller and 250 psi for sizes larger than 24 inches

6. NSF 61 certification

The expansion assembly must be factory set at 1/2 the extension capacity.

20-2.13C(2)(d) Flange Insulating Gaskets

Each flange insulating gasket must consist of a dielectric flange gasket, insulating washers and sleeves, and commercial-quality steel bolts and nuts. Dielectric flange gasket must have a dielectric strength of at least 500 VPM.

20-2.13C(2)(e) Casing Insulators

Each casing insulator must be:

1. 2-piece, 8-inch, 14-gauge epoxy-coated or galvanized steel band. The band must be four 2-inch-wide glass-reinforced polyester or polyethylene runners, with cadmium-plated nuts and bolts.
2. Coated with at least 15-mils of heat-fused PVC to provide a nonconductive inner liner.
3. Factory constructed to ensure that the water supply line is centered in the casing. Insulators must not allow any pipe to casing contact and have at least 2 runners seated on the bottom of the casing.
4. Sized for the casing and water supply line shown.

20-2.13C(2)(f) Dirt Stops

Dirt stops must consist of a redwood cover with polyurethane foam.

Redwood cover must be construction heart grade redwood complying with section 57-2.01B(2). Construct cover to fit snugly around the water supply line. The cover must be 2 inches taller and 2 inches wider than the casing.

Polyurethane foam must be expanding foam spray that is water resistant and moisture cured.

20-2.13C(2)(g) Seismic Expansion Assemblies

Each seismic expansion assembly must be a sleeve-type expansion joint with integral ball joints at each end.

Each seismic expansion assembly must have:

1. Ability to withstand at least a 15 degree angular deflection at each end and a maximum movement in all 3 planes at the same time
2. Ductile iron body complying with ANSI/AWWA C153/A21.53
3. Flanged ends complying with ANSI/AWWA C110/A21.10
4. Fusion-bonded epoxy internal lining complying with ANSI/AWWA C213 with a minimum thickness of 15 mils
5. Internal expansion-sleeve limiting-stop collars and be pressure balanced
6. Ball joints contained in flanged retainers with seal gaskets
7. Working pressure of at least 350 psi for sizes 24 inches and smaller and 250 psi for sizes larger than 24 inches
8. NSF 61 certification

The seismic expansion assembly must be factory set at 1/2 the extension capacity.

20-2.13C(2)(h) Lateral Restraint Assemblies

Each lateral restraint assembly must be:

1. Constructed from commercial-quality steel components complying with section 75-2
2. Adjustable
3. Able to resist a horizontal force of 10 percent of the contributory dead load

20-2.13C(3) Construction

Each ductile iron pipe must be connected and fully extended (pulled out) after joint assembly before the adjacent pipe section is added.

Install flange insulating gaskets on the outside flange of seismic expansion assemblies and expansion assemblies.

20-2.13C(4) Payment

Not Used

20-2.14 TEMPORARY IRRIGATION SYSTEMS

Reserved

20-2.15–20-2.18 RESERVED

20-3 PLANTING

20-3.01 GENERAL

20-3.01A General

20-3.01A(1) Summary

Section 20-3.01 includes general specifications for performing planting work.

20-3.01A(2) Definitions

average plant density: Number of living plants per square yard determined from a count of sample areas selected by the Engineer representing 3 to 5 percent of the total planted area.

20-3.01A(3) Submittals

20-3.01A(3)(a) General

Submit nursery invoices showing sizes, quantities, and botanical names of plants, including genus, species, and variety. Include lot numbers for plants grown from the same seed lot or cutting source.

If a root stimulant is required, submit a copy of the root stimulant manufacturer's product sheet and instructions for the application of the root stimulant.

If cuttings are to be taken from outside the right-of-way, submit proof of permits and payment of associated fees. Notify the Engineer of the location at least 15 days before taking cuttings.

20-3.01A(3)(b) Vendor Statements

At least 60 days before planting the plants, submit a statement from the vendor that the order for the plants required, including sample plants used for inspection, has been received and accepted by the vendor. The statement from the vendor must include the plant names, sizes, quantities, and anticipated delivery date.

20-3.01A(3)(c) Certificates of Compliance

Submit a certificate of compliance for sod and soil amendment.

20-3.01A(4) Quality Assurance

Plants must comply with federal and State laws requiring inspection for diseases and infestations. Inspection certificates required by law must accompany each shipment of plants.

The Engineer inspects the roots of container-grown sample plants by removing earth from the root ball of not less than 2 plants, nor more than 2 percent of the total number of plants of each species or variety. If container-grown plants are purchased from several sources, the Engineer inspects the roots of not less than 2 of each sample plant species or variety from each source. The root ball of container grown plants must not show evidence of having been restricted, or being underdevelvoped or deformed.

If the Engineer finds noncompliant plants, the entire lot represented by the noncompliant sample plants is rejected.

Cuttings with mature or brown stems and cuttings that have been trimmed will be rejected.

20-3.01B Materials

20-3.01B(1) General

Notify the Engineer at least 10 days before the plants are shipped to the job site.

20-3.01B(2) Plants

20-3.01B(2)(a) General

Plants must be true to the type or name shown. Plants must be individually tagged or tagged in groups identifying the plants by species or variety. Tagging is not required for cuttings.

Plants must be healthy, well-formed, free from insect pests and disease, and grown in nurseries inspected by the Department of Food and Agriculture. Plants must not be root-bound.

The plants must be the size and type shownin the following table:

Plant group designation	Description	Container size (cu in)
A	No. 1 container	152–251
B	No. 5 container	785–1242
C	Balled and burlapped	--
E	Bulb	--
F	In flats	--
H	Cutting	--
I	Pot	--
K	24-inch box	5775–6861
M	Liner[a]	--
O	Acorn	--
P	Plugs[a, b]	--
S	Seedling[c]	--
U	No. 15 container	2768–3696

[a]Do not use containers made of biodegradable material.
[b]Grown in individual container cells.
[c]Bare root.

Trucks used for transporting plants must be equipped with covers to protect plants from windburn and sunburn.

Handle and pack plants using authorized methods appropriate for the species or variety.

20-3.01B(2)(b) Cuttings

20-3.01B(2)(b)(i) General

Take cuttings at random from healthy, vigorous plants. Make cuts with sharp, clean tools. Do not take more than 25 percent of an individual plant and not more than 50 percent of the plants in an area.

Keep cuttings covered and wet until planted. Do not allow cuttings to dry or wither.

Plant cuttings within 2 days of being cut.

20-3.01B(2)(b)(ii) *Carpobrotus* and *Delosperma* Cuttings

You may take cuttings for new *Carpobrotus* and *Delosperma* groundcover from the existing highway planting areas, but these areas may not provide enough material to complete the work. Contact the local district's encroachment permit office to obtain a permit to harvest cuttings, identify acceptable cutting harvest areas, and determine acceptable quantities to take.

Take tip cuttings from healthy, vigorous *Carpobrotus* and *Delosperma* plants that are free of pests and disease.

Carpobrotus cuttings must be 10 inches or more in length and not have roots.

Delosperma cuttings must be 6 inches or more in length and not have roots.

20-3.01B(2)(b)(iii) Willow Cuttings

Take willow cuttings from areas shown or designated by the Engineer.

Willow cuttings must be:

1. Reasonably straight
2. From 20 to 24 inches in length
3. From 3/4 to 1-1/2 inch in diameter at the base of the cutting

Cut the top of each willow cutting square above a leaf bud. Cut the base below a leaf bud at approximately a 45 degree angle. Trim off leaves and branches flush with the stem of the cutting.

20-3.01B(2)(b)(iv) Cottonwood Cuttings

Cottonwood cuttings must comply with the specifications for willow cuttings in section 20-3.01B(2)(b)(iii).

20-3.01B(2)(b)(v)–20-3.01B(2)(b)(viii) Reserved

20-3.01B(2)(c) Sod

Sod must:

1. Be grown to comply with the Food & Agri Code
2. Be free from weeds and undesirable types of grasses and clovers
3. Be field-grown on soil containing less than 50 percent silt and clay
4. Have less than 1/2-inch-thick thatch
5. Be from 8 to 16 months old
6. Be machine cut to a uniform soil thickness of 5/8 ± 1/4 inch, not including top growth and thatch

Protect sod with tarps or other protective covers during delivery. Do not allow sod to dry out during delivery or before placement.

20-3.01B(3) Soil Amendments

20-3.01B(3)(a) General

Soil amendment must comply with the provisions in the Food & Agri Code and as specified in the special provisions.

20-3.01B(4) Fertilizers

20-3.01B(4)(a) General

Deliver fertilizer in labeled containers showing weight, chemical analysis, and manufacturer's name.

Fertilizer must comply with the provisions of the Food & Agri Code.

20-3.01B(4)(b) Slow-release Fertilizers

Slow-release fertilizer must be a pelleted or granular form with a nutrient release over an 8- to 12-month period and be within the chemical analysis ranges shown in the following table:

Ingredient	Range
Nitrogen (N) (percent)	16–21
Phosphoric acid (P) (percent)	6–8
Water soluble potash (K) (percent)	4–10

20-3.01B(4)(c) Packet Fertilizers

Packet fertilizer must be a biodegradable packet with a nutrient release over a 12-month period. Each packet must have a weight of 10 ± 1 grams and must comply with the chemical analysis requirements shown in the following table:

Ingredient	Requirement
Nitrogen (N) (percent)	20
Phosphoric acid (P) (percent)	10
Water soluble potash (K) (percent)	5

20-3.01B(4)(d) Organic Fertilizers

Organic fertilizer must be pelleted or granular with a cumulative nitrogen release rate at 86 degrees F of no more than 70 percent for the first 70 days and 100 percent at 350 days. Organic fertilizer must be within the chemical analysis ranges shown in the following table:

Ingredient	Range
Nitrogen (N) (percent)	5–7
Phosphoric acid (P) (percent)	1–5
Water soluble potash (K) (percent)	1–10

20-3.01B(5) Root Stimulants

Root stimulant must be a commercial-quality product.

20-3.01B(6) Plaster Sand

Backfill material for the palm tree planting holes must be 100 percent commercial-quality washed plaster sand.

20-3.01B(7) Root Barrier

Root barrier must be an injection-molded or extruded modular panel made of high-density polypropylene or polyethylene plastic.

Each panel must:

1. Be at least 1/16 inch
2. Have at least 4 molded root-deflecting vertical ribs from 0.5 to 0.8 inch wide and 6 to 8 inches apart
3. Have a locking strip or an integral male-female sliding lock designed to resist slippage between panels
4. Be at least 2 feet wide and 2 feet deep

20-3.01B(8) Root Protectors

Each root protector must be:

1. Fabricated from 1-inch, hexagonal pattern, 20-gauge mesh wire
2. Closed bottom design with a height and diameter that provides a minimum of 6 inches of clearance between the root ball and the sides and bottom of the wire cylinder

The wire edge at the top of the cylinder must be the manufactured finished edge, uncut and free of sharp points.

20-3.01B(9) Foliage Protectors

Each foliage protector must be:

1. Fabricated from 1-inch, hexagonal pattern, 20-gauge mesh wire
2. Approximately 4 feet high and 2 feet in diameter

The wire edge at the top of the cylinder must be the manufactured finished edge. Other wire edges that are cut must be free of sharp points.

Support stakes must be one of the following:

1. 3/4-inch reinforcing steel bar a minimum of 5 feet long with an orange or red plastic safety cap that fits snugly onto the top of the reinforcing steel bar.
2. 2-inch nominal diameter or 2-by-2-inch nominal size wood stakes a minimum of 5 feet long. Wood stakes must be straight.

The jute mesh cover must comply with section 21-2.02O(2). The material required to hold the jute mesh cover in place must be 1/8-inch-diameter manila hemp twine.

20-3.01B(10) Wood Plant Stakes

Each plant stake for vines must be nominal 1 by 1 inch and 18 inches long.

Each plant stake for trees must be nominal 2 by 2 inches or nominal 2 inches in diameter and long enough to keep the tree in an upright position.

20-3.01B(11) Plant Ties

Each plant tie for vines must be extruded vinyl-based tape, 1 inch wide and at least 8 mils thick.

Each plant tie for trees must be a (1) minimum 3/4-inch-wide, UV-resistant, flexible vinyl tie complying with ASTM D412 for tensile and elongation strength, or (2) lock-stitch, woven polypropylene with a minimum 900 lb tensile strength.

20-3.01C Construction

20-3.01C(1) General

Apply a root stimulant under the manufacturer's instructions to the plants specified in the special provisions.

Before transporting the plants to the planting area, thoroughly wet the root ball.

20-3.01C(2) Pruning

Prune plants under ANSI A 300 part 1, *Pruning* published by the Tree Care Industry Association.

Do not use tree seal compounds to cover pruning cuts.

20-3.01C(3) Watering

Water existing plants to be maintained, transplanted trees, and new plants as needed to keep the plants in a healthy growing condition.

20-3.01C(4) Replacement Plants

Plants that show signs of failure to grow at any time or which are so injured or damaged as to render them unsuitable for the purpose intended, must be removed, replaced, and replanted. Replace unsuitable plants within 2 weeks after the Engineer marks or indicates that the plants must be replaced.

Replacement planting must comply with the original planting specifications, sizes and spacing described for the plants being replaced.

Replacement planting for transplanted trees must comply with the work plan and be planted in the same planting hole.

Replacement ground cover plants must be the same species specified for the ground cover being replaced. Other replacement plants must be the same species as the plants being replaced.

Place orders for replacement plants with the vendor at a time such that the replacement plants are not in a root-bound condition.

The Department does not pay for replacement plants or the planting of replacement plants.

20-3.01C(5) Maintain Plants

Maintain plants from the time of planting until Contract acceptance.

20-3.01D Payment

Not Used

20-3.02 PLANTING WORK

20-3.02A General

Section 20-3.02 includes specifications for planting plants.

20-3.02B Materials

Not Used

20-3.02C Construction

20-3.02C(1) General

Do not start planting until authorized.

If an irrigation system is required, do not start planting in an area until the functional test has been completed and authorized for the irrigation system serving that area.

20-3.02C(2) Preparing Planting Areas

The Engineer may designate a location other than that shown, in which case, the Engineer marks the location by a stake, flag, or other marker.

Conduct work such that the existing flow line in drainage ditches is maintained. Material displaced by your activity that interferes with drainage must be removed.

Where a minimum distance to a drainage ditch is shown, locate the plant such that the outer edge of its basin wall is at least the minimum distance shown for each plant involved.

Excavate each planting hole by manual or machine method. The bottom of each planting hole must be flat. Do not use water to excavate the hole.

Unless a larger planting hole is described, the planting hole must be large enough to receive the root ball or the total length and width of roots, backfill, amendments, and fertilizer. Where rock or other hard material prohibits the hole from being excavated, a new hole must be excavated and the abandoned hole backfilled.

20-3.02C(3) Planting Plants

20-3.02C(3)(a) General

Do not plant plants in soil that is too wet, too dry, not properly amended as described, or in an unsatisfactory condition for planting.

Do not distribute more plants than can be planted and watered on that day.

Water plants immediately after planting. Apply water until the backfill soil around and below the roots or ball of earth around the roots of each plant is thoroughly saturated. If watering with a hose, use a nozzle, water disbursement device, or pressure reducing device. Do not allow the full force of the water from the open end of the hose to fall within the basin around any plant. Groundcover plants in areas with an irrigation system must be watered by sprinklers. Several consecutive watering cycles may be necessary to thoroughly saturate the soil.

If root barriers are shown, install them between trees and concrete sidewalk or curb. Install panels flush with finished grade and join with locking strips or integral male-female sliding locks. Install barriers with root deflectors facing inward.

If a tree grate is shown, install the root barrier panels 0.5 inch above finish grade.

Adjust planting locations such that each tree or shrub is at least 8 feet away from any sprinkler.

Where a tree, shrub, or vine is to be planted within a groundcover area or cutting planting area, plant it before planting groundcover or cuttings.

Where shrubs and groundcovers are shown to be planted in groups, the outer rows directly adjacent to the nearest roadway or highway fence must be parallel to the nearest roadway or highway fence. Stagger shrubs and groundcovers in adjacent rows. Adjust the alignment of the plants within the outer rows.

The Engineer determines the size and location of sample areas used to calculate average plant density.

Core holes in concrete masonry block wall where needed for vine planting.

Where a vine is to be planted against a wall or fence, plant it as close as possible to the wall or fence. If a vine planted adjacent to a wall is to be staked, stake and tie the vine at the time of planting. A vine planted adjacent to a fence must be tied to the fence immediately after planting.

Protect each tree trunk from injury. Do not:

1. Drag a tree
2. Use chains to move a tree
3. Lay tree on the ground

20-3.02C(3)(b) Trees, Shrubs, and Vines

After preparing holes, thoroughly mix soil amendment and granular fertilizer at the rate shown with native soil to be used as backfill material. Remove containers from plants in a way that the ball of earth surrounding the roots is not broken. Do not cut plant containers before delivery of the plants to the planting area. Plant and water plants immediately after removal from their containers.

Place packet fertilizer in the backfill within 6 to 8 inches of the ground surface and approximately 1 inch from the root ball. If more than 1 packet is required per plant, distribute the packets evenly around the root ball.

Apply any root stimulant under the manufacturer's instructions.

Ensure roots are not restricted or distorted.

Distribute backfill uniformly throughout the entire depth of the plant hole without clods or lumps. After the planting holes have been backfilled, jet water into the backfill with a pipe or tube inserted into the bottom of the hole until the backfill material is saturated for the full depth. If the backfill material settles below this level, add additional backfill to the required level. If a plant settles deeper than shown, replant it at the required level.

Remove nursery stakes after planting.

Install 2 plant stakes for each plant to be staked immediately after planting. Ensure the root ball is not damaged.

Spread the vine shoots and tie them with a plant tie to each stake above the crossing point.

Tie trees to the stakes with 2 tree ties, 1 tie to each stake. Each tie must form a figure eight by crossing the tie between the tree and the stake. Install ties at the lowest position that will support the tree in an upright position. Install the ties such that they provide trunk flexibility but do not allow the trunk to rub against the stakes. Wrap each end of the tie 1-1/2 turns around the stake and securely tie or nail it to the stake.

Construct a watering basin around each plant.

Install foliage protectors within 2 days after planting.

Install the foliage protector as follows:

1. Cut the bottom of the wire cylinder to match the slope of the ground. Do not leave sharp points of wire after cutting. Sharp points must be bent over or blunted.
2. Install 2 support stakes for foliage protectors vertically and embed in the soil on opposite sides of the plant crosswise to the direction of the prevailing wind.
3. Weave the support stakes through the wire cylinder mesh at 6-inch maximum centers or fasten the wire cylinder to the support stakes at a maximum 6 inches on center.
4. Ensure that the wire cylinder is snug against the support stakes but loose enough to be raised for pesticide application or to perform weeding within the plant basin.
5. Install jute mesh cover over the foliage protector and secure with twine.

20-3.02C(3)(c) Groundcover Plants

Each groundcover planting area irrigated by a single control valve must be completely planted and watered before planting other groundcover planting areas.

Plant groundcover plants in moist soil, and in neat, straight rows parallel to the nearest roadway. Stagger plants in adjacent rows.

Apply fertilizer to groundcover plants and water into the soil immediately after planting.

20-3.02C(3)(d) Cuttings, Liners, Plugs, and Seedling Plants

20-3.02C(3)(d)(i) General

Apply fertilizer to cuttings, liners, plugs, and seedling plants and water immediately after planting.

Ensure the soil is moist to a minimum depth of 8 inches before planting cuttings.

Apply any root stimulant under the manufacturer's instructions.

20-3.02C(3)(d)(ii) Willow Cuttings

Excavate planting holes for willow cuttings perpendicular to the ground line by using a steel bar, auger, post-hole digger, or similar tool. Holes must be large enough to receive the cuttings and a fertilizer packet. Plant the willow cuttings without damaging the bark.

If rock or other hard material prohibits the excavation of the planting holes, excavate new holes and backfill the unused holes.

Plant willow cuttings during the period specified in the special provisions.

Apply root stimulant under the manufacturer's instructions.

Plant the base of the cutting from 10 to 12 inches deep with 3 to 5 bud scars exposed above the ground. If more than 5 bud scars are exposed, trim off the excess willow cutting length.

Place 1 fertilizer packet in the backfill of each cutting, from 6 to 8 inches below the ground surface and approximately 1 inch from the cutting.

Backfill the plant holes with excavated material after planting. Distribute the excavated material evenly within the hole without clods, lumps, or air pockets. Compact the backfill such that the cutting cannot be easily removed from the soil. Do not damage the cutting's bark.

Dispose of trimmings and unused cuttings.

20-3.02C(3)(d)(iii) Cottonwood Cuttings

Reserved

20-3.02C(3)(d)(iv) *Carpobrotus* and *Delosperma* Cuttings

Plant *Carpobrotus* cuttings to a depth such that at least 2 nodes are covered with soil. The basal end of *Delosperma* cuttings must be at least 2 inches below the surface of the soil and the basal end of *Carpobrotus* cuttings must be at least 4 inches below the surface of the soil.

Apply root stimulant to *Delosperma* cuttings before planting.

Do not plant *Carpobrotus* or *Delosperma* cuttings in soil that does not contain sufficient moisture at an average depth of 2 inches below the surface.

20-3.02C(3)(d)(v) Liner Plants

Plant liner plants during the period specified in the special provisions.

If a foliage protector is required, install under section 20-3.02C(3)(b).

20-3.02C(3)(d)(vi) Plug Plants

Plant plug plants during the period specified in the special provisions.

20-3.02C(3)(d)(vii) Seedling Plants

Plant seedling plants during the period specified in the special provisions.

20-3.02C(3)(e) Sod

After all other planting is performed, grade sod areas to drain and to a smooth and uniform surface. Fine grade and roll sod areas before placing sod.

Areas adjacent to sidewalks, edging, and other paved borders and surfaced areas must be 1 inch below the finished surface elevation of the facilities, after fine grading, rolling, and settlement of the soil.

Place sod such that the end of each adjacent strip is staggered a minimum of 2 feet. Place the edge and end of sod firmly against adjacent sod and against sidewalks, edging, and other paved borders and surfaced areas.

Lightly roll the entire sodded area to eliminate air pockets and ensure close contact with the soil after placement of the sod. Water the sodded areas such that the soil is moist to a minimum depth of 4 inches after rolling. Do not allow the sod to dry out.

If irregular or uneven areas appear in the sodded areas, restore to a smooth and even appearance.

Trim sod to a uniform edge at sidewalks, edging, and other paved borders and surfaced areas. Trimming must be repeated whenever the edge of sod extends 1 inch or more beyond the edge of the edging, sidewalks, and other paved borders and surfaced areas. Remove trimmed sod.

Mow sod when it has reached a height of 4 inches. Mow sod to a height of 2.5 inches.

20-3.02D Payment

The payment quantity for soil amendment is the volume measured in the vehicle at the point of delivery.

The payment quantity for slow-release fertilizer, organic fertilizer, or iron sulfate (lb) is the weight determined from the marked weight or sack count.

The payment quantity for plants is measured by either the product of the average plant density and the total planted area, or by a count of the living plants in place.

20-3.03–20-3.07 RESERVED

20-4 PLANT ESTABLISHMENT WORK

20-4.01 GENERAL

20-4.01A Summary

Section 20-4 includes specifications for performing plant establishment work.

Plant establishment consists of caring for the plants, including:

1. Controlling plant growth
2. Fertilizing
3. Controlling rodents, insects, and weeds
4. Replacing damaged plants
5. Watering
6. Operating irrigation system
7. Repairing new irrigation system

Working days on which no work is required are credited as plant establishment working days regardless of whether or not you perform plant establishment work.

If any component of the electric automatic irrigation system is operated manually, the day will not be credited as a plant establishment working day unless the manual operation is authorized.

Working days on which you fail to adequately perform plant establishment work are not credited as plant establishment working days.

20-4.01B Definitions

Type 1 plant establishment: Plant establishment period with the number of working days specified for plant establishment starting after all work has been completed, except for plant establishment work, and other bid items specified to be performed until Contract acceptance.

Type 2 plant establishment: Plant establishment period with the number of working days specified for plant establishment starting after all planting work has been completed, except for plant establishment work, and other bid items specified to be performed until Contract acceptance. The Department will not accept the Contract unless the plant establishment work has been satisfactorily performed for at least the number of working days specified for plant establishment.

If maintenance and protection relief is granted for a portion of the work, Type 2 plant establishment period for that portion is the time between completion of all planting work, except for plant establishment work, and the granting of maintenance and protection relief. The Department will not grant relief unless the plant establishment work in the completed portion of the work has been

satisfactorily performed for at least the number of working days specified for the plant establishment period.

20-4.01C Submittals

20-4.01C(1) General

Submit seasonal watering schedules for use during the plant establishment period within 10 days after the start of the plant establishment period. Remote irrigation control system watering schedule must use the remote irrigation control system software program.

Submit updated watering schedules within 5 business days after any changes have been made to the authorized schedules.

Submit a revised watering schedule for each irrigation controller at least 30 days before completion of the plant establishment period.

20-4.01C(2) Notification

The Engineer notifies you when the plant establishment period starts and furnishes statements regarding the number of working days credited to the plant establishment period after the notification.

Notify the Engineer at least 5 business days before applying each application of fertilizer.

20-4.01D Quality Assurance

Provide training by a qualified person on the use and adjustment of the installed irrigation controllers no more than 30 days before completion of the plant establishment period.

Perform a final inspection of the plant establishment work in the presence of the Engineer 20 to 30 days before Contract acceptance.

20-4.02 MATERIALS

20-4.02A General

Reserved

20-4.02B Fertilizers

Fertilizer must comply with section 20-3.01B(4).

20-4.03 CONSTRUCTION

20-4.03A General

Dispose of surplus earth accumulated in roadside clearing and planting areas.

Remove the tops of foliage protectors if plants become restricted.

Remove foliage protectors, including support stakes, within 30 days before the completion of the plant establishment period.

Keep plant basin walls well formed.

Clean new wye strainers and existing wye strainers that are a part of the new irrigation system annually until the completion of the plant establishment period. The last cleaning must be done within 15 days before the completion of the plant establishment period.

Remove, clean, and reinstall new filters and existing filters that are a part of the new irrigation system annually until the completion of the plant establishment period. The last cleaning must be done within 15 days before the completion of the plant establishment period.

20-4.03B Plant Growth Control

Trim and mow turf areas as specified for sod in section 20-3.02C(3)(e). Dispose of trimmed and mowed material.

If irregular or uneven areas appear within turf areas, restore to a smooth and even appearance. Reseed turf seed areas.

Prune plants planted as part of the Contract as authorized.

Remove plant growth that extends within 2 feet of sidewalks, curbs, dikes, shoulders, walls or fences.

Remove new and existing ground cover from within the plant basins, including basin walls, turf areas, and planting areas within edging.

Vines adjacent to walls and fences must be kept staked and tied. Train vines on fences and walls or through cored holes in walls.

20-4.03C Fertilizing

Apply fertilizer to the plants as described and water into the soil after each application.

Apply fertilizer with a mechanical spreader, whenever possible.

20-4.03D Weed Control

Control weeds under section 20-1.03C(3).

20-4.03E Plant Staking

Replace plant stakes that are inadequate to support plants with larger stakes.

Remove plant stakes when the Engineer determines they are no longer needed.

20-4.03F Replacement Plants

Replacement plants must comply with section 20-3.01C(4).

Replacement of plants up to and including the 125th plant establishment working day must be with a plant of the same size as originally specified. Plants of a larger container size than those originally specified for replacement plants may be used during the first 125 working days of the plant establishment period.

Plants replaced after the 125th plant establishment working day must be the size shown in the following table:

Plant size (Original)	Plant size (Replacement)
Pot/liner/plug/seedling	No. 1 container
No. 1 container	No. 5 container
No. 5 container	No. 15 container

Other replacement plants must be the same size as originally specified.

Replacement ground cover plants must have the spacing shown in the following table:

Original spacing (inches)	On center spacing of replacement ground cover plants (inches)		
	Number of completed plant establishment working days		
	1–125	126–190	191–End of plant establishment period
9	9	6	6
12	12	9	6
18	18	12	9
24	24	18	12
36	36	24	18

20-4.03G Watering

Operate the electric automatic irrigation systems in the automatic mode unless otherwise authorized.

Water plants utilizing the remote irrigation control system software program unless authorized.

Implement the watering schedule at least 10 days before completion of the plant establishment period.

20-4.04 PAYMENT

Not Used

20-5 LANDSCAPE ELEMENTS

20-5.01 GENERAL

20-5.01A General

Section 20-5.01 includes general specifications for constructing and installing landscape elements.

Earthwork must comply with section 19.

20-5.01B Materials

Not Used

20-5.01C Construction

Not Used

20-5.01D Payment

Not Used

20-5.02 EDGING

20-5.02A General

Section 20-5.02 includes specifications for constructing landscape edging.

20-5.02B Materials

20-5.02B(1) General

Reserved

20-5.02B(2) Header Board Edging

Lumber for header board edging must be one of the following types:

1. Construction grade cedar
2. Pressure-treated Douglas fir
3. Construction heart grade redwood complying with section 57-2.01B(2)

Lumber must be:

1. Rough cut from sound timber.
2. Straight. Sweep must not exceed 1 inch in 6 feet.
3. Free from loose or unsound knots. Knots must be sound, tight, well spaced, and not to exceed 2 inches in size on any face.
4. Free of shakes in excess of 1/3 the thickness of the lumber.
5. Free of splits longer than the thickness of the lumber.
6. Free of other defects that would render the lumber unfit structurally for the purpose intended.

20-5.02B(3) Metal Edging

Metal edging must be commercial quality, made of aluminum or steel, and have an L-shaped design. Edging must be at least 4 inches in height. The thickness must be as recommended by the manufacturer for the use intended.

Edging anchors must be from the same manufacturer as the metal edging.

20-5.02B(4) HDPE Edging

HDPE edging must be commercial quality and a minimum of 4 inches in height. The thickness must be as recommended by the manufacturer for commercial installation for the use intended.

Edging anchors must be from the same manufacturer as the HDPE edging.

20-5.02B(5) Concrete Edging

Concrete for edging must be minor concrete.

20-5.02B(6)–20-5.02B(10) Reserved

20-5.02C Construction

20-5.02C(1) General

Where edging is used to delineate the limits of inert ground cover or wood mulch areas, install the edging before installing the inert ground cover or wood mulch.

Saw cut surfaces where (1) asphalt concrete or concrete surfacing must be removed to allow the installation of edging and (2) no joint exists between the surfacing to be removed and the surfacing to remain in place. The surfacing must be cut in a straight line to a minimum depth of 2 inches with a power-driven saw before the surfacing is removed.

Spike or stake spacing must comply with the manufacturer's instructions for use and job site conditions.

20-5.02C(2) Header Board Edging

Each stake must be driven flush with the top edge of the header board edging and the stake top must be beveled away from the header board at a 45 degree angle. Attach stake to header board with at least two 12-penny, hot-dipped galvanized nails per stake.

20-5.02C(3) Metal and HDPE Edging

Spike or stake spacing for metal and HDPE edging must comply with the manufacturer's instructions for use and job site conditions.

20-5.02C(4) Concrete Edging

Construct and finish minor concrete edging under section 73-2.

20-5.02C(5)–20-5.02C(9) Reserved

20-5.02D Payment

The payment quantity for edging is the length measured parallel to the ground surface.

20-5.03 INERT GROUND COVERS

20-5.03A General

20-5.03A(1) General

20-5.03A(1)(a) Summary

Section 20-5.03A includes general specifications for placing inert ground covers.

20-5.03A(1)(b) Definitions

Reserved

20-5.03A(1)(c) Submittals

For filter fabric submit:

1. Product data including the manufacturer's product sheet and installation instructions
2. Certificate of compliance at least 5 business days before delivery of the material to the job site

20-5.03A(1)(d) Quality Assurance

Reserved

20-5.03A(2) Materials

Soil sterilant must be an oxadiazon granular preemergent.

Filter fabric must be Class A. Staples for filter fabric must comply with section 21-2.02R.

20-5.03A(3) Construction

20-5.03A(3)(a) General

Before installing inert ground cover, remove plants and weeds to the ground level.

20-5.03A(3)(b) Earthwork

Excavate to the depth shown.

Maintain the planned flow lines, slope gradients, and contours of the job site. Grade subgrade to a smooth and uniform surface and compact to at least 90 percent relative compaction.

20-5.03A(3)(c) Treatment of Soil

After compaction, apply soil sterilant at the maximum label rate. Do not apply soil sterilant more than 12 inches beyond the inert ground cover limits. The soil sterilant application and inert ground cover placement must be completed within the same work day.

20-5.03A(3)(d) Filter Fabric

Immediately before placing filter fabric, the surfaces to receive filter fabric must be free of loose or extraneous material and sharp objects that may damage the filter fabric during installation.

Align fabric and place in a wrinkle-free manner.

Overlap adjacent rolls of the fabric from 12 to 18 inches. Spread each overlapping roll in the same direction. Fasten fabric with staples flush with the adjacent fabric to prevent movement of fabric by placement of inert ground cover.

Repair or replace fabric damaged during placement of inert ground cover with sufficient fabric to comply with overlap specifications.

20-5.03A(4) Payment

Not Used

20-5.03B Rock Blanket

20-5.03B(1) General

20-5.03B(1)(a) Summary

Section 20-5.03B includes specifications for placing rock blanket.

20-5.03B(1)(b) Definitions

Reserved

20-5.03B(1)(c) Submittals

Submit a 1 sq yd sample including rock of various sizes.

20-5.03B(1)(d) Quality Assurance

Reserved

20-5.03B(2) Materials

20-5.03B(2)(a) General

Do not use filter fabric.

20-5.03B(2)(b) Concrete

Concrete must be minor concrete.

20-5.03B(2)(c) Rock

Rock must be clean, smooth, obtained from a single source, and must comply with the following gradation requirements:

Gradation Requirements

Screen size (inches)	Percentage passing
8	100
6	50-85
4	0-50

You may use rock with superficial chipping or jagged edges if the rock is placed such that the chipped areas and jagged edges are submerged in the concrete.

20-5.03B(2)(d) Mortar

Mortar must comply with section 51-1.02F.

20-5.03B(3) Construction

Rock must be placed while concrete is still plastic. Remove concrete adhering to the exposed surfaces of the rock. Rock that is exposed on the finished surface must be round, smooth, clean and without jagged edges or chipped areas showing.

Loose rocks or rocks with a gap greater than 3/8 inch must be reset by an authorized method. The rock gap is measured from the edge of the rock to the surrounding concrete bedding.

20-5.03B(4) Payment

The payment quantity for rock blanket is the area measured parallel to the surface of the rock blanket.

20-5.03C Gravel Mulch

20-5.03C(1) General

20-5.03C(1)(a) Summary

Section 20-5.03C includes specifications for placing gravel mulch.

20-5.03C(1)(b) Definitions

Reserved

20-5.03C(1)(c) Submittals

Submit a 5 lb sample of the gravel mulch.

20-5.03C(1)(d) Quality Assurance

Reserved

20-5.03C(2) Materials

Gravel mulch must be:

1. Uniform gray color
2. From only 1 source
3. Crushed rock that complies with the gradation requirements shown in the following table:

Gradation Requirements

Sieve size	Percentage passing
1-1/4 inch	100
3/4 inch	60-80
1/2 inch	45-65
No. 40	5-20

20-5.03C(3) Construction

Place gravel and compact it by rolling.

The finished gravel mulch surface must be smooth, uniform and maintain the original flow lines, slope gradients, and contours of the job site.

20-5.03C(4) Payment

The payment quantity for gravel mulch is the area measured parallel to the surface of the gravel mulch.

20-5.03D Decomposed Granite

20-5.03D(1) General

20-5.03D(1)(a) Summary

Section 20-5.03D includes specifications for placing decomposed granite.

20-5.03D(1)(b) Definitions

Reserved

20-5.03D(1)(c) Submittals

Five business days before delivery of the materials to the job site, submit:

1. Solidifying emulsion product data including the manufacturers' product sheets and installation instructions
2. Certificate of compliance for solidifying emulsion
3. 5 lb sample of the decomposed granite

20-5.03D(1)(d) Quality Assurance

A test plot must be:

1. Constructed at an authorized location
2. At least 3 by 12 feet
3. Constructed using the materials, equipment, and methods to be used in the work
4. Authorized before starting decomposed granite work

Notify the Engineer at least 7 days before constructing the test plot.

The Engineer uses the authorized test plot to determine acceptability of the work.

If ordered, prepare additional test plots. Preparing additional test plots is change order work.

The Engineer may order you to remove any test plot not incorporated into the work.

20-5.03D(2) Materials

20-5.03D(2)(a) General

Decomposed granite must be:

1. Uniform gray or tan color
2. From only 1 source
3. Crushed granite rock that complies with the gradation requirements shown in the following table:

Gradation Requirements

Sieve size	Percentage passing
3/8 inch	100
No. 4	95–100
No. 8	75–80
No. 16	55–65
No. 30	40–50
No. 50	25–35
No. 100	20–25
No. 200	5–15

NOTE: Gradation is based on AASHTO T 11 and T 27.

20-5.03D(2)(b) Solidifying Emulsion

Solidifying emulsion must be either a water-based polymer or nontoxic organic powdered binder specifically manufactured to harden decomposed granite. The solidifying emulsion must not change the decomposed granite color.

20-5.03D(3) Construction

Do not place decomposed granite during rainy conditions.

Mix solidifying emulsion thoroughly and uniformly throughout the decomposed granite and under the manufacturer's instructions. Mix the material in the field using portable mixing equipment or have it delivered in mixer trucks from a local ready-mixed plant.

Place decomposed granite uniformly in layers no more than 1-1/2 inches thick. Compact each layer of decomposed granite to a relative compaction of not less than 90 percent. Start compaction at least 6 hours but no more than 48 hours after placement.

For field-mixed material, apply a solidifying emulsion after compaction as recommended by the manufacturer. Prevent runoff or overspray of solidifying emulsion onto adjacent paved or planting areas.

The finished decomposed granite surface must be smooth, uniform, and compacted to a relative compaction of not less than 90 percent. The finished surface must maintain the original flow lines, slope gradients, and contours of the job site.

20-5.03D(4) Payment

Not Used

20-5.03E Rock Mulch

Reserved

20-5.03F–20-5.03J Reserved

20-5.04 WOOD MULCH

20-5.04A General

20-5.04A(1) Summary

Section 20-5.04 includes specifications for placing wood mulch.

20-5.04A(2) Definitions

Reserved

20-5.04A(3) Submittals

Submit a certificate of compliance for wood mulch.

Submit a 2 cu ft mulch sample with the mulch source shown on the bag. Obtain authorization before delivering the mulch to the job site.

20-5.04A(4) Quality Assurance

Reserved

20-5.04B Materials

20-5.04B(1) General

Mulch must not contain more than 0.1 percent of deleterious materials such as rocks, glass, plastics, metals, clods, weeds, weed seeds, coarse objects, sticks larger than the specified particle size, salts, paint, petroleum products, pesticides or chemical residues harmful to plant or animal life.

20-5.04B(2) Tree Bark Mulch

Tree bark mulch must be derived from cedar, Douglas fir, or redwood species.

The mulch must be ground such that at least 95 percent of the material by volume is less than 2 inches long in any dimension and no more than 30 percent by volume is less than 1 inch long in any dimension.

20-5.04B(3) Wood Chip Mulch

Wood chip mulch must:

1. Be derived from clean wood
2. Not contain leaves or small twigs
3. Contain at least 95 percent by volume of wood chips with a width and thickness from 1/16 to 3/8 inch and a length from 1/2 to 3 inches

20-5.04B(4) Shredded Bark Mulch

Shredded bark mulch must:

1. Be derived from trees
2. Be a blend of loose, long, thin wood, or bark pieces
3. Contain at least 95 percent by volume of wood strands with a width and thickness from 1/8 to 1-1/2 inches and a length from 2 to 8 inches

20-5.04B(5) Tree Trimming Mulch

Tree trimming mulch must:

1. Be derived from chipped trees and may contain leaves and small twigs
2. Contain at least 95 percent by volume of material less than 3 inches long for any dimension and not more than 30 percent by volume of material less than 1 inch long for any dimension

20-5.04B(6)–20-5.04B(11) Reserved

20-5.04C Construction

Before placing wood mulch, remove plants and weeds to the ground level.

Maintain the planned flow lines, slope gradients, and contours of the job site. Grade the subgrade to a smooth and uniform surface.

Place mulch after the plants have been planted.

Place mulch in the plant basin at the rate described. Mulch must not come in contact with the plant crown and stem.

Place mulch as shown in areas outside of plant basins to a uniform thickness.

Spread mulch from the outside edge of the plant basin to the adjacent edges of shoulders, paving, retaining walls, dikes, edging, curbs, sidewalks, walls, fences, and existing plantings. If the plant is 12 feet or more from the adjacent edges of any of these elements, spread the mulch 6 feet beyond the outside edge of the plant basin.

Do not place mulch within 4 feet of:

1. Flow line of earthen drainage ditches
2. Edge of paved ditches
3. Drainage flow lines

20-5.04D Payment

The payment quantity for wood mulch is the volume measured in the vehicle at the point of delivery.

20-5.05 SITE FURNISHINGS

20-5.05A General

Section 20-5.05 includes specifications for installing site furnishings.

20-5.05B Materials

Not Used

20-5.05C Construction

Not Used

20-5.05D Payment

Not Used

20-5.05E–20-5.05Z Reserved

20-5.06–20-5.10 RESERVED

20-6–20-9 RESERVED

20-10 EXISTING LANDSCAPE

20-10.01 GENERAL

20-10.01A General

Section 20-10.01 includes general specifications for performing work on existing planting and irrigation facilities.

20-10.01B Materials

Not Used

20-10.01C Construction

Transplant any plant to be transplanted and protect any irrigation component to be relocated before performing any other construction activity in the area.

20-10.01D Payment

Not Used

20-10.02 EXISTING IRRIGATION FACILITIES

20-10.02A General

20-10.02A(1) Summary

Section 20-10.02 includes specifications for performing work on existing irrigation facilities.

Work performed on existing irrigation facilities must comply with section 15.

20-10.02A(2) Definitions

Reserved

20-10.02A(3) Submittals

Submit a list of irrigation system deficiencies within 7 days of checking the existing facilities.

20-10.02A(4) Quality Assurance

After irrigation facilities have been relocated, demonstrate in the presence of the Engineer that the relocated facilities function properly.

Certify each existing backflow preventer under section 20-2.02A(4).

20-10.02B Materials

Valve box covers must be the same size as the covers they replace.

Control and neutral conductors must be the same size and color as the control and neutral conductors they replace.

20-10.02C Construction

20-10.02C(1) General

Notify the Engineer at least 4 business days before shutting off the water supply to any portion of the existing irrigation system and immediately after restoring the water supply to any portion of the existing irrigation system.

If an irrigation facility to be relocated is determined unsuitable, replace the irrigation facility under section 20-2. The replacement of the unsuitable facility is change order work.

20-10.02C(2) Check and Test Existing Irrigation Facilities

Before performing irrigation system work, check existing irrigation facilities to remain in place or to be relocated. The Engineer determines the test watering cycle lengths. Check for deficiencies including missing parts, damaged components, and improper operation. Correct deficiencies as ordered. The correction of deficiencies is change order work.

20-10.02C(3) Operate Existing Irrigation Facilities

If the Contract includes a bid item for operate existing irrigation facilities, after performing work under section 20-10.02C(2), operate existing irrigation facilities through Contract acceptance.

Operate existing irrigation facilities except for water meters, underground supply lines, control and neutral conductors, and electrical conduits.

Check for proper operation at least once every 30 days. Adjust, repair, or replace existing irrigation facilities within 7 days of finding any deficiency.

Operate irrigation systems using the automatic irrigation controller until Contract acceptance. You may operate irrigation controllers manually during plant replacement, fertilization, weed germination, and repair work.

Program the irrigation controllers for seasonal requirements.

20-10.02C(4) Remove Irrigation Facilities

Irrigation facilities to be removed that are more than 6 inches below the finished grade may be abandoned in place unless salvaging is specified or shown

Immediately after disconnecting an existing irrigation facility to be removed or abandoned from an existing facility to remain, the remaining facility must be capped or plugged, or connected to a new or existing irrigation facility.

20-10.02C(5) Replace Valve Box Covers

Existing valve box covers shown to be replaced must remain in place until the new covers are ready to be installed.

20-10.02C(6) Relocate Backflow Preventer Assemblies

Install backflow preventer assemblies under section 20-2.02C.

20-10.02C(7) Relocate Water Meters

Relocate water meters.

20-10.02C(8) Relocate Irrigation Controllers

Install irrigation controllers under section 20-2.06C.

20-10.02C(9) Salvage Irrigation Facilities

Salvage irrigation facilities under section 15-1.03C.

20-10.02D Payment

Not Used

20-10.03 EXISTING PLANTING

20-10.03A General

20-10.03A(1) Summary

Section 20-10.03 includes specifications for performing work on existing planted areas.

Transplant palm trees between March 15 and October 15.

20-10.03A(2) Definitions

Reserved

20-10.03A(3) Submittals

Submit a work plan for:

1. Transplanting trees. The work plan must include methods for lifting, transporting, storing, planting, guying, and maintaining each tree to be transplanted. Include the root ball size, method of root ball containment, and a maintenance program for each tree.
2. Maintaining existing planted areas. The work plan must include controlling the weeds, fertilizing, mowing and trimming of turf areas, watering, and controlling rodents and pests.

Submit a copy of the manufacturer's product sheet for root stimulant including application instructions.

20-10.03A(4) Quality Assurance

Inspect for deficiencies of existing planted areas in the presence of the Engineer. Complete the inspection within 15 days of the start of job site activities.

Deficiencies requiring corrective action include:

1. Weeds
2. Dead, diseased, or unhealthy plants
3. Plant stakes and tree ties that are missing
4. Inadequate plant basins and basin mulch
5. Other deficiencies needing corrective action to promote healthy plant life
6. Rodents and pests

20-10.03B Materials

Not Used

20-10.03C Construction

20-10.03C(1) General

Correct deficiencies of the existing planted areas if ordered within 15 days of the order. Correction of deficiencies is change order work.

20-10.03C(2) Prune Existing Plants

If a bid item for prune existing plants is not shown on the Bid Item List, prune existing plants under section 20-3.01C(2) if ordered. Pruning existing plants is change order work.

20-10.03C(3) Transplant Trees

Prune under section 20-3.01C(2) each tree to be transplanted immediately before lifting.

Prune a palm tree by removing dead fronds and frond stubs from the trunk. Remove green fronds up to 2 rows of fronds away from the center of growth. Tie the remaining 2 rows of fronds in an upright position with light hemp or manila rope. Remove fronds and frond stubs at the trunk in a way that will not injure the trunk. Remove fronds and frond stubs for *Phoenix dactylifera* approximately 4 inches from the trunk.

Prepare each hole in the new location before lifting the tree to be transplanted.

Lift each tree to be transplanted as described in the work plan.

Handle and plant each tree to be transplanted under section 20-3.02C(3).

Until a tree is replanted, cover exposed root ball with wet burlap or canvas and cover the crown with 90 percent shade cloth.

Replant each tree on the same day it is lifted if possible. If the transplant location is not ready to receive the tree, store and maintain the tree to be transplanted until the transplant location is authorized. Store the tree in an upright position.

Replace each damaged transplanted tree under section 20-3.01C(4) with the number of trees specified in the special provisions.

The replacement trees must be planted in individual plant holes at the location determined by the Engineer within the area of the tree being replaced. Plant replacement trees under section 20-3.02C.

20-10.03C(4) Maintain Existing Planted Areas

Section 20-10.03C(4) applies if a bid item for maintain existing planted areas is shown on the Bid Item List.

After deficiencies are corrected, perform work to maintain existing planted areas in a neat and presentable condition and to promote healthy plant growth through Contract acceptance.

Existing plant basins must be kept well-formed and free of sediment. If the existing plant basins need repairs and the basins contain mulch, replace the mulch after the repairs are done.

Control weeds within the existing planted area and:

1. From the existing planted area limit to the adjacent edges of paving and fences if less than or equal to 12 feet
2. From the existing planted area limit to 6 feet beyond the outer limit of the existing planted area if the adjacent edge of paving or fence is more than 12 feet away
3. Within a 3-foot radius from each existing tree and shrub

If a bid item for maintain existing planted areas is not shown on the Bid Item List, maintain existing planted areas if ordered. Maintain existing planted areas is change order work.

20-10.03D Payment

Not Used

20-10.04–20-10.08 RESERVED

21 EROSION CONTROL

21-1 GENERAL

21-1.01 GENERAL

Section 21-1 includes general specifications for applying permanent erosion control measures.

21-1.02 MATERIALS

Not Used

21-1.03 CONSTRUCTION

Not Used

21-1.04 PAYMENT

Not Used

21-2 EROSION CONTROL WORK

21-2.01 GENERAL

21-2.01A Summary

Section 21-2 includes specifications for applying permanent erosion control measures to the soil surface.

Move-in/move-out for erosion control includes (1) moving onto the project when the Engineer determines an area is ready to receive erosion control materials, (2) setting up all required personnel and equipment, and (3) moving out all personnel and equipment when work in that area is complete.

21-2.01B Definitions

percent total viability: The sum of the percent germination, percent hard seed, and percent dormant seed.

TRM: Turf reinforcement mat.

21-2.01C Submittals

21-2.01C(1) General

Submit a certificate of compliance for straw, fiber, RECP, and fasteners before application.

If weed-free straw is used, the certificate of compliance must include the certificate of quarantine compliance.

Submit records for hydraulically applied erosion control materials that indicate (1) compliance with the specified application rates, (2) areas treated and quantity of materials applied, and (3) application date and time.

21-2.01C(2) Compost

Submit the compost producer's compost technical data sheet including test results and seal of testing assurance certificate before application.

21-2.01C(3) Seed

At least 60 days before seed application, submit proof that the order for seed required for the Contract has been placed and accepted by the seed vendor. Include the seed's botanical names, quantity ordered, and the anticipated date of delivery.

Submit a copy of the analysis report for each seed species before application.

Submit seed labels. Seed labels must show:

1. Seed variety including botanical name and common name
2. Lot number or other lot identification
3. Origin
4. Net weight
5. Percent pure live seed
6. Percent total viability
7. Percent by weight inert matter

8. Percent by weight other crop seed
9. Percent by weight weed seed
10. Name of restricted noxious weed seed by number per pound of seed
11. Name and address of the supplier or grower responsible for the analysis

21-2.01C(4) Tackifier

Submit a certificate of compliance for tackifier and bonded fiber matrix at least 5 business days before application. Certificates of compliance must include:

1. SDS
2. Product label
3. List of applicable nonvisible pollutant indicators for soil amendment and stabilization materials as shown in the table titled "Pollutant Testing Guidance Table" in the Department's *Construction Site Monitoring Program Guidance Manual.* For the manual, go to the Department's Division of Construction website
4. Report of acute and chronic toxicity tests on aquatic organisms complying with EPA methods
5. List of ingredients, including chemical formulation
6. Properties of polyacrylamide in tackifier including:
   6.1. Percent purity by weight
   6.2. Percent active content
   6.3. Average molecular weight
   6.4. Charge density

21-2.01D Quality Assurance

21-2.01D(1) General

Reserved

21-2.01D(2) Compost

Compost producers must be permitted by the Department of Resources Recycling and Recovery, Local Enforcement Agencies, and any other State and local agencies that regulate solid waste plants. If exempt from State permitting provisions, the composting plant must certify it complies with the guidelines and procedures for production of compost under 14 CA Code of Regs § 17868.

Compost producers must be participants in the United States Composting Council's seal of testing assurance program.

21-2.01D(3) Seed

Seed must be tested for purity and germination by a seed laboratory certified by the Association of Official Seed Analysts or by a seed technologist certified by the Society of Commercial Seed Technologists. Tests must be performed within 12 months before application.

The Engineer takes a sample of approximately 1 ounce or 1/4 cup of seed for each seed lot greater than 2 pounds. Provide the Engineer with a glassine-lined bag and custody seal tag for each seed lot sample.

21-2.02 MATERIALS

21-2.02A General

Water must be of a quality that promotes germination of seeds and growth of plants.

21-2.02B Duff

Duff must consist of vegetation removed and collected from clearing and grubbing activities. Vegetation may include trees, shrubs, ground cover, grasses, bark, leaves, and roots with attached soil.

Process vegetation into duff by tub grinding or chipping it into pieces not exceeding 6 inches in any dimension.

Stockpile duff until work area to receive duff is complete. Duff stockpiles must not exceed 5 feet in height.

21-2.02C Imported Topsoil

Imported topsoil must:

1. Consist of fertile, friable soil of loamy character that contains organic matter in quantities natural to the region and be capable of sustaining healthy plant life
2. Be free from deleterious substances such as litter, refuse, toxic waste, stones larger than 1 inch in size, coarse sand, heavy or stiff clay, brush, sticks, grasses, roots, noxious weed seed, weeds, and other substances detrimental to plant, animal, and human health

21-2.02D Fiber

Fiber must be wood fiber, cellulose fiber, alternate fiber, or a combination of these fibers.

Wood fiber must be a long-strand, whole-wood fiber thermo mechanically processed from clean whole wood chips.

Cellulose fiber must be made from natural or recycled pulp fiber, such as wood chips, sawdust, newsprint, chipboard, corrugated cardboard, or a combination of these materials.

Alternate fiber must be a long strand, whole natural fiber made from clean straw, cotton, corn, or other natural feed stock.

Fiber must:

1. Disperse into a uniform slurry when mixed with water.
2. Contain 3/8-inch fiber strands for at least 25 percent by total volume.
3. Have at least 40 percent retained when passed through a no. 25 sieve.
4. Have an initial moisture content of no more than 15 percent of its dry weight when tested under California Test 226. The moisture content must be marked on the packaging.
5. Have a water holding capacity, by weight, of at least 1,200 percent when tested under ASTM D7367.
6. Be nontoxic to plants and animal life.
7. Be free of synthetic or plastic materials, lead paint, printing ink, varnish, petroleum products, seed germination inhibitors, and chlorine bleach.
8. Contain less than 250 ppm of boron.
9. Be colored to contrast with the area where it is to be applied. The coloring agent must be biodegradable, nontoxic, and free from copper, mercury, and arsenic, and must not stain concrete or painted surfaces.

21-2.02E Tackifier

Tackifier must be (1) free from growth or germination inhibiting factors, (2) nonflammable, (3) nontoxic to aquatic organisms, and (4) functional for a minimum of 180 days.

Tackifier must be one of the following:

1. Plant based natural high-molecular-weight polysaccharide. Plant-based tackifier must be a high viscosity hydrocolloid that is miscible in water, and labeled as either guar, psyllium, or starch, as follows:
   1.1. Guar gum based tackifier must be derived from the ground endosperm of the guar plant, *Cyanmopsis tetragonolobus*. It must be treated with dispersing agents for easy mixing. It must be able to be diluted at the rate of 1 to 5 pounds per 100 gallons of water.
   1.2. Psyllium based tackifier must be manufactured from the finely ground, mucilloid coating of *Plantago ovata* or *Plantago ispaghula* seeds and able to dry and form a firm but rewettable membrane.
   1.3. Starch based tackifier must be a nonionic, water-soluble, granular material derived from corn, potato, or other plant-based source.
2. Prepackaged liquid or dry powder polymeric emulsion blend. Prepackaged tackifier must be an anionic formulation with a residual monomer content not exceeding 0.05 percent by weight. The tackifier must contain and be labeled with one of the following as the primary active ingredients:
   2.1. Acrylic copolymers and polymers.
   2.2. Polymers of methacrylates and acrylates.
   2.3. Copolymers of sodium acrylates and acrylamides.
   2.4. Polyacrylamide and copolymer of acrylamide.
   2.5. Hydrocolloid polymers.

21-2.02F Seed

Seed must not contain:

1. Prohibited noxious weed seed
2. More than 1.0 percent total weed seed by weight

Seed with a germination rate lower than the minimum rate shown may be used if authorized.

Deliver seed to the job site in unopened, separate containers with the seed tag attached.

Measure individual seed species and mix in the presence of the Engineer.

21-2.02G Fertilizer

Fertilizer must comply with the material specifications for fertilizer in section 20-3.01B(4).

21-2.02H Straw

Straw must be stalks from wheat, rice, or barley furnished in air-dry condition with a consistency compatible for application with commercial straw-blowing equipment. Wheat and barley straw must be derived from irrigated crops.

Straw must be free of plastic, glass, metal, rocks, and refuse or other deleterious material.

Straw must have not have been used for stable bedding.

21-2.02I Reserved

21-2.02J Bonded Fiber Matrix

Bonded fiber matrix must be a hydraulically-applied material composed of fiber and tackifier and may also include seed and fertilizer as shown.

Fiber for bonded fiber matrix must be 100 percent wood fiber and comply with the specifications for fiber under section 21-2.02D, except that at least 50 percent is retained when passed through a no. 25 sieve.

Tackifier for bonded fiber matrix must:

1. Be bonded to the fiber or prepackaged with the fiber by the manufacturer
2. Contain a minimum of 10 percent of the combined weight of the dry fiber, activating agents, and additives
3. Be an organic, high viscosity colloidal polysaccharide with activating agents or a blended hydrocolloid-based binder

21-2.02K Compost

Reserved

21-2.02L–21-2.02N Reserved

21-2.02O Rolled Erosion Control Products

21-2.02O(1) General

RECP must be a long-term, degradable, open-weave textile manufactured or fabricated into rolls designed to reduce soil erosion and assist in the growth, establishment, and protection of vegetation. RECP must conform to the classification system established by the ECTC.

Deliver RECP in suitable wrapping to protect against moisture and extended ultraviolet exposure occurring before placement.

21-2.02O(2) Jute Mesh

Jute mesh must be ECTC Type 3B made of unbleached and undyed woven jute. Jute mesh must comply with the requirements shown in the following table:

Jute Mesh

Quality characteristic	Test method	Requirement
Strands per foot (min, in each direction)	--	14–20

Roll width (min, inches)	--	48
USLE C-Factor for a 1.5:1 (H:V) unvegetated slope	--	≤ 0.25
Shear stress (max, psf)	ASTM D6460	2.0
Tensile strength (min, psf)	ASTM D5035	100
Functional longevity (months)	--	12
Average open area (%)	--	65 ± 5
Weight of fabric (min, oz/sq yd)	ASTM D3776	14.4–19.2

21-2.02O(3) Netting

Netting must be ECTC Type 4 and made of 100 percent coconut fiber woven into a matrix. Netting must comply with the requirements shown in the following table:

Netting

Quality characteristic	Test method	Requirement		
		Type A	Type B	Type C
Thickness (min, inch)	ASTM D6525	0.30		
Roll width (min, inches)	--	72–158		
USLE C-Factor for a 1:1 (H:V) unvegetated slope	--	≤ 0.25		
Shear stress (max, psf)	ASTM D6460	2.25	4.4	4.6
Tensile strength (min, psf)	ASTM D5035	125		
Functional longevity (months)		36		
Average open area (%)		63 ± 5	48 ± 5	38 ± 5
Weight of fabric (min, oz/sq yd)	ASTM D3776	11.8	20	26

21-2.02O(4) Erosion Control Blankets

Erosion control blanket must be ECTC Type 2D and made of processed natural fibers that are mechanically, structurally, or chemically bound together to form a continuous matrix that is surrounded by 2 natural nets. Erosion control blanket must comply with the requirements shown in the following table:

Erosion Control Blanket

Quality characteristic	Test method	Requirement		
		Type A	Type B	Type C
Roll width (min, inches)	--	72		
Matrix (%) Straw/coconut Woven coir (coconut fiber) Wood excelsior (6 inches or longer)	--	 70/30 -- --	 -- 100 --	 -- -- 80
USLE C-Factor for a 1:1 (H:V) unvegetated slope	--	≤ 0.20		
Shear stress (max, psf)	ASTM D6460	1.75		
Tensile strength (min, psf)	ASTM D5035	75		
Functional longevity (months)	--	12		

21-2.02O(5) Turf Reinforcement Mats

Turf reinforcement mat must be ECTC Type 5 and nondegradable, open-weave textile made of synthetic fibers, filaments, nets, wire mesh or other elements, processed into a permanent, 3-dimensional matrix. Turf reinforcement mat must comply with the requirements shown in the following table:

Turf Reinforcement Mat

Quality characteristic	Test method	Requirement		
		Type A	Type B	Type C
Roll width (min, inches)	--	72		
Thickness (min, inches)	ASTM D6525	0.25		
USLE C-Factor for a 1:1 (H:V) unvegetated slope	--	≤ 0.25		
Shear stress (max, psf)	ASTM D6460	6	8.4	10
Tensile strength (min, psf)	ASTM D5035	125	150	175
Functional longevity (months)	--	36		
UV stability (% at 500 hrs)	ASTM D4355	80		

21-2.02P Fiber Rolls

Fiber roll must be a premanufactured roll filled with rice or wheat straw, wood excelsior, or coconut fiber. Fiber roll must be covered with biodegradable jute, sisal, or coir fiber netting secured tightly at each end and must be one of the following:

1. 8 to 10 inches in diameter and at least 1.1 lb/ft
2. 10 to 12 inches in diameter and at least 3 lb/ft

Fiber roll must have a minimum functional longevity of 1 year.

21-2.02Q Compost Socks

Reserved

21-2.02R Fasteners

Wood stakes must be untreated fir, redwood, cedar, or pine and cut from sound timber. The ends must be pointed for driving into the ground. Notched stakes must be at least 1 by 2 by 24 inches in size. Stakes without notches must be at least 1 by 1 by 24 inches.

Metal stakes must be at least 1/2 inch in diameter and have tops bent at 90-degree angles or capped with an orange or red plastic safety cap that fits snugly onto the metal stake.

Steel staples must be a minimum of 11-gauge, 6-inch, U-shaped staples with a 1-inch crown. Provide heavier gauge and greater length if required by the job site conditions. You may use an alternative attachment device such as a 100 percent biodegradable fastener to install RECP instead of staples.

Rope to fasten fiber rolls must be 1/4 inch in diameter and biodegradable, such as sisal or manila.

21-2.02S–21-2.02V Reserved

21-2.03 CONSTRUCTION

21-2.03A General

The Engineer designates the extent of erosion control areas by directing the placement of stakes or other suitable markers in increments of 1 acre or less. Furnish tools, labor, materials, and transportation required to mark areas receiving erosion control treatments.

Before applying erosion control materials, verify that finished grades comply with the specifications for grade, compaction, and finish in section 19.

Remove and dispose of trash, debris, and weeds in areas to receive erosion control materials.

Remove and dispose of loose rocks larger than 2-1/2 inches in maximum dimension unless otherwise authorized.

Protect the traveled way, sidewalks, lined drainage channels, and existing vegetation from overspray of hydraulically-applied material.

Apply erosion control materials within 24 hours after the final preparation of the erosion control areas. Do not apply hydraulically applied materials if:

1. Precipitation occurs
2. Water is standing on or moving across the soil surface
3. Soil is frozen
4. Air temperature is below 40 degrees F during the tackifier curing period unless allowed by the tackifier manufacturer and authorized

21-2.03B Duff

Upon completion of the earthwork in an area, spread duff to a uniform thickness. Apply duff to the edge of the shoulder backing. When shoulder backing is absent, do not apply duff within 3 feet of the edge of pavement.

Trackwalk duff with tracked equipment run perpendicular to slope contours. Water may be used to assist this process but must not cause erosion.

21-2.03C Imported Topsoil

Place imported topsoil after all other earthwork in an area is complete.

Spread imported topsoil to a uniform thickness.

Trackwalk imported topsoil with tracked equipment run perpendicular to slope contours. Water may be used to assist the process but must not cause erosion.

21-2.03D Hydromulch and Hydroseed

Apply hydromulch with hydraulic spray equipment that mixes fiber, tackifier, fertilizer, and other erosion control materials specified. If applying hydroseed, add seed to hydromulch. Seed may be dry applied to small areas not accessible by hydroseeding equipment if authorized.

Add water to hydromulch and hydroseed materials as recommended by the manufacturer and mix sufficiently to ensure an even application. A dispersing agent may be added to the mixture if authorized.

Equipment must have a built-in continuous agitation and discharge system capable of producing a homogeneous mixture and a uniform application rate. The tank must have a minimum capacity of 1,000 gallons. You may use a smaller tank if authorized.

Apply materials in locations, rates, and number of applications shown and as follows:

1. Start application within 60 minutes after adding seed to the tank.
2. Apply in successive passes as necessary to achieve the specified application rate.
3. Apply all hydromulch or hydroseed materials shown for a single area within 72 hours.

If hydromulch or hydroseed materials are applied to areas covered by RECP, apply hydromulch and hydroseed materials to the rolled product as follows:

1. Verify the RECP is in uniform contact with the slope surface.
2. Spray materials into the RECP perpendicular to the slope and integrate well.
3. Do not displace or damage the RECP.

After the final application, do not allow pedestrians or equipment on the treated areas.

21-2.03E Dry Seed

Apply dry seed and fertilizer at the rates shown after job site preparation. Scarify areas to a minimum depth of 1 inch. Apply and incorporate materials into the soil to a maximum depth of 1/4 inch by dragging or raking.

21-2.03F Drill Seed

Drill-seeding equipment must be a rangeland drill seeder with a ring roller attached. The seeder must be equipped with a fluffy seed box with agitators to prevent bridging and clogging. The seed box must have metal row dividers and individual box adjustments to meter the seed flow.

Apply drill seed as follows:

1. Drill seed in rows no greater than 8 inches apart and to a depth of 1/4 inch.

2. Make a minimum of 2 passes in different directions with seeding equipment to reduce any uniform row appearance.

Apply seed to the edge of the shoulder backing. When shoulder backing is absent, do not apply seed within 3 feet of the edge of pavement.

21-2.03G Straw

Apply straw by spreading it uniformly without clumping or piling at the rates shown, based on slope measurements. Once straw work is started in an area, apply all materials for that area in the same work shift.

21-2.03H Bonded Fiber Matrix

Apply bonded fiber matrix materials in the locations, rates, and number of applications shown and as follows:

1. Apply in successive passes as necessary to achieve the specified application rate.
2. Form a continuous uniform mat with no gaps between the mat and the soil surface as follows:
   2.1. Apply in 2 or more directions if necessary.
   2.2. Apply in layers as necessary to avoid slumping and aid drying.

21-2.03I Compost

Apply compost to a uniform thickness in the locations shown. If compost and seed are applied simultaneously, mix and apply together with equipment suitable for the application such as a pneumatic blower truck. Apply compost to the edge of the shoulder backing. When shoulder backing is absent, do not apply compost within 3 feet of the edge of pavement.

21-2.03J Incorporate Materials

Incorporate topsoil, duff, compost, and mulch to the depth shown until well mixed. Materials may be mixed together before incorporation if authorized.

Do not incorporate materials within 2 feet of the pavement edge.

Incorporate straw with a roller made of approximately 7/8-inch steel plate equipped with straight studs placed approximately 8 inches apart and staggered. Studs must not be less than 6 inches long nor more than 6 inches wide and must be rounded to prevent the straw withdrawing from the soil. The roller weight must be sufficient to incorporate the straw into the soil to a depth that will not support combustion and result in a uniform surface.

Compact the area to a relative compaction between 82 and 90 percent except as otherwise specified in section 19-5.

21-2.03K–21-2.03N Reserved

21-2.03O Rolled Erosion Control Products

Before placing RECP, ensure the subgrade has been graded smooth and has no depressed voids. The subgrade must be free from obstructions, such as tree roots, projecting stones, or foreign matter greater than 1 inch in diameter.

Fasten RECP to the surface with staples and anchor as shown.

Do not drive vehicles on RECP.

21-2.03P Fiber Rolls

Before installing fiber roll remove obstructions from the ground, including rocks, clods, and debris greater than 1 inch in diameter.

Install fiber roll approximately parallel to the slope contour. For any 20-foot section of fiber roll, prevent the fiber roll from varying more than 5 percent from level. Install fiber roll on slopes at the following spacing unless shown otherwise:

1. 10 feet apart for slopes steeper than 2:1 (horizontal:vertical)
2. 15 feet apart for slopes from 2:1 to 4:1 (horizontal:vertical)

3. 20 feet apart for slopes from 4:1 to 10:1 (horizontal:vertical)
4. 50 feet apart for slopes flatter than 10:1 (horizontal:vertical)

Type 1 fiber roll installation consists of placing and fastening as follows:

1. Place in a furrow that is from 2 to 4 inches deep.
2. Fasten with wood stakes every 4 feet along the length of the fiber roll.
3. Fasten the ends of the fiber roll by placing a stake 6 inches from the end of the roll.
4. Drive the stakes into the soil so the top of the stake is less than 2 inches above the top of the fiber roll.

Type 2 fiber roll installation consists of placing and fastening as follows:

1. Fasten with notched wood stakes and rope.
2. Drive stakes into the soil until the notch is even with the top of the fiber roll.
3. Lace the rope between stakes and over the fiber roll. Knot the rope at each stake.
4. Tighten the fiber roll to the surface of the slope by driving the stakes further into the soil.

If soil conditions do not allow driving stakes into the soil, drill pilot holes to facilitate driving of the stakes.

Maintain fiber roll in a way that provides sediment holding capacity and reduces runoff velocities as follows:

1. Remove sediment from behind the fiber roll if sediment is 1/3 of fiber roll height above ground.
2. Repair or adjust the fiber roll if rills or other evidence of concentrated runoff occur beneath the fiber roll.
3. Repair or replace the fiber roll if they become split, torn, or unraveled.
4. Add stakes if the fiber roll slumps or sags.
5. Replace broken or split wood stakes.
6. Remove sediment deposits, trash, and debris from fiber roll as needed. If removed sediment is deposited within project limits, it must be stabilized and not exposed to erosion by wind or water.

21-2.03Q Compost Socks

Before installing compost sock, remove obstructions from the ground including rocks, clods, and debris greater than 1 inch in diameter.

Install and maintain compost sock under the specifications for fiber rolls in section 21-2.03P and the following requirements:

1. Place mesh tube, secure the end, and fill uniformly with compost. Secure the remaining end.
2. Fasten compost sock to soil surface.
3. Remove sock and stakes if ordered. Cut sock and empty contents in place. This work is change order work.

21-2.03R–21-2.03T Reserved

21-2.04 PAYMENT

The payment quantity for bid items paid for by area is the area measured parallel to the ground surface except overlaps.

The payment quantity for bid items paid for by length is the length measured parallel to the ground surface except overlaps.

The payment quantity for bid items paid for by volume is the volume measured in the vehicle at the point of delivery.

A move-in followed by a move-out counts as 1 measurement unit. The Department does not adjust the unit price for an increase or decrease in the move-in/move-out quantity.

21-3 PERMANENT EROSION CONTROL ESTABLISHMENT WORK

Reserved

22 FINISHING ROADWAY

22-1.01 GENERAL

Section 22 includes specifications for finishing the roadway.

Perform finishing activities after completing all other construction activities.

22-1.02 MATERIALS

Not Used

22-1.03 CONSTRUCTION

Trim and shape graded areas without surfacing to smooth and uniform cross sections and slopes:

1. Between edge of shoulder and hinge point of slopes
2. At medians

For a graded roadbed without surfacing or pavement, trim and shape the entire roadbed to uniform cross sections and slopes.

Trim slopes of gutters without lining or surfacing to the required grade and cross section.

Do not stockpile material on finished pavement or allow material to drift across pavement. Clean finished pavement of dirt and foreign material.

Clear debris and obstructions from ditches and channels constructed under the Contract.

Clean out sewers, culverts, and other drainage facilities and appurtenant structures constructed under the Contract.

Remove debris and excess material adjacent to culverts, headwalls and endwalls, bridge ends, poles, posts, trees, or other objects and leave in a neat and orderly condition.

Remove from slopes any exposed material that might become loose such as rocks and roots.

Remove loose rock larger than 2-1/2 inches in maximum dimension from:

1. Between the edge of shoulder and hinge point of slopes
2. Medians
3. Finished roadbed

Dispose of material resulting from finishing activities. If authorized, soil and rock resulting from finishing activities may be used along the roadway.

22-1.04 PAYMENT

Not Used

DIVISION IV SUBBASES AND BASES

23 GENERAL

23-1 GENERAL

23-1.01 GENERAL

23-1.01A Summary

Section 23 includes general specifications for constructing subbases and bases.

23-1.01B Definitions

Reserved

23-1.01C Submittals

Submit a QC plan for the types of subbases or bases where described.

23-1.01D Quality Assurance

23-1.01D(1) General

23-1.01D(1)(a) General

Take samples under California Test 125.

23-1.01D(1)(b) Test Result Disputes

You and the Engineer must work together to avoid potential conflicts and to resolve disputes regarding test result discrepancies. Notify the Engineer within 5 business days of receiving the test result if you dispute the test result.

If you or the Engineer dispute each other's test results, submit your test results and copies of paperwork including worksheets used to determine the disputed test results. An independent third party performs referee testing. Before the independent third party participates in a dispute resolution, it must be qualified under AASHTO re:source program and the Department's Independent Assurance Program. The independent third party must have no prior direct involvement with this Contract. By mutual agreement, the independent third party is chosen from:

1. Department laboratory in a district or region not in the district or region the project is located
2. Transportation Laboratory
3. Laboratory not currently employed by you or your material producer

If split acceptance samples are not available, the independent third party uses any available material representing the disputed material for evaluation.

If the independent third party determines the Department's test results are valid, the Engineer deducts the independent third party testing costs from payments. If the independent third party determines your test results are valid, the Department pays the independent third party testing costs.

23-1.01D(2) Quality Control

23-1.01D(2)(a) General

Provide a QC manager when the quantity of subbase or base is as shown in the following table:

QC Manager Requirements

Subbase or base	Requirement
Stabilized soil (sq yd)	≥ 20,000
Aggregate subbases (cu yd)	≥ 20,000
Aggregate bases (cu yd)	≥ 20,000
CTB (cu yd)	≥ 10,000
Lean concrete base (cu yd)	≥ 2,000
Rapid strength concrete base (cu yd)	≥ 1,000
Lean concrete base rapid setting (cu yd)	≥ 1,000
Concrete base (cu yd)	≥ 1,000
Treated permeable bases (cu yd)	≥ 2,000
Reclaimed pavements (sq yd)	≥ 10,000

Provide a testing laboratory to perform quality control tests. Maintain sampling and testing equipment in proper working condition.

You are not entitled to compensation for the suspension of work resulting from noncompliance with quality control requirements, including those identified within the QC plan.

23-1.01D(2)(b) Quality Control Plan

The QC plan must describe the organization and procedures used to:

1. Control the production process
2. Determine if a change to the production process is needed
3. Implement a change

The QC plan must include action and suspension limits and details of corrective action to be taken if any process is outside of those limits. Suspension limits must not exceed specified acceptance criteria.

The QC plan must describe how test results will be submitted including times for sampling and testing for each quality characteristic.

23-1.01D(2)(c) Qualifications

Testing laboratories and testing equipment must comply with the Department's Independent Assurance Program.

Personnel performing sampling and testing must be qualified under the Department's Independent Assurance Program for the sampling and testing performed.

23-1.01D(3) Department Acceptance

Reserved

23-1.02 MATERIALS

Not Used

23-1.03 CONSTRUCTION

Not Used

23-1.04 PAYMENT

Not Used

23-2–23-7 RESERVED

24 STABILIZED SOILS

24-1 GENERAL

24-1.01 GENERAL

24-1.01A Summary

Section 24-1 includes general specifications for stabilizing soils.

24-1.01B Definitions

stabilizing agent: Material added to improve strength and durability of the basement material.

24-1.01C Submittals

24-1.01C(1) General

At least 15 days before starting soil stabilization activities submit the name of the laboratory you will use for QC tests. The laboratory must be qualified under the Department's Independent Assurance Program.

Before performing QC sampling and testing, submit the time and location the sampling and testing will occur. Submit QC testing results within 24 hours of receiving the results.

Submit a certificate of compliance with the stabilizing agent samples that includes a statement certifying the stabilizing agent furnished is the same as on the Authorized Material Source List for the stabilizing agent specified.

Submit a weighmaster certificate for stabilizing agent remaining on hand after completion of the work.

Submit a stabilized soil quality control plan.

24-1.01C(2) Samples

From 30 to 180 days before use, submit one 10 lb sample of each stabilizing agent proposed and from each source.

Submit stabilizing agents in airtight containers. Mark the sample date on the container. Include the SDS.

24-1.01D Quality Assurance

24-1.01D(1) General

If requested, perform QC testing in the presence of the Engineer.

If required, construct test strips with materials, tools, equipment, and methods you will use in the work.

Construct test pads for compaction tests by scraping away material to the depth ordered. If a compaction test fails, corrective action must include the layers of material already placed above the test pad elevation.

24-1.01D(2) Quality Control

24-1.01D(2)(a) General

Reserved

24-1.01D(2)(b) Quality Control Plan

Reserved

24-1.01D(2)(c) Qualifications

Reserved

24-1.01D(2)(d) Preparing Basement Material

After preparing an area for soil stabilization, verify the surface grades.

24-1.01D(2)(e) Mixing

Except for clods larger than 1 inch, randomly test the adequacy of the mixing with a phenolphthalein pH indicator solution.

24-1.01D(3) Department Acceptance

Stabilized soil acceptance is based on:

1. Visual inspection
2. Compliance with the requirements shown in the following table:

Stabilized Soil Requirements for Acceptance

Quality characteristic	Test method	Requirement
Relative compaction, (min, %)	California Test 231 and 216	See section for the specified stabilization agent[a]
Stabilization agent application rate	Calibrated tray or equal	Final application rate ordered by the Engineer ± 5%

[a]For lime stabilized soil, see section 24-2.03E. For cement stabilized soil, see section 24-3.03D.

24-1.02 MATERIALS

24-1.02A General

Reserved

24-1.02B Water

Notify the Engineer if a water source other than potable water is used and perform testing for chlorides and sulfates. If potable water is not used, water for stabilized soil must be clean and contain no more than 650 parts per million of chlorides as Cl determined under California Test 422 and no more than 1,300 parts per million of sulfates as SO_4 determined under California Test 417.

24-1.02C Curing Seal

Curing seal must be asphaltic emulsion, Grade SS1, SS1h, CSS1, or CSS1h.

24-1.02D Stabilizing Agent

Lime sources must be on the Authorized Material List for approved producers of lime for use in soil stabilization.

24-1.03 CONSTRUCTION

24-1.03A General

Do not mix different types of stabilizing agent or from more than one source.

Deliver stabilizing agent in full loads unless it is the last load needed for a work shift.

24-1.03B Preparing Basement Material

For native soil and embankment other than imported borrow, remove rocks or solids larger than 1/3 of the layer thickness. Regardless of the layer thickness, remove rocks and solids greater than 4 inches. Removing soil clods is not required. Notify the Engineer if you encounter rocks or solids greater than 1/3 of the layer thickness. Removing rocks and solids is change order work.

Grade the basement material to be stabilized to within 0.08 foot of the lines and grades shown.

24-1.03C Applying Stabilizing Agent

The Engineer orders the application rate as pounds of stabilizing agent per square yard of basement material to be stabilized.

Do not vary from the Engineer's ordered application rate by more than 5 percent.

24-1.03D Mixing

Stabilizing agent and basement material must be uniformly mixed at least twice to within 0.05 foot of the depth shown at any point. If you exceed the mixing depth shown by more than 10 percent, add stabilizing agent in proportion to the exceeded depth.

Remix until the mixture is uniform with no streaks or pockets of stabilizing agent.

24-1.03E Compaction

Compact using a sheepsfoot or segmented wheel roller immediately followed by steel drum or pneumatic-tired rollers.

Wherever the thickness shown is 0.50 foot or less, compact in 1 layer. Wherever the thickness shown is more than 0.50 foot, compact in 2 or more layers of approximately equal thickness. The maximum compacted thickness of any 1 layer must not exceed 0.50 foot unless you first construct a test strip to demonstrate your equipment and methods provide uniform distribution of stabilizing agent and achieve the specified compaction. The test strip must contain at least 500 cu yd of material and no more material than 1 day's production. Construct test strips with materials, tools, equipment, and methods you will use in the work.

Use other compaction methods in areas inaccessible to rollers.

24-1.03F Finish Grading

Wherever the finished surface of stabilized soil is above the allowable tolerance, trim and remove the excess material. Do not leave loose material on the finished surface. If finish rolling cannot be completed within 2 hours of trimming, defer trimming.

Finish rolling of trimmed surfaces must be performed with at least 1 complete coverage with steel drum or pneumatic-tired rollers.

Do not proceed with construction activities for subsequent layers of material until the Engineer verifies the final grades of the stabilized soil.

24-1.03G Curing

24-1.03G(1) General

Cure by one of the following methods:

1. Water cure
2. Curing seal
3. Moist material blanket

24-1.03G(2) Water Cure

Water may be used to cure the finished surface before you place a moist material blanket or apply curing seal. Keep the surface above the optimum moisture content of the stabilized soil. Use this method for no more than 3 days, after which you must apply a curing seal or place a moist material blanket.

24-1.03G(3) Curing Seal

Curing seal equipment must have a gauge indicating the volume of curing seal in the storage tank.

Apply curing seal to the finished surface of stabilized soil under section 37-1.03 when the stabilized soil is at optimum moisture content and:

1. When the ambient temperature is above 40 degrees F and rising.
2. At a rate from 0.10 to 0.20 gallon per square yard. The exact rate is determined by the Engineer.

Repair damaged curing seal the same day the damage occurs.

24-1.03G(4) Moist Material Blanket

Moist material blanket may be either a temporary or permanent layer of material of sufficient thickness to prevent drying of the stabilized soil. You may use moist material blanket if the stabilized soil can bear the weight of construction equipment. Maintain the moist material blanket above the optimum moisture content, as appropriate, until the next structural layer is placed.

24-1.04 PAYMENT

The payment quantity for stabilized soil is measured from the horizontal planned surface of the stabilized soil.

The payment quantity for lime or cement (cement stabilized soil) does not include the quantity of stabilizing agent:

1. Wasted or disposed of in a manner not specified.
2. Remaining on hand after completion of the work. If you use a partial load of stabilizing agent, the quantity remaining is determined by scale weights of the truck and the remaining stabilizing agent.

3. Added stabilizing agent when the mixing depth exceeds the depth shown by more than 10 percent.

24-2 LIME STABILIZED SOIL

24-2.01 GENERAL

24-2.01A Summary

Section 24-2 includes specifications for stabilizing soil by mixing basement material with lime and water.

24-2.01B Definitions

mellowing period: Time between the initial and final mixing to promote initial chemical reactions between lime, water, and basement material.

24-2.01C Submittals

Submit lime samples under ASTM C50. Include the chemical and physical analyses with the submittal.

At least 25 days before applying lime in slurry form, submit the slurry's lime content for authorization.

24-2.01D Quality Assurance

24-2.01D(1) General

Place unique, sequentially numbered lock seals on each load and affix them to trailer blowdown valves that are locked open. The bill of lading for each lime delivery must have that specific lock seal number legibly and visibly imprinted.

24-2.01D(1)(a) Preparing Basement Material

For every 500 cu yd of basement material to be lime stabilized:

1. Test the relative compaction under California Test 231
2. Test the moisture content under California Test 226

24-2.01D(1)(b) Applying Lime

The Engineer determines the final application rate for each lime product proposed from the samples submitted based on California Test 373. Wherever the basement material to be stabilized changes, the Engineer changes the application rate. The Engineer provides the optimum moisture content determined under California Test 373 for each application rate.

Whenever lime in slurry form is used, report the quantity of slurry placed by measuring the volume of slurry in the holding tank once per 40,000 sq ft stabilized, or twice per day, whichever is greater.

The Engineer verifies the application rate of lime used in dry form with a calibrated tray, or equal, once per 40,000 sq ft of stabilized soil, or twice per day, whichever is greater.

24-2.01D(2) Quality Control

24-2.01D(2)(a) General

Reserved

24-2.01D(2)(b) Mixing

During mixing operations, measure and record the ground temperature at full mixing depth.

Take a composite sample from 5 random locations after initial mixing. The moisture content of the composite sample tested under California Test 226 must be a minimum of 3 percent greater than optimum. Determine the moisture versus density relationship of the composite sample material under California Test 216, except part 2, section E, paragraph 6 is modified as follows:

> After adjustment of the moisture content, compact each of the remaining test specimens in the mold, then record the water adjustment, tamper reading, and the corresponding adjusted wet density from the chart on Table 1 using the column corresponding to the actual wet weight of the test specimen compacted. Note each of these wet weights on Line I.

After mixing and before compacting, determine maximum density under California Test 216 from composite samples of mixed material samples from 5 random locations and at each distinct change in

material. Test the gradation for compliance with section 24-2.03D. Test the moisture content of the mixed material under California Test 226.

Moisture content during the mellowing period determined under California Test 226 must be at least 3 percent higher than the optimum moisture content.

24-2.01D(2)(c) Compaction

Test relative compaction on a wet weight basis.

After initial compaction determine the in-place density under California Test 231 and moisture content under California Test 226, at the same locations. Perform one test per 500 cu yd of lime stabilized soil. Test in 0.50-foot depth intervals.

24-2.01D(2)(d) Quality Control Testing

Lime stabilized soil quality control must include testing the quality characteristics at the frequencies shown in the following table:

QC Testing Frequencies

Quality characteristic	Test method	Sampling location	Minimum frequency
Ground surface temperature before adding lime and full depth ground temperature during mixing operations	--	Each temperature location	1 test per 20,000 sq ft, minimum 1 per day
Lime application rate	Calibrated tray or equal	Roadway	1 test per 40,000 sq ft, minimum 2 per day
Gradation on mixed material	California Test 202	Roadway	1 per 500 cu yd, minimum 1 per day
Moisture content	California Test 226	Roadway	1 per 500 cu yd on each layer, each day during mixing and mellowing periods, minimum 1 per day
Relative compaction	California Test 231	Roadway	1 per 500 cu yd on each layer, minimum 1 per day

24-2.02 MATERIALS

Lime must comply with ASTM C977 and the requirements shown in the following table:

Lime Quality

Quality characteristic	Test method	Requirement
Available calcium and magnesium oxide (min, %)	ASTM C25 or ASTM C1301 and C1271	High calcium quicklime: CaO > 90 Dolomitic quicklime: CaO > 55 and CaO + MgO > 90
Loss on ignition (max, %)	ASTM C25	7 (total loss) 5 (carbon dioxide) 2 (free moisture)
Slaking rate	ASTM C110	30 °C rise in 8 minutes

A 0.50 lb sample of lime dry-sieved in a mechanical sieve shaker for 10 minutes ± 30 seconds must comply with the percentage passing for the sieve size shown in the following table:

Lime Gradation

Sieve size	Percentage passing
3/8 inch	98–100

Slurry must:

1. Be free of contaminants
2. Contain at least the minimum dry solids
3. Have uniform consistency

Prepare lime slurry at the job site.

24-2.03 CONSTRUCTION

24-2.03A General

Before applying lime, measure the ground surface temperature. Apply lime at ground temperatures above 35 degrees F. Do not apply lime if you expect the ground temperature to drop below 35 degrees F before you complete mixing and compacting.

During mixing, maintain the in-place moisture of the basement material to be stabilized at a minimum of 3 percent above the optimum moisture determined under California Test 216 as modified in section 24-2.01D(2)(b). During compaction and finish grading, add water to the surface to prevent drying until the next layer of mixed material is placed, or until you apply curing treatment.

Scarify the surface of lime stabilized soil at least 2 inches between each layer. Do not scarify the finished surface of the lime stabilized soil.

From the application of lime to 3 days after the application of curing treatment, only equipment and vehicles essential to the lime stabilization work are allowed on the lime stabilized soil.

24-2.03B Preparing Basement Material

Compact the basement material to at least 90 percent relative compaction.

24-2.03C Applying Lime

Apply lime in dry form. You may apply lime in slurry form, if authorized.

Apply lime uniformly over the area to be stabilized using a vane spreader.

Lime slurry must be in suspension during application. Apply lime slurry uniformly making successive passes over a measured section of the roadway until the specified lime content is reached. Apply the residue from lime slurry over the length of the roadway being processed.

24-2.03D Mixing

Mix lime on the same day it is applied. After the initial mixing, allow a mellowing period for at least 36 hours before final mixing. You may add water and mix during the mellowing period.

Complete all the mixing work within 7 days of the initial application of lime.

Before compaction, the mixed material, except rock, must be within the percentage passing limits for the sieve sizes shown in the following table:

Mixed Material Gradation

Sieve size	Percentage passing
1"	98–100
No. 4	60–100

24-2.03E Compaction

Do not use vibratory rollers.

Start compacting immediately after final mixing.

Compact the lime stabilized soil to at least 95 percent relative compaction.

24-2.03F Finish Grading

The finished surface of the stabilized soil must not vary more than 0.08 foot above or below the grade established by the Engineer unless the stabilized soil is to be covered by material paid for by the cubic yard, in which case the finished surface must not vary above the grade established by the Engineer.

Maintain the moisture content of the lime stabilized soil at a minimum of 3 percent above optimum moisture content through the entire finish grading operation.

Wherever lime stabilized soil is below the allowable tolerance, you may use trimmed material to fill low areas only if final grading and final compaction occurs within 48 hours of beginning initial compaction. Before placing trimmed material, scarify the surface of the area to be filled at least 2 inches deep.

24-2.03G Curing

Choose the method of curing and apply the chosen curing method within 48 hours of completing the sheepsfoot or segmented wheel compaction and within the same day of any trimming and finish grading.

24-2.04 PAYMENT

The Department does not adjust the unit price for an increase or decrease in lime quantity.

24-3 CEMENT STABILIZED SOIL

24-3.01 GENERAL

24-3.01A Summary

Section 24-3 includes specifications for constructing CSS by mixing basement material with cement and water.

24-3.01B Definitions

Reserved

24-3.01C Submittals

Submit cement samples under California Test 125. Include the mill analysis.

Submit a certificate of compliance under section 90-1.01C(3).

24-3.01D Quality Assurance

24-3.01D(1) General

24-3.01D(1)(a) General

Stop CSS activities and immediately notify the Engineer if either of the following occurs:

1. Any quality control test result does not comply with the specifications
2. Visual inspection shows noncompliant CSS

If CSS activities are stopped, before resuming activities:

1. Notify the Engineer of the adjustments you will make
2. Reprocess, remedy, or replace the noncompliant CSS until it complies with specifications
3. Construct a 1,000 square yard test strip of CSS demonstrating ability to comply with the specifications
4. Obtain the Engineer's authorization

24-3.01D(1)(b) Preparing Basement Material

For every 1,000 sq yd of basement material to be cement stabilized:

1. Test the relative compaction under California Test 231
2. Test the moisture content under California Test 226

24-3.01D(1)(c) Applying Cement

The Engineer determines the final application rate based on ASTM D1633, Method A, except:

1. Test specimens must be compacted under ASTM D1557, Method A or B.
2. Test specimens must be cured by sealing each specimen with 2 layers of plastic at least 4 mil thick. The plastic must be tight around the specimen. Seal all seams with duct tape to prevent moisture

loss. Sealed specimens must be placed in an oven for 7 days at 100 ± 5 degree F. At the end of the curing period, specimens must be removed from the oven and air-cooled. Duct tape and plastic wrap must be removed before capping. Specimens must not be soaked before testing.

The application rate is ordered as pounds of cement per square yard of basement material to be stabilized.

Before applying cement, measure and record the air temperature and in situ moisture content of the basement material to be stabilized.

The Engineer verifies the application rate using a calibrated tray or equal once per 40,000 sq ft of stabilized basement material, or twice per day, whichever is greater.

24-3.01D(2) Quality Control

24-3.01D(2)(a) General

Reserved

24-3.01D(2)(b) Mixing

During mixing operations, measure and record the air temperature for the basement material to be stabilized.

For each day of mixing, test the in-place moisture content under California Test 231, Part 1, Section E and verify moisture content under California Test 226. Sample immediately after mixing.

After mixing, maintain the in-place moisture of the basement material to be stabilized within a range of 1 percent below to 2 percent above the optimum moisture determined under California Test 216. Determine in-place moisture content under California Test 231. During compaction and finish grading, add water to the surface to prevent drying until the next layer of mixed material is placed, or until you apply curing treatment.

24-3.01D(2)(c) Compaction

After compaction, determine in-place wet density under California Test 231 and moisture content under California Test 226, at the same locations. Perform one test per 1,000 sq yd of CSS. Test in 0.50-foot depth intervals from the bottom of the CSS layer regardless of the layer thickness. Convert wet density to dry density and calculate relative compaction under California Test 216 on a dry density basis.

24-3.01D(2)(d) Quality Control Testing

Cement stabilized soil quality control must include testing the quality characteristics at the frequencies shown in the following table:

QC Testing Frequencies

Quality characteristic	Test method	Sampling location	Minimum frequency
Air temperature before adding cement to basement material	--	Each temperature location	1 test per 20,000 sq ft, minimum 1 per day
Moisture content of basement material before adding cement	California Test 226	Roadway	1 per 1000 sq yd per layer, minimum 1 per day
Cement application rate	Calibrated tray or equal	Roadway	1 test per 20,000 sq ft, minimum 2 per day
Gradation on mixed material	California Test 202	Roadway	1 per 1000 sq yd per layer, minimum 1 per day
Moisture content of mixed material	California Test 226	Roadway	1 per 1000 sq yd per layer, minimum 1 per day
Moisture content of compacted material at time of relative compaction testing	California Test 231	Roadway	1 per 1000 sq yd per layer, minimum 1 per day
Relative compaction	California Test 231	Roadway	1 per 1000 sq yd per layer, minimum 1 per day

24-3.02 MATERIALS

Cement must comply with section 90-2.01A, Type II or Type V portland cement.

24-3.03 CONSTRUCTION

24-3.03A General

Remove standing water from the basement material.

Apply cement at air temperatures above 40 degrees F and rising. Do not apply cement to frozen basement material.

During compaction and finish grading, add water to the surface to prevent drying until the next layer of mixed material is placed, or until you apply curing treatment.

Do not scarify surfaces of intermediate or final layers of CSS.

24-3.03B Applying Cement

Apply cement uniformly over the area to be stabilized using a vane spreader.

Do not apply dry cement in windy conditions that will result in dust outside the treatment area.

24-3.03C Mixing

You may mix cement and the basement material off the job site.

Complete initial mixing work within 30 minutes of the application of cement.

After mixing, maintain the in-place moisture of the basement material to be stabilized within a range of 1 percent below to 2 percent above the optimum moisture.

Before compaction, the CSS, except rock, must within the percentage passing limits for the sieve sizes shown in the following table:

Cement Stabilized Soil Gradation

Sieve sizes	Percentage passing
2"	100
3/4"	98-100
No. 4	55-100

24-3.03D Compaction

Complete initial compaction of a layer within 2 hours of initial mixing of cement.

Complete all compaction of a layer within 4 hours of mixing of cement.

Compact the CSS to at least 97 percent relative compaction.

24-3.03E Finish Grading

Maintain the moisture content of the CSS to within a range of 1 percent below and 2 percent above the optimum moisture content through the entire finish grading operation.

Finish rolling of trimmed surfaces must be performed within 2 hours of completion of compacting.

The finished surface of the CSS must not vary more than 0.05 foot above or below the grade established by the Engineer unless the CSS is to be covered by material paid for by the cubic yard, in which case the finished surface may not vary above the grade established by the Engineer.

Fill areas of finished CSS that are lower than the grade established by the Engineer with material specified for the subsequent layer.

24-3.03F Curing

24-3.03F(1) General

Choose the method of curing and apply the chosen cure method on the same day as completing compaction and any trimming and finish grading.

Do not trim CSS after curing.

24-3.03F(2) Subsequent Pavement Layer

For CSS you may cure by placing a subsequent pavement layer over the finished CSS.

You may place subsequent pavement layers any time after finish grading if the CSS is sufficiently stable to support the required construction equipment without marring or permanently distorting the surface.

24-3.04 PAYMENT

The Department does not adjust the unit price for an increase or decrease in cement quantity.

The Department does not pay for subsequent layer material used to fill low areas of cement stabilized soil.

24-4–24-8 RESERVED

25 AGGREGATE SUBBASES

25-1 GENERAL

25-1.01 GENERAL

25-1.01A Summary

Section 25 includes specifications for placing aggregate subbase.

25-1.01B Definitions

Reserved

25-1.01C Submittals

Submit an aggregate subbase QC plan.

25-1.01D Quality Assurance

25-1.01D(1) General

Reserved

25-1.01D(2) Quality Control

25-1.01D(2)(a) General

Reserved

25-1.01D(2)(b) Quality Control Plan

Reserved

25-1.01D(2)(c) Qualifications

Reserved

25-1.01D(2)(d) Quality Control Testing

AS quality control must include testing the quality characteristics at the frequencies shown in the following table:

QC Testing Frequencies

Quality characteristic	Test method	Sampling location	Minimum frequency
R-value	California Test 301	Stockpiles, transportation units, windrows, or roadways	1 test before beginning work and every 2000 cu yd thereafter[a]
Aggregate gradation	California Test 202	Stockpiles, transportation units, windrows, or roadways	1 per 500 cu yd but at least one per day of placement
Sand equivalent	California Test 217	Stockpiles, transportation units, windrows, or roadways	
Relative compaction	California Test 231	Roadway	1 per 500 sq yd on each layer

[a]Additional R-value frequency testing will not be required when the average of 4 consecutive sand equivalent tests is 4 or more above the specified operating range value.

25-1.01D(3) Department Acceptance

The Department accepts AS based on aggregate gradation, R-value requirements, and sand equivalent requirements specified in section 25-1.02.

The Department accepts AS based on percent relative compaction specified in section 25-1.03E tested under California Test 231.

The Engineer takes aggregate subbase samples for R-value, aggregate gradation, and sand equivalent from any of the following locations:

1. Windrow
2. Roadway

For Class 1–4 AS, if the aggregate gradation test results, the sand equivalent test results, or both comply with contract compliance requirements but not operating range requirements, you may continue placing AS for the remainder of the work day. Do not place additional AS until you demonstrate to the Engineer the AS to be placed complies with the operating range requirements.

For Class 1–4 AS, if the aggregate gradation test results, sand equivalent test results, or both do not comply with contract compliance requirements, remove the AS or request a payment deduction. If your request is authorized, $2.00/cu yd is deducted.

Each aggregate gradation and sand equivalent test represents no more than 500 cu yd of AS or 1 day's production, whichever is smaller.

25-1.02 MATERIALS

25-1.02A General

Aggregate for Class 1, 2, 3, and 4 AS must be clean and consist of any combination of the following:

1. Broken stone
2. Crushed gravel
3. Natural rough surfaced gravel
4. Sand
5. Reclaimed processed asphalt concrete, PCC, LCB, or CTB

If Class 5 is specified, the location for obtaining the material and gradation requirements are in the special provisions.

25-1.02B Class 1, Class 2, and Class 3 Aggregate Subbases

Aggregate gradation must be within the percentage passing limits for the sieve sizes shown in the following table:

Aggregate Gradation

Sieve size	Percentage passing					
	Class 1		Class 2		Class 3	
	Operating range	Contract compliance	Operating range	Contract compliance	Operating range	Contract compliance
3"	100	100	100	100	100	100
2 1/2"	90–100	87–100	90–100	87–100	90–100	87–100
No. 4	35–70	30–75	40–90	35–95	50–100	45–100
No. 200	0–20	0–23	0–25	0–29	0–30	0–34

The aggregate quality characteristics must comply with the requirements for the classes shown in the following table:

Aggregate Quality Characteristics

Quality characteristic	Requirement					
	Class 1		Class 2		Class 3	
	Operating range	Contract compliance	Operating range	Contract compliance	Operating range	Contract compliance
Sand equivalent, (min)	21	18	21	18	21	18
Resistance, (R-value, min)	--	60	--	50	--	40

25-1.02C Class 4 Aggregate Subbase

Reserved

25-1.02D Class 5 Aggregate Subbase

Reserved

25-1.03 CONSTRUCTION

25-1.03A General

Apply water to the AS as needed for compaction.

25-1.03B Subgrade

Immediately before spreading the AS, the subgrade must comply with the specified compaction and elevation tolerance for the material involved and be free from loose or extraneous material.

You may fill areas of the subgrade lower than the grade established by the Engineer with AS.

Before placing biaxial geogrid, remove sharp objects that may come in contact with the material.

25-1.03C Placing Geosynthetics Materials

Section 25-1.03C applies if geosynthetic materials are shown.

Geosynthetic materials include filter fabric and biaxial geogrid.

If filter fabric is shown, place it on the subgrade.

Place biaxial geogrid if shown:

1. Under manufacturer's instructions
2. Longitudinally along the roadway alignment
3. Without wrinkles

Overlap adjacent edges of geosynthetic material at least 2 feet. Overlap the ends of the rolls at least 2 feet in the direction AS is spread.

You may fold or cut geosynthetic material to conform to curves. If material is cut, overlap it at least 2 feet. You may hold the material in place with mechanical ties, staples, pins, or small piles of AS.

Do not place stockpiles on geosynthetic material or place more material than can be covered in 72 hours.

Do not operate equipment or vehicles directly on filter fabric.

Do not operate equipment or vehicles directly on geogrid unless one of the following conditions is met:

1. Vehicles and equipment are:
   1.1. Equipped with rubber tires
   1.2. Operated under 10 mph
   1.3. Operated to avoid sudden braking and sharp turns
2. At least 0.35 ft of AS has been placed, spread, and compacted on the material

Repair or replace any damaged geosynthetic material by placing a new piece of material over the damaged area with at least 3 feet of overlap.

25-1.03D Spreading

Deliver uniform mixtures of AS to the roadbed. Deposit AS in layers or windrows. Spread and shape the AS to such thickness that after watering and compacting, the completed AS is within the tolerances specified in section 25-1.03E. When AS is spread and compacted the moisture content must be uniform and sufficient to obtain the required compaction. Avoid material segregation. AS must be free from pockets of coarse or fine material.

Where the subgrade is cohesionless sand and if authorized, you may dump AS in piles and spread it ahead in sufficient quantities to stabilize the subgrade.

Where the subbase thickness shown is 0.50 foot or less you may spread and compact the AS in one layer. Where the shown thickness is more than 0.50 foot, spread and compact in 2 or more layers approximately equal in thickness. The compacted thickness of any one layer must not exceed 0.50 foot. At locations inaccessible to spreading equipment, spread and compact AS by any means that will produce the specified results.

25-1.03E Compacting

Compact each AS layer to at least 95 percent relative compaction.

Where biaxial geogrid is shown, compact AS with either (1) a smooth-wheeled roller or (2) a rubber-tired roller. Do not use vibratory devices during compaction.

The finished surface of AS not covered, or covered by material paid for by weight, must not vary more than 0.08 foot above or below the grade established by the Engineer.

The finished surface of AS covered by material paid for by volume must not project above the grade established by the Engineer at any point.

Correct areas of AS that do not comply with the thickness shown if an equivalent thickness of overlying base will not compensate or request a payment deduction. If your request is authorized, the Engineer calculates the deduction by multiplying:

1. Deficient thickness less allowable tolerance
2. Planned width
3. Longitudinal distance of the deficient thickness
4. $11.00/cu yd

25-1.04 PAYMENT

The payment quantity of aggregate subbase is determined by the dimensions shown.

The payment quantity does not include the volume of aggregate subbase used to fill low areas of the subgrade.

25-2–25-10 RESERVED

26 AGGREGATE BASES

26-1 GENERAL

26-1.01 GENERAL

26-1.01A Summary

Section 26 includes specifications for placing aggregate base.

26-1.01B Definitions

Reserved

26-1.01C Submittals

Submit an aggregate base QC plan.

26-1.01D Quality Assurance

26-1.01D(1) General

Aggregate samples must not be treated with lime, cement, or chemicals before testing for durability index. Aggregate from untreated reclaimed processed AC, PCC, LCB, or CTB is not considered treated.

26-1.01D(2) Quality Control

26-1.01D(2)(a) General

Reserved

26-1.01D(2)(b) Quality Control Plan

Reserved

26-1.01D(2)(c) Qualifications

Reserved

26-1.01D(2)(d) Quality Control Testing

AB quality control must include testing the quality characteristics at the frequencies shown in the following table:

QC Testing Frequencies

Quality characteristic	Test method	Sampling location	Minimum frequency
R-value	California Test 301	Stockpiles, transportation units, windrows, or roadways	1 test before starting work and every 2,000 cu yd thereafter[a]
Aggregate gradation	California Test 202	Stockpiles, transportation units, windrows, or roadways	1 per 500 cu yd but at least one per day of placement
Sand equivalent	California Test 217	Stockpiles, transportation units, windrows, or roadways	
Durability index[b]	California Test 229	Stockpiles, transportation units, windrows, or roadways	1 per project
Relative compaction	California Test 231	Roadway	1 per 500 sq yd on each layer

[a]Additional R-value frequency testing will not be required when the average of 4 consecutive sand equivalent tests is 29 or greater for Class 2 AB or 25 or greater for Class 3 AB.
[b]Applies if section 26-1.02 contains an applicable requirement for durability index

26-1.01D(3) Department Acceptance

The Department accepts AB based on aggregate gradation, R-value requirements, durability, and sand equivalent requirements specified in section 26-1.02.

The Department accepts AB based on percent relative compaction specified in section 26-1.03E tested under California Test 231.

The Engineer takes aggregate base samples for R-value, aggregate gradation, sand equivalent, and durability index from any of the following locations:

1. Windrow
2. Roadway

If the aggregate gradation test results, sand equivalent test results, or both comply with the Contract compliance requirements but not the operating range requirements, you may continue placing AB for the remainder of the work day. Do not place additional AB until you demonstrate to the Engineer the AB to be placed complies with the operating range requirements.

If the aggregate gradation test results, sand equivalent test results, or both do not comply with Contract compliance requirements, remove the AB or request a payment deduction. If your request is authorized, $2.00/cu yd is deducted. If AB is paid by weight, the Engineer converts tons to cubic yards for the purpose of reducing payment for noncompliant AB left in place.

Each aggregate gradation and a sand equivalent test represents no more than 500 cu yd of AB or 1 day's production, whichever is smaller.

26-1.02 MATERIALS

26-1.02A General

Aggregate must be clean and consist of any combination of the following:

1. Broken stone
2. Crushed gravel
3. Natural rough-surfaced gravel
4. Sand
5. Processed reclaimed asphalt concrete, PCC, LCB, or CTB

Use either 1-1/2-inch or 3/4-inch maximum aggregate gradation unless otherwise specified. Do not change your selected aggregate gradation without authorization.

26-1.02B Class 2 Aggregate Base

Aggregate gradation must be within the percentage passing limits for the sieve sizes shown in the following table:

Aggregate Gradation

Sieve size	Percentage passing			
	1-1/2 inch maximum		3/4 inch maximum	
	Operating range	Contract compliance	Operating range	Contract compliance
2"	100	100	--	--
1-1/2"	90–100	87–100	--	--
1"	--	--	100	100
3/4"	50–85	45–90	90–100	87–100
No. 4	25–45	20–50	35–60	30–65
No. 30	10–25	6–29	10–30	5–35
No. 200	2–9	0–12	2–9	0–12

The aggregate quality characteristics must comply with the requirements shown in the following table:

Aggregate Quality Characteristics

Quality characteristic	Requirement	
	Operating range	Contract compliance
Resistance (R-value, min)	--	78
Sand equivalent (min)	25	22
Durability index (min)	--	35

26-1.02C Class 3 Aggregate Base

Aggregate gradation must be within the percentage passing limits for the sieve sizes shown in the following table:

Aggregate Gradation

Sieve size	Percentage passing			
	1-1/2 inch maximum		3/4 inch maximum	
	Operating range	Contract compliance	Operating range	Contract compliance
2"	100	100	--	--
1-1/2"	90–100	87–100	--	--
1"	--	--	100	100
3/4"	50–90	45–95	90–100	87–100
No. 4	25–60	20–65	40–70	35–75
No. 30	10–35	6–39	12–40	7–45
No. 200	3–15	0–19	3–15	0–19

The aggregate quality characteristics must comply with the requirements shown in the following table:

Aggregate Quality Characteristic

Quality characteristic	Requirement	
	Operating range	Contract compliance
Resistance (R-value) (min)	--	50
Sand equivalent (min)	21	18

26-1.03 CONSTRUCTION

26-1.03A General

Apply water to the AB as needed for compaction.

26-1.03B Subgrade

Immediately before spreading AB, the subgrade must comply with the specified compaction and elevation tolerance for the material involved and be free from loose or extraneous material.

You may use AB to fill areas of the subgrade that are lower than the grade established by the Engineer.

26-1.03C Placing Geosynthetic Materials

Section 26-1.03C applies if geosynthetic materials are shown.

Geosynthetic materials include filter fabric and biaxial geogrid.

If filter fabric is shown, place it on the subgrade.

Before placing geosynthetic materials, remove sharp objects that may come in contact with the material.

Place the material:

1. Under manufacturer's instructions
2. Longitudinally along the roadway alignment
3. Without wrinkles

Overlap adjacent edges of geosynthetic material at least 2 feet. Overlap the ends of the rolls at least 2 feet in the direction AB is spread.

You may fold or cut geosynthetic material to conform to curves. If material is cut, overlap it at least 2 feet. You may hold material in place with mechanical ties, staples, pins, or small piles of AB.

Do not place stockpiles on geosynthetic material or place more material than can be covered in 72 hours.

Do not operate equipment or vehicles directly on filter fabric.

Do not operate equipment or vehicles directly on geogrid unless one of the following conditions is met:

1. Vehicles and equipment are:
   1.1. Equipped with rubber tires
   1.2. Operated under 10 mph
   1.3. Operated to avoid sudden braking and sharp turns
2. At least 0.35 ft of AB has been placed, spread, and compacted on the material

Repair or replace any damaged geosynthetic material by placing a new piece of material over the damaged area with at least 3 feet of overlap.

26-1.03D Spreading

Deliver uniform mixtures of AB to the roadbed. Deposit AB in layers or windrows. Spread and shape the AB to such thickness that after watering and compacting, the completed AB is within the tolerances specified in section 26-1.03E. When AB is spread and compacted the moisture content must be uniform and sufficient to obtain the required compaction. Avoid material segregation. AB must be free from pockets of coarse or fine material.

If the subgrade is cohesionless sand, you may dump AB in piles and spread it ahead in sufficient quantities to stabilize the subgrade, if authorized.

If the AB thickness shown is 0.50 foot or less, spread and compact the AB in at least1 layer. If the thickness shown is more than 0.50 foot, spread and compact the AB in at least 2 approximately equal layers in thickness. The compacted thickness of any one layer must not exceed 0.50 foot.

At locations inaccessible to spreading equipment, spread and compact AB by any means that will attain the specified requirements.

26-1.03E Compacting

Compact each AB layer to at least 95 percent relative compaction.

If biaxial geogrid is shown, compact AB with either (1) a smooth-wheeled roller or (2) a rubber-tired roller. Do not use vibratory devices during compaction.

The finished AB surface must not vary more than 0.05 foot from the grade established by the Engineer.

Correct areas of AB that do not comply with the described thickness or request a payment deduction if AB is paid for by volume. If your request is authorized, the Engineer calculates the deduction by multiplying:

1. Deficient thickness less allowable tolerance
2. Planned width
3. Longitudinal distance of the deficient thickness
4. $17.00/cu yd or the item bid price adjusted for cubic yards, whichever is higher

26-1.04 PAYMENT

If aggregate base is paid for by volume, the payment quantity is determined from the dimensions shown. The payment quantity does not include the volume of aggregate base used to fill low areas of the subgrade.

If the basement material is imported borrow, aggregate base placed to fill low areas is not measured or paid for as imported borrow.

If aggregate base is paid for by weight, the Engineer deducts the weight of the water at the time of weighing in excess of the optimum moisture content plus 1 percent from the weight of the aggregate base. The Engineer determines the optimum moisture content under California Test 216.

26-2–26-10 RESERVED

27 CEMENT TREATED BASES

27-1 GENERAL

27-1.01 GENERAL

27-1.01A Summary

Section 27 includes specifications for placing cement treated base.

27-1.01B Definitions

coarse aggregate: Aggregate retained on a no. 4 sieve.

fine aggregate: Aggregate passing a no. 4 sieve.

27-1.01C Submittals

Submit evidence of the cost of cement used for an ordered increase or decrease.

Submit cement treated base QC plan.

27-1.01D Quality Assurance

27-1.01D(1) General

After the CTB has been spread on the subgrade and before initial compaction, the cement content of the completed mixture of CTB must not vary from the specified cement content by more than 0.6 percent of the weight of the dry aggregate when tested under California Test 338.

For Class A CTB, compaction is tested under California Test 312 or 231.

The relative compaction of CTB must be at least 95 percent. Each layer of CTB may be tested for compaction, or all layers may be tested together at the option the Engineer. If all layers are tested together, you are not relieved of the responsibility to achieve the required compaction in each layer placed.

27-1.01D(1)(a) Aggregate

When tested under California Test 301, aggregate for Class B CTB must have (1) an R-value of at least 60 before mixing with cement and (2) an R-value of at least 80 when aggregate is mixed with an amount of cement that does not exceed 2.5 percent by weight of the dry aggregate.

Before sand equivalent testing, aggregate samples must not be treated with lime, cement, or chemicals.

If the aggregate gradation test results, the sand equivalent test results, or both comply with contract compliance requirements but not operating range requirements, you may continue placing CTB for the remainder of the work day. Do not place additional CTB until you demonstrate to the Engineer that the CTB to be placed complies with the operating range requirements.

If the aggregate gradation test results, sand equivalent test results, or both do not comply with contract compliance requirements, remove the CTB or request a payment deduction. If your request is authorized, $2.50/cu yd is deducted. If CTB is paid for by weight, the Engineer converts tons to cubic yards for the purpose of reducing payment for noncompliant CTB left in place. An aggregate gradation and a sand equivalent test represents up to (1) 500 cu yd or (2) 1 day's production if less than 500 cu yd.

27-1.01D(1)(b) Road-Mixed Cement Treated Base Moisture Content

Just before initial compaction the moisture content of the completed mixture must be at least the optimum moisture content less 1 percent. The moisture content is determined under California Test 226 and optimum moisture content is determined under California Test 312.

27-1.01D(1)(c) Plant-Mixed Cement Treated Base Moisture Content

At the point of delivery to the work, the moisture content of the completed mixture must be at least the optimum moisture content less 1 percent. The moisture content is determined under California Test 226 and optimum moisture content under California Test 312.

27-1.01D(2) Quality Control

27-1.01D(2)(a) General

Reserved

27-1.01D(2)(b) Quality Control Plan

Reserved

27-1.01D(2)(c) Qualifications

Reserved

27-1.01D(2)(d) Quality Control Testing

CTB quality control must include testing the quality characteristics at the frequencies shown in the following table:

QC Testing Frequencies

Quality characteristic	Test method	Sampling location	Minimum frequency
Aggregate gradation	California Test 202 modified	Stockpiles, plant, transportation units, windrow, or roadway	1 per 500 cu yd but at least one per day of placement
Sand equivalent	California Test 217	Stockpiles, plant, transportation units, windrow, or roadway	
R-value[a]	California Test 301	Stockpiles, plant, transportation units, windrows, or roadway	1 test before starting work and every 2000 cu yd thereafter[b]
Optimum moisture content	California Test 312	Plant, transportation units, windrow, or roadway	1 per day of placement
Moisture content	California Test 226	Roadway	1 per 500 cu yd but at least one per day of placement
Cement content	California Test 338	Windrows or roadway	1 per 1000 cu yd but at least one per day of placement
Relative compaction	California Test 312 or 231	Roadway	1 per 2000 sq yd but at least one per day of placement
Compressive strength[c]	California Test 312	Windrow or roadways	1 per day of placement

[a]R-value is required for Class B CTB only.
[b]Additional R-value frequency testing will not be required while the average of 4 consecutive sand equivalent tests is 4 or more above the specified operating range value.
[c]Compressive strength is required for Class A CTB only when specified.

27-1.01D(3) Department Acceptance

The Department's acceptance testing includes testing the CTB quality characteristics shown in the following table:

CTB Requirements for Acceptance

Quality characteristic	Test method
Aggregate gradation	California Test 202 modified
Sand equivalent	California Test 217
R-value[a]	California Test 301
Optimum moisture content	California Test 312
Moisture content	California Test 226
Cement content	California Test 338
Relative compaction	California Test 312 or 231
Compressive strength[b]	California Test 312

[a]R-value is required for Class B CTB only.
[b]Compressive strength is required for Class A CTB only when specified.

The Engineer takes samples for aggregate gradation and sand equivalent from any of the following locations:

1. Plant
2. Truck
3. Windrow, for road-mixed only
4. Roadbed, for road-mixed only

27-1.02 MATERIALS

Cement must be Type II portland cement.

Asphaltic emulsion curing seal must be Grade SS1 or CSS1.

Aggregate must be clean and free from deleterious substances.

Aggregate must be within the percentage passing limits for the sieve sizes shown in the following table:

Aggregate Gradation[a]

Sieve size	Percentage passing			
	Class A		Class B	
	Operating range	Contract compliance	Operating range	Contract compliance
3"	--	--	100	100
2-1/2"	--	--	90–100	87–100
1"	100	100	--	--
3/4"	90–100	87–100	--	--
No. 4	40–70	35–75	35–70	28–77
No. 30	12–40	7–45	--	--
No. 200	3–15	0–19	3–20	0–24

[a]California Test 202 is modified by California Test 105 if the difference in specific gravity between the coarse and fine portions of the aggregate or between the blends of different aggregates is 0.2 or more.

The aggregate quality characteristics must comply with the requirements shown in the following table:

Aggregate Quality Characteristics

Quality characteristic	Requirement		
	California Test	Operating range	Contract compliance
Sand equivalent (min)	217	21	18
Compressive strength (min, psi)[a]	312	--	750

[a]For Class A CTB only

Water must comply with section 90-1.02D.

27-1.03 CONSTRUCTION

27-1.03A General

Reserved

27-1.03B Subgrade

Immediately before spreading CTB, the subgrade, must comply with the specified compaction and elevation tolerance for the material involved and be free from loose or extraneous material.

27-1.03C Depositing Aggregate and Mixing Road-Mixed Cement Treated Base

27-1.03C(1) General

Reserved

27-1.03C(2) Depositing Aggregate

For road-mixed CTB, deposit enough untreated aggregate on the roadbed to comply with the depth shown, the depth specifications in section 27-1.03E, and the grade tolerance specifications in section 27-1.03F. Do not mix the aggregate to be treated with roadbed material that is not to be treated.

If 2 or more nominal sizes of coarse and fine aggregate are deposited on the grade, accurately and uniformly meter each nominal size as it is deposited. Before adding cement, mix the deposited aggregate as many times as necessary to produce a uniform mixture that complies with the specified gradation.

For mixing done from windrows, shape the windrow to a uniform cross section with a sizing device. Do not use a motor grader unless equipped with a sizing device.

Aggregate mixed with cement and water before delivery on the roadbed must be deposited and spread on the prepared subgrade under section 27-1.03E.

27-1.03C(3) Mixing

Mix road-mixed CTB by either of the following methods:

1. Road-mixed method on the roadbed or at a location off the roadbed
2. Plant-mixed method under section 27-1.03D except a Class 2 batch plant may be used

Use mechanical equipment that uniformly distributes cement and water. Whenever cement is added to windrowed aggregates, flatten or slightly trench the top of the windrow to receive cement. If cross-shaft mixers are used, spread cement uniformly over the entire surface of the deposited aggregate. Do not spread cement on aggregate more than 4 hours before the road-mixing operation.

The road-mixing machine must introduce water at the time of mixing with a metering device or other authorized methods. Supply the correct quantity of water by means of controls that will produce a completed mixture with a uniform moisture content. Correct water leaks from equipment or excessive amounts of water during application before proceeding.

For CTB spread and compacted in 2 or more layers, mix material for each layer separately.

If more than 1 pass of the road-mixing machine is required to obtain a uniform mixture, at least 1 pass must be made before adding water to the material.

Regulate the length of road-mixed sections to comply with section 27-1.03G.

27-1.03D Proportioning and Mixing Plant-Mixed Cement Treated Base

27-1.03D(1) General

Mix plant-mixed CTB at a central mixing plant by either of the following:

1. Batch type mixing using either of the following:
   1.1. Revolving blade
   1.2. Rotary drum mixers
2. Continuous type mixing.

In all mixing plants, proportion aggregate, cement, and water by weight or volume. The Engineer must be able to readily verify the amount of water per batch or the flow rate for continuous mixing. The time of the addition of water or the points where it is introduced into the mixer must be authorized.

In all mixing plants, add cement in such a manner that it will be uniformly distributed throughout the aggregates during the mixing operation.

27-1.03D(2) Batch Mixing

If different aggregate sizes are used, the aggregates must be blended as they enter the mixer.

Weigh cement for each batch on scales that are separate and distinct from the aggregate batching scales. Each cement scale graduation must be approximately 1/1000 of the total scale capacity. The total capacity of the scale must not exceed the capacity of the smallest commercially available scale that is capable of weighing twice the amount of cement when the plant is operated at full capacity. No scale is required to have a total capacity less than 1000 lb or graduations less than 1 lb.

Mixing plants must be Class 1 unless Class 2 is specified.

Class 1 batch mixing plants must be equipped with:

1. Enough paddles arranged to produce a uniform mixture

2. Mixer platform large enough to provide safe and convenient access to the mixer and other equipment
3. Timing device accurate to within 2 seconds that indicates the end of the mixing period by an audible or visual signal

For Class 1 mixing plants, the mixing period begins after all the ingredients are in the mixer and ends when the mixer is half empty. Mix until a homogeneous mixture with uniformly distributed and properly coated aggregates, that do not change appearance, is produced and testing indicates the cement content consistently complies with section 27-1.01D(1). The mixing period must not be less than 30 seconds.

Class 1 mixing plants must be equipped with automatic sampling devices actuated by operation of a push button or similar device. When a sampling device is actuated it must simultaneously deliver a representative sample of each size of aggregate or the combined aggregates to adequately sized receptacles. Each sample must weigh from 55 to 65 lb. Locate receptacles safely clear of plant operations with convenient access.

Class 2 mixing plants must comply with the specifications for a Class 1 mixing plant except (1) a timing device to signal the end of mixing is not required and (2) automatic sampling devices are not required.

Class 2 mixing plants must provide safe and convenient access to sampling facilities for obtaining representative samples of aggregate and the mixture.

27-1.03D(3) Continuous Mixing

Draw aggregate from storage facilities by a feeder or feeders that continuously supply the correct amount of aggregate in proportion to cement. If different aggregate sizes are used, arrange feeders such that the proportion of each aggregate size can be separately adjusted.

Storage facilities for fine aggregate must be equipped with a device that effectively vibrates the side walls of the feeder preventing hang-up of material while the plant is operating.

The plant must be equipped with a control system that automatically closes down the plant when the material in any storage facility approaches the strike-off capacity of the feed gate. The plant must not be operated unless the automatic control system is in good working condition.

The aggregate feeder must be mechanically or electrically driven.

Mechanically driven feeders must be directly connected to the cement feeder drive. The drive shaft on the feeder must be equipped with a revolution counter that reads to 1/10 revolution with sufficient capacity to register the total number of revolutions in a day's run.

Electrically driven feeders must be actuated by the same circuit that provides power to the cement feeder motor. For electric power obtained from a noncommercial source, a frequency meter must be connected to the cement feeder motor circuit. The meter must have a minimum range from 57 to 63 Hz and must be graduated in 1 Hz increments or less.

A voltage regulating transformer must be installed in the circuit of vibratory aggregate feeders. The transformer must maintain the voltage to the feeder motors to within 1 percent of their nameplate voltage. A voltmeter must be connected to the secondary of the voltage regulating transformer. The meter must have a range from -10 to +10 percent of the motor nameplate voltage and must be graduated in increments of 1 percent of the nameplate voltage, or less.

For plants equipped with electrically actuated aggregate feeders, the power must have a frequency of 60 ± 1 Hz.

Continuous mixing plants must be equipped with an automatic sampling device specified for Class 1 plants in section 27-1.03D(2) that allows sampling when the plant is in full operation.

The cement feeder and aggregate feeders must be equipped with devices that allow the feed rate to be determined when the plant is in full operation.

27-1.03E Spreading Treated Mixture

Transport materials mixed at a location off the roadbed as a uniform mixture. Cover the mixture during transport to avoid moisture loss, if ordered. Deposit the mixture on the roadbed at a quantity that provides the specified compacted thickness without spotting, picking up, or shifting the mixture.

Just before depositing plant-mixed or spreading road-mixed CTB, moisten the area to be covered. The area must be kept moist, but not excessively wet.

Avoid material segregation. CTB must be free from pockets of coarse or fine material.

Spread the mixed materials in widths of not less than 2 lanes, insofar as the width of the CTB to be spread permits. Sections with 3-lane width may be spread as a 2-lane width and a 1-lane width. Spread materials with 1 spreader or with several spreaders operating in a staggered position across the subgrade, unless traffic conditions limit spreading to less than a 2-lane width. If traffic conditions limit spreading to less than a 2-lane width, spread the remainder of the 2-lane section within 2 hours. For traffic conditions that prevent placement of CTB in adjacent lanes within 2 hours, a longer time may be authorized.

Longitudinal construction joints must be within 1 foot of lane line delineation.

For areas inaccessible to mechanical spreading equipment, spread CTB in 1 layer using an authorized method. After spreading, thoroughly compact the mixture with pneumatic tampers or other compacting equipment that obtains the degree of compaction specified in section 27-1.03F to the required lines, grades, and cross section.

Do not mix or place CTB while the atmospheric temperature is below 35 degrees F. Do not place CTB on frozen ground. Apply curing seal to completed CTB before the atmospheric temperature falls below 35 degrees F.

Comply with one of the following types of spreading operations:

1. For Type 1 spreading operation, spread CTB with a self-propelled mechanical spreader in 1 operation. The CTB must be ready for compaction without further shaping. Equipment not propelled by the unloading equipment is considered self-propelled. The spreader must be equipped with a screed that strikes off and distributes the material to the full width being spread and within the specified surface tolerance. The screed must be adjustable to produce the required cross section. Screed action includes any cutting, crowding or other practical motion that produces a finished surface texture of uniform appearance. The mechanical spreader must be equipped with fully automatic screed and grade sensing controls that control the longitudinal grade and cross slopes of the screed. Screed controls must be able to automatically compensate for differences from the slope and grade established by the Engineer.
2. For Type 2 spreading operation, comply with Type 1 except automatic screed controls and grade sensing controls are not required.
3. For Type 3 spreading operation, spread the treated mixture with any equipment that will consistently finish the base within the tolerance specified in section 27-1.03F without material segregation.

If a spreading type is not specified, use Type 3 on ramps and Type 1 at all other locations.

Except as otherwise specified in section 27-1.03F, do not use motor graders for spreading and compacting operations. To finish the base within the specified tolerance, motor graders may be used to trim the edges and surface of CTB after initial compaction. A motor grader is considered a self-propelled mechanical spreader if:

1. It is equipped with end wings on the blade
2. Blade is locked in a position perpendicular to the direction of travel
3. It is equipped with cross slope and automatic grade controls that comply with the requirements for the specified type of spreading operation

27-1.03F Compacting

Compacting equipment must produce the required compaction within the operation time limit specified in 27-1.03G.

Immediately following the spreading operation, compact the CTB with at least 1 complete coverage.

After initial compaction, wherever the finished surface is higher than the specified tolerance, trim off high spots to within tolerance. Do not fill low areas by drifting or hauling trimmed material. Following trimming, the trimmed areas must be compacted with 1 complete coverage such that the entire layer of CTB

complies with the specified compaction requirements. Perform final compaction in such a manner that no loose material remains on the surface and tear marks are eliminated.

If CTB is spread and compacted in more than 1 layer, compact each layer to the required degree of compaction before placing the next layer. Trim only to comply with the specified layer thickness.

The compacted thickness of any 1 layer must not exceed 0.50 foot or be less than 0.25 foot. When placed in more than 1 layer, keep the compacted material moist until covering with the next layer or applying curing seal. Apply curing seal to the surface of a lower layer that will not be covered with the next layer on the same day.

The finished CTB surface must be uniform and must not deviate at any point by more than 0.03 foot from the bottom of a 12-foot straight edge laid in any direction.

The finished CTB surface must be within 0.05 foot above or below the grade established by the Engineer, except wherever concrete pavement will be placed on CTB, the finished CTB surface must not extend above the grade established by the Engineer.

The surface must be kept moist at all times until the curing seal is applied.

Wherever the surface of hardened CTB is lower than 0.05 foot from the grade established by the Engineer, remove the base and replace it with CTB or if authorized fill low areas according to the pavement material as follows:

1. For HMA pavement, fill low areas with HMA that complies with the specifications for the lowest layer of pavement. Do not fill low areas concurrently with the paving operation.
2. For concrete pavement, fill low areas with pavement concrete concurrent with the paving operation.

If CTB is paid for by the cubic yard, a deduction will be made if there are areas that are deficient in thickness and the deficient thickness has not been compensated for by filling of low areas. The deduction will be computed as the product of:

1. Deficient thickness less allowable tolerance
2. Spread width
3. Longitudinal distance of the deficient thickness
4. $28.00 per cubic yard or the item bid price, whichever is higher

For determining areas of deficient thickness, the longitudinal distance between thickness measurements will not exceed 1,000 linear feet for each direction of travel. Whenever requested, the Engineer will make additional measurements at the Engineer's discretion to define the area of deficient thickness at your cost.

Excess material may be placed as aggregate for shoulder construction if:

1. Shoulder subgrade is prepared as specified.
2. Hardened chunks of trimmed material are removed or reduced to the maximum size specified for shoulder aggregate.
3. Trimmed material incorporated into the shoulder does not exceed 25 percent of the planned volume of shoulder aggregate per foot of shoulder. If trimmed material exceeds this limit, it must be removed and placed in other areas under the 25 percent limit.
4. Excess material is uniformly distributed in the shoulder area before spreading additional shoulder aggregate.

Excess material may be used in other work if the material complies with the applicable specifications.

The relative compaction of CTB must be at least 95 percent.

27-1.03G Operation Time Requirement

Complete initial compaction before trimming within 2 hours of adding water to the aggregate and cement. Complete final compaction after trimming within 2-1/2 hours of adding water to the aggregate and cement.

27-1.03H Contact Joints

Construct a contact joint at the end of each work day and whenever CTB operations are delayed or stopped for more than 2 hours. Contact joints must be constructed in thoroughly compacted material, normal to the roadbed centerline, with a vertical face. Do not place additional CTB until the contact joint is accepted.

Where CTB has been finally compacted for more than 1 hour, construct longitudinal joints by cutting vertically into the existing edge approximately 3 inches deep. Moisten the face of the cut joint in advance of placing adjacent base. Material from cutting may be used as excess material as specified in section 27-1.03F.

27-1.03I Curing

Cover the completed CTB with asphaltic emulsion curing seal.

Dilute and thoroughly mix asphaltic emulsion for curing seal at a ratio of 1 part water to 1 part asphaltic emulsion. The water must not cause premature separation of the emulsion. Uniformly apply the diluted curing seal at a rate between 0.20 to 0.30 gal/sq yd of CTB surface. The Engineer determines the exact rate.

Apply curing seal on the same day as completion of final compaction and as soon after final compaction is practicable. Keep the surface moist until curing seal is applied.

Do not allow traffic or equipment on the CTB for 72 hours after application of the curing seal. After 72 hours, limit traffic and equipment on the CTB to that used in paving operations or placing additional layers of CTB.

27-1.04 PAYMENT

If excess material is placed in an area in which the item is measured by the ton, payment as the item where placed is not made unless applicable measurement specifications for the item where placed are complied with.

If cement treated base is paid for by the ton, the payment quantity for cement treated base does not include the quantity of excess material except for the quantity of excess material used in shoulders.

If cement treated base is paid for by the cubic yard:

1. The payment quantity for cement treated base is the volume determined from the dimensions shown
2. The payment quantity for cement treated base does not include the volume of any cement treated base placed below the grade established by the Engineer.
3. If an increase or decrease in the specified quantity of cement is ordered, the quantity of cement subject to increased or decreased payment is the difference between the specified theoretical quantity of cement and the theoretical quantity of cement ordered. The theoretical quantity of cement is determined from the following formula:

$$W_c = \frac{1686C \times V(D - M)}{100 + C}$$

where:
W_c = Theoretical quantity of cement in lb
V = Pay volume of cement treated base in cu yd
C = Percentage of cement in the mix
D = Average in-place wet density in g/cc
M = Average in-place moisture in g/cc

If cement treated base is paid for by the ton:

1. Payment quantity of cement treated base is the sum of the weight of the aggregate used in the mix and the weight of cement to be added to the mix.
2. Weight of aggregate for road-mixed cement treated base that is mixed on the roadbed is measured before delivery to the roadbed under section 9-1.02 except the weight to be paid for is determined by

deducting from the weight of the aggregate, the weight of the water in the aggregate at the time of weighing in excess of 3 percent of the dry weight of the aggregate.

3. Weight of cement for road-mixed cement treated base that is mixed on the roadbed to be included in the payment quantity of road-mixed cement treated base is the product of the specified percentage of cement to be added to the mix and the weight of dry aggregate.
4. Weight of plant-mixed cement treated base or road-mixed cement treated base that is mixed by the plant-mixed method is measured after mixing under section 9-1.02 except that moisture in excess of 3 percent of the dry weight of the mixture is deducted from the weight of the combined aggregate, cement, and water. When the specified quantity of cement is increased in plant-mixed cement treated base or road-mixed cement treated base mixed by the plant-mixed method, the weight of cement for which increased compensation is made, as specified in section 27-1.04, is deducted from the combined weight of aggregate and cement.

If an increase or decrease in the specified cement content is ordered, payment is adjusted based on the cost of cement per ton, FOB from the cement mill, including sales tax plus the freight cost per ton for delivery from the mill to the plant. In determining the cost of cement, any cash or trade discount offered or available is credited to the Department even if the purchaser did not take the discount.

Maintain records that allow a clear determination of the cement costs associated with the increase or decrease.

Submit evidence of the cost of cement used for the increase or decrease.

If your records show an excessive cost for the increase or decrease of cement or you furnish inadequate evidence for the cost, the Engineer determines the cost to be the lowest wholesale price that the cement was available for in the quantities delivered to the point of production less any available discounts.

The quantity of cement subject to increased or decreased compensation will be the difference between the specified theoretical quantity of cement and the theoretical quantity of cement ordered. The Department does not adjust payment for variations in the cost of work resulting from the change in the quantity of cement.

27-2–27-10 RESERVED

28 CONCRETE BASES

28-1 GENERAL

28-1.01 GENERAL

28-1.01A Summary

Section 28-1 includes general specifications for constructing concrete bases.

28-1.01B Definitions

Reserved

28-1.01C Submittals

For a concrete base requiring field qualification, submit the name of your proposed testing laboratory at least 25 days before the qualification. For a base not requiring field qualification, submit the name of the proposed laboratory at least 10 days before submitting your mix design.

28-1.01D Quality Assurance

28-1.01D(1) General

Aggregate samples must not be treated with lime, cement, or chemicals before testing for sand equivalent.

Stop concrete base activities and immediately notify the Engineer whenever:

1. Any QC or QA test result does not comply with the specifications
2. Visual inspection shows a noncompliant concrete base

If concrete base activities are stopped, before resuming activities:

1. Notify the Engineer of the adjustments you will make
2. Remedy or replace the noncompliant concrete base
3. Field qualify or construct a new test strip as specified for the concrete base involved to demonstrate compliance with the specifications
4. Obtain authorization

28-1.01D(2) Quality Control

28-1.01D(2)(a) General

Reserved

28-1.01D(2)(b) Quality Control Plan

Reserved

28-1.01D(2)(c) Qualifications

Reserved

28-1.01D(3) Department Acceptance

Reserved

28-1.02 MATERIALS

Aggregate must be clean and free of decomposed material, organic material, and other deleterious substances.

28-1.03 CONSTRUCTION

28-1.03A General

Reserved

28-1.03B Subgrade Preparation

Immediately before placing the base, verify that the subgrade to receive the base complies with the specified compaction and elevation tolerances and is:

1. Free of loose and extraneous material

2. Uniformly moist, but free of standing or flowing water

28-1.03C Placing

Place concrete base under section 40-1.03F(1) except the 3rd paragraph does not apply.

Spread, screed, shape, and consolidate concrete base under section 40-1.03F(4) or under section 40-1.03F(5) except where there are confined work areas. If authorized for confined work areas, you may:

1. Spread and shape concrete base using suitable powered finishing machines and supplement with hand work as necessary.
2. Consolidate the base using high-frequency internal vibrators within 15 minutes after depositing the base on the subgrade.
3. Vibrate such that adequate consolidation occurs across the full paving width. Do not use vibrators for extensive weight shifting of the concrete base.

Contraction joints must comply with section 40-1.03B(3).

28-1.04 PAYMENT

The payment quantity for any type of concrete base is the volume determined from the dimensions shown.

The payment quantity for asphaltic emulsion (concrete base) is determined from the gauge reading on the curing seal equipment.

28-2 LEAN CONCRETE BASES

28-2.01 GENERAL

28-2.01A Summary

Section 28-2 includes specifications for constructing lean concrete base.

28-2.01B Definitions

Reserved

28-2.01C Submittals

28-2.01C(1) General

Submit QC test data and QC test results within 24 hours of test completion.

At least 10 days before field qualification, submit:

1. Aggregate qualification test results
2. Proposed aggregate gradation
3. Mix design, including:
   3.1. Proportions
   3.2. Types and amounts of chemical admixtures
4. Optional notice of intent to produce LCB qualifying for a transverse contraction joint waiver under section 28-2.03D

Submit a lean concrete base QC plan.

28-2.01C(2) Field Qualification

For each field qualification test, submit 6 of the 12 cylinders within 24 to 72 hours after preparing them.

Submit field qualification data and test reports including:

1. Mixing date
2. Mixing equipment and procedures used
3. Batch volume in cubic yards, the minimum is 5 cu yd
4. Type and source of ingredients used
5. Age and strength from compression strength results

The test reports must be signed by the person in responsible charge of the laboratory performing the tests.

28-2.01D Quality Assurance

28-2.01D(1) General

28-2.01D(1)(a) General

The molds for compressive strength testing under ASTM C31 or ASTM C192 must be 6 by 12 inches.

If the aggregate gradation test results, sand equivalent test results or both comply with the contract compliance requirements but not the operating range requirements, you may continue placing LCB for the remainder of the work day. Do not place additional LCB until you demonstrate the LCB to be placed complies with the operating range requirements.

28-2.01D(1)(b) Qualifications

Field qualification tests and calculations must be performed by an ACI certified Concrete Laboratory Technician, Grade I.

28-2.01D(1)(c) Aggregate Qualification Testing

Qualify the aggregate for each proposed aggregate source and gradation. The qualification tests include (1) a sand equivalent and (2) an average 7-day compressive strength under ASTM C39 of 3 cylinders manufactured under ASTM C192 except cure cylinders in molds without lids after initial curing.

For the compressive strength test, the cement content for each cylinder must be 300 lb/cu yd. The 7-day average compressive strength must be at least 610 psi. The cement must be Type II portland cement.

LCB must have from 3 to 4 percent air content during aggregate qualification testing.

28-2.01D(1)(d) Field Qualification Testing

Before placing LCB, you must perform field qualification testing and obtain authorization for each mix design. Retest and obtain authorization for changes to the authorized mix designs.

Notify the Engineer at least 5 business days before field qualification. Perform the field qualification at the job site or an authorized location.

Field qualification testing includes tests for compressive strength, air content, and penetration or slump.

For compressive strength field qualification testing:

1. Prepare 12 cylinders under ASTM C31 except final cure cylinders in molds without lids from a single batch.
2. Perform 3 tests; each test consists of determining the average compressive strength of 2 cylinders at 7 days under ASTM C39. The average compressive strength for each test must be at least 530 psi

If you submitted a notice to produce LCB qualifying for a transverse contraction joint waiver, manufacture additional specimens and test the LCB for compressive strength at 3 days. Prepare the compressive strength cylinders under ASTM C31 except final cure cylinders in molds without lids at the same time using the same material and procedures as the 7-day compressive strength cylinders except do not submit 6 additional test cylinders. The average 3-day compressive strength for each test must be not more than 500 psi.

28-2.01D(2) Quality Control

28-2.01D(2)(a) General

Reserved

28-2.01D(2)(b) Quality Control Manager

Reserved

28-2.01D(2)(c) Quality Control Testing

Test the LCB under the test methods and at the locations and frequencies shown in the following table:

LCB Sampling Location and Testing Frequencies

Quality characteristic	Test method	Sampling location	Minimum sampling and testing frequency
Sand equivalent	ASTM D2419	Source	1 per 500 cubic yards but at least 1 per day of production
Aggregate gradation	ASTM C136		
Air content	ASTM C231	Job site	
Penetration[a]	ASTM C360		
Slump[a]	ASTM C143		
Compressive strength	ASTM C39 [b]		

[a]Test for either penetration or slump.
[b]Prepare cylinders under ASTM C31 except final cure cylinders in molds without lids.

28-2.01D(3) Department Acceptance

The Department accepts LCB based on compliance with the requirements shown in the following table:

LCB Requirements for Acceptance

Quality characteristic	Test method	Requirement
Compressive strength (min, psi at 7 days)	ASTM C39 [a]	530 [b]

[a]Cylinders prepared under ASTM C31 except final cure cylinders in molds without lids.
[b]A compressive strength test represents up to (1) 1,000 cu yd or (2) 1 day's production if less than 1,000 cu yd.

28-2.02 MATERIALS

28-2.02A General

You may use a water-reducing chemical admixture. Water-reducing chemical admixture must comply with ASTM C494, Type A or Type F.

The air content in LCB must not exceed 4 percent. If the aggregate used for LCB is produced from processed reclaimed asphalt concrete or other material that may cause the air content to exceed 4 percent, reduce the air content with an admixture.

Portland cement content in LCB must not exceed 300 lb/cu yd.

LCB must comply with the requirements shown in the following table:

LCB Requirements

Quality characteristic	Test method	Requirement
Sand equivalent (min)	ASTM D2419	18
Aggregate gradation	ASTM C136	Note a
Air content (max, %) [b]	ASTM C231	4
Penetration (inches)	ASTM C360	0 to 1-1/2 nominal [c]
Slump (inches)	ASTM C143	0–3 nominal [c]
Compressive strength (min, psi at 7 days)	ASTM C39	530
Compressive strength (max, psi at 3 days) [d]	ASTM C39	500

[a]Comply with the table titled "Aggregate Gradation" in section 28-2.02C.
[b]If no single test in the first 5 air content tests exceeds 1-1/2 percent, no further air content tests are required.
[c]Maximum penetration must not exceed 2 inches and maximum slump must not exceed 4 inches
[d]Only applicable if you (1) submitted a notice stating intent to produce LCB qualifying for a transverse contraction joint waiver and (2) successfully field qualified the LCB for 3-day compressive strength.

28-2.02B Cementitious Material

SCM must comply with section 90-1.02B except the equations for SCM content under section 90-1.02B(3) do not apply.

For aggregate qualification testing, use Type II portland cement under section 90-1.02B(2) without SCM.

28-2.02C Aggregate

Use either 1-1/2 inch or 1 inch gradation. Do not change your selected aggregate gradation without authorization.

When tested under ASTM C136, the aggregate gradation must be within the percentage passing limits for the sieve sizes shown in the following table:

Aggregate Gradation

Sieve size	Percentage passing			
	1-1/2" maximum		1" maximum	
	Operating range	Contract compliance	Operating range	Contract compliance
2"	100	100	--	--
1-1/2"	90-100	87-100	100	100
1"	--	--	90-100	87-100
3/4"	50-85	45-90	50-100	45-100
3/8"	40-75	35-80	40-75	35-80
No. 4	25-60	20-65	35-60	30-65
No. 30	10-30	6-34	10-30	6-34
No. 200	0-12	0-15	0-12	0-15

Aggregate must comply with the quality requirements shown in the following table:

Aggregate Quality

Quality characteristic	Test method	Operating range	Contract compliance
Sand equivalent (min)	ASTM D2419	21	18
Compressive strength (min, psi at 7 days)	ASTM C192 ASTM C39	--	610 at 300 lb/cu yd cement content

NOTE: Cement must comply with the specifications for Type II portland cement in section 90-1.02B(2).

28-2.03 CONSTRUCTION

28-2.03A General

Do not allow traffic or equipment on the LCB for at least 72 hours after the 1st application of the curing compound and completion of contraction joints. Limit the traffic and equipment on the LCB to that required for placing additional layers of LCB or paving.

28-2.03B Subgrade

Areas of the subgrade lower than the grade established by the Engineer must be filled with LCB.

28-2.03C Proportioning, Mixing, and Transporting

Proportion LCB under section 90-1.02F except the aggregate does not have to be separated into sizes.

Mix and transport LCB under section 90-1.02G except the 5th and 7th paragraphs in section 90-1.02G(6) do not apply.

28-2.03D Placing

Do not mix or place LCB if the atmospheric temperature is below 35 degrees F. Do not place LCB on frozen ground.

Unless otherwise described, construct LCB in minimum widths of 12 feet separated by construction joints. For LCB constructed monolithically in widths greater than 26 feet, construct a longitudinal contraction joint offset no more than 3 feet from the centerline of the width being constructed.

If concrete pavement will be placed on LCB, construct longitudinal construction and longitudinal contraction joints in the LCB to provide at least 1 foot of horizontal clearance from planned longitudinal construction and longitudinal contraction joints in the concrete pavement.

Construct transverse contraction joints in intervals that result in LCB areas where the lengths and widths are within 20 percent of each other. Measure the widths from any longitudinal construction or longitudinal contraction joints.

The Engineer waives the requirement for transverse contraction joints if you:

1. Submitted a notice under 28-2.01C(1)
2. Successfully field qualified LCB for 3-day compressive strength testing under section 28-2.02A
3. Submit QC test results for 3-day compressive strength under section 28-2.01D(1)(c)

28-2.03E Finishing

For LCB to be paved with HMA, before the curing operation texture the LCB finished surface by dragging either a broom, burlap, or a spring steel tine device. If using a spring steel tine device, the device must produce a scored surface with scores parallel or transverse to the pavement centerline. Texture at a time and in a manner that produces the coarsest texture for the method used.

For LCB to be paved with HMA, the finished surface must not vary more than 0.05 foot from the grade established by the Engineer.

For LCB to be paved with concrete pavement, do not texture LCB. Before applying curing compound, finish LCB to a smooth surface free from mortar ridges and other projections.

For LCB to be paved with concrete pavement, the finished surface must not be above the grade, or more than 0.05 foot below the grade established by the Engineer.

The finished surface must be free from porous areas.

28-2.03F Curing

After finishing LCB, cure LCB with pigmented curing compound under section 90-1.03B(3) and 40-1.03I. Apply curing compound:

1. In 2 separate applications
2. Before the atmospheric temperature falls below 40 degrees F
3. At a rate of 1 gal/150 sq ft for the first application
4. At a rate of 1 gal/200 sq ft for the second application

Within 4 days after the first application, clean the surface and apply the second application.

Immediately repair damage to the curing compound or LCB.

28-2.03G Surfaces Not Within Tolerance

For LCB not to be paved with concrete pavement, remove the base where the surface is higher than 0.05 foot above the grade established by the Engineer and replace it with LCB.

For LCB to be paved with concrete pavement, remove the base where the surface is higher than the grade established by the Engineer and replace it with LCB. If authorized, grind the surface with either a diamond or carborundum blade to within tolerance. After grinding LCB to be paved with concrete pavement and after all free water has left the surface, clean foreign material and grinding residue from the surface. Apply curing compound to the ground area at a rate of approximately 1 gal/150 sq ft.

Where the surface of the LCB is lower than 0.05 foot from the grade established by the Engineer, remove the base and replace it with LCB or, if authorized, fill low areas according to the pavement material as follows:

1. For HMA pavement, fill low areas with HMA that complies with the specifications for the lowest layer of pavement. Do not fill low areas concurrently with the paving operation.
2. For concrete pavement, fill low areas with pavement concrete concurrent with the paving operation.

28-2.04 PAYMENT

The payment quantity for lean concrete base does not include lean concrete base used to fill low areas of subgrade

28-3 RAPID STRENGTH CONCRETE BASE

28-3.01 GENERAL

28-3.01A Summary

Section 28-3 includes specifications for constructing rapid strength concrete base.

28-3.01B Definitions

early age: Any age less than 10 times the RSC base final set time.

final set time: Elapsed time after the initial contact of the cement and water required for the mortar sieved from the concrete to reach a penetration resistance of 4,000 psi determined under ASTM C403.

opening age: Age at which the RSC base achieves the specified strength for opening to traffic and construction traffic.

28-3.01C Submittals

28-3.01C(1) General

At least 10 days before placing RSC base, submit a mix design that includes:

1. Opening age
2. Proposed aggregate gradation
3. Proportions of hydraulic cement and aggregate
4. Types and amounts of chemical admixtures
5. Maximum time allowed between batching and placing
6. Final set time
7. Any special instructions or conditions such as water temperature requirements

28-3.01C(2) Quality Assurance Submittals

At least 45 days before placing RSC base, submit (1) a sample of cement from each proposed lot and (2) samples of proposed admixtures in the quantities ordered.

During RSC base activities, submit uniformity reports for hydraulic cement at least once every 30 days to METS, Attention: Cement Laboratory. Uniformity reports must comply with ASTM C917, except testing age and water content may be modified to suit the particular material.

28-3.01C(3) Quality Control Plan

Submit a rapid strength concrete base QC plan.

28-3.01D Quality Assurance

28-3.01D(1) General

28-3.01D(1)(a) General

At the preconstruction meeting be prepared to discuss the project specifications and methods of performing each item of work. Items discussed must include the processes for:

1. Production
2. Transportation
3. Placement
4. QC plan, if specified in the special provisions
5. Contingency plan
6. QC sampling and testing
7. Acceptance criteria

Beams for modulus of rupture testing must be fabricated and tested under California Test 524. The beams may be fabricated using an internal vibrator under ASTM C31. For each test, 3 beam must be fabricated and the test results averaged. No single test represents more than that day's production or 130 cu yd, whichever is less.

For early age testing, beams must be cured so the monitored temperatures in the beams and the test strip are always within 5 degrees F. The internal temperatures of the RSC base and early age beams

must be monitored and recorded at intervals of at least 5 minutes. Thermocouples or thermistors connected to strip-chart recorders or digital data loggers must be installed to monitor the temperatures. Temperature recording devices must be accurate to within ±2 degrees F. Until early age testing is completed, internal temperatures must be measured at 1 inch from the top, 1 inch from the bottom, and no closer than 3 inches from any edge.

For other age testing, beams must be cured under California Test 524 except beams must be placed into sand at a time that is the earlier of either from 5 to 10 times the final set time, or 24 hours.

RSC base must have an opening age modulus of rupture of not less than 400 psi and a 7-day modulus of rupture of not less than 600 psi.

28-3.01D(1)(b) Preconstruction Meeting

Reserved

28-3.01D(1)(c) Test Strip

Reserved

28-3.01D(2) Quality Control

28-3.01D(2)(a) General

Reserved

28-3.01D(2)(b) Quality Control Manager

Reserved

28-3.01D(2)(c) Quality Control Testing

Test the rapid strength concrete base under the test methods and at the locations and frequencies shown in the following table:

Rapid Strength Concrete Base Sampling Location and Testing Frequencies

Quality characteristic	Test method	Sample Location	Minimum testing frequency[a]
Cleanness value	California Test 227	Source	1 per 500 cubic yards but at least 1 per shift
Sand equivalent	California Test 217		
Aggregate gradation	California Test 202		
Air content	California Test 504	Job site	1 per 130 cu yd but at least 1 per shift
Yield	California Test 518		1 per shift
Slump or penetration	ASTM C143 or California Test 533		1 per 2 hours of placement
Density	California Test 518		1 per shift
Aggregate moisture meter calibration[b]	California Test 223 or California Test 226		1 per shift
Modulus of rupture	California Test 524		1 per 130 cu yd but at least 1 per shift

[a]Test at the most frequent interval.
[b]Check calibration of the plant moisture meter by comparing moisture meter readings with California Test 223 or California Test 226 test results.

Notify the Engineer at least 2 business days before any sampling and testing. Submit testing results within 15 minutes of testing completion. Record inspection, sampling, and testing on the forms accepted with the QC plan and submit them within 48 hours of completion of each day of production and within 24 hours of 7-day modulus of rupture tests.

During the placement of RSC base, fabricate beams and test for the modulus of rupture:

1. At opening age
2. At 7 days after placing the first 30 cu yd
3. At least once every 130 cu yd

4. Within the final truckload

Opening age tests must be performed in the presence of the Engineer.

28-3.01D(3) Department Acceptance

The Department accepts RSC base based on compliance with the requirements shown in the following table:

RSC Base Requirements for Acceptance

Quality characteristic	Test method	Requirement
Modulus of rupture (min, psi at 7 days)	California Test 524	600

The Engineer adjust payment for RSC base for the 7-day modulus of rupture as follows:

1. Payment for a base with a modulus of rupture of 600 psi or greater is not adjusted.
2. Payment for a base with a modulus of rupture of less than 600 and greater than or equal to 550 psi is reduced by 5 percent.
3. Payment for a base with a modulus of rupture of less than 550 and greater than or equal to 500 psi is reduced by 10 percent.
4. Payment for a base with a modulus of rupture of less than 500 psi is not adjusted and no payment is made. Remove and replace this base.

28-3.02 MATERIALS

28-3.02A General

Reserved

28-3.02B Rapid Strength Concrete Base

Concrete for RSC base must be RSC.

For batches with a volume of 1 cu yd or more, comply with one of the following methods:

1. Batch the ingredients at a central batch plant and charge them into a mixer truck for transportation to the pour site.
2. Batch the ingredients except the cement at a central batch plant and charge them into a mixer truck for transportation to a cement silo and weigh system, which must proportion cement for charging into the mixer truck.
3. Batch ingredients except the cement at a central batch plant and charge them into a mixer truck for transportation to a location where preweighed containerized cement is added to the mixer truck. The cement preweighing operation must use a platform scale. The platform scale must have a maximum capacity of 2.75 tons with a maximum graduation size of 1 lb. Preweigh cement into a fabric container. The minimum amount of cement to be proportioned into any single container must be 1/2 of the total amount required for the load of RSC base being produced.
4. Proportion cement, water, and aggregate volumetrically.

For the combined aggregate gradation, the difference between the percent passing the 3/8-inch sieve and the percent passing the No. 8 sieve must be at least 16 percent of the total aggregate.

You may use Type C accelerating and Type E accelerating and water reducing chemical admixtures.

28-3.02C Curing Seal

Asphaltic emulsion must be Grade RS1 or SS1.

28-3.03 CONSTRUCTION

28-3.03A General

Reserved

28-3.03B Subgrade

Reserved

28-3.03C Placing, Spreading, and Shaping

You may place RSC base in 2-lane monolithic segments. A longitudinal joint is not required in the center of the concrete base.

Construct transverse contraction joints at 30-foot intervals. Cut a groove in the RSCB with a power driven concrete saw. Grooves for longitudinal and transverse contraction joints must be the minimum width possible for the type of saw used. Immediately wash slurry from the joint with water at a pressure less than 100 psi.

The RSC base finished surface must not vary more than 1/4 inch from the bottom of a 12-foot long straightedge placed parallel with the center line.

Broom the RSC base surface to produce a uniform, rough surface. Do not broom the surface until the concrete base has set sufficiently.

28-3.03D Curing

Begin curing work as soon as free water leaves the RSC base surface.

Cure RSC base by applying a curing seal of asphaltic emulsion under section 94. Apply curing seal at a rate from 0.15 to 0.25 gal/sq yd. The Engineer determines the exact application rate. If you damage applied curing seal, immediately cover the damaged area with additional curing seal. Do not remove curing seal until surfacing is placed.

If you do not place HMA within 24 hours of applying curing seal, apply more asphaltic emulsion at a rate from 0.03 to 0.05 gal/sq yd residual binder content immediately before placing HMA.

28-3.03E Surfaces Not Within Tolerance

RSC base must be within 0.05 foot of the grade established be the Engineer. Remove and replace hardened RSC base with a surface higher than 0.05-foot above the grade established by the Engineer with RSC base, or if authorized, high areas may be ground until the surface of RSC base conforms to the tolerances specified. Grinding equipment must be equipped with diamond or carborundum blades. Clean the ground area of RSC base that is to be covered with pavement of all foreign material and grinding residue as soon as any free water has left the surface and apply curing seal.

Where the surface of RSC base is lower than 0.05 foot from the grade established by the Engineer, remove the base and replace it with RSC base or, if authorized, fill low areas with HMA that complies with the specifications for the lowest layer of pavement. Do not fill low areas concurrently with the paving operation.

28-3.04 PAYMENT

Not Used

28-4 LEAN CONCRETE BASE RAPID SETTING

28-4.01 GENERAL

28-4.01A Summary

Section 28-4 includes specifications for constructing lean concrete base rapid setting.

28-4.01B Definitions

early age: Any age less than 10 times the lean concrete base rapid setting final set time.

final set time: Elapsed time after initial contact of cement and water required for the mortar sieved from the concrete to reach a penetration resistance of 4,000 psi determined under ASTM C403.

opening age: Age at which the lean concrete base rapid setting achieves the specified strength for opening to traffic, including construction traffic.

28-4.01C Submittals

28-4.01C(1) General

At least 25 days before field qualification, submit the name of your proposed testing laboratory.

Submit QC test date and QC test results within 24 hours of test completion.

Submit a lean concrete base rapid setting QC plan.

28-4.01C(2) Mix Design

At least 10 days before field qualification, submit a mix design for lean concrete base rapid setting and include:

1. Opening age
2. Proposed aggregate gradation
3. Mix design, including
   3.1. Proportions
   3.2. Types and amounts of chemical admixtures
4. Maximum time allowed between batching and placing
5. Range of ambient temperatures over which the mix design is applicable
6. Final-set-time
7. Aggregate qualification test results if required

Submit 1 mix design for each ambient temperature variation anticipated during base placement. Each mix design must have a maximum ambient temperature range of 18 degrees F.

Submit compressive strength development data for each mix design. You may use strength development data from laboratory-prepared samples. The testing ages for strength development data must include 1 hour before opening age, opening age, 1 hour after opening age, 24 hours, and 7 days.

28-4.01C(3) Field Qualification

Submit field qualification data and test reports including:

1. Mixing date
2. Mixing equipment and procedures used
3. Batch volume in cubic yards, minimum 5 cu yd
4. Type and source of ingredients used
5. Age and strength at time of cylinder testing

Reports must be certified with a signature by an official in responsible charge of the laboratory performing the tests.

28-4.01D Quality Assurance

28-4.01D(1) General

28-4.01D(1)(a) General

For compressive strength testing, prepare 6 cylinders under California Test 540. Test cylinders must be 6 by 12 inches. As an alternative to rodding, a vibrator may be used under California Test 524. Test cylinders under California Test 521 and perform 3 tests with each test consisting of 2 cylinders. The test result is the average from the 2 cylinders.

28-4.01D(1)(b) Field Qualification

Before placing lean concrete base rapid setting, you must perform field qualification testing and obtain authorization for each mix design. Retest and obtain authorization for changes to authorized mixed designs.

Proposed mix designs must be field qualified before you place the base represented by those mix designs. The technician performing the field test must hold current ACI certification as a Concrete Field Testing Technician-Grade I.

Notify the Engineer at least 5 days before field qualification. Perform field qualification within the job site or a location authorized.

Field qualification testing includes compressive strength, air content, and penetration or slump in compliance with the table titled "Lean Concrete Base Rapid Setting Requirements."

Field qualification must comply with the following:

1. Test for compressive strength at opening age and 7 days of age

2. At opening age, the compressive strength for each test must be at least 180 psi and the average strength for the 3 tests must be at least 200 psi
3. At 7 days age, the compressive strength for each test must be at least 600 psi and the average strength for the 3 tests must be at least 725 psi

28-4.01D(2) Quality Control

28-4.01D(2)(a) General

Reserved

28-4.01D(2)(b) Quality Control Manager

Reserved

28-4.01D(2)(c) Quality Control Testing

Test the base under the test methods and at the locations and frequencies shown in the following table:

LCB Rapid Setting Sampling Location and Testing Frequencies

Quality characteristic	Test method	Sampling location	Minimum sampling and testing frequency
Sand equivalent	ASTM D2419	Source	1 per 500 cu yd, minimum 1 per day of production
Aggregate gradation	ASTM C136		
Air content	ASTM C231	Job site	1 per 4 hours of placement work, plus one in the last hour of placement work
Penetration[a]	ASTM C360		
Slump[a]	ASTM C143		
Compressive strength	California Test 521		

[a]Test either penetration or slump

During placement of lean concrete base rapid setting, fabricate cylinders and test compressive strength for opening age and 7 days. Opening age tests must be performed in the presence of the Engineer.

28-4.01D(3) Department Acceptance

The Department accepts LCB rapid setting based on compliance with the requirement shown in the following table:

LCB Rapid Setting Requirements for Acceptance

Quality characteristic	Test method	Requirement
Compressive strength (min, psi at 7 days)	California Test 521[a]	725

[a]Cylinders made under California Test 540

28-4.02 MATERIALS

28-4.02A General

LCB rapid setting must comply with the requirements shown in the following table:

LCB Rapid Setting Requirements

Quality characteristic	Test method	Requirement
Sand equivalent (min)	ASTM D2419	71[a]
Aggregate gradation	ASTM C136	Comply with section 28-2.02C
Air content (max, percent)[b]	ASTM C231	4
Penetration (inches)	ASTM C360	0–2-1/2 nominal 3 maximum
Slump (inches)	ASTM C143	0–5 nominal 6 maximum
Compressive strength (min, psi at 7 days)	California Test 521	725
Compressive strength (min, psi at opening age)	California Test 521	200

[a] If aggregate is qualified under section 28-4.02D, item 2, the minimum is 18.
[b] If no single test in the first 5 air content tests exceeds 1-1/2 percent, no further air content tests are required.

28-4.02B Cement

Cement must comply with the requirements for RSC.

28-4.02C Chemical Admixtures

Chemical admixtures must comply with chemical admixtures for concrete except you may use Type E chemical admixture. You may submit a request to use citric acid or borax. Your request must include a request from the cement manufacturer and a test sample.

28-4.02D Aggregates

Aggregate must comply with either of the following:

1. Section 90-1.02C except aggregate gradation must comply with the aggregate gradation table in section 28-2.02C.
2. Section 28-2.02C and the following:
   2.1. Qualify the aggregate for each proposed aggregate source and gradation.
   2.2. Qualification tests include (1) sand equivalent and (2) average 7-day compressive strength under ASTM C39 on 3 specimens manufactured under ASTM C192. The cement content for this test must be 300 lb/cu yd, and the 7-day compressive strength must be at least 610 psi. Cement must be Type II portland cement under section 90-1.02B(2) without SCM.

28-4.03 CONSTRUCTION

28-4.03A General

Construct LCB rapid setting under section 28-2.03 except (1) section 28-2.03A does not apply and (2) the 3rd through 5th paragraphs of section 28-2.03D do not apply.

Concrete paving operations with equipment not supported by the base may start before opening age. Do not open pavement for traffic before opening age of the LCB rapid setting.

Any other paving operations must start after the final set time of the base. The base must have a compressive strength of at least 450 psi under California Test 521 before:

1. Placing HMA
2. Placing other base material
3. Operating equipment on the base

28-4.03B Proportioning, Mixing, and Transporting

For batches 1 cu yd or more, comply with one of the following methods:

1. Batch the ingredients at a central batch plant and charge them into a mixer truck for transportation to the pour site.

2. Batch the ingredients except the cement at a central batch plant and charge them into a mixer truck for transportation to a cement silo and weigh system, which must proportion cement for charging into the mixer truck.
3. Batch ingredients except the cement at a central batch plant and charge them into a mixer truck for transportation to a location where preweighed containerized cement is added to the mixer truck. The cement preweighing operation must utilize a platform scale. The platform scale must have a maximum capacity of 2.75 tons with a maximum graduation size of 1 lb. Preweigh cement into a fabric container. The minimum amount of cement to be proportioned into any single container must be 1/2 of the total amount required for the load of lean concrete base rapid setting being produced.
4. Proportion cement, water, and aggregate volumetrically under ASTM C685 or section 90-3.02B.

28-4.03C Spreading, Compacting and Shaping

You may use metal or wood side forms. Wood side forms must be at least 1-1/2 inches thick.

After you deposit the LCB rapid setting on the subgrade, consolidate it with high-frequency internal vibrators. Consolidate adjacent to the forms and across the full pavement width. Place the base as nearly as possible to its final position.

Spread and shape the base with powered finishing machines and supplement with hand work if necessary

After you place lean concrete base rapid setting, do not add water to the surface to facilitate finishing. If authorized, you may use surface finishing additives as recommended by the manufacturer of the cement.

28-4.04 PAYMENT

If volumetric proportioning is used and calibration is performed more than 100 miles from the project limits, the Department deducts $1,000 for each calibration session.

28-5 CONCRETE BASE

28-5.01 GENERAL

28-5.01A Summary

Section 28-5 includes specifications for constructing concrete base.

28-5.01B Definitions

Reserved

28-5.01C Submittals

Submit a concrete base QC plan.

28-5.01D Quality Assurance

28-5.01D(1) General

For each lot of concrete for a concrete base:

1. Quantity must not exceed 1,000 cu yd.
2. Department determines the modulus of rupture of test beams aged 28 days under California Test 523.
3. Department calculates the modulus of rupture by averaging the individual test results of 2 beams aged for 28 days.

28-5.01D(2) Quality Control

28-5.01D(2)(a) General

Reserved

28-5.01D(2)(b) Quality Control Manager

Reserved

28-5.01D(2)(c) Quality Control Testing

Test the concrete base under the test methods and at the locations and frequencies shown in the following table:

Concrete Base Sampling Location and Testing Frequencies

Quality characteristic	Test method	Sample location	Minimum testing frequency[a]
Cleanness value	California Test 227	Source	1 per 500 cubic yards but at least 1 per shift
Sand equivalent	California Test 217		
Aggregate gradation	California Test 202		
Air content	California Test 504	Job site	1 per 500 cu yd but at least 1 per shift
Yield	California Test 518		1 per shift
Slump or penetration	ASTM C143 or California Test 533		1 per 2 hours of placement
Density	California Test 518		1 per shift
Aggregate moisture meter calibration[b]	California Test 223 or California Test 226		1 per shift
Modulus of rupture	California Test 524		1 per 500 cu yd but at least 1 per shift

[a]Test at the most frequent interval.
[b]Check calibration of the plant moisture meter by comparing moisture meter readings with California Test 223 or California Test 226 test results.

28-5.01D(3) Department Acceptance

The Department accepts a concrete base based on compliance with the requirements shown in the following table:

Concrete Base Requirements for Acceptance

Quality characteristic	Test method	Requirement
Modulus of rupture (min, psi at 28 days)	California Test 523	570

Acceptance for the modulus of rupture is on a lot basis. The Department provides the molds and machines for the modulus of rupture acceptance testing. Provide any material and labor the Engineer may require for the testing.

28-5.02 MATERIALS

28-5.02A General

Reserved

28-5.02B Portland Cement Concrete

Concrete must be PCC.

For the combined aggregate gradation, the difference between the percentage passing the 3/8-inch sieve and the percentage passing the no. 8 sieve must be at least 16 percent of the total aggregate.

The specifications for the reduction in operating range and contract compliance for cleanness value and sand equivalent for coarse aggregate in section 90-1.02C(2), and fine aggregate in section 90-1.02C(3) do not apply to a concrete base.

The base must contain not less than 550 lb of cementitious material per cubic yard.

28-5.02C Curing Seal

The curing seal must be asphaltic emulsion Grade RS1 or SS1.

28-5.03 CONSTRUCTION

28-5.03A General

Aggregate and bulk cementitious material must be proportioned by weight using authorized automatic proportioning devices.

28-5.03B Placing, Spreading, and Shaping

You may place concrete base in 2-lane monolithic segments. A longitudinal joint is not required in the center of the base.

The finished surface must not vary more than 1/4 inch from the bottom of a 12-foot long straightedge placed parallel with the centerline.

After the base has sufficiently set, broom the concrete base surface to produce a uniform, rough surface.

After the free water leaves the surface and the surface is finished but not later than 3 hours after placement, cure the base by applying asphaltic emulsion.

Apply the curing seal at a rate from 0.15 to 0.25 gal/sq yd. The Engineer determines the exact application rate. If you damage the applied curing seal, immediately cover the damaged area with additional curing seal.

Construct transverse contraction joints at 30-foot intervals. Apply the curing seal on cleaned contraction joints.

Saw transverse contraction joints before any volunteer cracking occurs and after the concrete base is hard enough to saw without spalling, raveling, or tearing.

The base must be within 0.05 foot of the grade established be the Engineer

Where the surface of the base is lower than 0.05 foot from the grade established by the Engineer, remove and replace it with concrete base or, if authorized, fill low areas with HMA that complies with the specifications for the lowest layer of pavement. Do not fill low areas concurrently with the paving operation.

If you do not place the HMA within 24 hours of applying curing seal, apply more asphaltic emulsion at a residual binder rate from 0.03 to 0.05 gal/sq yd immediately before placing the HMA.

28-5.04 PAYMENT

Not Used

28-6–28-14 RESERVED

28-15 EXISTING CONCRETE BASES

28-15.01 GENERAL

28-15.01A General

Section 28-15 contains specifications for performing work on existing concrete bases.

Work performed on existing bases must comply with section 15.

28-15.01B Materials

Not Used

28-15.01C Construction

Not Used

28-15.01D Payment

Not Used

28-15.02 REPLACE BASES

Reserved

28-15.03–28-15.08 RESERVED

29 TREATED PERMEABLE BASES

29-1 GENERAL

29-1.01 GENERAL

29-1.01A Summary

Section 29-1 includes general specifications for constructing treated permeable bases.

29-1.01B Definitions

Reserved

29-1.01C Submittals

Submit a treated permeable base quality control plan.

29-1.01D Quality Assurance

29-1.01D(1) General

Reserved

29-1.01D(2) Quality Control

29-1.01D(2)(a) General

Reserved

29-1.01D(2)(b) Quality Control Plan

Reserved

29-1.01D(2)(c) Qualifications

Reserved

29-1.01D(3) Department Acceptance

Reserved

29-1.02 MATERIALS

Not Used

29-1.03 CONSTRUCTION

29-1.03A General

Immediately before spreading the treated permeable base, the subgrade must:

1. Comply with the specified compaction and elevation tolerance for the material involved
2. Be free from loose or extraneous material
3. Be uniformly moist

Areas of subgrade lower than the grade established by the Engineer must be filled with permeable base.

Spread the permeable base when the atmospheric temperature is above 40 degrees F.

Finish the permeable base to a uniform surface within 0.05 foot of the grade established by the Engineer.

Place filter fabric on the edge and on the top of the high side, the side opposite the edge drain side, of the treated permeable base and at intermediate cross drain interceptors. Place filter fabric under section 68-1.03.

Place and compact the treated permeable base for edge drains under section 68-4.03.

29-1.03B Surfaces Out of Tolerance

Where the surface of the permeable base is higher than 0.05 foot from the grade established by the Engineer, remove the base and replace it with the specified treated permeable base. If authorized, remove high spots to comply with the specified tolerance by any method that does not produce contaminating fines or damage the base remaining in place. Grinding is not allowed.

Where the surface of the treated permeable base is lower than 0.05 foot from the grade established by the Engineer, remove the base and replace it with the specified treated permeable base. If authorized, fill low areas with pavement material as follows:

1. For HMA pavement, fill low areas with HMA that complies with the specifications for the lowest layer of HMA pavement. Do not fill low areas concurrently with the HMA paving operation.
2. For concrete pavement, fill low areas with paving concrete concurrent with the concrete pavement paving operation.

29-1.04 PAYMENT

The payment quantity for treated permeable base is the volume determined from the dimensions shown.

The payment quantity for treated permeable base does not include:

1. Quantity used for edge drains installed adjacent to the treated permeable base
2. Treated permeable base used to fill low areas of subgrade

29-2 ASPHALT TREATED PERMEABLE BASES

29-2.01 GENERAL

29-2.01A Summary

Section 29-2 includes specifications for constructing asphalt treated permeable bases.

29-2.01B Definitions

Reserved

29-2.01C Submittals

Reserved

29-2.01D Quality Assurance

29-2.01D(1) General

The Engineer determines the asphalt content of the asphalt mixture under California Test 382. The bitumen ratio, pounds of asphalt per 100 lb of dry aggregate, must not vary more than 0.5 lb of asphalt above or below the quantity designated by the Engineer. Samples used to determine the bitumen ratio are obtained from trucks at the plant or from the mat behind the paver before rolling. If the sample is taken from the mat behind the paver, the bitumen ratio must not be less than the quantity designated by the Engineer, less 0.7 lb of asphalt per 100 lb of dry aggregate.

29-2.01D(2) Quality Control

29-2.01D(2)(a) General

Reserved

29-2.01D(2)(b) Quality Control Testing

ATPB quality control must include testing the quality characteristics at the frequencies shown in the following table:

QC Testing Frequencies

Quality characteristic	Test method	Sampling location	Minimum frequency
Gradation	California Test 202	Stockpiles or plant	1 for every 4 hours of production but at least one per day of placement
Cleanness value	California Test 227	Stockpiles or plant	1 for every 4 hours of production but at least one per day
Percentage of crushed particles	California Test 205	Stockpiles or plant	1 test before production and one every 5,000 cu yd thereafter
Los Angeles rattler loss at 500 rev	California Test 211	Stockpiles or plant	1 test before production and one every 5,000 cu yd thereafter
Film stripping	California Test 302	Plant	1 test before production and one every 5000 cu yd thereafter
Asphalt content of the asphalt mixture	California Test 382	Plant, transportation units, windrows, or roadway	1 for every 4 hours of production but at least one per day

29-2.01D(3) Department Acceptance

The Department accepts ATPB based on aggregate gradation, cleanness value, percent of crushed particles, Los Angeles rattler, film stripping and asphalt content requirements specified in section 29-2.02 and section 29-2.01D(1).

The Engineer takes samples for aggregate gradation, cleanness value, percent of crushed particles, Los Angeles rattler, and film stripping from the plant.

The Engineer takes samples for asphalt content of the asphalt mixture from any of the following locations:

1. Plant
2. Truck
3. Windrow
4. Roadbed

29-2.02 MATERIALS

29-2.02A General

Aggregate for ATPB must be clean and free from decomposed material, organic material, and other deleterious substances.

Produce ATPB under section 39-2.01B(8), except a JMF is not required. Do not use RAP.

The temperature of the aggregate must be from 275 to 325 degrees F before adding the asphalt binder.

Do not store ATPB material longer than 2 hours.

Combine aggregate with 2.5 percent asphalt binder by weight of dry aggregate. An increase or decrease in the asphalt content may be ordered after your proposed aggregate supply has been tested.

29-2.02B Aggregate

The aggregate must comply with the gradation shown in the following table:

Aggregate Gradation

Sieve size	Percentage passing
1"	100
3/4"	90–100
1/2"	35–65
3/8"	20–45
No. 4	0–10
No. 8	0–5
No. 200	0–2

The aggregate must comply with the requirements shown in the following table:

Aggregate Requirements

Quality characteristic	Test method	Requirement
Percentage of crushed particles (min, %)	California Test 205	90
Los Angeles rattler loss at 500 rev (max, %)	California Test 211	45
Cleanness value (min)	California Test 227	57
Film stripping (max, %)	California Test 302	25

29-2.03 CONSTRUCTION

Equipment for spreading and compacting ATPB must comply with section 39-2.01C(2) except, compact ATPB in 1 layer using one of the following methods:

1. One complete coverage with a steel-tired, 2-axle tandem roller that has an operating weight below 110 lb per linear inch of steel-tire width. Compact when the base mixture is from 200 to 250 degrees F.
2. One complete coverage with a steel-tired, 2-axle tandem roller weighing from 8 to 12 tons. Compact when the base mixture is from 100 to 150 degrees F.

Do not use water to cool the ATPB.

Vibratory rollers complying with the above requirements may be used if the vibratory unit is turned off.

29-2.04 PAYMENT

The Department adjusts the unit price of asphalt treated permeable base if an ordered increase or decrease in asphalt content exceeds the specified amount by more than 0.1 percent by weight of dry aggregate.

29-3 CEMENT TREATED PERMEABLE BASE

29-3.01 GENERAL

29-3.01A Summary

Section 29-3 includes specifications for constructing cement treated permeable bases.

29-3.01B Definitions

Reserved

29-3.01C Submittals

Reserved

29-3.01D Quality Assurance

29-3.01D(1) General

Reserved

29-3.01D(2) Quality Control

29-3.01D(2)(a) General

Reserved

29-3.01D(2)(b) Quality Control Testing

CTPB quality control must include testing the quality characteristics at the frequencies shown in the following table:

QC Testing Frequencies

Quality characteristic	Test method	Sampling location	Minimum frequency
Gradation	California Test 202	Stockpiles or plant	1 for every 4 hours of production but at least one per day of placement
Cleanness value	California Test 227	Stockpiles or plant	1 for every 4 hours of production but at least one per day
Los Angeles rattler loss at 500 rev	California Test 211	Stockpiles or plant	1 test before production and one every 5,000 cu yd thereafter
Soundness	California Test 214	Stockpiles or plant	1 test before production and one every 5,000 cu yd thereafter

29-3.01D(3) Department Acceptance

The Department accepts CTPB based on aggregate gradation, cleanness value, Los Angeles rattler and soundness requirements in section 29-3.02.

The Engineer takes samples for aggregate gradation, cleanness value, Los Angeles rattler and soundness from the plant.

29-3.02 MATERIALS

29-3.02A General

Cement must comply with section 90-1.02B(2),Type II.

The cement content of CTPB must be at least 287 lb/cu yd.

The water-cement ratio must be approximately 0.37. The Engineer determines the exact water-cement ratio.

Water must comply with section 90-1.02D.

29-3.02B Aggregate

Aggregate for CTPB must comply with section 90-1.02C. Aggregate gradation must comply with the specifications for the 1" x no. 4 primary aggregate nominal size coarse gradation in section 90-1.02C(4)(b).

29-3.03 CONSTRUCTION

Store, proportion, mix, and transport aggregates, cement and water, under sections 90-1.02F and 90-1.02G except aggregate does not have to be separated into sizes and the quantity of water and penetration requirements do not apply.

Place CTPB under section 40-1.03F(1) except the 4th paragraph does not apply.

Spread, compact, and shape CTPB under section 40-1.03F(4) or under section 40-1.03F(5). Vibrators must not be used.

Compact with a 2-axle steel-tired roller weighing from 6 to 10 tons. Compact within 30 minutes after spreading the CTPB. Compaction must consist of 2 complete passes of the CTPB.

Cure CTPB by sprinkling the completed surface with a fine spray of water every 2 hours for a period of 8 hours. Start curing the morning after base has been placed.

29-3.04 PAYMENT

Not Used

29-4–29-7 RESERVED

30 RECLAIMED PAVEMENT

30-1 GENERAL

30-1.01 GENERAL

30-1.01A Summary

Section 30-1 includes general specifications for constructing reclaimed pavement bases.

30-1.01B Definitions

OMC: Optimum moisture content

30-1.01C Submittals

30-1.01C(1) General

At least 20 days before starting pavement reclamation work, submit the QC plan.

The QC plan must describe the organization, responsible parties, and procedures you will use to:

1. Perform QC including sampling, testing, and reporting
2. Determine action limits if corrective actions are needed
3. Implement corrective actions
4. Ensure pulverizing, compacting, grading, and finishing activities are coordinated

The QC plan must include copies of the forms that will be used to provide the required inspection records and sampling and testing results. Forms must show project requirements. The form for recording and reporting the QC measurements must show the proportions of materials used.

The QC plan must include a contingency plan that describes the corrective actions you will take in the event of equipment break down. The corrective actions must include repairing and reopening the roadway to traffic using minor HMA under section 39.

30-1.01C(2) Asphaltic Emulsion

For each dilution of asphaltic emulsion used on the finished reclaimed pavement surface submit as an informational submittal:

1. Asphaltic emulsion type
2. Weight ratio of water to bituminous material in the original asphaltic emulsion
3. Weight of asphaltic emulsion before diluting
4. Weight of added water
5. Final dilution weight ratio of water to asphaltic emulsion

30-1.01C(3) Quality Assurance Submittals

30-1.01C(3)(a) General

Reserved

30-1.01C(3)(b) Test Strip

Submit a summary of the determinations made from test strips.

30-1.01C(3)(c) Quality Control Reporting

For each lot, submit a report daily that includes the following items based on the frequencies specified in the table for sampling locations and testing frequencies for the type of pavement reclamation work performed or if not specified, once per lot:

1. General Information:
    1.1. Lot number
    1.2. Location description
    1.3. Beginning and ending stations
    1.4. Lane number and offset from centerline
2. A summary of any weight or load slips for each weighed material indicating truck and trailer numbers, tare weight, gross weight, net weight, and date
3. For asphalt emulsion used on finished reclaimed pavement surface, if asphaltic emulsion is specified:
    3.1. Emulsion type

   3.2. Emulsion application rate in gal/sq yd
   3.3. Emulsion dilution as the weight ratio of added water to the original asphaltic emulsion
4. Calculated supplementary aggregate application rate in lb/sq yd and percent of dry weight of reclaimed processed material if supplementary aggregate is specified
5. Calculated cement application rate by lb/sq yd and percent dry weight of reclaimed processed material if cement is specified
6. QC test results for:
   6.1. Gradation
   6.2. Moisture content, if applicable
   6.3. In-place wet density
   6.4. Relative compaction
   6.5. Depth of cut
7. Note on the daily report the postmile or station limits of any unsuitable materials locations and when the Engineer was notified

Update each day's submitted report within 24 hours of obtaining test results. Consolidate all lots completed in a day into one report with each lot reported separately.

30-1.01D Quality Assurance

30-1.01D(1) General

Divide the area to be reclaimed into lots except the 1st test strip is the 1st lot and must be at least 2,000 sq yd. A quantity placed at the end of a work shift greater than 500 sq yd is considered 1 lot. If a quantity of reclaimed pavement placed at the end of a work shift is less than 500 sq yd, you may either count this quantity as 1 lot or include the test results for quality control in the previous lot.

For any lot including the test strip, stop reclaimed pavement activities and immediately inform the Engineer if any test result does not comply with the specifications.

Stop reclaimed pavement activities for noncompliance with the specifications. Before resuming activities:

1. Notify the Engineer of the adjustments you will make
2. Remedy or replace the noncompliant lot until it complies with specifications
3. Construct a 1000 sq yd test strip with proposed adjustments demonstrating ability to comply with the specifications
4. Obtain authorization

30-1.01D(2) Preoperation Meeting

Schedule a preoperation meeting at a mutually agreed time at the job site to meet with the Engineer. Discuss the project specifications and methods of performing each item of the work. Items discussed must include the processes for:

1. Determining the mix design
2. Production
3. Compacting
4. Grading
5. Finishing
6. Implementing the authorized QC plan
7. Implementing the contingency plan
8. QC sampling and testing
9. Acceptance criteria

Preoperation meeting attendees must sign an attendance sheet provided by the Engineer. The preoperation meeting must be attended by your:

1. Project superintendent
2. Project manager
3. QC manager
4. Workers and your subcontractor's workers, including:
   4.1. Foremen
   4.2. Ground supervisors

4.3. Representative from testing lab

Do not start pavement reclamation activities, including test strips, until the listed personnel have attended a preoperation meeting.

30-1.01D(3) Test Strip

On the 1st day of pavement reclamation activities and using the same equipment and materials that will be used during production, construct at least 1,500 feet in a single lane width to determine the:

1. Equipment, materials, and processes can produce reclaimed pavement in compliance with the specifications
2. Effect of varying the pulverizing machine's forward speed and drum rotation rate on the consistency of the pulverized material
3. Optimal proportions, as applicable, of supplementary aggregate, stabilizing agents, and water
4. Rolling method and sequence complies with the compaction and finishing specifications
5. Application rate of asphaltic emulsion, as applicable

Do not proceed with reclaimed pavement activities until the Engineer informs you the test strip is authorized. For production, adjustments to the equipment, material, and process determined by the test strip must be authorized. If QC or acceptance test results are not available, you may proceed at your own risk.

30-1.01D(4) Quality Control

30-1.01D(4)(a) General

Reserved

30-1.01D(4)(b) Sampling and Testing

Take samples under California Test 125.

Testing must be performed by an authorized laboratory. Testing personnel for QC must be qualified under the Department's Independent Assurance Program.

Measure and record the actual cut depth at both ends of the pulverizing drum at least once every 300 feet along the cut length. Take measurements in the Engineer’s presence.

30-1.01D(5) Department Acceptance

Reserved

30-1.02 MATERIALS

30-1.02A General

Reserved

30-1.02B Supplementary Aggregate

If supplementary aggregate is specified, supplementary aggregate must comply with 3/4 inch maximum gradation specified in section 26-1.02. Supplementary aggregate must not include cinders. Do not use supplementary aggregate with more than 50 percent by volume of reclaimed asphalt concrete. Supplementary aggregate must weigh at least 105 lb/cu ft, determined under California Test 212, Compacted Method (by Rodding).

30-1.02C Water

Notify the Engineer if a water source other than potable water is used and perform testing for chlorides and sulfates before starting work. If potable water is not used, water must be clean and contain no more than 650 parts per million of chlorides as Cl determined under California Test 422 and no more than 1,300 parts per million of sulfates as SO_4 determined under California Test 417.

30-1.02D Cement

If cement is specified, cement must be Type II or Type V portland cement as specified in ASTM C150/150M.

30-1.02E Asphaltic Emulsion

Asphaltic emulsion must be Grade SS1h or CSS1h.

For dilution, the weight ratio of water added to asphaltic emulsion must not exceed 1 to 1.

30-1.03 CONSTRUCTION

30-1.03A General

Except for pulverized roadbed, before starting daily pavement reclaiming activities sweep the area constructed the previous day to remove loose material.

Do not use a heating device to soften the pavement.

30-1.03B Equipment

Do not interrupt traffic while servicing equipment.

Grading equipment must be a motor grader with automatic grade controls for profile elevation and cross slope.

If specified, supplementary aggregate or cement spreading equipment must uniformly distribute the supplementary aggregate or cement throughout the area to receive it. The spreader must be equipped with working scales or proportioning and distance measuring devices to control the spread rate.

If supplementary aggregate or cement is spread before pulverizing the existing pavement, the pulverizing equipment must produce a uniform mixture without segregation.

30-1.03C Surface Preparation

Before pavement reclamation activities start, prepare the existing roadway surface by:

1. Clearing foreign matter including vegetation
2. Removing standing water
3. Referencing the profile and cross slope
4. Marking the proposed longitudinal cut lines on the existing pavement as follows:
   4.1. Cut lines must coincide with points where the existing cross slope changes, approximately at the centerline and edge of traveled way
   4.2. Cut lines must indicate the sequence of the cuts
5. Referencing existing lane lines and striping layout

If excess material is to be stored adjacent to the shoulder, clear and dispose of the weeds, grass, and debris from the area.

30-1.03D Pulverizing and Mixing

If the established grade will cause noncompliance with the thickness requirements, notify the Engineer.

If you encounter unstable subgrade or rocks greater than 4 inches in the roadway section notify the Engineer. The Engineer determines the extent of the problem and the corrective measures to be taken.

30-1.03E Compacting and Grading

Remove any solids that are larger than 3 inches in the pulverized roadbed mixture before shaping and compacting.

30-1.03F Finishing

The finished roadbed surface must not vary more than 0.05 foot from the lower edge of a 12-foot straight edge laid in directions parallel and perpendicular to the centerline.

30-1.04 PAYMENT

The payment quantity for supplementary aggregate is determined as specified for aggregate base in section 26.

The payment quantity for asphaltic emulsion is measured under section 94.

30-2 PULVERIZED ROADBED

30-2.01 GENERAL

30-2.01A Summary

Section 30-2 includes specifications for constructing a uniform reclaimed pavement base by pulverizing the asphalt concrete pavement and underlying material.

30-2.01B Definitions

Lot: 2000 sq yd of pulverized roadbed.

30-2.01C Submittals

At least 10 days before starting pulverized roadbed activities submit the QC plan.

The QC plan must include a pulverizing and paving plan outlining the sequence of work, including the maximum production rate for pulverizing activities.

Submit the test results for the quality characteristics within the times after sampling shown in the following table:

Quality characteristic	Maximum reporting time allowance
Gradation	24 hours
Depth of cut	
In-place wet density	
Relative compaction	

30-2.01D Quality Assurance

30-2.01D(1) General

The specifications for a preoperation meeting under section 30-1.01D(2) do not apply to pulverized roadbed.

30-2.01D(2) Quality Control

30-2.01D(2)(a) General

Meet with the Engineer 1 week before starting pulverized roadbed activities to review the QC plan.

Perform sampling and testing for each test strip and production work at the specified frequency for the quality characteristics shown in the following table:

Pulverized Roadbed Quality Characteristic Sampling Locations and Testing Frequencies

Quality characteristic	Test method	Minimum sampling and testing frequency	Sampling location
Gradation	California Test 202	Test strip and 1 per lot	Loose mix after pulverizing and mixing
Depth of cut	NA	300 feet	Both sides of reclaiming machine along cut length
In-place wet density	California Test 231	The same locations as relative compaction tests	
Relative compaction	California Test 231	One per test strip and 10 random locations per lot	Compacted roadbed

30-2.01D(2)(b) Test Strip

Allow 24 hours for authorization of the test strip.

30-2.01D(3) Department Acceptance

The Department accepts pulverized roadbed based on:

1. Visual inspection including:
   1.1. Segregation, tearing, and scarring of the finished surface
   1.2. Variance of more than 0.05 foot measured from the lower edge of a 12-foot straightedge
   1.3. Uniform surface texture throughout the work limits
   1.4. Repaired areas
2. Compliance with the following table:

Pulverized Roadbed Requirements for Acceptance

Quality characteristic	Test method	Requirement
Relative compaction (min, %)	California Test 231	95
Thickness (ft)	Field measurement	Not more than 0.05 ft less than the thickness shown

30-2.02 MATERIALS

30-2.02A General

The quality characteristics of pulverized roadbed must comply with the requirements shown in the following table:

Pulverized Roadbed Quality Characteristic Requirements

Quality characteristic	Test method	Requirement
Gradation (%, passing) Sieve Size: 2 inch 1 1/2 inch	California Test 202	 100 90-100
Depth of cut (ft)	NA	Not more than 0.05 ft less than the thickness shown
In-place wet density (lb/cu ft)	California Test 231	Report only
Relative compaction (min, %)	California Test 231	95

30-2.02B Sand Cover

Reserved

30-2.02C Supplementary Aggregate

If supplementary aggregate is specified, supplementary aggregate must comply with the specifications for Class 2 aggregate base in section 26.

30-2.03 CONSTRUCTION

30-2.03A General

Reserved

30-2.03B Equipment

Pulverizing equipment must:

1. Be a self-propelled reclaiming machine
2. Pulverize the existing pavement and underlying material to the required size
3. Mix the pulverized pavement, underlying material, and water into a homogeneous and uniform mixture
4. Be equipped with automatic depth controls capable of maintaining the cutting depth to within 0.05 foot of the depth shown
5. Have a minimum 8-foot wide cutter that can remove the existing pavement to the specified depths

Compacting equipment must be a sheepsfoot roller, a vibratory steel-tired roller, and a pneumatic-tired roller. All compacting equipment must be self-propelled and reversible. The frequency of amplitude of vibrating rollers must be adjustable and exceed a static force of 15 tons in vibratory mode.

30-2.03C Spreading

Reserved

30-2.03D Compacting and Grading

Reserved

30-2.03E Finishing

The finished surface must be free from segregation, tearing, and scarring, and have a uniform surface texture throughout the work limits.

Maintain the pulverized roadbed surface free of ruts, bumps, indentations, raveling, and segregation. Repair damaged pulverized roadbed with minor HMA.

30-2.04 PAYMENT

Not Used

30-3 FULL DEPTH RECLAMATION—FOAMED ASPHALT

30-3.01 GENERAL

30-3.01A Summary

Section 30-3 includes specifications for constructing a reclaimed pavement base using FDR—foamed asphalt.

Constructing an FDR—foamed asphalt base includes:

1. Pulverizing existing asphalt concrete and existing underlying materials
2. Mixing with water, foamed asphalt, cement, and if required, supplementary aggregate
3. Grading and compacting the mixture
4. Applying asphaltic emulsion

30-3.01B Definitions

Lot: 1000 sq yd of FDR—foamed asphalt

30-3.01C Submittals

30-3.01C(1) General

With the QC plan, submit the mix design.

30-3.01C(2) Quality Assurance Submittals

30-3.01C(2)(a) General

Reserved

30-3.01C(2)(b) Mix Design

Submit FDR—foamed asphalt mix design under California Test 313. With the mix design forms, include actual test results, worksheets, photographs, and graphs. The mix design submittal must be sealed and signed by an engineer who is registered as a civil engineer in the State.

30-3.01C(2)(c) Quality Control Reporting

With the daily report specifed in section 30-1.01C(3)(c), submit the following based on the testing frequencies specified or if not specified, once per lot:

1. General Information:
   - 1.1. Weather:
     - 1.1.1. Ambient air temperature before starting daily FDR—foamed asphalt activities including time of temperature reading
     - 1.1.2. Road surface temperature before starting daily FDR—foamed asphalt activities including time of temperature reading
2. Asphalt binder:
   - 2.1. Injection rate from controller
   - 2.2. Temperature in degrees F from thermometer in the asphalt binder feed line for each truck load
3. Water application rate by percent dry weight of FDR—foamed asphalt from the controller

4. Average forward speed of pulverizing equipment
5. FDR—foamed asphalt core thickness in feet and location of coring

With the daily report, submit the test results for the quality characteristics within the times after sampling shown in the following table:

FDR—Foamed Asphalt Quality Characteristic Test Results Reporting Time Allowances

Quality characteristic	Maximum reporting time allowance
Water sulfates	Before work starts
Water chlorides	
Moisture content before HMA paving	
Asphalt binder expansion ratio	24 hours
Asphalt binder half-life	
Gradation	
Moisture content	
In-place wet density	
Relative compaction	
Indirect dry tensile strength	5 business days
Indirect wet tensile strength	
Tensile strength ratio	

Before each day of HMA paving, submit a report of the moisture content at mid depth based on the frequency specified in section 30-3.01D(2)(c) for the area to be paved that day.

30-3.01D Quality Assurance

30-3.01D(1) General

30-3.01D(1)(a) General

Relative compaction must be determined under California Test 231 and the following:

1. Nuclear gauge counts are taken at 3 elevations within the FDR—foamed asphalt layer identified as E_1, E_2, and E_3 measured from the finished FDR—foamed asphalt surface as follows:
   1.1. E_1 = 1/3 x (FDR—foamed asphalt thickness - 1 inch).
   1.2. E_2 = 2/3 x (FDR—foamed asphalt thickness - 1 inch).
   1.3. E_3 = (FDR—foamed asphalt thickness - 1 inch).
   1.4. Do not take nuclear gauge counts at elevations less than 2 inches below finished surface.
2. Correction for oversize material does not apply.
3. A sample must contain no more than 5 percent retained on the 1-inch sieve and 10 percent retained on the 3/4-inch sieve.
4. Use the laboratory wet test maximum density closest in proximity to the lot to determine relative compaction. If the relative compaction for a lot is less than 98 percent, perform California Test 216 and California Test 226 for each noncompliant lot and recalculate the relative compaction.
5. Measure relative compaction at each elevation E_1, E_2, and E_3. Do not average the elevation compaction measurements at each location.

Before starting FDR—foamed asphalt activities, calibrate the asphalt meter in the presence of the Engineer in compliance with the material plant quality program. The Engineer determines the frequency of testing and calibration.

Before placing HMA, test moisture content at mid depth of the FDR—foamed asphalt layer under California Test 226. Sampling must not introduce water to the material. Test in the Engineer's presence.

30-3.01D(1)(b) Preoperation Meeting

In addition to the listed personnel in section 30-1.01D(2), the preoperation meeting must be attended by your:

1. FDR—foamed asphalt machine operators
2. Grading and compacting equipment operators

30-3.01D(1)(c) Test Strip

The Engineer tests each test strip under section 30-3.01D(3) and California Test 371.

30-3.01D(2) Quality Control

30-3.01D(2)(a) General

Reserved

30-3.01D(2)(b) Mix Design Sampling and Testing

The FDR—foamed asphalt mix design process must comply with California Test 313.

Notify the Engineer at least 2 business days before sampling for a mix design.

Obtain representative pavement and underlying base material samples for FDR—foamed asphalt from the test pits. If additional samples of subgrade material are needed, test pits can be excavated outside the edge of pavement to variable dimensions. Characterize and record test pit features such as layer thicknesses and types, distresses, interlayers, thin or thick areas, digouts, and adhesion to the base. Use the sampled material to determine the mix design according to the proportions of the pavement structure shown.

Before opening the mix design sampling locations to traffic, backfill test pits by replacing and compacting the remaining excavated materials. Place and compact authorized material or minor HMA complying with section 39-2.07 to the existing grade and thickness of AC, in the Engineer's presence. When mix design sampling is complete at all locations, remove authorized backfill material at test pit locations and place and compact with minor HMA to existing grade.

30-3.01D(2)(c) Quality Control Sampling and Testing

Assign a ground supervisor whose sole purpose is to monitor the FDR—foamed asphalt activities, advise project personnel, and interface with the quality control testing personnel. The ground supervisor must not have any sampling or testing duties.

Perform sampling and testing for each test strip and at the specified frequency for the quality characteristics shown in the following table:

FDR—Foamed Asphalt Quality Characteristic Sampling Locations and Testing Frequencies

Quality characteristic	Test method	Sampling location	Minimum testing frequency
Moisture content before HMA paving	California Test 226	Mid depth	One per 5 lots
Asphalt binder expansion ratio	--	Asphalt binder spray bar	One before start of FDR—foamed asphalt work each day and 2 per day
Asphalt binder half-life			
Gradation	California Test 202	Loose mix after pulverizing and mixing	Test strip and 1 per lot
Moisture content	California Test 226		Test strip and 2 per day[a]
In-place wet density	California Test 216		Test strip and 2 per day[a]
Relative compaction	California Test 231	Compacted mix	Test strip and 1 per lot
Indirect dry tensile strength	California Test 371	Loose mix after pulverizing and mixing	Test strip
Indirect wet tensile strength	California Test 371		
Tensile strength ratio	California Test 371		

[a]If lot fails minimum test frequency is one per lot.

Take a 1-quart asphalt binder sample and record the temperature from the truck for each load delivered to the job site. Sample asphalt binder in the Engineer's presence and provide the sample to the Engineer.

Take 1 thickness core for every lot. Record the location and station or postmile for each thickness core.

30-3.01D(3) Department Acceptance

The Department accepts FDR—foamed asphalt based on:

1. Visual inspection for:
   1.1. Segregation, raveling, and loose material
   1.2. Variance of more than 0.05 foot measured from the lower edge of a 12-foot straightedge
   1.3. Uniform surface texture throughout the work limits
   1.4. Repaired areas
2. Compliance with the quality characteristics shown in the following table:

FDR—Foamed Asphalt Requirements for Acceptance

Quality characteristic	Test method	Requirements
Relative compaction (%, min)	California Test 231	98% at each elevation E_1, E_2, and E_3
Thickness (ft) [a]	Core measurements	±0.05 ft of the specified thickness

[a]Take 4- or 6-inch cores from random locations the Engineer selects. The Engineer may require 3 locations per lot, coring more than three locations per lot is change order work. At time of coring, submit cores to the Engineer for measurement.

30-3.02 MATERIALS

30-3.02A General

The quality characteristics of the FDR—foamed asphalt must comply with the requirements shown in the following table:

FDR—Foamed Asphalt Quality Characteristic Requirements

Quality characteristic	Test method	Requirement
Moisture content before HMA paving	California Test 226	< 50% of OMC
Asphalt binder expansion ratio (min, %)	Note a	10
Asphalt binder half-life (seconds, min)		12
Gradation (%, passing) Sieve Size: 3 inch 2 inch 1-1/2 inch	California Test 202	 100 95–100 85–100
Moisture content Maximum Minimum	California Test 226	 OMC OMC - 2%
In-place wet density (lb/cu ft)	California Test 216	Report only
Relative compaction (min, %)	California Test 231	98
Indirect dry tensile strength (psi)[b]	California Test 371	90% of mix design value
Indirect wet tensile strength (psi)[b]	California Test 371	90% of mix design value
Tensile strength ratio (%)	California Test 371	90% of mix design value

[a]Test at the foaming temperature and percentage of foaming water by dry weight of FDR—foamed asphalt material designated in the mix design. To test asphalt binder expansion ratio and half-life, use a pail of known volume and a dipstick calibrated for the pail. From the inspection nozzle on the asphalt binder spray bar, inject foamed asphalt into the pail without exceeding the pail's capacity. With the dipstick, immediately measure and record the level of foamed asphalt in the pail. Record the half-life in seconds from the time the injection of foamed asphalt in the pail is turned off to half the dip stick reading after peak. Calculate the expansion ratio as the volume of the foamed asphalt upon injection divided by the volume of the unfoamed asphalt binder.

[b]From material passing the 1-inch sieve, compact 6 specimens under California Test 304, Part 2. Cure the specimens at 100 °F for 72 hours and allow the specimens to cool to room temperature. Test 3 specimens for dry tensile strength under California Test 371. Test 3 specimens for wet tensile strength under California Test 371 after moisture conditioning.

30-3.02B Asphalt Binder

Asphalt binder must be PG 64-10.

Do not heat asphalt binder above 375 degree F.

30-3.02C Core Backfill Material

Material to fill cored holes for thickness measurements must be packaged rapid-hardening cementitious material under ASTM C928, Type R2 or R3.

30-3.03 CONSTRUCTION

30-3.03A General

Do not start FDR—foamed asphalt activities if the ambient air temperature is below 50 degrees F or the road surface is below 50 degrees F. If the ambient air temperature falls below 50 degrees F during FDR—foamed asphalt activities, you may only compact and finish FDR—foamed asphalt.

30-3.03B Equipment

The FDR—foamed asphalt machine must have independent and interlocked systems for water and foamed asphalt, and each must include:

1. Digital electronic controller system
2. Pumping system

3. Spray bar system

Based on the mix design of the material being reclaimed and the equipment's forward speed:

1. Controller, pumping, and spray bar systems must regulate the foamed asphalt and the moisture content of the pulverized material.
2. Rate by weight of foaming water must be controlled with the same controller.

Spray bars must be fitted with self-cleaning nozzles or nozzles that indicate flow. Space the nozzles evenly at a rate of 1 nozzle for every 6 to 8 inches of mixing chamber width.

Apply the asphalt binder atomized under pressure through individual and separate small orifices.

Fit an inspection nozzle at 1 end of the asphalt binder spray bar. The inspection nozzle must produce a representative sample of foamed asphalt.

Asphalt binder storage equipment must:

1. Be attached to the FDR—foamed asphalt machine
2. Not leak
3. Have a sampling valve
4. Have a heating system to maintain the temperature of asphalt binder above 340 degrees F including when the asphalt binder is injected
5. Have a thermometer in the asphalt binder feed line before introduction of water

Use a mass flow, Coriolis effect type asphalt meter with a visible readout display, and printing capabilities.

The distance from the foamed asphalt spray nozzle to the top of the cutter tooth holder must be at least equal to the cut depth.

Storage equipment for compaction water must be attached to the FDR—foamed asphalt machine and not leak.

The FDR—foamed asphalt machine must spread the mixed material or a screed mounted on the machine may be used.

Compacting equipment must consist of 1 vibratory sheepsfoot roller with a blade for each FDR—foamed asphalt machine, a vibratory steel drum roller, and a pneumatic-tired roller. All compacting equipment must be self-propelled and reversible. The frequency and amplitude of vibrating rollers must be adjustable and exceed a force of 15 tons in vibratory mode.

30-3.03C Spreading Materials

Reserved

30-3.03D Pulverizing and Mixing

Do not leave a wedge where the pulverizing drum cuts into the existing material. The 1st cut width must use the full width of the pulverizing drum. Subsequent cuts must overlap by at least 4 inches. Do not leave a gap of unpulverized material between cuts. With each cut, adjust the quantity of water and foamed asphalt proportionally to the actual cut width. If a cut deviates more than 4 inches outside the cut line, immediately adjust. If a cut deviates more than 4 inches inside the cut line, immediately back up and pulverize the deviation along the correct cut line without adding water or foamed asphalt.

Mark the existing pavement where the center of the pulverizing drum stops. Start the following cut on this alignment at least 2 feet behind the mark.

The injection rate of asphalt binder must be the percent by dry weight of pulverized material designated in the mix design but not less than 2.5 percent. Notify the Engineer if adjustments to the asphalt binder injection rate are necessary.

The injection rate of mixing water must be sufficient to produce the FDR—foamed asphalt material moisture content shown in table titled "FDR—Foamed Asphalt Quality Characteristic Requirements" at time of compaction.

Do not apply water to an uncompacted surface.

Do not allow more than 3 hours between mixing the pulverized material with foamed asphalt and cement and completion of compaction with vibratory steel drum rollers.

30-3.03E Compacting and Grading

Immediately after pulverizing and mixing, compact FDR—foamed asphalt with a sheepsfoot roller. Each sheepsfoot roller must stay within 100 feet of its FDR—foamed asphalt train. Do not add water or use a motor grader to spread material until initial compaction with sheepsfoot rollers is complete.

During grading and final compaction with vibratory steel drum rollers, add water to maintain the moisture content as shown in the table titled, "FDR—Foamed Asphalt Quality Characteristic Requirements."

30-3.03F Finishing

Immediately after compaction, apply water and roll with pneumatic-tired rollers or steel drum roller with no vibration. The finished surface must be free of ruts, bumps, indentations, segregation, raveling, and any loose material.

Keep the compacted surface damp by lightly watering until asphaltic emulsion is applied.

Apply a coat of diluted asphaltic emulsion to the finished surface when it is damp but free of standing water. The application rate of asphaltic emulsion must be from 0.13 to 0.25 gal/sq yd. Do not water after applying asphaltic emulsion. Place temporary traffic control. Do not open to traffic without the Engineer's authorization.

Maintain the FDR—foamed asphalt surface free of ruts, bumps, indentations, raveling, and segregation. Repair damaged FDR—foamed asphalt material with minor HMA.

Take cores to determine the finished FDR—foamed asphalt thickness before placing HMA.

If a core indicates FDR—foamed asphalt thickness is less than the specified thickness by more than 0.05 foot, core in the vicinity of the noncompliant core to determine the extent of the deficient thickness. Remove the FDR—foamed asphalt material deficient in thickness by cold planing to a depth of 0.2 foot below the finished FDR—foamed asphalt grade. Replace the planed FDR—foamed asphalt with the HMA specified for the project and compact under the method compaction specifications in section 39-2.01C.

Immediately before placing HMA, apply asphaltic emulsion at a rate from 0.03 to 0.05 percent residual binder content.

Do not place HMA until authorized.

30-3.04 PAYMENT

The payment quantity for asphalt binder is measured as specified for asphalt in section 92-1.04.

The Department does not adjust the unit price for an increase or decrease in cement or asphalt binder quantities.

30-4 FULL DEPTH RECLAMATION—CEMENT

30-4.01 GENERAL

30-4.01A Summary

Section 30-4 includes specifications for constructing a reclaimed pavement base using FDR—cement.

Constructing an FDR—cement base includes:

1. Pulverizing existing asphalt concrete pavement and underlying materials
2. Mixing with water, cement, and if specified, supplementary aggregate
3. Grading and compacting the mixture
4. Applying asphaltic emulsion

30-4.01B Definitions

Lot: 1,000 sq yd of FDR—cement

30-4.01C Submittals

30-4.01C(1) General

With the QC plan, submit the mix design.

30-4.01C(2) Quality Assurance Submittals

30-4.01C(2)(a) General

Reserved

30-4.01C(2)(b) Mix Design

Submit each FDR—cement mix design on a form you create specifically for FDR—cement. Each mix design submittal must be sealed and signed by an engineer who is registered as a civil engineer in the State.

You may submit multiple mix designs to optimize the cement content and adjust for varying underlying materials.

Each mix design submittal must include:

1. Area represented by the mix design by beginning and ending stations
2. Gradation of the mixture before addition of cement
3. Cement content in percent by weight of the dry mixture and in lb/sq yd surface application rate
4. Supplementary aggregate in percent by weight of the dry mixture, if supplementary aggregate is specified
5. Moisture content of the material when mixing, relative to OMC
6. Test results and any worksheets, photographs, and graphs

30-4.01C(2)(c) Quality Control Reporting

With the daily report, submit the following based on the testing frequencies specified or if not specified, once per lot:

1. General Information:
   - 1.1. Weather:
     - 1.1.1. Ambient air temperature before starting daily FDR—cement activities including time of temperature reading
     - 1.1.2. Road surface temperature before starting daily FDR—cement activities including time of temperature reading
2. Average forward speed of pulverizing equipment
3. FDR—cement quality control test results for unconfined compressive strength

With the daily report, submit the test results for the quality characteristics within the times after sampling shown in the following table:

FDR—Cement Quality Characteristic Test Result Reporting Time Allowances

Quality characteristic	Maximum reporting time allowance
Water sulfates	Before work starts
Water chlorides	
Gradation	24 hours
Moisture content	
Laboratory maximum wet density	
Relative compaction	
Unconfined compressive strength	24 hours after testing specimens

30-4.01D Quality Assurance

30-4.01D(1) General

Relative compaction must be determined under California Test 231 and the following:

1. Test in 0.50-foot depth intervals from the bottom of the FDR—cement layer regardless of the layer thickness.

2. Correction for oversize material does not apply.
3. A sample must contain no more than 5 percent retained on the 2-inch sieve and 15 percent retained on the 1-1/2 inch sieve.
4. Use the laboratory wet test maximum density closest in proximity to the lot to determine relative compaction. If the relative compaction for a lot is less than 97 percent, perform California Test 216 and California Test 226 for each noncompliant lot and recalculate the relative compaction.

The Engineer tests each test strip under section 30-4.01D(4).

30-4.01D(2) Mix Design

The mix design must include 7-day unconfined compressive strength tests on specimens with 3 cement contents using the proposed cement and optimum mixing moisture content. The cement contents must be -1 percent of specified content, specified content, and +1 percent of specified content by dry weight of FDR—cement. Manufacture 3 specimens for each cement content and average the results for each. Plot the average 7-day compressive strengths on the ordinate versus the cement contents in percent on the abscissa on a graph. Indicate the cement contents from the line corresponding to the minimum and maximum 7-day compressive strengths from the specified range.

Based on the mix design test results, you may propose a cement content different from the specified cement content. If you propose a different cement content, your mix design submittal must include data to support (1) the specified cement content will not produce FDR—cement that complies with the specifications or (2) there is variability in the FDR—cement materials resulting in risk of not complying with the specifications. The revised cement content must be authorized. Compensation or deductions for an ordered increase or decrease is specified in section 30-4.04.

Notify the Engineer at least 2 business days before sampling.

Use materials from the specified FDR—cement mixing depth. If any portion of existing asphalt concrete pavement is to be removed before pulverizing, remove that portion of asphalt concrete pavement from the samples used in the mix design. If additional samples of subgrade material are needed, sampling locations can be excavated outside the edge of pavement to variable dimensions. Characterize and record sampling location features such as layer thicknesses and types, distresses, interlayers, thin or thick areas, digouts, and adhesion to the base. Use the sampled material to determine the mix design represented by the sampling location, according to the proportions of the pavement structure shown.

Before opening the mix design sampling locations to traffic, backfill sampling locations by replacing and compacting with an authorized material or minor HMA that complies with section 39-2.07. Backfill and compact to the existing grade and thickness of asphalt concrete pavement, in the Engineer's presence.

30-4.01D(3) Quality Control

30-4.01D(3)(a) General

Reserved

30-4.01D(3)(b) Sampling, and Testing

Assign a ground supervisor whose sole purpose is to monitor the FDR—cement activities, advise project personnel, and interface with the quality control testing personnel. The ground supervisor must not have any sampling or testing duties.

Test the quality characteristics of FDR—cement shown in the following table:

FDR—Cement Quality Characteristic Sampling Locations and Testing Frequencies

Quality characteristic	Test method	Minimum sampling and testing frequency	Sampling location
Gradation	California Test 202	Test strip and 1 per lot	Loose mix after pulverizing and mixing
Moisture content	California Test 226	Test strip and 2 per day[a]	Loose mix after pulverizing and mixing [b]
Unconfined compressive strength	ASTM D1633	Test strip and 1 per 2 lots	Loose mix after pulverizing and mixing [b]
Laboratory maximum wet density	California Test 216	Test strip and 2 per day	Same location as a California Test 231 test
Relative compaction [c]	California Test 231	Test strip and 1 per lot	Compacted mix

[a]If test fails, minimum test frequency is 1 per lot.
[b] Sample immediately after mixing is complete.
[c]Verify the moisture content reading made under California Test 231 with California Test 226.

Measure and record the actual cut depth at both ends of the pulverizing drum at least once every 300 feet along the cut length. Take measurements in the Engineer's presence.

30-4.01D(4) Department Acceptance

The Department accepts FDR—cement based on:

1. Visual inspection for the following:
   1.1. Segregation, raveling, and loose material
   1.2. Variance of more than 0.05 foot measured from the lower edge of a 12-foot straightedge
   1.3. Uniform surface texture throughout the work limits
   1.4. Repaired areas
2. Compliance with the quality characteristics shown in the following table:

FDR—Cement Requirements for Acceptance

Quality characteristic	Test method	Value
Cement application rate (lb/sq yd)	Calibrated tray or equal	Mix design rate ± 5%
Relative compaction (min, %, wet density)	California Test 231	97
Thickness (ft) [a]	Core measurements	±0.05 of the thickness shown

[a]Take 4- or 6-inch diameter cores from random locations the Engineer selects. The Engineer may require 3 locations per lot; coring more than 3 locations per lot is change order work. At time of coring, submit cores to the Engineer for measurement.

30-4.02 MATERIALS

30-4.02A General

The quality characteristics for the FDR—cement must comply with the requirements shown in the following table:

FDR—Cement Quality Characteristic Requirements

Quality characteristic	Test method	Requirement
Gradation (%, passing) Sieve Size 3 inch 2 inch 1-1/2 inch	California Test 202	 100 95–100 85–100
Moisture content (%)	California Test 226	Mix design ± 2 percent
Unconfined compressive strength (psi)	ASTM D1633[a]	Specified in section 30-4.01D(2)
Laboratory maximum wet density (lb/cu ft)	California Test 216	Use for relative compaction calculation
Relative compaction (min, %) (wet density)[b]	California Test 231	97

[a]Method A, except:

1. Test specimens must be compacted under ASTM D1557, Method A or B.
2. Test specimens must be cured by sealing each specimen with 2 layers of plastic at least 4-mil thick. The plastic must be tight around the specimen. Seal all seams with duct tape to prevent moisture loss. Sealed specimens must be placed in an oven for 7 days at 100 ± 5 degrees F. At the end of the cure period, specimens must be removed from the oven and air-cooled. Duct tape and plastic wrap must be removed before capping. Specimens must not be soaked before testing.

[b]Verify the moisture content reading made under California Test 231 with California Test 226.

30-4.02B Cement

Reserved

30-4.02C Water

Reserved

30-4.02D Supplementary Aggregate

If supplementary aggregate is specified, supplementary aggregate must comply with the specifications for Class 2 aggregate base in section 26.

30-4.02E Core Backfill Material

Material to fill cored holes for thickness measurements must be packaged rapid-hardening cementitious material under ASTM C928, Type R2 or R3.

30-4.03 CONSTRUCTION

30-4.03A General

Do not start FDR—cement activities if the ambient air temperature is below 40 degrees F or the road surface is below 40 degrees F. If the ambient air temperature falls below 40 degrees F during FDR—cement activities, you may only compact and finish FDR—cement.

30-4.03B Equipment

The FDR—cement machine must have independent and interlocked systems for water and must include the following:

1. Digital electronic controller system
2. Pumping system
3. Spray bar system

Storage equipment for water must not leak and must be attached to the FDR—cement machine with a tow bar and hose.

Grading and compacting equipment must be self-propelled and reversible. The frequency and amplitude of vibrating rollers must be adjustable and exceed a force of 15 tons in vibratory mode.

30-4.03C Pulverizing

Do not pulverize more material than can be mixed with cement and compacted in one day.

Do not leave a wedge where the pulverizing drum cuts into the existing material. The 1st cut width must use the full width of the pulverizing drum. Subsequent cuts must overlap at least 4 inches. Do not leave a gap of unpulverized material between cuts. If an overlap is more than 4 inches, immediately adjust. If an overlap is less than 4 inches, immediately back up and pulverize the deviation along the correct cut line.

Mark the existing pavement where the center of the pulverizing drum stops. Start the following cut on this alignment at least 2 feet behind the mark.

30-4.03D Spreading Materials

Spread cement uniformly over the full roadway surface width. Do not spread cement more than 30 minutes before mixing. Do not apply dry cement in windy conditions that will result in dust outside the FDR—cement area. The spread rate must be the mix design rate or the ordered rate in lb/sq yd ± 5 percent.

Do not spread cement and supplementary aggregate before pulverizing.

30-4.03E Mixing

The overlap requirements in section 30-4.03C apply to mixing. With each cut, adjust the quantity of water proportionally to the actual cut width. If an overlap is less than 4 inches, immediately back up and pulverize the deviation along the correct line without adding water or cement.

Water must be injected through the pulverizing machine. The injection rate of mixing water must be sufficient to produce the FDR—cement material mixing moisture content described in the mix design.

Mark where the center of the pulverizing drum stops. Start the following cut on this alignment at least 2 feet behind the mark.

30-4.03F Compacting and Grading

Immediately after pulverizing and mixing, compact FDR—cement to the minimum relative compaction. Do not allow more than 2 hours between final mixing of the pulverized material with cement and completion of compaction with vibratory steel drum rollers.

During grading and final compaction with vibratory steel drum rollers, add water to maintain the mixing moisture content as described in the mix design.

30-4.03G Finishing

Immediately after compaction, apply water and roll with pneumatic-tired rollers or steel drum roller with no vibration. The finished surface must be free of ruts, bumps, indentations, segregation, raveling, and any loose material.

Keep the compacted surface damp by lightly watering until asphaltic emulsion is applied.

During the period from 48 to 72 hours after compaction, microcrack the surface by applying 3 single passes with a 12-ton vibratory steel drum roller at maximum amplitude travelling from 2 to 3 mph, regardless of whether asphaltic emulsion has been applied.

Apply a coat of diluted asphaltic emulsion to the finished surface when it is damp but free of standing water. The application rate of asphaltic emulsion must be from 0.13 to 0.25 gal/sq yd. Do not water after applying asphaltic emulsion. Do not open to traffic without authorization.

Maintain the FDR—cement surface free of ruts, bumps, indentations, raveling, and segregation. Repair damaged FDR—cement material with minor HMA.

Take cores to determine the finished FDR—cement thickness before placing HMA.

If a core indicates FDR—cement thickness is less than the specified thickness by more than 0.05 foot, core in the vicinity of the noncompliant core to determine the extent of the deficient thickness. Remove the FDR—cement material deficient in thickness by cold planing to a depth of 0.2 foot below the finished FDR—cement grade. Replace the planed FDR—cement with the HMA specified for the project and compact under section 39-2.01C.

Immediately before placing HMA, apply asphaltic emulsion at a rate from 0.03 to 0.05 percent residual binder content.

Do not place HMA until authorized.

30-4.04 PAYMENT

If an increase or decrease in the specified cement content is ordered, payment for the increase or decrease in cement is the cost of cement per ton, FOB from the cement mill, including sales tax plus the freight cost per ton for delivery from the mill to the job site. If any cash or trade discount is offered or available, regardless of whether it is taken, that discount is deducted.

Maintain records that allow a clear determination of the cement costs associated with an ordered increase or decrease. Submit evidence of the cost of cement used for the increase or decrease.

If your records show an excessive cost for the increase or decrease of cement or you furnish inadequate evidence for the cost, the Engineer determines the cost to be the lowest wholesale price the cement was available for in the quantities delivered to the point of production, less any available discounts.

The quantity of cement subject to an increase or decrease in payment is the difference between the specified theoretical quantity of cement and the quantity of cement ordered.

30-5–30-9 RESERVED

30-10 CRACK AND SEAT

30-10.01 GENERAL

30-10.01A Summary

Section 30-10 includes specifications for constructing a base by cracking, seating, and preparing the surface of existing concrete pavement.

Section 30-1 does not apply to crack and seat.

30-10.01B Definitions

Reserved

30-10.01C Submittals

Submit each core in a plastic bag or tube for authorization at the time of sampling. Mark each core with a location description.

30-10.01D Quality Assurance

30-10.01D(1) General

If cracking is noncompliant:

1. Stop crack and seat work
2. Modify your equipment and procedures and crack the noncompliant pavement again
3. Construct another test section
4. Take additional core samples to verify compliance
5. Construct an inspection strip if the concrete pavement has HMA on the surface

30-10.01D(2) Test Section

The Engineer determines and marks a test section up to 1000 sq ft within the crack and seat area shown. Construct the test section and obtain the Engineer's verbal authorization before starting crack and seat work.

Immediately before cracking the test section, apply water to the pavement surface so that cracking can be readily evaluated. Crack the test section and vary impact energy and striking patterns to verify your procedure.

30-10.01D(3) Quality Control

Drill cores at least 6 inches in diameter under ASTM C42 to verify cracking in the Engineer’s presence. Take at least 2 cores per test section and 1 core per lane mile for each pavement cracking machine used. The Engineer determines the core locations.

30-10.01D(4) Department Acceptance

Reserved

30-10.02 MATERIALS

30-10.02A General

Use fast-setting or polyester concrete to fill core holes.

30-10.03 CONSTRUCTION

30-10.03A General

Reserved

30-10.03B Cracking

Crack existing concrete pavement using the procedures and equipment from the authorized test section.

Do not allow flying debris during cracking operations.

Crack existing concrete pavement into segments that nominally measure 6 feet transversely by 4 feet longitudinally. If the existing pavement is already cracked into segments, crack it into equal-sized square or rectangular pieces that nominally measure not more than 6 feet transversely and from 3 to 5 feet longitudinally. Do not impact the pavement within 1 foot of another break line, pavement joint, or edge of pavement.

Cracks must be vertical, continuous, and penetrate the full depth of pavement. Cracks must be within 6 inches of vertical along the full depth of pavement. Do not cause surface spalling over 0.10-foot deep or excessive shattering of the pavement or base.

Cracking equipment must impact the pavement with a variable force in a controlled location. Do not use unguided free-falling weights such as "headache balls."

If the concrete pavement has no more than 0.10 foot of asphalt concrete on the surface, you may crack the pavement without removing the asphalt concrete. After cracking, construct an inspection strip by removing at least 500 square feet of asphalt concrete at a location determined by the Engineer. Construct additional inspection strips to demonstrate compliance where ordered by the Engineer.

After cracking, allow public traffic on the cracked or initial pavement layer for no more than 15 days.

30-10.03C Seating

Seat cracked concrete by making at least 5 passes over the cracked concrete with either:

1. Oscillating type pneumatic-tired roller at least 4 feet wide. Pneumatic tires must be of equal size, diameter, type, and ply. The tires must be inflated to 60 psi minimum and maintained so that the air pressure does not vary more than 5 psi. The roller's gross static weight must be at least 15 tons.
2. Vibratory pad-foot roller exerting a dynamic centrifugal force of at least 10 tons.

A pass is 1 movement of a roller in either direction at 5 mph or less.

After all segments have been seated, clean loose debris from joints and cracks using compressed air free of moisture and oil.

Reseat any segment of cracked pavement that has not been overlaid within 24 hours of seating.

30-10.03D Surface Preparation

Before opening cracked and seated pavement to traffic or overlaying:

1. Fill joints, cracks, and spalls wider than 3/4 inch and deeper than 1 inch by applying tack coat and placing minor HMA under section 39, except use the no. 4 gradation instead of 3/8-inch.
2. Remove all loose debris and sweep the pavement.

30-10.03E Reserved

30-10.04 PAYMENT

The payment quantity for crack and seat is the area measured with no deductions for existing cracked segments.

31–35 RESERVED

DIVISION V SURFACINGS AND PAVEMENTS

36 GENERAL

36-1 GENERAL

36-1.01 GENERAL

36-1.01A Summary

Section 36 includes general specifications for constructing surfacings and pavements.

36-1.01B Definitions

Reserved

36-1.01C Submittals

Reserved

36-1.01D Quality Assurance

36-1.01D(1) General

Reserved

36-1.01D(2) Preconstruction Meetings

At least 3 business days before the start of surfacing and pavement operations, hold a preconstruction meeting with the Engineer and your:

1. Project manager
2. QC manager
3. Project superintendent
4. Project foreman
5. Plant manager
6. Traffic control foreman
7. Subcontractors' foremen

Meeting attendees must sign an attendance sheet provided by the Engineer. The Engineer retains the attendance sheet.

Discuss the project specifications and the processes for producing materials and constructing each item of work, including:

1. Quality assurance:
   1.1. Quality control
   1.2. Department acceptance
2. Placement of materials:
   2.1. Training
   2.2. Checklists
   2.3. Test sections or trial slabs
3. Contingency plan
4. Issues specific to the project, including:
   4.1. Weather
   4.2. Alignment and geometrics
   4.3. Traffic control issues
   4.4. Haul distances
   4.5. Presence and absence of shaded areas
   4.6. Other local issues

Do not place trial slabs, construct test strips, or start paving activities until the listed personnel have attended the meeting.

36-1.02 MATERIALS

Not Used

36-1.03 CONSTRUCTION

Not Used

36-1.04 PAYMENT

Not Used

36-2 BASE BOND BREAKER

36-2.01 GENERAL

36-2.01A Summary

Section 36-2 includes specifications for applying or placing a base bond breaker between a base and concrete pavement.

36-2.01B Definitions

Reserved

36-2.01C Submittals

Submit a certificate of compliance for each shipment of base bond breaker material delivered.

36-2.01D Quality Assurance

Reserved

36-2.02 MATERIALS

The base bond breaker must be one of the following:

Base bond breaker no.	Description
1	PG asphalt binder, Grade PG 64-10
2	Curing compound no. 3
3	White opaque polyethylene film under ASTM C171 except the minimum thickness must be 6 mils
4	White curing paper under ASTM C171
5	Geosynthetic bond breaker

36-2.03 CONSTRUCTION

36-2.03A General

Before applying or placing a base bond breaker, remove foreign and loose materials from the base.

Do not place a base bond breaker until the base has cured.

Pave over the base bond breaker within 72 hours of placing it.

36-2.03B Applying and Placing Base Bond Breaker

Select a bond breaker to apply or place over the base material as shown in the following table:

Base material	Bond breaker no.
LCB	1, 2, 5
Concrete base	
LCB rapid setting	3, 4, 5
RSC base	
CTPB	
Existing base	

Apply base bond breaker no. 1 in a single application at a uniform rate from 0.09 to 0.15 gal/sq yd over the entire surface of the base. Cure for at least 4 hours before paving.

Mix base bond breaker no. 2 as specified for mixing curing compound for concrete. Apply the bond breaker in 1 or more applications to achieve a coverage rate of at least 0.12 gal/sq yd over the entire surface of the base. Cure for at least 4 hours before paving.

Place base bond breakers no. 3 and 4 without wrinkles. Overlap adjacent sheets a minimum of 6 inches in the same direction as the concrete pour. Tape or bond the sheets together as needed to prevent the sheets from folding or wrinkling. Secure the bond breaker such that it remains in place during concrete placement. Ensure that no concrete gets under the bond breaker.

Place base bond breaker no. 5 without wrinkles. Overlap adjacent sheets a minimum of 8 inches in the same direction as the concrete pour. Overlap no more than 3 layers at any location. Secure the base bond breaker to the base with pins or nails punched through galvanized washers or discs from 2 to 2.75 inches in diameter. Place fasteners less than 3 feet apart along the edges and 6 feet apart elsewhere. If the bond breaker moves or wrinkles during concrete pavement placement, use more fasteners at a smaller spacing. Ensure that no concrete gets under the bond breaker.

36-2.04 PAYMENT

The payment quantity for base bond breaker does not include the quantity used for overlaps.

36-3 PAVEMENT SMOOTHNESS

36-3.01 GENERAL

36-3.01A Summary

Section 36-3 includes specifications for measuring the smoothness of pavement surfaces.

36-3.01B Definitions

area of localized roughness: Moving average of the International Roughness Index values for each wheel path using a 25-foot continuous interval and a 250-mm filter.

Mean Roughness Index: Average of the International Roughness Index values for the left and right wheel paths for the same traffic lane using a fixed interval and a 250-mm filter.

wheel paths: Pair of lines 3 feet from and parallel to the edges of a traffic lane. Left and right wheel paths are based on the direction of travel.

36-3.01C Submittals

36-3.01C(1) General

Reserved

36-3.01C(2) Inertial Profiler Certification

At least 5 business days before starting initial profiling or changing the inertial profiler or operator, submit:

1. Inertial profiler certification issued by the Department
2. Operator certification for the inertial profiler issued by the Department
3. Manufacturer's instructions and test procedures for calibration and verification of the inertial profiler

Within 2 business days after cross-correlation testing, submit a ProVAL profiler certification analysis report for the test results to the Engineer and to the electronic mailbox address smoothness@dot.ca.gov.

36-3.01C(3) Inertial Profiler Data

36-3.01C(3)(a) General

At least 15 days before inertial profiling, you must register with the Department's secure file sharing system. To obtain information on the registration process, send an e-mail with your contact information to smoothness@dot.ca.gov.

Within 2 business days after each day of profiling, submit the profile information to the Engineer and to the Department's secure file sharing system. After submitting the profile information to the Department’s file sharing system, send a notification of your electronic submittal to the Engineer and to the above electronic mailbox address with the names of the files submitted.

For each surface with inertial profile smoothness requirements, the profiling information must include:

1. Raw profile data for each lane
2. ProVAL ride quality analysis report for the Mean Roughness Index of each lane in a PDF file. Report the following:

2.1. Listing of Mean Roughness Index values for 0.1-mile segments or portions thereof
2.2. Inputs, including the specified Mean Roughness Index threshold and fixed segment length
2.3. Raw profile data name selections
2.4. Areas exempt from inertial profile smoothness

3. ProVAL ride quality analysis report for the International Roughness Index of the left and right wheel paths of each lane in a PDF file. Report the following:
   3.1. Listing of areas of localized roughness
   3.2. Inputs, including the specified area of the localized roughness threshold and continuous segment length
   3.3. Raw profile data name selections
   3.4. Areas exempt from inertial profile smoothness
4. GPS data file for each lane. Submit the data file in GPS eXchange file format.
5. Manufacturer's recommended calibration and verification test results for the inertial profiler.
6. Inertial profiler's calibration and verification test results, including results for bounce, block, and the distance measurement instrument.
7. Completed Pavement Smoothness Inertial Profiler Submittal Record.

Submit Asphalt Concrete Pavement Smoothness Corrections Information or Concrete Pavement Smoothness Corrections Information with your final profiling information submittal.

Submit the raw profile data in an unfiltered electronic pavement profile file format. Use the following file-naming convention:

YYYYMMDD_TTCCCRRR_EA_D_L_W_B_E_X_PT.PPF

where:

YYYY = year

MM = month, leading zero

DD = day of month, leading zero

TT = district, leading zero

CCC = county, 2- or 3-letter abbreviation as shown in section 1-1.08

RRR = route number with no leading zeros

EA = Contract number, excluding the district identification number, expressed as 6 characters

D = traffic direction, *NB*, *SB*, *WB*, or *EB*

L = lane number from left to right in the direction of travel

W = wheel path, *L* for left, *R* for right, or *B* for both

B = beginning station to the nearest foot, such as 10+20, or beginning post mile to the nearest hundredth, such as 25.06 with no leading zero

E = ending station to the nearest foot, such as 14+20, or ending post mile to the nearest hundredth, such as 28.06 with no leading zero

X = profile operation, *EXIST* for existing pavement, *INTER* for after prepaving smoothness correction, *MILL* for after milling, *PAVE* for after paving, and *CORR* for after final surface pavement correction, and FINAL for completed pavement documentation of compliance.

PT = type of pavement surface profiled, such as Type A HMA, RHMA-G, OGFC, JPCP, or CRCP

If you are submitting multiple inertial profiler data files, compress the files into a .ZIP file format and submit them using the file-naming convention TT_EA_X_YYYYMMDD.zip.

36-3.01C(3)(b) Smoothness Corrective Grinding Plan

At least 2 business days before performing corrective grinding for areas of localized roughness or areas exceeding the specified thresholds for the Mean Roughness Index, submit a corrective grinding plan as an informational submittal.

The corrective grinding plan must include:

1. Grinder manufacturer make and model
2. Grinder wheelbase in feet, measured from the front centerline to the back centerline of the single wheel or tandem wheel spread
3. Grinder head position in feet, measured relative to the centerline of the front single wheel or the front tandem wheel spread
4. Tandem wheel spreads in feet, for rear and front wheels as applicable
5. Tabular listing of the planned corrective grinding, including:
   5.1. Start and stop locations in stationing to the nearest foot
   5.2. Width of grind, such as left half lane, right half lane, or full width lane
   5.3. Corresponding grinder head depths to the nearest 0.01 inch
   5.4. Direction of grind, up to 2 passes per grind location, such as forward, reverse, forward-forward, reverse-reverse, forward-reverse, reverse-forward
   5.5. Distance from start or stop locations to the nearest semipermanent reference point
6. Forecasted improvement in terms of the Mean Roughness Index and area of localized roughness values

36-3.01C(4) Straightedge Measurements

Within 2 business days of measuring smoothness with a straightedge, submit a list of the areas requiring smoothness correction or a report stating there are no areas requiring smoothness correction. Identify the areas requiring smoothness correction by:

1. Location number
2. District-County-Route
3. Beginning station or post mile to the nearest 0.01 mile
4. For correction areas within a traffic lane:
   4.1. Lane direction, *NB, SB, EB*, or *WB*
   4.2. Lane number from left to right in the direction of travel
   4.3. Wheel path, *L* for left, *R* for right, or *B* for both
5. For correction areas not within a traffic lane:
   5.1. Identify the pavement area, such as shoulder, weigh station, or turnout
   5.2. Direction and distance from the centerline, *L* for left or *R* for right
6. Estimated size of correction area

36-3.01D Quality Assurance

36-3.01D(1) General

Reserved

36-3.01D(2) Certifications

The inertial profiler must display a current certification decal showing the expiration date.

The operator must be certified for each model of inertial profiler operated.

The certifications issued by the Department for the inertial profiler and operator must not be more than 12 months old.

36-3.01D(3) Quality Control

36-3.01D(3)(a) General

Reserved

36-3.01D(3)(b) Smoothness

36-3.01D(3)(b)(i) General

Test pavement smoothness using an inertial profiler except use a 12-foot straightedge for the pavement at:

1. Traffic lanes less than 1,000 feet in length, including ramps, turn lanes, and acceleration and deceleration lanes
2. Horizontal curves with a centerline radius less than the following and within the superelevation transition of such curves:
   2.1. 150 feet for asphalt concrete pavements
   2.2. 300 feet for Portland cement concrete pavements
3. Areas within 12.5 feet of manholes
4. Shoulders
5. Weigh-in-motion areas
6. Miscellaneous areas such as medians, gore areas, turnouts, and maintenance pullouts

Where inertial profiler testing is required:

1. Determine the pavement smoothness for each traffic lane by obtaining the International Roughness Index for the left and right wheel paths in an individual lane
2. Determine the Mean Roughness Index and areas of localized roughness using FHWA's engineering software ProVAL

Where OGFC is required, test the pavement smoothness of the final HMA or concrete pavement surface before placing OGFC and after placing OGFC.

36-3.01D(3)(b)(ii) Inertial Profiler Calibration and Verification Tests

Notify the Engineer at least 2 business days before performing calibration and verification testing of the inertial profiler.

Conduct the following calibration and verification tests in the Engineer's presence each day before profiling:

1. Block test to verify the accuracy of the height sensor under California Test 387
2. Bounce test to verify the combined accuracy of the height sensor and accelerometer under California Test 387
3. Distance measurement instrument test to verify the accuracy of the distance measuring instrument under California Test 387
4. Manufacturer's recommended tests

Conduct a cross-correlation verification test of the inertial profiler in the Engineer's presence before performing the initial profiling. A verification test must be performed at least annually. Conduct 5 repeat runs of the inertial profiler on an authorized test section. The test section must be a 0.1-mile segment of existing concrete pavement if you are measuring new concrete pavement or existing asphalt concrete pavement if you are measuring new asphalt concrete pavement. Where micro-milled asphalt concrete surfaces are to be measured, the cross-correlation verification test may be performed on the initial 0.1-mile section of milled asphalt concrete surface. Calculate a cross-correlation to determine the repeatability of your device under California Test 387 using a ProVAL profiler certification analysis with a 3-foot maximum offset. The cross-correlation must be a minimum of 0.92.

36-3.01D(3)(b)(iii) Performing, Analyzing, and Collecting Data

Operate the inertial profiler under the manufacturer's instructions and AASHTO R 57 at 1-inch recording intervals using a minimum 4-inch line laser sensor.

Establish semipermanent reference points for aligning inertial profiler runs and locating potential corrective grinding. Place semipermanent reference points at a frequency of 0.5 mile or less along the edge of the traffic lane or roadway. Maintain semipermanent reference points until Department acceptance testing is completed.

Collect profiling data under AASHTO R 57 and analyze it using 250 mm and International Roughness Index filters.

While collecting the profile data to determine the International Roughness Index values, record semipermanent reference points and the beginning and end of the following locations in the raw profile data:

1. Bridge approach slabs
2. Bridges
3. Culverts visible on the roadway surface
4. Railroad crossings
5. At-grade intersections
6. Project limits
7. Change in pavement type

Profile the left and right wheel paths of each lane.

Determine the Mean Roughness Index for 0.1-mile fixed sections using the ProVAL ride quality analysis with a 250 mm filter. Calculate the Mean Roughness Index of each lane. A partial section equal or less than 0.05-mile length is to be included with the previous or the subsequent segment forming up to a 0.15-mile length. A partial section greater than 0.05 mile, but less than 0.10 mile, is a separate segment. Sections must comply with the Mean Roughness Index specifications for a full section. A weighted average calculation will be used for those partial sections that have been combined with previous or subsequent segments.

Determine the areas of localized roughness using ProVAL with the average International Roughness Index values for each wheel path using a 25-foot continuous interval and a 250 mm filter.

36-3.01D(4) Department Acceptance

The Department accepts pavement surfaces for smoothness based on compliance with the smoothness specifications for the type of pavement surface specified.

For areas that require pavement smoothness determined using a 12-foot straightedge, the pavement surface must not vary from the lower edge of the straightedge by more than:

1. 0.01 foot when the straightedge is laid parallel with the centerline
2. 0.02 foot when the straightedge is laid perpendicular to the centerline and extends from edge to edge of a traffic lane
3. 0.02 foot when the straightedge is laid within 24 feet of a pavement conform

Pavement located within 12.5 feet of the ends of bridges, approach slabs, culverts visible on the roadway surface, railroad crossings, at-grade intersections, and transverse surface joints with existing pavement must comply with Mean Roughness Index and 12-foot straightedge requirements. The requirements for areas of localized roughness do not apply to these areas.

For each 0.1-mile section, your International Roughness Index values must be within 10 percent of the Department's International Roughness Index values. The Engineer may order you to recalibrate your inertial profiler equipment and reprofile. If your results are inaccurate due to operator error, the Engineer may disqualify your inertial profiler operator.

36-3.02 MATERIALS

Not Used

36-3.03 CONSTRUCTION

Notify the Engineer of the start location by station and start time at least 2 business days before each day of profiling.

Before profiling, remove foreign objects from the pavement surface and mark the beginning and ending station on the pavement shoulder. The stationing must be the same when profiling more than one surface.

36-3.04 PAYMENT

Not Used

36-4 RESIDUE CONTAINING LEAD FROM PAINT AND THERMOPLASTIC

Reserved

36-5–36-15 RESERVED

37 BITUMINOUS SEALS

37-1 GENERAL

37-1.01 GENERAL

37-1.01A Summary

Section 37-1 includes general specifications for applying seal coats.

37-1.01B Definitions

Reserved

37-1.01C Submittals

At least 10 days before the preconstruction meeting submit a list of participants in the preconstruction meeting. Provide each participant's name, employer, title, and role in the production and placement of the seal coats.

At least 10 days before starting seal coat activities, submit the names of the authorized laboratories for quality control testing.

For each delivery of asphalt binder or asphaltic emulsion to the job site, submit a certificate of compliance and a copy of the specified test results.

For a seal coat that uses crumb rubber modifier, submit a Crumb Rubber Usage Report form monthly and at the end of project.

37-1.01D Quality Assurance

37-1.01D(1) General

For aggregate testing, quality control laboratories must be in compliance with the Department's Independent Assurance Program to be an authorized laboratory. Quality control personnel must be qualified under the Department's Independent Assurance Program.

For emulsion testing, quality control laboratories must participate in the AASHTO re:source proficiency sample program.

37-1.01D(2) Preconstruction Meeting

Hold a preconstruction meeting within 5 days before start of seal coat work at a mutually agreed time and place with the Engineer and your:

1. Project superintendent
2. Project foreman
3. Traffic control foreman

Make arrangements for the conference facility. Preconstruction meeting participants must sign an attendance sheet provided by the Engineer. Be prepared to discuss:

1. Quality control testing
2. Acceptance testing
3. Seal coat placement
4. Proposed application rates for asphaltic emulsion or asphalt binder and aggregate.
5. Training on placement methods
6. Checklist of items for proper placement
7. Unique issues specific to the project, including:
    7.1. Weather
    7.2. Alignment and geometrics
    7.3. Traffic control requirements
    7.4. Haul distances
    7.5. Presence and absence of shaded areas
    7.6. Any other local conditions
8. Contingency plan for material deliveries, equipment breakdowns, and traffic handling
9. Who in the field has authority to adjust application rates and how adjustments will be documented
10. Schedule of sweepings

37-1.02 MATERIALS

Not Used

37-1.03 CONSTRUCTION

37-1.03A General

If seal coat activities affect access to public parking, residential property, or commercial property, post signs at 100-foot intervals on the affected streets. Signs must display *No Parking – Tow Away*. Signs must state the dates and hours parking or access will be restricted. Notify residents, businesses, and local agencies at least 24 hours before starting activities. The notice must:

1. Describe the work to be performed
2. Detail streets and limits of activities
3. Indicate dates and work hours
4. Be authorized

Asphaltic emulsion or asphalt binder for seal coats may be reheated if necessary. After loading the asphaltic emulsion or asphalt binder into a truck for transport to the job site, do not heat asphaltic emulsion above 160 degrees F and asphalt rubber binder above 425 degrees F. During reheating, circulate or agitate the asphaltic emulsion or asphalt binder to prevent localized overheating.

Except for fog seals, apply quick setting Grade 1 asphaltic emulsions at a temperature from 75 to 130 degrees F and apply quick setting Grade 2 asphaltic emulsions at a temperature from 110 to 185 degrees F.

You determine the application rates for asphaltic emulsion or asphalt binder and aggregate and the Engineer authorizes the application rates.

37-1.03B Equipment

A self-propelled distributor truck for applying asphaltic emulsion or asphalt binder must be equipped with:

1. Pressure-type system with insulated tanks with circulating unit
2. Spray bars:
   - 2.1. With minimum length of 9 feet and full-circulating type
   - 2.2. With full-circulating-type extensions if needed to cover a greater width
   - 2.3. Adjustable to allow positioning at various heights above the surface to be treated
   - 2.4. Operated by levers such that 1 or all valves may be quickly opened or closed in one operation
3. Devices and charts to provide for accurate and rapid determination and control of asphaltic emulsion or asphalt binder quantities being applied. Include an auxiliary wheel type meter that registers:
   - 3.1. Speed in ft/min
   - 3.2. Trip by count
   - 3.3. Total distance in feet
4. Distribution system:
   - 4.1. Capable of producing a uniform application of asphaltic emulsion or asphalt binder in controlled quantities ranging from 0.02 to 1 gal/sq yd of surface and at a pressure ranging from 25 to 75 psi
   - 4.2. Pumps that spray asphaltic emulsion or asphalt binder within 0.02 gal/sq yd of the set rate
   - 4.3. With a hose and nozzle for application of asphaltic emulsion to areas inaccessible to the spray bar
   - 4.4. With pressure gauges and a thermometer for determining temperatures of the asphaltic emulsion or asphalt binder

You may use cab-controlled valves for the application of asphaltic emulsion or asphalt binder. The valves controlling the flow from nozzles must act positively to provide a uniform unbroken application of asphaltic emulsion or asphalt binder.

Maintain distributor and storage tanks at all times to prevent dripping.

37-1.04 PAYMENT

Not Used

37-2 CHIP SEALS

37-2.01 GENERAL

37-2.01A General

37-2.01A(1) Summary

Section 37-2.01 includes general specifications for applying chip seals.

37-2.01A(2) Definitions

Reserved

37-2.01A(3) Submittals

At least 15 days before starting placement of chip seal, submit:

1. Samples for:
   1.1. Asphaltic emulsion chip seal, two 1-quart wide mouth plastic containers with screw top lid of asphaltic emulsion
   1.2. Polymer modified asphaltic emulsion chip seal, two 1-quart wide mouth plastic containers with screw top lid of polymer modified asphaltic emulsion
   1.3. Asphalt rubber binder chip seal, two 1-quart cans of base asphalt binder
   1.4. Asphalt rubber binder chip seal, five 1-quart cans of asphalt rubber binder
2. Asphaltic emulsion, polymer modified asphaltic emulsion, asphalt binder or asphalt rubber binder data as follows:
   2.1. Supplier and Type/Grade of asphaltic emulsion or asphalt binder
   2.2. Type of modifier used including polymer or crumb rubber or both
   2.3. Percent of crumb rubber, if used as modifier
   2.4. Copy of the specified test results for asphaltic emulsion or asphalt binder
3. 50 lb of uncoated aggregate
4. Aggregate test results for the following:
   4.1. Gradation
   4.2. Los Angeles Rattler
   4.3. Percent of crushed particles
   4.4. Flat and elongated particles
   4.5. Film stripping
   4.6. Cleanness value
   4.7. Durability
5. Vialit test results

Submit quality control test results for the quality characteristics within the reporting times allowance after sampling shown in the following table:

Quality Control Test Result Reporting

Quality characteristic	Maximum reporting time allowance
Los Angeles Rattler loss (max, %)	48 hours
Percent of crushed particles (min, %)	48 hours
Flat and elongated particles (max by weight at 3:1, %)	48 hours
Film stripping (max, %)	48 hours
Durability (min)	48 hours
Gradation (percentage passing)	24 hours
Cleanness value (min)	24 hours
Asphaltic emulsion spread rate (gal/sq yd)	24 hours

Within 3 days after taking asphaltic emulsion or asphalt binder quality control samples, submit the authorized laboratory's test results.

37-2.01A(4) Quality Assurance

37-2.01A(4)(a) General

Reserved

37-2.01A(4)(b) Quality Control

37-2.01A(4)(b)(i) General

Reserved

37-2.01A(4)(b)(ii) Aggregate

All tests must be performed on uncoated aggregate except for film stripping which must be performed on precoated aggregate.

For aggregate, the authorized laboratory must perform sampling and testing at the specified frequency and location for the following quality characteristics:

Aggregate Quality Control Requirements

Quality characteristic	Test method	Minimum sampling and testing frequency	Location of sampling
Los Angeles Rattler loss (max, %) At 100 revolutions At 500 revolutions	California Test 211	1st day of production	See California Test 125
Percent of crushed particles Coarse aggregate (min, %) One-fractured face Two-fractured faces Fine aggregate (min, %) (Passing No. 4 sieve and retained on No. 8 sieve) One fractured face	AASHTO T 335	1st day of production	See California Test 125
Flat and elongated particles (max by weight at 3:1, %)	ASTM D4791	1st day of production	See California Test 125
Film stripping (max, %)	California Test 302	1st day of production	See California Test 125
Durability (min)	California Test 229	1st day of production	See California Test 125
Gradation (% passing)	California Test 202	2 per day	See California Test 125
Cleanness value (min)	California Test 227	2 per day	See California Test 125

37-2.01A(4)(b)(iii) Chip Seals

For a chip seal, the authorized laboratory must perform sampling and testing at the specified frequency and location for the following quality characteristics:

Chip Seal Quality Control Requirements

Quality characteristic	Test method	Minimum sampling and testing frequency	Location of sampling
Asphaltic emulsion binder spread rate (gal/sq yd)	California Test 339	1 per day per distributor truck	Pavement surface

37-2.01A(4)(c) Department Acceptance

Department Acceptance shall not apply to identified areas where the existing surfacing before application of chip seal, contains defective areas as determined by the Engineer and Contractor. At least 7 days before starting placement of the chip seal, the Contractor shall submit a written list of existing defective areas, identifying the lane direction, lane number, starting and ending highway post mile locations, and defect type. The Engineer must agree on which of the identified areas are defective.

Defective areas are defined as one of the following:

1. Areas with wheel path rutting in excess of 3/8 inch when measured by placing a straightedge 12 feet long on the finished surface perpendicular to the center line and measuring the vertical distance between the finished surface and the lower edge of the straightedge
2. Areas exhibiting flushing

For a chip seal, acceptance is based on visual inspection for the following:

1. Uniform surface texture
2. Raveling, which consists of the separation of the aggregate from the asphaltic emulsion or asphalt binder
3. Flushing, which consists of the occurrence of a film of asphaltic material on the surface of the chip seal.
4. Streaking, which consists of alternating longitudinal bands of asphaltic emulsion or asphalt binder without uniform aggregate retention, approximately parallel with the lane line.

Areas of raveling, flushing or streaking that are greater than 0.5 sq ft shall be considered defective and must be repaired.

Raveling and streaking must be repaired by placing an additional layer of chip seal over the defective area.

For asphaltic emulsion or asphalt binder, acceptance is based on the Department's sampling and testing for compliance with the requirements for the quality characteristics specified.

For aggregate, acceptance is based on the Department's sampling and testing for compliance with the requirements shown in the following table:

Chip Seal Aggregate Acceptance Criteria

Quality characteristic	Test method	Requirements
Los Angeles Rattler loss (max, %) At 100 revolutions At 500 revolutions	California Test 211	 10 40
Percent of crushed particles: Coarse aggregate (min, %) One-fractured face Two-fractured faces Fine aggregate (min, %) (Passing No. 4 sieve and retained on No. 8 sieve) One fractured face	AASHTO T 335	 95 90 70
Flat and elongated particles (max by weight at 3:1, %)	ASTM D4791	10
Film stripping (max, %)	California Test 302	25
Durability (min)	California Test 229	52
Gradation (% passing by weight)	California Test 202	Aggregate Gradation table shown under Materials for the chip seal type specified.
Cleanness value (min)	California Test 227	80

If test results for the aggregate gradation do not comply with specifications, you may remove the chip seal represented by these tests or request that it remain in place with a payment deduction. The deduction is $1.75 per ton for the aggregate represented by the test results.

If test results for aggregate cleanness value do not comply with the specifications, you may remove the chip seal represented by these tests or you may request that the chip seal remain in place with a pay deduction corresponding to the cleanness value shown in the following table:

Chip Seal Cleanness Value Deductions

Cleanness value	Deduction
80 or over	None
79	$2.00 /ton
77–78	$4.00 /ton
75–76	$6.00 /ton

If the aggregate cleanness value is less than 75, remove the chip seal.

37-2.01B Materials

37-2.01B(1) General

Reserved

37-2.01B(2) Asphaltic Emulsions and Asphalt Binders

Reserved

37-2.01B(3) Aggregate

37-2.01B(3)(a) General

Aggregate must be broken stone, crushed gravel, or both.

Aggregate must comply with the requirements shown in the following table:

Chip Seal Aggregate Requirements

Quality characteristic	Test method	Requirements
Los Angeles Rattler loss (max, %) At 100 revolutions At 500 revolutions	California Test 211	 10 40
Percent of crushed particles Coarse aggregate (min, %) One-fractured face Two-fractured faces Fine aggregate (min, %) (Passing No. 4 sieve and retained on No. 8 sieve) One fractured face	AASHTO T 335	 95 90 70
Flat and elongated particles (max by weight at 3:1, %)	ASTM D4791	10
Film stripping (max, %)	California Test 302	25
Durability (min)	California Test 229	52
Gradation (% passing by weight)	California Test 202	Aggregate Gradation table shown under Materials for the chip seal type specified.
Cleanness value (min)	California Test 227	80

The authorized laboratory must conduct the Vialit test using the proposed asphaltic emulsion or asphalt binder and aggregate for compliance with the requirements shown in the following table:

Chip Retention Requirements

Quality characteristic	Test method	Requirement
Chip retention (%)	Vialit test method for aggregate in chip seals, French chip (Modified)[a]	95

[a]The asphaltic emulsion or asphalt binder must be within the field placement temperature range and application rate during specimen preparation. For asphalt binder cure the specimen for first 2 hours at 100 °F.

37-2.01B(3)(b) Precoated Aggregate

Precoating of aggregate must be performed at a central mixing plant. The plant must be authorized under the Department's *MPQP*.

When precoating aggregate, do not recombine fine materials collected in dust control systems.

Precoated aggregate must be preheated from 260 to 325 degrees F. Coat with any of the asphalts specified in the table titled "Performance Graded Asphalt Binder" in section 92. The asphalt must be from 0.5 to 1.0 percent by weight of dry aggregate. You determine the exact asphalt rate for precoating of aggregate.

Do not stockpile precoated aggregate.

37-2.01C Construction

37-2.01C(1) General

For chip seals on 2-lane, 2-way roadways, place a W8-7 (LOOSE GRAVEL) sign and a W13-1 (35) plaque at 2,000-foot maximum intervals along each side of the traveled way where aggregate is spread on a traffic lane and at public roads or streets entering the chip seal area. Place the 1st W8-7 sign in each direction where traffic first encounters the loose aggregate, regardless of which lane the aggregate is spread on. A W13-1 (35) plaque is not required where the posted speed limit is less than 40 mph.

For chip seals on freeways, expressways, and multilane conventional highways, place a W8-7, (LOOSE GRAVEL) sign and a W13-1 (35) plaque at 2,000-foot maximum intervals along the outside edge of the traveled way nearest to the lane worked on, at on ramps, and at public roads or streets entering the chip seal area. Place the 1st W8-7 sign where the aggregate starts with respect to the direction of travel on that lane. A W13-1 (35) plaque is not required where the posted speed limit is less than 40 mph.

Pilot cars must have cellular or radio contact with other pilot cars and personnel in the work zone. The maximum speed of the pilot cars convoying or controlling traffic through the traffic control zone must be 15 mph on 2-lane, two-way highways and 25 mph on multilane divided and undivided highways. Pilot cars must only use traffic lanes open to traffic.

On the days that closures are not allowed, you may use a moving closure to maintain the seal coat surface. The moving closure is only allowed during daylight hours when traffic will be the least inconvenienced and delayed. The Engineer determines the hours for the moving closure.

Maintain signs in place at each location until the final sweeping of the chip seal surface for that location is complete. Signs may be set on temporary portable supports with the W13-1 sign below the W8-7 sign or on barricades with the W13-1 sign alternating with the W8-7 sign.

Schedule chip seal activities so that the chip seals are placed on both lanes of the traveled way each work shift.

If traffic is routed over a surface where a chip seal application is intended, the chip seal must not be applied to more than half the width of the traveled way at a time, and the remaining width must be kept free of obstructions and open to traffic until the previously applied width is ready for traffic use.

Wherever maintenance sweeping of the chip seal surface is complete, place permanent traffic stripes and pavement markings within 10 days.

If you fail to place the permanent traffic stripes and pavement markings within the specified time, the Department withholds 50 percent of the estimated value of the chip seal work completed that has not received permanent traffic stripes and pavement markings.

37-2.01C(2) Equipment

Equipment for chip seals must include and comply with the following:

1. Aggregate haul trucks must have:
   1.1. Tailgate that discharge aggregate
   1.2. Device to lock onto the rear aggregate spreader hitch
   1.3. Dump bed that will not push down on the spreader when fully raised
   1.4. Dump bed that will not spill aggregate on the roadway when transferred to the spreader hopper

1.5. Tarpaulin to cover precoated aggregate when haul distance exceeds 30 minutes or ambient temperature is less than 65 degrees F

2. Self-propelled aggregate spreaders must have:
   2.1. Aggregate hopper in the rear
   2.2. Belt conveyor that carries the aggregate to the front
   2.3. Spreading hopper capable of providing a uniform aggregate spread rate over the entire width of the traffic lane in 1 application.
3. Self-propelled power brooms must:
   3.1. Not be steel-tined brooms on emulsion chip seals
   3.2. Be capable of removing loose aggregate adjacent to barriers that prevent aggregate from being swept off the roadway, including curbs, gutters, dikes, berms, and railings
4. Pneumatic or foam filled rubber tired rollers must:
   4.1. Be an oscillating type at least 4 feet wide
   4.2. Be self-propelled and reversible
   4.3. Have tires of equal size, diameter, type, and ply
   4.4. Carry at least 3,000 lbs of load on each wheel
   4.5 Have tires with an air pressure of 100 ± 5 psi or be foam filled

37-2.01C(3) Surface Preparation

Before applying chip seals, cover manholes, valve and monument covers, grates, or other exposed facilities located within the area of application, using a plastic or oil resistant construction paper secured by tape or adhesive to the facility being covered. Reference the covered facilities with enough control points to relocate the facilities after the application of the chip seal.

Immediately before applying chip seals, clean the surface to receive a chip seal by removing any extraneous material affecting adhesion of the chip seal with the existing surface and drying. Use self-propelled power brooms to clean the existing pavement.

37-2.01C(4) Placement

37-2.01C(4)(a) General

Schedule the operations so that chip seals are placed on both lanes of the traveled way each work shift. At the end of the work shift, the end of the chip seals on both lanes must generally match.

37-2.01C(4)(b) Applying Asphaltic Emulsions or Asphalt Binders

Prevent spraying on existing pavement not intended for chip seals or on previously applied chip seals using a material such as building paper. Remove the material after use.

Align longitudinal joints between chip seal applications with designated traffic lanes.

For asphaltic emulsion or asphalt binder, overlap longitudinal joints by not more than 4 inches. You may overlap longitudinal joints up to 8 inches if authorized.

For areas not accessible to a truck distributor bar apply:

1. Asphaltic emulsions by hand spraying
2. Asphalt binders with a squeegee or other authorized means

You may overlap the asphaltic emulsion or asphalt binder applications before the application of aggregate at longitudinal joints.

Do not apply the asphaltic emulsion or asphalt binder unless there is sufficient aggregate at the job site to cover the asphaltic emulsion or asphalt binder.

Discontinue application of asphaltic emulsion or asphalt binder early enough to comply with lane closure requirements. Apply to 1 lane at a time and cover the lane width entirely in 1 operation.

37-2.01C(4)(c) Spreading Aggregates

37-2.01C(4)(c)(i) General

Prevent vehicles from driving on asphaltic emulsion or asphalt binder before spreading aggregate.

Spread aggregate within 10 percent of your determined rate.

Spread aggregate at a uniform rate over the full lane width in 1 application. Apply to 1 lane at a time.

Sweep excess aggregate at joints before spreading adjacent aggregate.

Operate the spreader at speeds slow enough to prevent aggregate from rolling over after dropping.

If the spreader is not moving, aggregate must not drop. If you stop spreading and aggregate drops, remove the excess aggregate before resuming activities.

37-2.01C(4)(c)(ii) Precoated Aggregate Application

During transit, cover precoated aggregate with tarpaulins if the ambient air temperature is below 65 degrees F or the haul time exceeds 30 minutes.

When applied, precoated aggregate must be from 225 to 325 degrees F.

37-2.01C(4)(d) Finishing

37-2.01C(4)(d)(i) General

Remove piles, ridges, or unevenly distributed aggregate. Repair permanent ridges, bumps, streaks or depressions in the finished surface. Spread additional aggregate and roll if aggregate is picked up by rollers or vehicles.

Chip seal joints between adjacent applications of a chip seal must be smooth, straight, uniform, and completely covered.

A coverage is 1 roller movement over the entire width of lane. A pass is 1 roller movement parallel to the chip seal application in either direction. Overlapping passes are part of the coverage being made and are not part of a subsequent coverage. Do not start a new coverage until completing the previous coverage.

Before opening to traffic, finish the chip seals in the following sequence:

1. Perform initial rolling consisting of 1 coverage with a pneumatic-tired roller
2. Perform final rolling consisting of 2 coverages with a pneumatic-tired roller
3. Sweep excess aggregate from the roadway and adjacent abutting areas
4. Apply a flush coat if specified
5. Remove covers from the facilities

37-2.01C(4)(d)(ii) Traffic Control With Pilot Car

For 2-lane 2-way roadways under 1-way traffic control, upon completion of final rolling, traffic must be controlled with pilot cars and routed over the new chip seal for a period of 2 to 4 hours before opening the lane to traffic not controlled with pilot cars.

For multilane roadways, when traffic is controlled with pilot cars, a maximum of 1 lane in the direction of travel must be open to traffic. Traffic must be controlled with pilot cars and be routed on the new chip seal surface of the lane for a minimum of 2 hours after completion of the initial sweeping and before opening the lane to traffic not controlled with pilot cars. Once traffic controlled with pilot cars is routed over the chip seal at a particular location, continuous control must be maintained at that location until the chip seal placement and sweeping on adjacent lanes to receive a chip seal is completed.

37-2.01C(4)(d)(iii) Sweeping

Sweeping must be performed after the chip seal has set and there is no damage or dislodging of aggregate from the chip seal surface. As a minimum, sweeping is required at the following times:

1. On 2-lane 2-way roadways, from 2 to 4 hours after traffic, controlled with pilot cars, has been routed on the chip seal
2. On multilane roadways, from 2 to 4 hours after aggregate have been placed
3. In addition to previous sweeping, perform final sweeping immediately before opening any lane to public traffic, not controlled with pilot cars

37-2.01C(4)(d)(iv) Excess Aggregate

Dispose of excess aggregate. If ordered, salvaging and stockpiling of excess aggregate is change order work.

37-2.01C(4)(e) Chip Seal Maintenance

Perform sweeping on the morning following the application of aggregate on any lane that has been open to traffic not controlled with pilot cars and before starting any other activities.

Chip seal surfaces must be maintained for 4 consecutive days from the day aggregate is applied. Maintenance must include sweeping to maintain a surface free of loose aggregate and to prevent formation of corrugations. Sweeping must not dislodge aggregate set in asphaltic emulsion or asphalt binder.

After 4 consecutive days, excess aggregate must be removed from the paved areas.

37-2.01D Payment

If there is no bid item for traffic control system, furnishing and using a pilot car is included in the various items of the work involved in applying the chip seal.

The payment quantity for precoated aggregate is the weight measured after the aggregate is preheated and precoated with asphalt binder.

If recorded batch weights are printed automatically, the payment quantity for aggregate is the weight determined from the printed batch weights if:

1. Total weight for the precoated aggregate per batch is printed
2. Total asphalt binder weight per batch is printed
3. Zero tolerance weight is printed before weighing the first batch and after weighing the last batch for each truckload
4. Time, date, mix number, load number, and truck identification are correlated with a load slip
5. Copy of the recorded batch weights is certified by a licensed weighmaster

37-2.02 ASPHALTIC EMULSION CHIP SEALS

37-2.02A General

37-2.02A(1) Summary

Section 37-2.02 includes specifications for applying asphaltic emulsion chip seals. An asphaltic emulsion chip seal includes applying an asphaltic emulsion, followed by aggregate, and then a flush coat.

A double asphaltic emulsion chip seal is the application of an asphaltic emulsion followed by aggregate, applied twice in sequence and then a flush coat.

37-2.02A(2) Definitions

Reserved

37-2.02A(3) Submittals

Immediately after sampling, submit two 1-quart plastic containers of asphaltic emulsion taken in the presence of the Engineer. Samples must be submitted in insulated shipping container.

37-2.02A(4) Quality Assurance

37-2.02A(4)(a) General

Reserved

37-2.02A(4)(b) Quality Control

37-2.02A(4)(b)(i) General

Reserved

37-2.02A(4)(b)(ii) Asphaltic Emulsions

Circulate asphaltic emulsion in the distributor truck before sampling. Take samples from the distributor truck at mid load or from a sampling tap or thief. Before taking samples, draw and dispose of 1 gallon. In the presence of the Engineer, take two 1-quart samples in a plastic container with lined sealed lid for acceptance testing.

For asphaltic emulsion, the authorized laboratory must perform quality control sampling and testing at the specified frequency and location for the following quality characteristics:

Asphaltic Emulsion

Quality characteristic	Test method	Minimum sampling and testing frequency	Sampling location
Saybolt Furol Viscosity, at 25 °C (Saybolt Furol seconds)	AASHTO T 59	Minimum 1 per day per delivery truck	Distributor truck
Sieve Test (%)			
Storage stability, 1 day (%)			
Residue by distillation (%)			
Particle charge[a]			
Tests on Residue from Distillation Test:			
Penetration, 25 °C	AASHTO T 49	Minimum 1 per day per delivery truck	Distributor truck
Ductility	AASHTO T 51		
Solubility in trichloroethylene	AASHTO T 44		

[a]If the result of the particle charge is inconclusive, the asphaltic emulsion must be tested for pH under ASTM E70. Grade QS1h asphaltic emulsion must have a minimum pH of 7.3. Grade CQS1h asphaltic emulsion must have a maximum pH of 6.7.

37-2.02A(4)(c) Department Acceptance

Aggregate acceptance is based on the Department's sampling and testing for compliance with the requirements shown in the following table:

Aggregate Gradation Acceptance Criteria

Quality characteristic	Test method	Requirement		
Gradation (% passing by weight) Sieve size:	California Test 202	3/8"	5/16"	1/4"
3/4"		--	--	--
1/2"		100	--	--
3/8"		85–100	100	100
No. 4		0–15	0–50	60–85
No. 8		0–5	0–15	0–25
No. 16		--	0–5	0–5
No. 30		--	0–3	0–3
No. 200		0–2	0–2	0–2

37-2.02B Materials

37-2.02B(1) General

Reserved

37-2.02B(2) Asphaltic Emulsions

Reserved

37-2.02B(3) Aggregate

Aggregate gradation for an asphaltic emulsion chip seal must comply with the requirements shown in the following table:

Asphaltic Emulsion Chip Seal Aggregate Gradation

Quality characteristic	Test method	Requirement		
Gradation (% passing by weight) Sieve size:	California Test 202	3/8"	5/16"	1/4"
3/4"		--	--	--
1/2"		100	--	--
3/8"		85–100	100	100
No. 4		0–15	0–50	60–85
No. 8		0–5	0–15	0–25
No. 16		--	0–5	0–5
No. 30		--	0–3	0–3
No. 200		0–2	0–2	0–2

37-2.02C Construction

37-2.02C(1) General

Reserved

37-2.02C(2) Asphaltic Emulsions

Asphaltic emulsions must be applied within the application rate ranges shown in the following table:

Asphaltic Emulsion Application Rates

Aggregate gradation	Application rate range (gal/sq yd)
3/8"	0.30–0.45
5/16"	0.25–0.35
1/4"	0.20–0.30

For double asphaltic emulsion chip seals, the asphaltic emulsions must be applied within the application rates shown in the following table:

Asphaltic Emulsion Application Rates

Double chip seals	Application rate range (gal/sq yd)
1st application	0.30–0.45
2nd application	0.20–0.30

When applied, the temperature of the asphaltic emulsions must be from 130 to 180 degrees F.

Apply asphaltic emulsions when the ambient air temperature is from 65 to 110 degrees F and the pavement surface temperature is at least 80 degrees F.

Do not apply asphaltic emulsions when weather forecasts predict the ambient air temperature will fall below 39 degrees F within 24 hours after application.

37-2.02C(3) Spreading Aggregates

Aggregate must be spread within the spread rate ranges shown in the following table:

Aggregate Spread Rates

Aggregate gradation	Spread rate range (lb/sq yd)
3/8"	20–30
5/16"	16–25
1/4"	12–20

For double asphaltic emulsion chip seals, aggregate must be spread within the spread rate ranges shown in the following table:

Aggregate Spread Rates

Double chip seal	Spread rate range (lb/sq yd)
1st application	23–30
2nd application	12–20

Remove excess aggregate on the 1st application before the 2nd application of asphaltic emulsion.

You may stockpile aggregate for asphaltic emulsion chip seals if you prevent contamination. Aggregate must have a damp surface at spreading. If water visibly separates from the aggregate, do not spread. You may re-dampen aggregate in the delivery vehicle.

Spread aggregate before an asphaltic emulsion sets or breaks.

Do not spread aggregate more than 2,500 feet ahead of the completed initial rolling.

37-2.02D Payment

Not Used

37-2.03 POLYMER MODIFIED ASPHALTIC EMULSION CHIP SEALS

37-2.03A General

37-2.03A(1) Summary

Section 37-2.03 includes specifications for applying polymer modified asphaltic emulsion chip seals. A polymer modified asphaltic emulsion chip seal includes applying a polymer modified asphaltic emulsion, followed by aggregate, and then a flush coat.

A double polymer modified asphaltic emulsion chip seal is the application of a polymer modified asphaltic emulsion followed by aggregate, applied twice in sequence and then a flush coat.

37-2.03A(2) Definitions

Reserved

37-2.03A(3) Submittals

Immediately after sampling, submit two 1-quart cans of polymer modified asphaltic emulsion taken in the presence of the Engineer. A sample must be submitted in an insulated shipping container.

37-2.03A(4) Quality Assurance

37-2.03A(4)(a) General

Reserved

37-2.03A(4)(b) Quality Control

37-2.03A(4)(b)(i) General

Reserved

37-2.03A(4)(b)(ii) Polymer Modified Asphaltic Emulsions

Circulate polymer modified asphaltic emulsions in the distributor truck before sampling. Take samples from the distributor truck at mid load or from a sampling tap or thief. Before taking samples, draw and dispose of 1 gallon. In the presence of the Engineer, take two 1-quart samples for acceptance testing.

For polymer modified asphaltic emulsions, the authorized laboratory must perform quality control sampling and testing at the specified frequency and location for the following quality characteristics:

Polymer Modified Asphaltic Emulsion

Quality characteristic	Test method	Minimum sampling and testing frequency	Sampling location
Saybolt Furol Viscosity, at 50 °C (Saybolt Furol seconds)	AASHTO T 59	Minimum 1 per day per delivery truck	Distributor truck
Settlement, 5 days (max, %)			
Storage stability test, 1 day (max, %)			
Sieve test (max, %)			
Demulsibility (min, %)			
Particle charge			
Ash content (max, %)	ASTM D3723		
Residue by evaporation (min, %)	California Test 331		
Tests on residue from evaporation test:			
Penetration, 25 °C	AASHTO T 49	Minimum 1 per day per delivery truck	Distributor truck
Penetration, 4 °C, 200g for 60 seconds	AASHTO T 49		
Ductility, 25 °C (min, mm)	AASHTO T 51		
Torsional recovery (min, %)	California Test 332		
Ring and Ball Softening Point (min, °F)	AASHTO T 53		

37-2.03A(4)(c) Department Acceptance

Aggregate acceptance is based on the Department's sampling and testing for compliance with the requirements shown in the following table:

Aggregate Gradation Acceptance Criteria

Quality characteristic	Test method	Requirement		
Gradation (% passing by weight) Sieve size:	California Test 202	3/8"	5/16"	1/4"
3/4"		--	--	--
1/2"		100	--	--
3/8"		85–100	100	100
No. 4		0–15	0–50	60–85
No. 8		0–5	0–15	0–25
No. 16		--	0–5	0–5
No. 30		--	0–3	0–3
No. 200		0–2	0–2	0–2

37-2.03B Materials

37-2.03B(1) General

Reserved

37-2.03B(2) Polymer Modified Asphaltic Emulsions

A polymer modified asphaltic emulsion must include elastomeric polymer.

A polymer modified asphaltic emulsion must be Grade PMRS2, PMRS2h, PMCRS2, or PMCRS2h. Polymer content in percent by weight does not apply.

A polymer modified asphaltic emulsion must comply with section 94 and the quality characteristic requirements in the following table:

Polymeric Asphaltic Emulsion

Quality characteristic	Test method	Requirement
Penetration, 4 °C, 200g for 60 seconds (min)	AASHTO T 49	6
Ring and Ball Softening Point (min, °F)	AASHTO T 53	135

37-2.03B(3) Aggregate

The aggregate gradation for a polymer modified asphaltic emulsion chip seal must comply with the requirements shown in the following table:

Asphaltic Emulsion Chip Seal Aggregate Gradation

Quality characteristic	Test method	Requirement		
Gradation (% passing by weight) Sieve Size	California Test 202	3/8"	5/16"	1/4"
3/4"		--	--	--
1/2"		100	--	--
3/8"		85–100	100	100
No. 4		0–15	0–50	60–85
No. 8		0–5	0–15	0–25
No. 16		--	0–5	0–5
No. 30		--	0–3	0–3
No. 200		0–2	0–2	0–2

37-2.03C Construction

Polymer modified asphaltic emulsions must be applied within the application rate ranges shown in the following table:

Polymer Modified Asphaltic Emulsion Application Rates

Aggregate gradation	Application rate range (gal/sq yd)
3/8"	0.30–0.45
5/16"	0.25–0.35
1/4"	0.20–0.30

For double polymer modified asphaltic emulsion chip seals, polymer modified asphaltic emulsions must be applied within the application rates shown in the following table:

Polymer Modified Asphaltic Emulsion Application Rates

Double application	Application rate range (gal/sq yd)
1st application	0.30–0.45
2nd application	0.20–0.30

Apply polymer modified asphaltic emulsions when the ambient air temperature is from 60 to 105 degrees F and the pavement surface temperature is at least 80 degrees F.

Do not apply polymer modified asphaltic emulsions when weather forecasts predict the ambient air temperature will fall below 39 degrees F within 24 hours after application.

Aggregate must be spread within the spread rate ranges shown in the following table:

Aggregate Spread Rates

Chip seal type	Spread rate range (lb/sq yd)
3/8"	20–30
5/16"	16–25
1/4"	12–20

For double chip seals, aggregate must be spread within spread rate ranges shown in the following table:

Aggregate Spread Rates

Double application	Spread rate range (lb/sq yd)
1st application	23–30
2nd application	12–20

Remove excess aggregate on the 1st application before the 2nd application of asphaltic emulsion.

You may stockpile aggregate for the polymer modified asphaltic emulsion chip seals if you prevent contamination. Aggregate must have damp surfaces at spreading. If water visibly separates from the aggregate, do not spread. You may redampen aggregate in the delivery vehicle.

Spread aggregate before the polymer modified asphaltic emulsion sets or breaks.

Do not spread aggregate more than 2,500 feet ahead of the completed initial rolling.

37-2.03D Payment

Not Used

37-2.04 ASPHALT RUBBER BINDER CHIP SEALS

37-2.04A General

37-2.04A(1) Summary

Section 37-2.04 includes specifications for applying asphalt rubber binder chip seals.

An asphalt rubber binder chip seal consists of applying asphalt rubber binder followed by heated aggregate precoated with asphalt binder followed by a flush coat.

37-2.04A(2) Definitions

crumb rubber modifier: Combination of ground or granulated high natural scrap tire crumb rubber and scrap tire crumb rubber derived from waste tires described in Pub Res Code § 42703.

descending viscosity reading: Subsequent viscosity reading at least 5 percent lower than the previous viscosity reading.

high natural scrap tire crumb rubber: Material containing 40 to 48 percent natural rubber.

scrap tire crumb rubber: Any combination of vehicle tires or tire buffing.

37-2.04A(3) Submittals

At least 5 business days before use, submit the permit issued by the local air district for asphalt rubber binder field blending equipment and application equipment. If an air quality permit is not required by the local air district for producing asphalt rubber binder, submit verification from the local air district that an air quality permit is not required.

For each delivery of asphalt rubber binder ingredients to the job site, submit a certificate of compliance with a copy of the specified test results.

Submit a certified volume or weight slip for each delivery of asphalt rubber binder ingredients and asphalt rubber binder.

Submit a SDS for each asphalt rubber binder ingredient and the asphalt rubber binder.

At least 15 days before use, submit:

1. Samples of each asphalt rubber binder ingredient:
   1.1. 2 lbs of scrap tire crumb rubber
   1.2. 2 lbs of high natural scrap tire crumb rubber
   1.3. Two 1-quart cans of base asphalt binder
   1.4. Two 1-quart cans of asphalt modifier
2. Asphalt rubber binder formulation and data as follows:
   2.1. For asphalt modifier, include:
      2.1.1. Source of asphalt modifier
      2.1.2. Type of asphalt modifier
      2.1.3. Percentage of asphalt modifier by weight of asphalt binder
      2.1.4. Percentage of combined asphalt binder and asphalt modifier by weight of asphalt rubber binder
      2.1.5. Test results for the specified quality characteristics
   2.2. For crumb rubber modifier, include:
      2.2.1. Each source and type of scrap tire crumb rubber and high natural scrap tire crumb rubber
      2.2.2. Percentage of scrap tire crumb rubber and high natural scrap tire crumb rubber by total weight of asphalt rubber binder
      2.2.3. Test results for the specified quality characteristics
   2.3. For asphalt rubber binder, include minimum reaction time and temperature

Immediately after sampling, submit five 1-quart cans of asphalt rubber binder taken in the presence of the Engineer. Sample must be submitted in insulated shipping containers.

Submit notification 15 minutes before each viscosity test or submit a schedule of testing times.

Submit the log of asphalt rubber binder descending viscosity test results within 1 business day after sampling.

Submit asphalt rubber binder quality control viscosity test results within 1 business day after sampling.

37-2.04A(4) Quality Assurance

37-2.04A(4)(a) General

The equipment used in producing asphalt rubber binder and the equipment used in spreading asphalt rubber binder must be permitted for use or exempted by the local air district.

37-2.04A(4)(b) Quality Control

37-2.04A(4)(b)(i) General

Reserved

37-2.04A(4)(b)(ii) Asphalt Modifiers

For asphalt modifiers, the authorized laboratory must perform quality control sampling and testing at the specified frequency for the following quality characteristics:

Asphalt Modifier for Asphalt Rubber Binder

Quality characteristic	Test method	Frequency
Viscosity	ASTM D445	1 per shipment
Flash point	ASTM D92	
Molecular Analysis:		
Asphaltenes	ASTM D2007	1 per shipment
Aromatics	ASTM D2007	

37-2.04A(4)(b)(iii) Crumb Rubber Modifiers

Sample and test scrap tire crumb rubber and high natural scrap tire crumb rubber separately.

Perform quality control sampling and testing at the specified frequency for the following quality characteristics:

Crumb Rubber Modifier

Quality characteristic	Test method	Frequency
Scrap tire crumb rubber gradation	California Test 385	1 per 10,000
High natural scrap tire crumb rubber gradation	California Test 385	1 per 3,400 lb
Wire in CRM	California Test 385	1 per 10,000 lb
Fabric in CRM	California Test 385	
CRM particle length	--	
CRM specific gravity	California Test 208	
Natural rubber content in high natural scrap tire crumb rubber	ASTM D297	1 per 3,400 lb

37-2.04A(4)(b)(iv) Asphalt Rubber Binders

For asphalt rubber binders, the authorized laboratory must perform quality control sampling and testing at the specified frequency and location for the following quality characteristics:

Asphalt Rubber Binder Quality Control Requirements

Quality characteristic	Test method	Sampling location	Frequency
Descending viscosity[a] at 375 °F (Pa•s x 10^{-3})	ASTM D7741	Reaction vessel	1 per lot[b]
Viscosity at 375 °F (Pa•s x 10^{-3})	ASTM D7741	Distribution truck	15 minutes before use per lot[b]
Cone penetration at 25 °C (0.10 mm)	ASTM D217	Distribution truck	1 per lot[b]
Resilience at 25 °C (% rebound)	ASTM D5329		
Softening point (°C)	ASTM D36		

[a]Start taking viscosity readings at least 45 minutes after adding crumb rubber modifier and continue taking viscosity readings every 30 minutes until 2 consecutive descending viscosity readings have been obtained and the final viscosity complies with the specification requirement.
[b]A lot is defined in the *MPQP*.

Retain samples from each lot. Test samples for cone penetration, resilience, and softening point for the first 3 lots and if all 3 lots pass, the testing frequency may be reduced to once for every 3 lots.

If QC test results indicate that the asphalt rubber binder does not comply with the specifications, take corrective action and notify the Engineer.

37-2.04A(4)(c) Department Acceptance

37-2.04A(4)(c)(i) General

Reserved

37-2.04A(4)(c)(ii) Asphalt Modifiers

The Department accepts asphalt modifier based on compliance with the requirements shown in the following table:

Asphalt Modifier for Asphalt Rubber Binder

Quality characteristic	Test method	Requirement
Viscosity at 100 °C (m^2/s x 10^{-6})	ASTM D445	X ± 3[a]
Flash point (min, °C)	ASTM D92	207
Molecular Analysis:		
Asphaltenes (max, % by mass)	ASTM D2007	0.1
Aromatics (min, % by mass)	ASTM D2007	55

[a]The symbol "X" is the asphalt modifier viscosity.

37-2.04A(4)(c)(iii) Crumb Rubber Modifiers

Scrap tire CRM and high natural CRM are sampled and tested separately.

The Department accepts scrap tire CRM and high natural CRM based on compliance with the requirements shown in the following table:

Crumb Rubber Modifier for Asphalt Rubber Binder

Quality characteristic	Test method	Requirement
Wire in CRM (max, %)	California Test 385	0.01
Fabric in CRM (max, %)	California Test 385	0.05
CRM particle length (max, in)	--	3/16
CRM specific gravity	California Test 208	1.1–1.2
Natural rubber content in high natural CRM (%)	ASTM D297	40.0–48.0

The Department accepts CRM gradation based on the requirements shown in the following table:

Crumb Rubber Modifier Gradation Requirements

Quality characteristic	Test method	Requirement			
Gradation (% passing by weight) Sieve size:	California Test 385	Scrap tire crumb rubber		High natural scrap tire crumb rubber	
		Operating range	Contract compliance	Operating range	Contract compliance
No. 8		100	100	--	--
No. 10		95–100	90–100	100	100
No. 16		35–85	32–88	92–100	85–100
No. 30		2–25	1–30	25–95	20–98
No. 50		0–10	0–15	6–35	2–40
No. 100		0–5	0–10	0–7	0–10
No. 200		0–2	0–5	0–3	0–5

If a test result for CRM gradation does not comply with the specifications, the Department deducts the corresponding amount for each gradation test as shown in the following table:

Material	Gradation test result[a]	Deduction
Scrap tire crumb rubber	Operating range < TR < Contract compliance	$250
Scrap tire crumb rubber	TR > Contract compliance	$1,100
High natural scrap tire crumb rubber	Operating range < TR < Contract compliance	$250
High natural scrap tire crumb rubber	TR > Contract compliance	$600

[a]Test Result = TR

Each gradation test for scrap tire crumb rubber represents 10,000 lb or the quantity used in that day's production, whichever is less.

Each gradation test for high natural scrap tire crumb rubber represents 3,400 lb or the quantity used in that day's production, whichever is less.

37-2.04A(4)(c)(iv) Asphalt Rubber Binders

For Department acceptance testing, take a sample of asphalt rubber binder in the Engineer's presence every 5 lots or once a day, whichever is greater. Each sample must be in five 1-quart cans with an open top and friction lid.

For an asphalt rubber binder, acceptance is based on the Department’s sampling and testing for compliance with the requirements shown in the following table:

Asphalt Rubber Binder

Quality characteristic	Test method	Requirement
Cone penetration at 25 °C (0.10 mm)	ASTM D217	25–60
Resilience at 25 °C (% rebound)	ASTM D5329	18–50
Softening point (°C)	ASTM D36	55–88
Viscosity at 375 °F (Pa•s x 10^{-3})[a]	ASTM D7741	1,500–2,500

[a]Prepare sample for viscosity test under California Test 388.

37-2.04A(4)(c)(v) Precoated Aggregate

The Department accepts precoated aggregate based on compliance with the requirements shown in the following table:

Precoated Aggregate Gradation Acceptance Criteria

Quality Characteristic	Test method	Requirement
1/2" gradation (% passing by weight) Sieve size:	California Test 202	
3/4"		100
1/2"		85–90
3/8"		0–30
No. 4		0–5
No. 8		--
No. 200		0–1
3/8" gradation (% passing by weight) Sieve size:	California Test 202	
3/4"		100
1/2"		95–100
3/8"		70–85
No. 4		0–15
No. 8		0–5
No. 200		0–1

37-2.04B Materials

37-2.04B(1) General

Reserved

37-2.04B(2) Asphalt Binders

Asphalt binder used as the base binder for asphalt rubber binder must comply with the specifications for asphalt binder. Do not modify asphalt binder with polymer.

37-2.04B(3) Asphalt Modifiers

An asphalt modifier must be a resinous, high flash point, and aromatic hydrocarbon. An asphalt modifier must comply with the requirements shown in the following table:

Asphalt Modifier for Asphalt Rubber Binder

Quality characteristic	Test method	Requirement
Viscosity at 100 °C (m^2/s x 10^{-6})	ASTM D445	X ± 3[a]
Flash point (min, CL.O.C., °C)	ASTM D92	207
Molecular analysis:		
Asphaltenes by mass (max, %)	ASTM D2007	0.1
Aromatics by mass (min, %)	ASTM D2007	55

[a]*X* denotes the proposed asphalt modifier viscosity from 19 to 36. A change in *X* requires a new asphalt rubber binder submittal.

37-2.04B(4) Crumb Rubber Modifiers

The CRM to be used must be on the Authorized Materials List for crumb rubber modifier.

The CRM must be ground or granulated at ambient temperature.

Scrap tire crumb rubber and high natural scrap tire crumb rubber must be delivered to the asphalt rubber binder production site in separate bags.

Steel and fiber must be separated. If steel and fiber are cryogenically separated, it must occur before grinding and granulating. Cryogenically-produced CRM particles must be large enough to be ground or granulated.

The CRM must be dry, free-flowing particles that do not stick together. A maximum of 3 percent calcium carbonate or talc by weight of CRM may be added. The CRM must not cause foaming when combined with the asphalt binder and asphalt modifier.

The CRM must comply with the requirements shown in the following table:

Crumb Rubber Modifier for Asphalt Rubber Binder

Quality characteristic	Test method	Requirement
Wire in CRM (max, %)	California Test 385	0.01
Fabric in CRM (max, %)	California Test 385	0.05
CRM particle length (max, in)	--	3/16
CRM specific gravity	California Test 208	1.1–1.2

The CRM must comply with the requirements shown in the following table:

Crumb Rubber Modifier Requirements

Quality characteristic	Test method	Requirement	
		Scrap tire crumb rubber	High natural scrap tire crumb rubber
Acetone extract (%)	ASTM D297	6.0–16.0	4.0–16.0
Rubber hydrocarbon (min, %)		42.0–65.0	50.0
Natural rubber content (%)		22.0–39.0	40.0–48.0
Carbon black content (%)		28.0–38.0	--
Ash content (max, %)		8.0	--

Scrap tire crumb rubber gradation must comply with the gradation requirements shown in the following table:

Scrap Tire Crumb Rubber Gradation

Quality characteristic	Test method	Requirement		
Gradation (% passing by weight) Sieve size:	California Test 385	Gradation limit	Operating range	Contract compliance
No. 8		100	100	100
No. 10		98–100	95–100	90–100
No. 16		45–75	35–85	32–88
No. 30		2–20	2–25	1–30
No. 50		0–6	0–10	0–15
No. 100		0–2	0–5	0–10
No. 200		0	0–2	0–5

High natural scrap tire crumb rubber gradation must comply with the gradation requirements shown in the following table:

High Natural Scrap Tire Crumb Rubber Gradation

Quality characteristic	Test method	Requirement		
Gradation (% passing by weight) Sieve size:	California Test 385	Gradation limit	Operating range	Contract compliance
No. 10		100	100	100
No. 16		95–100	92–100	85–100
No. 30		35–85	25–95	20–98
No. 50		10–30	6–35	2–40
No. 100		0–4	0–7	0–10
No. 200		0–1	0–3	0–5

37-2.04B(5) Asphalt Rubber Binders

An asphalt rubber binder must be a combination of:

1. Asphalt binder
2. Asphalt modifier
3. Crumb rubber modifier

Asphalt rubber binder blending equipment must be authorized under the Department's *MPQP*.

The blending equipment must allow the determination of weight percentages of each asphalt rubber binder ingredient.

An asphalt rubber binder must be 79 ± 1 percent by weight asphalt binder and 21 ± 1 percent by weight of CRM. The minimum percentage of CRM must be 20.0 percent and lower values must not be rounded up.

The CRM must be 75 ± 2 percent by weight scrap tire crumb rubber and 25 ± 2 percent by weight high natural scrap tire crumb rubber.

An asphalt modifier and asphalt binder must be blended at the production site. An asphalt modifier must be from 2.5 to 6.0 percent by weight of the asphalt binder in the asphalt rubber binder. The asphalt rubber binder supplier determines the exact percentage.

If blended before adding CRM, the asphalt binder must be from 375 to 440 degrees F when an asphalt modifier is added and the mixture must circulate for at least 20 minutes. An asphalt binder, asphalt modifier, and CRM may be proportioned and combined simultaneously.

The blend of an asphalt binder and an asphalt modifier must be combined with the CRM at the asphalt rubber binder production site. The asphalt binder and asphalt modifier blend must be from 375 to 440 degrees F when the CRM is added. Combined ingredients must be allowed to react at least 45 minutes at temperatures from 375 to 425 degrees F except the temperature must be at least 10 degrees F below the flash point of the asphalt rubber binder.

After reacting, the asphalt rubber binder must comply with the requirements shown in the following table:

Asphalt Rubber Binder

Quality characteristic	Test method	Requirement
Cone penetration at 25 °C (0.10 mm)	ASTM D217	25–60
Resilience at 25 °C (% rebound)	ASTM D5329	18–50
Softening point (°C)	ASTM D36	55–88
Viscosity at 375 °F (Pa•s x 10^{-3})[a]	ASTM D7741	1,500–2,500

[a]Prepare sample for viscosity test under California Test 388.

Maintain asphalt rubber binder at a temperature from 375 to 415 degrees F.

Stop heating unused asphalt rubber binder 4 hours after the 45-minute reaction period. Reheating asphalt rubber binder that cools below 375 degrees F is a reheat cycle. Do not exceed 2 reheat cycles. If reheating, the asphalt rubber binder must be from 375 to 415 degrees F before use.

During reheating, you may add CRM. The CRM must not exceed 10 percent by weight of the asphalt rubber binder. Allow added CRM to react for at least 45 minutes. Reheated asphalt rubber binder must comply with the specifications for asphalt rubber binder.

37-2.04B(6) Precoated Aggregate

Before precoating with asphalt binder, aggregate for an asphalt rubber binder chip seal must comply with the gradation requirements shown in the following table:

Asphalt Rubber Binder Chip Seal Aggregate Gradation

Quality characteristic	Test method	Requirement	
Gradation (% passing by weight) Sieve size:	California Test 202	1/2"	3/8"
3/4"		100	100
1/2"		85–90	95–100
3/8"		0–30	70–85
No. 4		0–5	0–15
No. 8		--	0–5
No. 200		0–1	0–1

37-2.04C Construction

37-2.04C(1) General

Reserved

37-2.04C(2) Equipment

Distributor trucks must be equipped with:

1. Mixing and heating unit
2. Observation platform on the rear of the truck for an observer on the platform to see the nozzles and unplug them if needed

37-2.04C(3) Asphalt Rubber Binder Application

Apply the asphalt rubber binder when the ambient temperature is from 60 to 105 degrees F and the pavement surface temperature is at least 55 degrees F.

Do not apply the asphalt rubber binder unless enough aggregate is available at the job site to cover the asphalt rubber binder within 2 minutes. Intersections, turn lanes, gore points, and irregular areas must be covered within 15 minutes.

Do not apply asphalt rubber binder when pavement is damp or during high wind conditions. If authorized, you may adjust the distributor bar height and distribution speed and use shielding equipment during high wind conditions.

When applied, the temperature of the asphalt rubber binder must be from 385 to 415 degrees F.

Apply the asphalt rubber binder at a rate from 0.55 to 0.65 gal/sq yd. You may reduce the application rate by 0.050 gal/sq yd in the wheel paths.

37-2.04C(4) Precoated Aggregate Spreading

Spread aggregate at a rate from 28 to 40 lb/sq yd. Do not spread aggregate more than 200 feet ahead of the completed initial rolling.

37-2.04C(5) Rolling and Sweeping

Perform initial rolling within 90 seconds of spreading aggregate. If authorized for final rolling, you may use a steel-wheeled roller weighing from 8 to 10 tons in static mode only.

Perform a final sweeping before Contract acceptance. The final sweeping must not dislodge aggregate.

37-2.04D Payment

Asphalt rubber binder is measured as specified for asphalt binder.

37-2.05 STRESS ABSORBING MEMBRANE INTERLAYERS

37-2.05A General

Section 37-2.05 includes specifications for placing stress absorbing membrane interlayers (SAMI).

Comply with section 37-2.04 except a flush coat is not required.

Traffic must not be allowed on a SAMI.

37-2.05B Materials

For a SAMI, aggregate must comply with the 3/8-inch gradation.

37-2.05C Construction

If a SAMI is overlaid in the same work shift, section 37-2.01C(4)(e) does not apply.

Final sweeping is not required for a SAMI.

37-2.05D Payment

Not Used

37-2.06 MODIFIED ASPHALT BINDER CHIP SEALS

Reserved

37-2.07 SCRUB SEALS

Reserved

37-3 SLURRY SEALS AND MICRO-SURFACINGS

37-3.01 GENERAL

37-3.01A General

37-3.01A(1) Summary

Section 37-3.01 includes general specifications for applying slurry seals and micro-surfacings.

37-3.01A(2) Definitions

Reserved

37-3.01A(3) Submittals

At least 15 days before starting placement of a slurry seal or micro-surfacing, submit:

1. Samples for:
   - 1.1. Asphaltic emulsion slurry seal, two 1-quart wide mouth plastic containers with screw top lid of asphaltic emulsion
   - 1.2 Polymer modified asphaltic emulsion slurry seal, two 1-quart wide mouth plastic containers with screw top lid of polymer modified asphaltic emulsion
   - 1.3. Micro-surfacing, two 1-quart wide mouth plastic containers with screw top lid of micro-surfacing emulsion
2. Asphaltic emulsion, polymer modified asphaltic emulsion, or micro-surfacing emulsion data as follows:
   - 2.1. Supplier and Type/Grade of asphaltic emulsion
   - 2.2. Type of modifier polymer for polymer modified asphaltic emulsion or micro-surfacing emulsion
   - 2.3. Copy of the specified test results for asphaltic emulsion, polymer modified asphaltic emulsion, or micro-surfacing emulsion
3. 50 lb of aggregate
4. Aggregate test results for the followings:
   - 4.1. Gradation
   - 4.2. Los Angeles Rattler
   - 4.3. Percent of crushed particles

4.4 Sand equivalent
4.5 Durability

At least 10 days before starting placement of a slurry seal or micro-surfacing, submit a laboratory report of test results and the proposed mix design from an authorized laboratory. The authorized laboratory must sign the laboratory report and mix design.

The report must include:

1. Test results used in the mix design compared with specification requirements
2. Proportions based on the dry weight of aggregate, including ranges, for:
   2.1. Aggregate
   2.2. Water
   2.3. Additives
   2.4. Mineral filler
   2.5. Slurry seal emulsion or micro-surfacing emulsion residual asphalt content
3. Recommended changes to the proportions based on heating the mixture to 100 degrees F and mixing for 60 seconds, if atmospheric temperatures during application will be 90 degrees F or above, for:
   3.1. Water
   3.2. Additives
   3.3. Mineral filler
4. Quantitative moisture effects on the aggregate's unit weight determined under ASTM C29M

If the mix design consists of the same materials covered by a previous laboratory report, you may submit the previous laboratory report that must include material testing data performed within the previous 12 months for authorization.

If you change any of the materials in the mix design, submit a new mix design and laboratory report at least 10 days before starting slurry seal or micro-surfacing work.

Submit a certificate of compliance as specified for asphaltic emulsion in section 94-1.01C with each shipment of asphaltic emulsion, polymer modified asphaltic emulsion or micro-surfacing emulsion.

Submit quality control test results for the quality characteristics within the reporting times allowance after sampling shown in the following table:

Quality Control Test Reporting Requirements

Quality characteristic	Maximum reporting time allowance
Los Angeles Rattler loss (max, %)	2 business days
Percent of crushed particles (min, %)	2 business days
Durability (min)	2 business days
Resistance of fine aggregate to degradation by abrasion in the Micro-Deval Apparatus (% loss by weight)	2 business days
Gradation (% passing by weight)	48 hours
Sand equivalent (min)	48 hours
Moisture content (%)	48 hours

Within 3 days after taking asphaltic emulsion, polymer modified asphaltic emulsion or micro-surfacing emulsion quality control samples, submit the authorized laboratory's test results.

37-3.01A(4) Quality Assurance

37-3.01A(4)(a) General

Your authorized laboratory must be able to perform International Slurry Surfacing Association tests and mix design.

37-3.01A(4)(b) Quality Control

37-3.01A(4)(b)(i) General

Reserved

37-3.01A(4)(b)(ii) Aggregate

For aggregate, the authorized laboratory must perform sampling and testing at the specified frequency and location for the following quality characteristics:

Aggregate Quality Control

Quality characteristic	Test method	Minimum sampling and testing frequency	Location of sampling
Los Angeles Rattler loss (max, %) At 500 revolutions	California Test 211	1st day of production	See California Test 125
Percent of crushed particles (min, %)	AASHTO T 335	1st day of production	See California Test 125
Sand equivalent (min)	California Test 217	1 per working stockpile per day	See California Test 125
Resistance of fine aggregate to degradation by abrasion in the Micro-Deval Apparatus (% loss by weight)	ASTM D7428	1 per working stockpile per day	See California Test 125
Gradation (% passing by weight)	California Test 202	1 per working stockpile per day	See California Test 125
Moisture content, from field stockpile (%)	AASHTO T 255[a]	1 per working stockpile per day	See California Test 125

[a]Test aggregate moisture at field stockpile every 2 hours if you are unable to maintain the moisture content to within a maximum daily variation of ±0.5 percent.

37-3.01A(4)(b)(iii) Slurry Seals and Micro-surfacings

Reserved

37-3.01A(4)(c) Department Acceptance

Slurry Seal and micro-surfacing acceptance is based on:

1. Visual inspection for the following:
   - 1.1. Uniform surface texture throughout the work limits.
   - 1.2. Marks in the surface:
     - 1.2.1. Up to 4 marks in the completed slurry seal or micro-surfacing surface that are up to 1 inch wide and up to 6 inches long per 1000 square feet of slurry seal or micro-surfacing placed.
     - 1.2.2. No marks in the completed slurry seal or micro-surfacing surface that are over 1 inch wide or 6 inches long.
   - 1.3. Excessive raveling consisting of the separation of the aggregate from the asphaltic emulsion, polymer modified asphaltic emulsion or micro-surfacing emulsion.
   - 1.4. Bleeding consists of the occurrence of a film of asphaltic material on the surface of the slurry seal or micro-surfacing.
   - 1.5. Delaminating of slurry seal or micro-surfacing from the existing pavement.
   - 1.6. Rutting or wash-boarding.
2. Department's sampling and testing for compliance with the requirements for aggregate shown in the following table:

Aggregate Gradation Acceptance Criteria

Quality characteristic	Test method	Requirements		
Gradation (% passing by weight) Sieve Size:	California Test 202	Type I	Type II	Type III
3/8"		--	100	100
No. 4		100	94–100	70–90
No. 8		90–100	65–90	45–70
No. 16		60–90	40–70	28–50
No. 30		40–65	25–50	19–34
No. 200		10–20	5–15	5–15

An aggregate gradation test represents 300 tons or 1 day's production, whichever is less.

If test results for aggregate gradation do not comply with the specifications, you may remove the slurry seal or micro-surfacing represented by the test results or request it remain in place with a payment deduction. If your request is authorized, the Department deducts:

1. $1.75 per ton of slurry seal for each noncompliant aggregate gradation
2. $2.00 per ton of micro-surfacing for each noncompliant aggregate gradation

37-3.01B Materials

37-3.01B(1) General

Additional water must not cause separation of the asphaltic emulsion, polymer modified asphaltic emulsion or micro-surfacing emulsion from the aggregate before placement.

You may use an additive that does not adversely affect the slurry seal or micro-surfacing.

37-3.01B(2) Aggregate

Aggregate must be rock dust. Aggregate must be free from vegetable matter, deleterious substances, caked or clay lumps, and oversized particles.

Aggregate for a slurry seal and micro-surfacing must comply with the gradations shown in the following table:

Aggregate Gradation

Quality characteristic	Test method	Requirements		
Gradation (% passing by weight) Sieve size:	California Test 202	Type I	Type II	Type III
3/8"		--	100	100
No. 4		100	94–100	70–90
No. 8		90–100	65–90	45–70
No. 16		60–90	40–70	28–50
No. 30		40–65	25–50	19–34
No. 200		10–20	5–15	5–15

37-3.01C Construction

37-3.01C(1) General

Before applying slurry seals or micro-surfacings, cover manholes, valve and monument covers, grates, and other exposed facilities located within the area of application using plastic or oil resistant construction paper secured by tape or adhesive to the facility being covered. Reference the covered facilities with enough control points to relocate the facilities after application of the slurry seals or micro-surfacings.

37-3.01C(2) Proportioning

Proportion slurry seal and micro-surfacing ingredients in compliance with the authorized mix design.

37-3.01C(3) Mixing and Spreading Equipment

37-3.01C(3)(a) General

Mixing and spreading equipment for slurry seals and micro-surfacings must proportion the asphaltic emulsions, water, aggregate, and any additives by volume and mix them in continuous pug mill mixers.

Introduce emulsions into the mixer with a positive displacement pump. If you use a variable-rate pump, the adjusting unit must be sealed in its calibrated position.

Introduce water into the mixer through a meter that measures gallons.

Choose a truck mounted mixer-spreader or continuous self-loading mixer spreader.

37-3.01C(3)(b) Truck Mounted Mixer Spreaders

Truck mounted mixer spreaders must comply with:

1. Rotating and reciprocating equipment must be covered with metal guards.
2. Proportion aggregate using a belt feeder with an adjustable cutoff gate. The Engineer verifies the height of the gate opening.
3. Belt feeder must have a depth monitor device. The depth monitor device must automatically shut down power to the belt feeder when the aggregate depth is less than 70 percent of the target depth.
4. Separate monitor device must detect the revolutions of the belt feeder. This device must automatically shut down power to the belt feeder if it detects no revolutions. If the belt feeder is an integral part of the equipment's drive chain, the monitor device is not required.
5. Aggregate belt feeder must be connected directly to the drive on the emulsion pump. The aggregate feeder drive shaft must have a revolution counter reading the nearest 0.10 revolution for micro-surfacing, and nearest 1 revolution for slurry seal.
6. Emulsion storage must be equipped with a device that automatically shuts down power to the emulsion pump and aggregate belt feeder when the level of stored emulsion is lowered. To allow for normal fluctuations, there may be a delay of 3 seconds between detection of low emulsion storage levels or low aggregate depths and automatic power shut down.
7. Emulsion storage must be located immediately before the emulsion pump.
8. Emulsion storage tank must have a temperature indicator at the pump suction level. The indicator must be accurate to ±5 degrees F.
9. No-flow and revolution warning devices must be in working condition. Low-flow indicators must be visible while walking alongside the equipment.

37-3.01C(3)(c) Continuous Self-Loading Mixer Spreaders

Continuous self-loading mixer spreaders must be automatically sequenced and self-propelled. The mixing machine must deliver each material to a double shafted mixer and discharge the mixed material on a continuous flow basis. The mixing machines must have sufficient storage capacity to maintain a continuous supply of material to the proportioning controls. The mixing machine operators must have full control of forward and reverse speeds during placement.

37-3.01C(3)(d) Spreader Boxes

The spreader boxes used to spread slurry seals and micro-surfacings must be:

1. Capable of spreading the slurry seal or micro-surfacing a minimum of 12 feet wide and preventing the loss of slurry seal or micro-surfacing.
2. Equipped with flexible rubber belting on each side. The belting must contact the pavement to prevent the loss of slurry seal or micro-surfacing from the box.
3. Equipped to uniformly apply the slurry seal or micro-surfacing on superelevated sections and shoulder slopes. Micro-surfacing spreader box must be equipped with reversible motor driven augers.
4. Equipped with a series of strike-off devices at its rear.
   - 4.1. The leading strike off device must be:
     - 4.1.1. Fabricated of a suitable material such as steel or stiff rubber
     - 4.1.2. Designed to maintain close contact with the pavement during spreading
     - 4.1.3. Capable of obtaining the specified thickness
     - 4.1.4. Capable of being adjusted to the various pavement cross sections
   - 4.2. The final strike-off device must be:
     - 4.2.1. Fabricated of flexible material that produces a uniform texture in the finished surface

4.2.2. Cleaned daily and changed if longitudinal scouring occurs in the slurry seal of micro-surfacing

5. Clean and free of slurry seal or micro-surfacing at the start of each work shift.

37-3.01C(3)(e) Shoulder Equipment

Spread the slurry seal or micro-surfacing on shoulders with a device such as an edge box that forms clean and straight joints and edges.

37-3.01C(3)(f) Equipment Calibration

Equipment calibration must comply with the *MPQP*. Notify the Engineer at least 5 business days before calibrating.

If the Department authorizes a truck or continuous mixer spreader, its calibration is valid for 6 months provided you:

1. Use the same truck or continuous mixer spreader verified with a unique identifying number
2. Use the same materials in compliance with the authorized mix design
3. Do not perform any repair or alteration to the proportioning systems

Calibrate the adjustable cut-off gate settings of each truck or continuous mixer spreader on the project to achieve the correct delivery rate of aggregate and emulsion per revolution of the aggregate feeder under the *MPQP*.

Checks must be performed for each aggregate source using an authorized vehicle scale.

Individual checks of the aggregate belt feeder's delivery rate to the pug mill mixer must not vary more than 2 percent from the average of 3 runs of at least 3 tons each.

Before using a variable-rate emulsion pump, the pump must be calibrated and sealed in the calibrated condition under the *MPQP*.

Individual checks of the emulsion pump's delivery rate to the pug mill mixer must not vary more than 2 percent from the average of 3 runs of at least 500 gal each.

37-3.01C(4) Surface Preparation

Immediately before applying slurry seals or micro-surfacings, clean the surface to receive slurry seals or micro-surfacings by removing any extraneous material affecting adhesion of the slurry seal or micro-surfacing with the existing surface. Use self-propelled power brooms or other methods such as flushing to clean the existing pavement.

37-3.01C(5) Placement

37-3.01C(5)(a) General

If truck-mounted mixer-spreaders are used, keep at least 2 operational spreaders at the job site during placement.

Spread slurry seals and micro-surfacings uniformly and do not spot, rehandle, or shift the mixture. However in areas inaccessible to spreading equipment, spread the slurry seal or micro-surfacing mixtures with hand tools or other authorized methods. If placing with hand tools, lightly dampen the area first.

You may fog the roadway surface with water ahead of the spreader box. The fog spray must be adjusted for pavement:

1. Temperature
2. Surface texture
3. Dryness

You determine the application rates for slurry seals or micro-surfacings and the Engineer authorizes the application rates. Spread within 10 percent of authorized rate.

The mixtures must be uniform and homogeneous after spreading, and there must not be separation of the emulsion and aggregate after setting.

37-3.01C(5)(b) Weather Conditions

Only place slurry seals or micro-surfacings if both the pavement and air temperatures are at least 50 degrees F and rising. The expected high temperature must be at least 65 degrees F within 24 hours after placement.

Do not place slurry seals or micro-surfacings if rain is imminent or the air temperature is expected to be below 36 degrees F within 24 hours after placement.

37-3.01C(5)(c) Joints

Transverse and longitudinal joints must be:

1. Uniform
2. Straight
3. Neat in appearance
4. Without material buildup
5. Without uncovered areas

Transverse joints must be butt-type joints.

Prevent double placement at transverse joints over previously placed slurry seals or micro-surfacings.

Place longitudinal joints:

1. On centerlines, lane lines, edge lines, or shoulder lines
2. With overlaps not more than 4 inches

You may request other longitudinal joint patterns if they do not adversely affect the slurry seals or micro-surfacings.

The maximum difference between the pavement surface and the bottom edge of a 12-foot straightedge placed perpendicular to the longitudinal joint must be 0.04 foot.

37-3.01C(5)(d) Finished Surfaces

Finished slurry seals or micro-surfacings must be smooth and free of irregularities such as scratch or tear marks. You may leave up to 4 marks that are up to 1 inch wide and 6 inches long per 75 linear feet of slurry seal or micro-surfacing placed. Do not leave any marks that are over 1 inch wide or 6 inches long.

37-3.01C(5)(e) Maintenance Sweeping

Sweep the slurry seals or micro-surfacings 24 hours after placement without damaging the slurry seals or micro-surfacings. For 4 days afterwards, sweep the slurry seals or micro-surfacings daily unless determined otherwise by the Engineer.

37-3.01C(5)(f) Repair of Early Distress

The slurry seals or micro-surfacings must not show bleeding, raveling, separation, or other distresses for 15 days after placing. If bleeding, raveling, delaminating, rutting, or wash-boarding occurs after placing the slurry seals or micro-surfacings, make repairs using an authorized method.

37-3.01D Payment

Not Used

37-3.02 SLURRY SEALS

37-3.02A General

37-3.02A(1) Summary

Section 37-3.02 includes specifications for applying slurry seals.

Applying a slurry seal consists of spreading a mixture of asphaltic emulsion or polymer modified asphaltic emulsion, aggregate, additives, and water on a surface or pavement.

37-3.02A(2) Definitions

Reserved

37-3.02A(3) Submittals

Immediately after sampling, submit two 1-quart wide mouth plastic containers of asphaltic emulsion or polymer modified asphaltic emulsion taken in the presence of the Engineer. Samples must be submitted in insulated shipping containers.

37-3.02A(4) Quality Assurance

37-3.02A(4)(a) General

Reserved

37-3.02A(4)(b) Quality Control

37-3.02A(4)(b)(i) General

Take samples of asphaltic emulsion and polymer modified asphaltic emulsion from the tank truck at mid load or from a sampling tap or thief. Before taking samples, draw and dispose of 1 gallon. In the presence of the Engineer take two 1-quart samples in wide mouth plastic containers with lined, sealed lids for acceptance testing.

37-3.02A(4)(b)(ii) Asphaltic Emulsion

For asphaltic emulsions, the authorized laboratory must perform quality control sampling and testing at the specified frequency and location for the following quality characteristics:

Asphaltic Emulsion

Quality characteristic	Test method	Minimum sampling and testing frequency	Sampling location
Saybolt Furol Viscosity, at 25 °C (Saybolt Furol seconds)	AASHTO T 59	Minimum 1 per day per delivery truck	Delivery truck
Sieve Test (%)			
Storage stability, 1 day (%)			
Residue by distillation (%)			
Particle charge[a]			
Tests on Residue from Distillation Test:			
Penetration, 25 °C	AASHTO T 49	Minimum 1 per day per delivery truck	Delivery truck
Ductility	AASHTO T 51		
Solubility in tricloroethylene	AASHTO T 44		

[a]If the result of the particle charge is inconclusive, the asphaltic emulsion must be tested for pH under ASTM E70. Grade QS1h asphaltic emulsion must have a minimum pH of 7.3. Grade CQS1h asphaltic emulsion must have a maximum pH of 6.7.

37-3.02A(4)(b)(iii) Polymer Modified Asphaltic Emulsion

For polymer modified asphaltic emulsions, the authorized laboratory must perform quality control sampling and testing at the specified frequency and location for the following quality characteristics:

Polymer Modified Asphaltic Emulsion

Quality characteristic	Test method	Minimum sampling and testing frequency	Sampling Location
Tests on emulsion:			
Saybolt Furol Viscosity at 25 °C (Saybolt Furol seconds)	AASHTO T 59	Minimum 1 per day per delivery truck	Delivery truck
Sieve test (%)	AASHTO T 59		
Storage stability after 1 day (%)	AASHTO T 59		
Residue by evaporation (min, %)	California Test 331		
Particle charge	AASHTO T 59		
Tests on residue by evaporation:			
Penetration at 25 °C	AASHTO T 49	Minimum 1 per day per delivery truck	Delivery truck
Ductility at 25 °C (min, mm)	AASHTO T 51		
Torsional recovery (min, %) Or Polymer content based on residual asphalt (min, %)	California Test 332 California Test 401		

37-3.02A(4)(c) Department Acceptance

For a slurry seal asphaltic emulsion and polymer modified asphaltic emulsion, acceptance is based on the Department's sampling and testing for compliance with the requirements for the quality characteristics specified.

Aggregate acceptance is based on the Department's sampling and testing for compliance with the requirements shown in the following table:

Aggregate Acceptance Criteria

Quality characteristic	Test method	Requirement
Los Angeles Rattler loss (max, %) At 500 revolutions	California Test 211[a]	35
Percent of crushed particles (min, %)	California Test 205	95
Durability (min)	California Test 229	55
Sand equivalent (min) Type I Type II Type III	California Test 217	 45 55 60

[a]California Test 211 must be performed on the source aggregate before crushing.

A sand equivalent test represents 300 tons or 1 day's production, whichever is less.

If test results for sand equivalent do not comply with the specifications, you may remove the slurry seal represented by the test results or request it remain in place with a payment deduction. If your request is authorized, the Department deducts $1.75 per ton of slurry seal for each noncompliant sand equivalent test.

37-3.02B Materials

37-3.02B(1) General

Reserved

37-3.02B(2) Asphaltic Emulsions

An asphaltic emulsion must comply with the requirements in Section 94. The asphaltic emulsion must be Grade CQS1h.

37-3.02B(3) Polymer Modified Asphaltic Emulsions

A polymer modified asphaltic emulsion must:

1. Consist of an elastomeric polymer mixed with an asphaltic material uniformly emulsified with water and an emulsifying or stabilization agent.
2. Use either neoprene polymer or butadiene and styrene copolymer. The polymer must be homogeneous and milled into the asphaltic emulsion at the colloid mill.
3. Be Grade PMCQS1h and must comply with the requirements shown in the following table:

Polymer Modified Asphaltic Emulsion Requirements

Quality characteristic	Test method	Requirement
Tests on emulsion:		
Saybolt Furol Viscosity at 25 °C (Saybolt Furol seconds)	AASHTO T 59	15–90
Sieve test (%)	AASHTO T 59	0–0.3
Storage stability after 1 day (%)	AASHTO T 59	0–1
Residue by evaporation (min, %)	California Test 331	60
Particle charge	AASHTO T 59	Positive
Tests on residue by evaporation:		
Penetration at 25 °C	AASHTO T 49	40–90
Ductility at 25 °C (min, mm)	AASHTO T 51	400
Torsional recovery (min, %) Or Polymer content based on residual asphalt (min, %)	California Test 332 California Test 401	18 2.5

37-3.02B(4) Aggregate

Aggregate must comply with the quality characteristic requirements shown in the following table:

Aggregate Requirements

Quality characteristic	Test method	Requirement
Los Angeles Rattler loss (max, %) At 500 revolutions	California Test 211[a]	 35
Percent of crushed particles (min, %)	California Test 205	95
Durability (min)	California Test 229	55
Sand equivalent (min) Type I Type II Type III	California Test 217	 45 55 60

[a]California Test 211 must be performed on the source aggregate before crushing. The aggregate supplier must certify that the crushed aggregate being used on the project is manufactured from the source aggregate complying with the LA rattler requirements.

37-3.02B(5) Slurry Seal Mix Design

The slurry seal mix design, using project source aggregate, an asphaltic emulsion, and set-control agents if any, must comply with the requirements shown in the following table:

Slurry Seal Mix Design Requirements

Quality characteristic	Test method[a]	Requirement
Consistency (max, mm)	Technical Bulletin 106	30
Wet stripping	Technical Bulletin 114	Pass
Compatibility	Technical Bulletin 115	Pass[b]
Cohesion test, within 1 hour (min, kg-mm)	Technical Bulletin 139	200
Wet track abrasion (max, g/m^2)	Technical Bulletin 100	810

[a]Test methods are by the International Slurry Surfacing Association.
[b]Mixing test must pass at the maximum expected air temperature at the job site during placement.

The mix design must have the percent of asphaltic residue, based on percentage by weight of the dry aggregate, within the ranges shown in the following table:

Slurry seal type	Residue range
Type I	10–16
Type II	7.5–13.5
Type III	6.5–12.0

Determine the exact percentage based on the design asphalt binder content and the asphalt residual content of the asphaltic emulsion furnished.

37-3.02C Construction

37-3.02C(1) General

Reserved

37-3.02C(2) Proportioning

After proportioning, slurry seal mixtures must be workable.

37-3.02C(3) Mixing and Spreading Equipment

Reserved

37-3.02C(4) Placement

The slurry seal spread rates must be within the ranges shown in the following table:

Slurry Seal Spread Rates

Slurry seal type	Application range (lb of dry aggregate/sq yd)
Type I	8–12
Type II	10–18
Type III	20–25

Within 4 hours after placement, slurry seals must be set enough to allow traffic without pilot cars. Protect slurry seals from damage until it has set and will not adhere or be picked up by vehicle tires. Slurry seals must not exhibit distress from traffic such as bleeding, raveling, separation or other distresses.

37-3.02D Payment

The payment quantity for slurry seal is the weight determined by combining the weights of the aggregate and asphaltic emulsion or polymeric asphaltic emulsion. The payment quantity for slurry seal does not include the weights of the added water and set-control additives.

37-3.03 MICRO-SURFACINGS

37-3.03A General

37-3.03A(1) Summary

Section 37-3.03 includes specifications for applying micro-surfacings.

Applying a micro-surfacing consists of spreading a mixture of a micro-surfacing emulsion, water, additives, mineral filler, and aggregate on the pavement.

37-3.03A(2) Definitions

Reserved

37-3.03A(3) Submittals

Immediately after sampling, submit two 1-quart wide mouth plastic containers of micro-surfacing emulsion taken in the presence of the Engineer. Samples must be submitted in insulated shipping container.

37-3.03A(4) Quality Assurance

37-3.03A(4)(a) General

Reserved

37-3.03A(4)(b) Quality Control

37-3.03A(4)(b)(i) General

Reserved

37-3.03A(4)(b)(ii) Micro-surfacing Emulsions

Take samples from the truck tank at mid load from a sampling tap or thief. Before taking samples, draw and dispose of 1 gallon. In the presence of the Engineer, take two 1-quart wide mouth plastic containers for acceptance testing.

For a micro-surfacing emulsion, the authorized laboratory must perform quality control sampling and testing at the specified frequency and location for the quality characteristics shown in the following table:

Micro-Surfacing Emulsion

Quality characteristic	Test method	Minimum sampling and testing frequency	Sampling location
Tests on emulsion:			
Saybolt Furol Viscosity, at 25°C (Saybolt Furol seconds)	AASHTO T 59	Minimum 1 per day per delivery truck	Delivery truck
Storage stability, 1 day (max, %)[a]			
Sieve test (max, %)			
Residue by evaporation (min, %)	California Test 331	Minimum 1 per day per delivery truck	Delivery truck
Tests on residue from evaporation test:			
Penetration at 25 °C	AASHTO T 49	Minimum 1 per day per delivery truck	Delivery truck
Softening point (min, ºC)	AASHTO T 53		

[a]Storage stability test will be run if the storage exceeds 48 hours

37-3.03A(4)(c) Department Acceptance

For micro-surfacing emulsions, acceptance is based on the Department's sampling and testing for compliance with the requirements shown in the following table:

Micro-surfacing Emulsion Acceptance Criteria

Quality characteristic	Test method	Requirement
Tests on emulsion:		
Saybolt Furol Viscosity at 25 °C (Saybolt Furol seconds)	AASHTO T 59	15–90
Sieve test (%)	AASHTO T 59	0.30
Storage stability, 1 day (max, %)	AASHTO T 59	0–1
Settlement[a], 5 days (max, %)	ASTM D244	5
Residue by evaporation (min, %)	California Test 331	62
Tests on residue by evaporation:		
Penetration at 25 °C	AASHTO T 49	40–90
Softening point (min, ºC)	AASHTO T 53	57

[a]Settlement test on emulsion is not required if used within 48 hours of shipment.

Acceptance of aggregate, except mineral filler, is based on the Department's sampling and testing for compliance with the requirements shown in the following table:

Aggregate Acceptance Criteria

Quality characteristic	Test method	Requirement
Los Angeles Rattler loss (max, %) At 500 revolutions	California Test 211[a]	35
Percent of crushed particles (min, %)	California Test 205	95
Durability (min)	California Test 229	65
Sand equivalent (min) Type II Type III	California Test 217	 65 65

[a]California Test 211 must be performed on the aggregate before crushing. The aggregate supplier must certify that the crushed aggregate being used on the project is manufactured from the source aggregate complying with the LA rattler requirements.

An aggregate sand equivalent test represents 300 tons or 1 day's production, whichever is less.

If the test results for aggregate sand equivalent do not comply with the specifications, you may remove the micro-surfacing represented by the test results or request it remain in place with a payment deduction. If your request is authorized, the Department deducts $2.00 per ton of micro-surfacing for each noncompliant aggregate sand equivalent test.

37-3.03B Materials

37-3.03B(1) General

Reserved

37-3.03B(2) Micro-surfacing Emulsions

A micro-surfacing emulsion must be a homogeneous mixture of asphalt, an elastomeric polymer and an emulsifier solution.

Add an elastomeric polymer modifier to asphalt or emulsifier solution before emulsification. An elastomeric polymer solid must be a minimum of 3 percent by weight of the micro-surfacing emulsion's residual asphalt.

A micro-surfacing emulsion must comply with the requirements shown in the following table:

Micro-surfacing Emulsion Requirements

Quality characteristic	Test method	Requirement
Tests on emulsion:		
Saybolt Furol Viscosity at 25 °C (Saybolt Furol seconds)	AASHTO T 59	15–90
Sieve test (%)	AASHTO T 59	0.30
Storage stability, 1 day (max, %)	AASHTO T 59	0–1
Settlement[a], 5 days (max, %)	ASTM D244	5
Residue by evaporation (min, %)	California Test 331	62
Tests on residue by evaporation:		
Penetration at 25 °C	AASHTO T 49	40–90
Softening point (min, ºC)	AASHTO T 53	57

[a]Settlement test on emulsion is not required if used within 48 hours of shipment.

37-3.03B(3) Aggregate

Aggregate must comply with the quality characteristic requirements shown in the following table:

Aggregate Requirements

Quality characteristic	Test method	Requirement
Los Angeles Rattler loss (max, %) At 500 revolutions	California Test 211[a]	35
Percent of crushed particles (min, %)	California Test 205	95
Durability (min)	California Test 229	65
Sand equivalent (min) Type II Type III	California Test 217	 65 65

[a]California Test 211 must be performed on the source aggregate before crushing. The aggregate supplier must certify that the crushed aggregate being used on the project is manufactured from the source aggregate complying with the LA rattler requirements.

37-3.03B(4) Mineral Fillers

If a mineral filler is used, it must be type I or type II Portland cement. A mineral filler used during mix design must be used during production.

37-3.03B(5) Micro-Surfacing Mix Designs

The micro-surfacing mix design must have the material proportion limits shown in the following table:

Micro-surfacing Mix Design Proportion Limits

Material	Proportion limits
Micro-surfacing emulsion asphalt residual content (% of dry weight of aggregate)	5.5–10.5
Water and additives	As Required
Mineral filler (% of dry weight of aggregate)	0–3

The micro-surfacing mix design must comply with the requirements shown in the following table:

Micro-surfacing Mix Design Requirements

Quality characteristics	Test method[a]	Requirement
Wet cohesion At 30 minutes (set) (min, kg-cm) At 60 minutes (traffic) (min, kg-cm)	Technical Bulletin 139	 12 20
Excess asphalt (max, g/m^2)	Technical Bulletin 109	540
Wet stripping (min, %)	Technical Bulletin 114	90
Wet track abrasion loss 6-day soak (max, g/m^2)	Technical Bulletin 100	 810
Displacement Lateral (max, %) Specific gravity after 1000 cycles of 57 kg (max)	Technical Bulletin 147A	 5 2.10
Classification compatibility (min, grade points)	Technical Bulletin 144	(AAA, BAA) 11
Mix time at 25 °C (min)	Technical Bulletin 113	Controllable to 120 seconds

[a]Test methods are by the International Slurry Surfacing Association.

37-3.03B(6) Tack Coats

If there is a bid item for tack coat, you must coat the pavement surface with an asphaltic emulsion mixed with additional water before applying a micro-surfacing. The maximum ratio of water to asphaltic emulsion must be 2 to 1. Apply the tack coat at a rate from 0.08 to 0.15 gal/sq yd. The exact rate must be authorized.

You determine the grade of slow-setting or quick setting asphaltic emulsion to be used.

37-3.03C Construction

37-3.03C(1) General

Reserved

37-3.03C(2) Proportioning

Field conditions may require adjustments to the proportions within the authorized mix design during construction.

37-3.03C(3) Mixing and Spreading Equipment

37-3.03C(3)(a) General

Reserved

37-3.03C(3)(b) Scratch Course Boxes

Spread the scratch courses with the same type of spreader box used to spread micro-surfacings except use an adjustable steel strike-off device instead of a final strike-off device.

37-3.03C(3)(c) Wheel Path Depression Boxes

Each wheel path depression box must have adjustable strike-off device between 5 and 6 feet wide to regulate depth. The wheel path depression box must also have devices such as hydraulic augers capable of:

1. Moving the mixed material from the rear to the front of the filling chamber
2. Guiding larger aggregate into the deeper section of the wheel path depression
3. Forcing the finer material towards the outer edges of the spreader box

37-3.03C(4) Test Strips

If micro-surfacing placement will require more than 1 day, you must construct a test strip. The test strip must be:

1. From 300 to 450 feet long
2. The same as the full production micro-surfacing
3. On 1 of the application courses specified at an authorized location

4. At the same time of day or night the full production micro-surfacing is to be applied

If multiple application courses are specified, you may construct test strips over 2 days or nights.

The Engineer evaluates the test strip after traffic has used it for 12 hours. If the Engineer determines the mix design or placement procedure is unacceptable, make modifications and construct a new test strip for the Engineer's evaluation.

37-3.03C(5) Placement

37-3.03C(5)(a) General

Reserved

37-3.03C(5)(b) Repair Wheel Path Depressions

If repairing wheel path depressions is shown in plans, fill wheel path depressions and irregularities with micro-surfacing material before spreading micro-surfacing. If the depressions are less than 0.04 foot deep, fill with a scratch course. If the depressions are 0.04 foot deep or more, fill the depressions using a wheel path depression box.

Spread scratch courses by adjusting the steel strike-off of a scratch course box until it is directly in contact with the pavement surface.

Spread micro-surfacings with a wheel path depression box leaving a slight crown at the surface. Use multiple applications to fill depressions more than 0.12 foot deep. Do not apply more than 0.12 foot in a single application.

Allow traffic to compact each filled wheel path depression for a minimum of 12 hours before placing additional micro-surfacings.

37-3.03C(5)(c) Micro-surfacing Pavement Surfaces

The micro-surfacing spread rates must be within the ranges shown in the following table:

Micro-surfacing type	Application range (lb of dry aggregate/sq yd)
Type II	10–20
Type III[a]	20–32
Type III[b]	30–32

[a]Over asphalt concrete pavement
[b]Over concrete pavement and concrete bridge decks

Within 2 hours after placement, micro-surfacings must be set enough to allow traffic without pilot cars. Protect the micro-surfacings from damage until it has set and will not adhere or be picked up by vehicle tires. Micro-surfacings must not exhibit distress from traffic such as bleeding, raveling, separation or other distresses.

37-3.03D Payment

The payment quantity for micro-surfacing is the weight determined by combining the weights of the aggregate and micro-surfacing emulsion. The payment quantity for micro-surfacing does not include the weights of added water, mineral filler, and additives.

37-3.04 RUBBERIZED AND MODIFIED SLURRY SEALS

Reserved

37-4 FOG SEALS AND FLUSH COATS

37-4.01 GENERAL

37-4.01A General

37-4.01A(1) Summary

Section 37-4.01 includes general specifications for applying fog seals and flush coats.

37-4.01A(2) Definitions

Reserved

37-4.01A(3) Submittals

At least 15 days before use, submit:

1. Sample of asphaltic emulsion in two 1-quart plastic container with lined, sealed lid
2. Asphaltic emulsion information and test data as follows:
   2.1. Supplier
   2.2. Type/Grade of asphalt emulsion
   2.3. Copy of the specified test results for asphaltic emulsion

37-4.01B Materials

Not Used

37-4.01C Construction

37-4.01C(1) General

Reserved

37-4.01C(2) Weather Conditions

Only place a fog seal or flush coat if both the pavement and ambient temperatures are at least 50 degrees F and rising. Do not place a fog seal or flush coat within 24 hours of rain or within 24 hours of forecast rain or freezing temperatures.

37-4.01D Payment

Not Used

37-4.02 FOG SEALS

37-4.02A General

37-4.02A(1) Summary

Section 37-4.02 includes specifications for applying fog seals.

Applying a fog seal includes applying a diluted slow-setting or quick setting asphaltic emulsion.

37-4.02A(2) Definitions

Reserved

37-4.02A(3) Submittals

Immediately after sampling, submit two 1-quart plastic container of asphaltic emulsion taken in the presence of the Engineer. Samples must be submitted in insulated shipping container.

37-4.02A(4) Quality Assurance

37-4.02A(4)(a) General

Reserved

37-4.02A(4)(b) Quality Control

37-4.02A(4)(b)(i) General

Reserved

37-4.02A(4)(b)(ii) Asphaltic Emulsions

Circulate asphaltic emulsions in the distributor truck before sampling. Take samples from the distributor truck at mid load or from a sampling tap or thief. Before taking samples, draw and dispose of 1 gallon. In the presence of the Engineer, take asphalt emulsion sample in two 1-quart plastic container with lined, sealed lid.

For asphaltic emulsions, the authorized laboratory must perform quality control sampling and testing at the specified frequency and location for the following quality characteristics:

Asphaltic Emulsion

Quality characteristic	Test Method	Minimum sampling and testing frequency	Sampling location
Saybolt Furol Viscosity, at 25 °C (Saybolt Furl seconds)	AASHTO T 59	Minimum 1 per day per delivery truck	Distributor truck
Sieve Test (%)			
Storage stability, 1 day (%)			
Residue by distillation (%)			
Particle charge[a]			
Tests on Residue from Distillation Test:			
Penetration, 25 °C	AASHTO T 49	Minimum 1 per day per delivery truck	Distributor truck
Ductility	AASHTO T 51		
Solubility in tricloroethylene	AASHTO T 44		

[a]If the result of the particle charge is inconclusive, the asphaltic emulsion must be tested for pH under ASTM E70. Grade QS1h asphaltic emulsion must have a minimum pH of 7.3. Grade CQS1h asphaltic emulsion must have a maximum pH of 6.7.

37-4.02A(4)(b)(iii) Asphaltic Emulsion Spread Rates

For fog seals, the authorized laboratory must perform sampling and testing at the specified frequency and location for the following quality characteristics:

Fog Seal Quality Control Requirements

Quality characteristic	Test method	Minimum sampling and testing frequency	Location of sampling
Asphaltic emulsion spread rate (gal/sq yd)	California Test 339	2 per day	Pavement surface

37-4.02A(4)(c) Department Acceptance

Fog seal acceptance is based on:

1. Visual inspection for the following:
   1.1. Uniform surface texture throughout the work limits
   1.2. Flushing consisting of the occurrence of a film of asphaltic material on the surface
   1.4 Streaking consisting of alternating longitudinal bands of asphaltic emulsion approximately parallel with the lane line
2. The Department's sampling and testing for compliance with the requirements for the quality characteristics specified in section 94 for asphaltic emulsion
3. Department's sampling and testing for compliance with the requirements for fog seal shown in the following table:

Fog Seal Acceptance Criteria

Quality Characteristic	Test Method	Requirement
Asphaltic emulsion spread rate (gal/sq yd)	California Test 339	TV ± 10%

37-4.02B Materials

You determine the grade of slow-setting or quick setting asphaltic emulsion to be used.

37-4.02C Construction

Apply asphaltic emulsions for fog seals at a residual asphalt rate from 0.02 to 0.06 gal/sq yd.

If additional water is added to the asphaltic emulsions, the resultant mixture must not be more than 1 part asphaltic emulsion to 1 part water. You determine the dilution rate.

If the fog seals become tacky, sprinkle water as required.

If fog seals and chip seals are on the same project, the joint between the seal coats must be neat and uniform.

37-4.02D Payment

The Department does not adjust the unit price for an increase or decrease in the asphaltic emulsion quantity.

37-4.03 FLUSH COATS

37-4.03A General

37-4.03A(1) Summary

Section 37-4.03 includes specifications for applying flush coats.

Applying a flush coat includes applying a fog seal coat followed by sand.

37-4.03A(2) Definitions

Reserved

37-4.03A(3) Submittals

At least 15 days before use, submit:

1. Proposed target X values for sand gradation.
2. Gradation test results for sand

Submit quality control test results for sand gradation within 2 business days of sampling.

37-4.03A(4) Quality Assurance

37-4.03A(4)(a) General

Reserved

37-4.03A(4)(b) Quality Control

For sand, the authorized laboratory must perform sampling and testing at the specified frequency and location for the following quality characteristics:

Sand Quality Control

Quality characteristic	Test method	Minimum sampling and testing frequency	Location of sampling
Gradation (% passing by weight)	California Test 202	1 per day	See California Test 125

37-4.03A(4)(c) Department Acceptance

Flush coat acceptance is based on fog seal acceptance and the following:

1. Visual inspection for uniform application of sand.
2. Sand acceptance is based on the Department's sampling and testing for compliance with the requirements shown in the following table:

Sand Gradation Acceptance Criteria

Quality characteristic	Test method	Requirement
Gradation (% passing by weight) Sieve size:	California Test 202	
3/8"		100
No. 4		93–100
No. 8		61–99
No. 16		X ± 13
No. 30		X ± 12
No. 50		X ± 9
No.100		1–15
No. 200		0–10

NOTE: "X" is the gradation that you propose to furnish for the specific sieve size.

37-4.03B Material

37-4.03B(1) General

Reserved

37-4.03B(2) Sand

Sand must be free from deleterious coatings, clay balls, roots, bark, sticks, rags, and other extraneous material.

Sand for a flush coat must comply with the gradations shown in the following table:

Sand Gradation

Quality characteristic	Test method	Requirement
Gradation (% passing by weight) Sieve size:	California Test 202	
3/8"		100
No. 4		93–100
No. 8		61–99
No. 16		X ± 13
No. 30		X ± 12
No. 50		X ± 9
No.100		1–15
No. 200		0–10

NOTE: "X" is the gradation that you propose to furnish for the specific sieve size.

Fine aggregate sizes must be distributed such that the difference between the total percentage passing the No. 16 and No. 30 sieves is from 10 to 40, and the difference between the percentage passing the No. 30 and No. 50 sieves is from 10 to 40.

37-4.03C Construction

37-4.03C(1) General

During flush coat activities, close adjacent lanes to traffic. Do not track asphaltic emulsion on existing pavement surfaces.

Apply sand immediately after applying asphaltic emulsions.

Spread sand aggregate with a mechanical device that spreads sand at a uniform rate over the full width of a traffic lane in a single application. Spread sand at a rate from 2 to 6 lb/sq yd. You determine the application rates for sand and the Engineer authorizes the application rate.

37-4.03C(2) Sweeping

Sweep loose sand material remaining on the surface 24 hours after application.

37-4.03D Payment

The Department does not adjust the unit price for an increase or decrease in the sand cover (seal) quantity.

37-5 PARKING AREA SEALS

37-5.01 GENERAL

37-5.01A Summary

Section 37-5 includes specifications for applying parking area seals. Sealing a parking area consists of spreading a mixture of asphaltic emulsion, aggregate, polymer, and water.

37-5.01B Definitions

Reserved

37-5.01C Submittals

At least 15 days before starting placement, submit a 20 lb sample of the aggregate to be used.

At least 10 days before starting placement, submit:

1. Name of the authorized laboratory to perform testing and mix design.
2. Laboratory report of test results and a proposed mix design. The report and mix design must include the specific materials to be used and show a comparison of test results and specifications. The mix design report must include the quantity of water allowed to be added at the job site. The authorized laboratory performing the tests must sign the original laboratory report and mix design.
3. Manufacturer's data for oil seal primer and polymer.

If the mix design consists of the same materials covered by a previous laboratory report, you may submit the previous laboratory report that must include material testing data performed within the previous 12 months for authorization.

If you request substitute materials, submit a new laboratory report and mix design at least 10 days before starting placement.

Submit a certificate of compliance for the parking area seal material.

Immediately after sampling, submit two 1-quart plastic containers of parking area seal taken in the presence of the Engineer. Samples must be submitted in insulated shipping containers.

37-5.01D Quality Assurance

37-5.01D(1) General

Reserved

37-5.01D(2) Quality Control

37-5.01D(2)(a) General

Reserved

37-5.01D(2)(b) Asphaltic Emulsions

For an asphaltic emulsion, the authorized laboratory must perform quality control sampling and testing at the specified frequency and location for the following quality characteristics:

Asphaltic Emulsion

Quality characteristic	Test Method	Minimum sampling and testing frequency	Sampling location
Saybolt Furol Viscosity, at 25 °C (Saybolt Furol seconds)	AASHTO T 59	Minimum 1 per day per delivery truck	Distributor truck
Sieve Test (%)			
Storage stability, 1 day (%)			
Residue by distillation (%)			
Particle charge[a]			
Tests on Residue from Distillation Test			
Penetration, 25 °C	AASHTO T 49	Minimum 1 per day per delivery truck	Distributor truck
Ductility	AASHTO T 51		
Solubility in trichloroethylene	AASHTO T 44		

[a]If the result of the particle char is inconclusive, the asphaltic emulsion must be tested for pH under ASTM E70. Grade QS1h asphaltic emulsion must have a minimum pH of 7.3. Grade CQS1h asphaltic emulsion must have a maximum pH of 6.7.

37-5.01D(2)(c) Sand

For sand, the authorized laboratory must perform sampling and testing at the specified frequency and location for the following quality characteristics:

Sand Quality Control

Quality characteristic	Test method	Minimum sampling and testing frequency	Location of sampling
Gradation (% passing by weight)	California Test 202	One per project	See California Test 125

37-5.01D(2)(d) Parking Area Seals

For a parking area seal, the authorized laboratory must perform quality control sampling and testing at the specified frequency for the following quality characteristics:

Parking Area Seal Requirements

Quality characteristic	Test method	Frequency
Mass per liter (kg)	ASTM D244	One per project
Cone penetration (mm)	California Test 413	
Nonvolatile (%)	ASTM D2042[a]	
Nonvolatile soluble in trichloroethylene (%)		
Wet track abrasion (g/m^2)	ASTM D3910	
Dried film color	--	
Viscosity (KU)[b]	ASTM D562	

[a]Weigh 10 g of homogenous material into a previously tarred, small can. Place in a constant temperature oven at 165 ± 5 °C for 90 ± 3 minutes. Cool, reweigh, and calculate nonvolatile components as a percent of the original weight.
[b]Krebs units

37-5.01D(3) Department Acceptance

Parking area seal acceptance is based on:

1. Visual inspection for:
   1.1. Uniform surface texture throughout the work limits
   1.2 Marks in the surface:
      1.2.1. Up to 4 marks in the completed parking area seal that are up to 1 inch wide and up to 6 inches long per 1,000 square feet of parking area seal placed.

1.2.2. No marks in the completed parking area seal surface that are over 1 inch wide or 6 inches long.

1.2. Raveling consisting of the separation of the aggregate from the asphaltic emulsion

1.3. Bleeding consisting of the occurrence of a film of asphaltic material on the surface of the parking area seal

1.4 Delaminating of the parking area seal from the existing pavement

1.5 Rutting or wash-boarding

2. The Department's sampling and testing of aggregate for compliance with 100 percent passing no. 16 sieve under California Test 202
3. The Department's sampling and testing for compliance with the requirements shown in the following table:

Parking Area Seal Acceptance Criteria

Quality characteristic	Test method	Requirement
Mass per liter (min, kg)	ASTM D244	1.1
Cone penetration (mm)	California Test 413	340–700
Nonvolatile (min, %)	ASTM D2042[a]	50
Nonvolatile soluble in trichloroethylene (%)		10–35
Wet track abrasion (max, g/m^2)	ASTM D3910	380
Dried film color	--	Black
Viscosity (min, KU)[b]	ASTM D562	75

[a]Weigh 10 g of homogenous material into a previously tared, small ointment can. Place in a constant temperature oven at 165 ± 5 °C for 90 ± 3 minutes. Cool, reweigh, and calculate nonvolatile components as a percent of the original weight.

[b]Krebs units

37-5.02 MATERIALS

37-5.02A General

Aggregate must be clean, hard, durable, uncoated, and free from organic and deleterious substances. One hundred percent of the aggregate must pass the no. 16 sieve.

Asphaltic emulsion must be either Grade SS1h or CSS1h, except the values for penetration at 25 degrees C for tests on residue from distillation must be from 20 to 60.

Polymer must be either neoprene, ethylene vinyl acetate, or a blend of butadiene and styrene.

Oil seal primer must be a quick-drying emulsion with admixtures. Oil seal primer must be manufactured to isolate the parking area seal from pavement with residual oils, petroleum grease, and spilled gasoline.

Crack sealant must comply with section 37-6.

Water must be potable and not separate from the emulsion before the material is placed.

37-5.02B Mix Design

The proposed mix design for a parking area seal must comply with the requirements shown in the following table:

Parking Area Seal Mix Design Requirements

Quality characteristic	Test method	Requirement
Mass per liter (min, kg)	ASTM D244	1.1
Cone penetration (mm)	California Test 413	340–700
Nonvolatile (min, %)	ASTM D2042[a]	50
Nonvolatile soluble in trichloroethylene (%)		10–35
Wet track abrasion (max, g/m^2)	ASTM D3910	380
Dried film color	--	Black
Viscosity (min, KU)[b]	ASTM D562	75

[a]Weigh 10 g of homogenous material into a previously tarred, small ointment can. Place in a constant temperature oven at 165 ± 5 °C for 90 ± 3 minutes. Cool, reweigh, and calculate nonvolatile components as a percent of the original weight.
[b]Krebs units

A parking area seal must contain a minimum of 2 percent polymer by volume of undiluted asphaltic emulsion.

37-5.02C Proportioning

Parking area seal ingredients must be mixed at a central plant. The plant must include mechanical or electronic controls that consistently proportion the ingredients. Mix an asphaltic emulsion with the other ingredients mechanically.

Store the parking area seal in a tank equipped with mixing or agitation devices. Keep stored materials thoroughly mixed. Protect stored materials from freezing conditions.

37-5.03 CONSTRUCTION

37-5.03A General

Request that the Engineer shut off the irrigation control system at least 5 days before placing the seal. Do not water plants adjacent to the seal at least 24 hours before and after the seal coat placement.

37-5.03B Surface Preparations

If cracks in the existing pavement are from 1/4 to 1 inch wide, treat the cracks under section 37-6. Do not place the parking area seals until the Engineer determines that the crack treatments are cured.

If cracks in the existing pavement are greater than 1 inch wide, the Engineer orders the repair. This work is change order work.

After any crack treatment and before placing parking area seals, clean the pavement surface, including removal of oil and grease spots. Do not use solvents.

If cleaning the pavement with detergents, thoroughly rinse with water. Allow all water to dry before placing parking area seals.

You must seal oil and grease spots that remain after cleaning. Use an oil seal primer and comply with the manufacturer's instructions.

If the existing pavement has oil and grease spots that do not come clean and sealing is insufficient, the Engineer orders the repair of the pavement. This work is change order work.

Before placing the parking area seals, dampen the pavement surface using a distributor truck. Place the seal on the damp pavement but do not place it with standing water on the pavement.

37-5.03C Placement

If adding water at the job site based on the manufacturer's instructions for consistency and spreadability, do not exceed 15 percent by volume of undiluted asphaltic emulsion.

Place the parking area seals in 1 or more application. The seals must be uniform and smooth, free of ridges or uncoated areas.

If placing in multiple applications, allow the last application to thoroughly dry before the subsequent application.

Do not allow traffic on the parking area seals for at least 24 hours after placement.

Do not stripe over the parking area seals until it is dry.

37-5.04 PAYMENT

The payment quantity for parking area seal is the weight determined by combining the weights of the aggregate and asphaltic emulsion. The payment quantity for parking area seal does not include the added water and set-control additive.

37-6 CRACK TREATMENTS

37-6.01 GENERAL

37-6.01A Summary

Section 37-6 includes specifications for treating cracks in asphalt concrete pavement.

37-6.01B Definitions

Reserved

37-6.01C Submittals

If your selected crack treatment material is on the Authorized Material List for flexible pavement crack treatment material, submit a certificate of compliance including:

1. Manufacturer's name
2. Production location
3. Brand or trade name
4. Designation
5. Batch or lot number
6. Crack treatment material type
7. Contractor or subcontractor name
8. Contract number
9. Lot size
10. Shipment date
11. Manufacturer's signature

If your selected crack treatment material is not on the Authorized Material List for flexible pavement crack treatment material, submit a sample and test results from each batch or lot 20 days before use. Testing must be performed by an authorized laboratory and test results must show compliance with the specifications. Test reports must include the information specified for the certificate of compliance submittal. Each hot-applied crack treatment material sample must be a minimum of 3 lb and submitted in a silicone release container. Each cold-applied crack treatment material sample must be a minimum of 2 quarts and submitted in a plastic container.

At least 10 days before the start of work, submit sand gradation test results under California Test 202.

Submit the following with each delivery of crack treatment material to the job site:

1. Manufacturer's heating and application instructions
2. Manufacturer's SDS
3. Name of the manufacturer's recommended detackifying agent

37-6.01D Quality Assurance

37-6.01D(1) General

Hot-applied crack treatment material must be sampled at least once per project in the Engineer's presence. Collect two 3-pounds-minimum samples of crack treatment material from the dispensing wand into silicone release boxes.

Cold-applied crack treatment material must be sampled at least once per project in the Engineer's presence. Collect 2 samples of crack treatment material from the dispensing wand into 1-quart containers.

37-6.01D(2) Quality Control

Reserved

37-6.01D(3) Department Acceptance

Crack treatment acceptance is based on:

1. Visual inspection for uniform filling of cracks throughout the work limits including:
   1.2. Crack treatment is not more than a 1/4 inch below the specified level
   1.3. Sealant failures
   1.4. Crack re-opening
   1.5. Crack overbanding is less than 3 inches wide
2. The Department's sampling and testing for compliance with the requirements shown in the following table:

Crack Treatment Acceptance Criteria

Quality characteristic[a]	Test method[b]	Requirement				
		Type 1	Type 2	Type 3	Type 4	Type 5
Softening point (min, °C)	ASTM D36	102	96	90	84	84
Cone penetration at 77 °F (max)	ASTM D5329	35	40	50	70	90
Resilience at 77 °F, unaged (%)	ASTM D5329	20–60	25–65	30–70	35–75	40–80
Flexibility (°C)[c]	ASTM D3111	0	0	0	-11	-28
Tensile adhesion (min, %)	ASTM D5329	300	400	400	500	500
Specific gravity (max)	ASTM D70	1.25	1.25	1.25	1.25	1.25
Asphalt compatibility	ASTM D5329	Pass	Pass	Pass	Pass	Pass
Sieve test (% passing)	See note d	100	100	100	100	100

[a]Cold-applied crack treatment material residue collected under ASTM D6943, Method B and sampled under ASTM D140 must comply with the grade specified.
[b]Except for viscosity, cure each specimen at a temperature of 23 ± 2 °C and a relative humidity of 50 ± 10 percent for 24 ± 2 hours before testing.
[c]For the flexibility test, the specimen size must be 6.4 ± 0.2 mm thick by 25 ± 0.2 mm wide by 150 ± 0.5 mm long. The test mandrel diameter must be 6.4 ± 0.2 mm. The bend arc must be 180 degrees. The bend rate must be 2 ± 1 seconds. At least 4 of 5 test specimens must pass at the specified test temperature without fracture, crazing, or cracking.
[d]For hot-applied crack treatment, dilute with toluene and sieve through a no. 8 sieve. For cold-applied crack treatment, sieve the material as-received through a no. 8 sieve. If the manufacturer provides a statement that added components passed the no. 16 sieve before blending, this requirement is void.

37-6.02 MATERIALS

37-6.02A General

Reserved

37-6.02B Crack Treatment Material

A crack treatment material must comply with the requirements shown in the following table:

Crack Treatment Material

Quality characteristic[a]	Test method[b]	Requirement				
		Type 1	Type 2	Type 3	Type 4	Type 5

Softening point (min, °C)	ASTM D36	102	96	90	84	84
Cone penetration at 77 °F (max)	ASTM D5329	35	40	50	70	90
Resilience at 77 °F, unaged (%)	ASTM D5329	20–60	25–65	30–70	35–75	40–80
Flexibility (°C)[c]	ASTM D3111	0	0	0	-11	-28
Tensile adhesion (min, %)	ASTM D5329	300	400	400	500	500
Specific gravity (max)	ASTM D70	1.25	1.25	1.25	1.25	1.25
Asphalt compatibility	ASTM D5329	Pass	Pass	Pass	Pass	Pass
Sieve test (% passing)	See note d	100	100	100	100	100

[a]Cold-applied crack treatment material residue collected under ASTM D6943, Method B and sampled under ASTM D140 must comply with the grade specifications.
[b]Except for viscosity, cure each specimen at a temperature of 23 ± 2 °C and a relative humidity of 50 ± 10 percent for 24 ± 2 hours before testing.
[c]For the flexibility test, the specimen size must be 6.4 ± 0.2 mm thick by 25 ± 0.2 mm wide by 150 ± 0.5 mm long. The test mandrel diameter must be 6.4 ± 0.2 mm. The bend arc must be 180 degrees. The bend rate must be 2 ± 1 seconds. At least 4 of 5 test specimens must pass at the specified test temperature without fracture, crazing, or cracking.
[d]For hot-applied crack treatment, dilute with toluene and sieve through a no. 8 sieve. For cold-applied crack treatment, sieve the material as-received through a no. 8 sieve. If the manufacturer provides a statement that added components passed the no. 16 sieve before blending, this requirement is void.

A crack treatment material must be delivered to the job site with the information listed below. If crack treatment material is delivered to the job site in containers, each container must be marked with the following information.

1. Manufacturer's name
2. Production location
3. Brand or trade name
4. Designation
5. Crack treatment trade name
6. Batch or lot number
7. Maximum heating temperature
8. Expiration date for cold application only

Hot-applied crack treatment must be delivered to the job site premixed in cardboard containers with meltable inclusion liners or in a fully meltable package.

Cold-applied crack treatment must have a minimum shelf life of 3 months from the date of manufacture.

37-6.02C Sand

Sand applied to tacky crack treatment material must be clean, free of clay, and comply with the gradation shown in the following table:

Sand Gradation

Quality characteristic	Test method	Requirement
Gradation (% passing by weight) Sieve size:	California Test 202	
No. 4		100
No. 50		0–30
No. 200		0–5

37-6.03 CONSTRUCTION

Treat cracks from 1/4 to 1 inch in width for the entire length of the crack. Fill or repair cracks wider than 1 inch as ordered. Filling cracks wider than 1 inch is change order work.

If treating cracks on a traffic lane adjacent to a shoulder, treat the cracks on the shoulder.

For hot-applied crack treatment material, rout cracks or saw cut to form a reservoir.

Cracks must be clean and dry before treating. Before treating, blast cracks with oil-free compressed air at a pressure of at least 90 psi.

If the pavement temperature is below 40 degrees F or if there is evidence of moisture in the crack, use a hot air lance immediately before applying crack treatment. The hot air lance must not apply flame directly on the pavement.

Heat and apply hot-applied crack treatment material under with the manufacturer's instructions.

Apply cold-applied crack treatment material with a distributor kettle, a piston, or a diaphragm barrel pump that can deliver from 50 to 75 psi. The application line must have a pressure gauge and a filter. The pressure in the application line must not exceed 20 psi. The pressure gauge must have a regulator. Use a high-pressure hose with a 1/2-inch NPT swivel connection and a dispensing wand.

Apply crack treatment with a nozzle inserted into the crack. Fill the crack flush. If after 2 days the crack treatment is more than 1/4 inch below the specified level, the sealant fails, or the crack re-opens, re-treat the crack.

Immediately remove crack treatment material that is spilled or deposited on the pavement surface.

Before opening to traffic, apply sand or the manufacturer's recommended detackifying agent to tacky crack treatment material on the traveled way.

Sweep up excess sand before opening to traffic.

37-6.04 PAYMENT

The payment quantity for crack treatment is the length measured in lane miles along the edge of each paved lane parallel to the pavement's centerline. The payment for a lane includes crack treatment of the adjacent shoulder.

37-7–37-10 RESERVED

38 RESERVED

39 ASPHALT CONCRETE

39-1 GENERAL

39-1.01 GENERAL

Section 39 includes specifications for performing asphalt concrete work.

39-1.02 MATERIALS

Not Used

39-1.03 CONSTRUCTION

Not Used

39-1.04 PAYMENT

Not Used

39-2 HOT MIX ASPHALT

39-2.01 GENERAL

39-2.01A General

39-2.01A(1) Summary

Section 39-2.01 includes general specifications for producing and placing hot mix asphalt.

HMA includes one or more of the following types:

1. Type A HMA
2. RHMA-G
3. OGFC
4. BWC
5. Minor HMA

WMA technologies must be on the Authorized Material List for WMA authorized technologies.

For HMA that uses asphalt binder containing crumb rubber modifier, submit a Crumb Rubber Usage Report form monthly and at the end of the project.

Wherever reference is made to the following test methods, the year of publication for these test methods is as shown in the following table:

Test method	Year of publication
AASHTO M 17	2011 (2015)
AASHTO M 323	2013
AASHTO R 30	2002 (2015)
AASHTO R 59	2011 (2015)
AASHTO T 27	2014
AASHTO T 49	2014
AASHTO T 59	2013
AASHTO T 96	2002 (2010)
AASHTO T 164	2014
AASHTO T 176	2008
AASHTO T 209	2012
AASHTO T 269	2014
AASHTO T 275	2007 (2012)
AASHTO T 283	2014
AASHTO T 304	2011
AASHTO T 305	2014
AASHTO T 308	2010
AASHTO T 312	2014
AASHTO T 313	2012 (2016)
AASHTO T 315	2012 (2016)
AASHTO T 324	2014
AASHTO T 329	2013
AASHTO T 335	2009
ASTM D36/D36M	2014$^{\varepsilon 1}$
ASTM D92	2012b
ASTM D217	2010
ASTM D297	2013
ASTM D445	2014
ASTM D1856	2009 (Reapproved 2015)
ASTM D2007	2011
ASTM D2074	2007 (Reapproved 2013)
ASTM D2995	1999 (Reapproved 2009)
ASTM D4791	2010
ASTM D5329	2009
ASTM D7741/D7741M	2011$^{\varepsilon 1}$
Asphalt Institute MS-2	7th edition (2015)

39-2.01A(2) Definitions

binder replacement: Binder from RAP expressed as a percent of the total binder in the mix.

coarse aggregate: Aggregate retained on a no. 4 sieve.

fine aggregate: Aggregate passing a no. 4 sieve.

leveling course: Thin layer of HMA used to correct minor variations in the longitudinal and transverse profile of the pavement before placement of other pavement layers.

miscellaneous areas: Areas outside the traveled way and shoulders such as:

1. Median areas not including inside shoulders
2. Island areas
3. Sidewalks
4. Gutters
5. Ditches
6. Overside drains
7. Aprons at ends of drainage structures

processed RAP: RAP that has been fractionated.

supplemental fine aggregate: Mineral filler consisting of rock dust, slag dust, hydrated lime, hydraulic cement, or any combination of these and complying with AASHTO M 17.

39-2.01A(3) Submittals

39-2.01A(3)(a) General

Reserved

39-2.01A(3)(b) Job Mix Formula

39-2.01A(3)(b)(i) General

Except for the HMA to be used in miscellaneous areas and dikes, submit your proposed JMF for each type of HMA to be used. The JMF must be submitted on the Contractor Job Mix Formula Proposal form along with:

1. Mix design documentation on a Contractor Hot Mix Asphalt Design Data form dated within 12 months of the submittal for the JMF verification.
2. JMF verification on a Caltrans Hot Mix Asphalt Verification form and the Contractor Hot Mix Asphalt Design Data form that was submitted for the JMF verification, if applicable.
3. JMF renewal on a Caltrans Job Mix Formula Renewal form, if applicable
4. SDS for:
   4.1. Asphalt binder
   4.2. Supplemental fine aggregate except fines from dust collectors
   4.3. Antistrip additives

The Contractor Hot Mix Asphalt Design Data form must identify the AASHTO resource accredited lab responsible for the mix design and show documentation on aggregate quality.

If you cannot submit a Department-verified JMF on a Caltrans Hot Mix Asphalt Verification form dated within 12 months before HMA production, the Engineer verifies the JMF.

Submit a new JMF if you change any of the following:

1. Target asphalt binder percentage greater than ±0.2 percent
2. Asphalt binder supplier
3. Combined aggregate gradation
4. Aggregate sources
5. Liquid antistrip producer or dosage
6. Average binder content in a new processed RAP stockpile by more than ±2.00 percent from the average RAP binder content reported on page 4 of your Contractor Hot Mix Asphalt Design Data form
7. Average maximum specific gravity in a new processed RAP stockpile by more than ±0.060 from the average maximum specific gravity value reported on page 4 of your Contractor Hot Mix Asphalt Design Data form
8. Any material in the JMF, except lime supplier and source

Allow the Engineer 5 business days from a complete JMF submittal for document review of the aggregate qualities, mix design, and JMF. The Engineer notifies you if the proposed JMF submittal is accepted.

If your JMF fails verification testing, submit an adjusted JMF based on your testing. The adjusted JMF must include a new Contractor Job Mix Formula Proposal form, Contractor Hot Mix Asphalt Design Data form, and the results of the failed verification testing.

You may submit an adjusted aggregate gradation TV on a Contractor Job Mix Formula Proposal form before verification testing. Aggregate gradation TV must be within the TV limits specified.

39-2.01A(3)(b)(ii) Job Mix Formula Renewal

You may request a JMF renewal by submitting:

1. Proposed JMF on a Contractor Job Mix Formula Proposal form

2. Previously verified JMF documented on a Caltrans Hot Mix Asphalt Verification form dated within 12 months
3. Mix design documentation on a Contractor Hot Mix Asphalt Design Data form used for the previously verified JMF

39-2.01A(3)(b)(iii) Job Mix Formula Modification

For an authorized JMF, submit a modified JMF if you change any of the following:

1. Asphalt binder supplier
2. Liquid antistrip producer
3. Liquid antistrip dosage

You may change any of the above items only once during the Contract.

Submit your modified JMF request at least 15 days before production. Each modified JMF submittal must include:

1. Proposed modified JMF on Contractor Job Mix Formula Proposal form, marked *Modified*.
2. Mix design records on Contractor Hot Mix Asphalt Design Data form for the authorized JMF to be modified.
3. JMF verification on Hot Mix Asphalt Verification form for the authorized JMF to be modified.
4. Test results for the modified JMF in compliance with the mix design specifications. Perform tests at the mix design OBC as shown on the Contractor Asphalt Mix Design Data form.

With an accepted modified JMF submittal, the Engineer verifies each modified JMF within 10 days of receiving all verification samples.

39-2.01A(3)(c) Quality Control Plan

At least 5 business days prior to the pre-paving meeting, submit a QC plan for HMA.

The QC plan must describe the organization and procedures for:

1. Controlling HMA quality characteristics
2. Taking samples, including sampling locations
3. Establishing, implementing, and maintaining QC
4. Determining when corrective actions are needed
5. Implementing corrective actions
6. Using methods and materials for backfilling core locations

The QC plan must address the elements affecting HMA quality, including:

1. Aggregates
2. Asphalt binder
3. Additives
4. Production
5. Paving

The QC plan must include aggregate QC sampling and testing during lime treatment.

Allow 5 business days for review of the QC plan.

If you change QC procedures, personnel, or sample testing locations, submit a QC plan supplement before implementing the proposed change. Allow 3 business days for review of the QC plan supplement.

39-2.01A(3)(d) Test Results

For mix design, JMF verification, production start-up, and each 10,000 tons, submit AASHTO T 283 and AASHTO T 324 (Modified) test results to the Engineer and electronically to:

Moisture_Tests@dot.ca.gov

Submit all QC test results, except AASHTO T 283 and AASHTO T 324 (Modified), within 3 business days of a request. Submit AASHTO T 283 QC tests within 15 days of sampling.

For tests performed under AASHTO T 324 (Modified), submit test data and 1 tested sample set within 5 business days of sampling.

If coarse and fine durability index tests are required, submit test results within 2 business days of testing.

If a tapered notched wedge is used, submit compaction test result values within 24 hours of testing.

39-2.01A(3)(e) Reserved

39-2.01A(3)(f) Liquid Antistrip Treatment

If liquid antistrip treatment is used, submit the following with your proposed JMF submittal:

1. One 1 pt sample
2. Infrared analysis, including copy of absorption spectra
3. Certified copy of test results
4. Certificate of compliance for each liquid antistrip shipment. On each certificate of compliance, include:
   - 4.1. Your signature and printed name
   - 4.2. Shipment number
   - 4.3. Material type
   - 4.4. Material specific gravity
   - 4.5. Refinery
   - 4.6. Consignee
   - 4.7. Destination
   - 4.8. Quantity
   - 4.9. Contact or purchase order number
   - 4.10. Shipment date
5. Proposed proportions for the liquid antistrip

For each delivery of liquid antistrip to the HMA production plant, submit a 1 pt sample to METS. Submit shipping documents. Label each liquid antistrip sampling container with:

1. Liquid antistrip type
2. Application rate
3. Sample date
4. Contract number

At the end of each day's production shift, submit production data in electronic and printed media. Present data on electronic media in a tab delimited format. Use line feed carriage return with 1 separate record per line for each production data set. Allow enough fields for the specified data. Include data titles at least once per report. For each HMA mixing plant type, submit the following information in the order specified:

1. For batch plant mixing:
   - 1.1. Production date
   - 1.2. Time of batch completion
   - 1.3. Mix size and type
   - 1.4. Each ingredient's weight
   - 1.5. Asphalt binder content as a percentage of the total weight of mix
   - 1.6. Liquid antistrip content as a percentage of the asphalt binder weight
2. For continuous mixing plant:
   - 2.1. Production date
   - 2.2. Data capture time
   - 2.3. Mix size and type
   - 2.4. Flow rate of wet aggregate collected directly from the aggregate weigh belt
   - 2.5. Aggregate moisture content as a percentage of the dry aggregate weight
   - 2.6. Flow rate of asphalt binder collected from the asphalt binder meter
   - 2.7. Flow rate of liquid antistrip collected from the liquid antistrip meter
   - 2.8. Asphalt binder content as a percentage of the total weight of mix calculated from:
     - 2.8.1. Aggregate weigh belt output
     - 2.8.2. Aggregate moisture input
     - 2.8.3. Asphalt binder meter output
   - 2.9. Liquid antistrip content as a percentage of the asphalt binder weight calculated from:

2.9.1. Asphalt binder meter output
2.9.2. Liquid antistrip meter output

39-2.01A(3)(g) Lime Treatment

If aggregate lime treatment is used, submit the following with your proposed JMF submittal and each time you produce lime-treated aggregate:

1. Exact lime proportions for fine and coarse virgin aggregates
2. If marination is required, the averaged aggregate quality test results within 24 hours of sampling
3. For dry lime aggregate treatment, a treatment data log from the dry lime and aggregate proportioning device in the following order:
   3.1. Treatment date
   3.2. Time of day the data is captured
   3.3. Aggregate size being treated
   3.4. HMA type and mix aggregate size
   3.5. Wet aggregate flow rate collected directly from the aggregate weigh belt
   3.6. Aggregate moisture content, expressed as a percentage of the dry aggregate weight
   3.7. Flow rate of dry aggregate calculated from the flow rate of wet aggregate
   3.8. Dry lime flow rate
   3.9. Lime ratio from the authorized JMF for each aggregate size being treated
   3.10. Lime ratio from the authorized JMF for the combined aggregates
   3.11. Actual lime ratio calculated from the aggregate weigh belt output, aggregate moisture input, and dry lime meter output, expressed as a percentage of the dry aggregate weight
   3.12. Calculated difference between the authorized lime ratio and the actual lime ratio
4. For lime slurry aggregate treatment, a treatment data log from the slurry proportioning device in the following order:
   4.1. Treatment date
   4.2. Time of day the data is captured
   4.3. Aggregate size being treated
   4.4. Wet aggregate flow rate collected directly from the aggregate weigh belt
   4.5. Moisture content of the aggregate just before treatment, expressed as a percentage of the dry aggregate weight
   4.6. Dry aggregate flow rate calculated from the wet aggregate flow rate
   4.7. Lime slurry flow rate measured by the slurry meter
   4.8. Dry lime flow rate calculated from the slurry meter output
   4.9. Authorized lime ratio for each aggregate size being treated
   4.10. Actual lime ratio calculated from the aggregate weigh belt and slurry meter output, expressed as a percentage of the dry aggregate weight
   4.11. Calculated difference between the authorized lime ratio and actual lime ratio
   4.12. Dry lime and water proportions at the slurry treatment time

Each day during lime treatment, submit the treatment data log on electronic media in tab delimited format on a removable CD-ROM storage disk. Each continuous treatment data set must be a separate record using a line feed carriage return to present the specified data on 1 line. The reported data must include data titles at least once per report.

39-2.01A(3)(h) Warm Mix Asphalt Technology

If a WMA technology is used, submit the following with your proposed JMF submittal:

1. SDS for the WMA technology
2. For water injection foam technology:
   2.1. Name of technology
   2.2. Proposed foaming water content
   2.3. Proposed HMA production temperature range
   2.4. Certification from binder supplier stating no antifoaming agent is used
3. For additive technology:
   3.1. Name of technology
   3.2. Percent admixture by weight of binder and percent admixture by total weight of HMA as recommended by the manufacturer

3.3. Methodology for inclusion of admixture in laboratory-produced HMA
3.4. Proposed HMA production temperature range

Collect and hold data for the duration of the Contract and submit the electronic media daily. The snapshot of production data must include the following:

1. Production date
2. Production location
3. Time of day the data is captured
4. HMA mix type being produced and target binder rate
5. HMA additive type, brand, and target rate
6. Temperature of the binder and HMA mixture
7. For a continuous mixing plant, the rate of flow of the dry aggregate calculated from the wet aggregate flow rate as determined by the conveyor scale
8. For a continuous mixing plant, the rate of flow of the asphalt meter
9. For a continuous mixing plant, the rate of flow of HMA additive meter
10. For batch plant mixing, actual batch weights of all ingredients
11. Dry aggregate to binder ratio calculated from metered ingredient output
12. Dry aggregate to HMA additive ratio calculated from metered output

At the end of each day's production shift, submit electronic and printed media from the HMA plant process controller. Present data on electronic media in comma-separated values or tab-separated values format. The captured data for the ingredients represented by the production snapshot must have allowances for sufficient fields to satisfy the amount of data required by these specifications and include data titles at least once per report.

39-2.01A(3)(i) Reserved

39-2.01A(3)(j) Tack Coat

Prior to applying tack coat, submit calculations for the minimum spray rate required to achieve the minimum residual rate.

39-2.01A(3)(k) Reserved

39-2.01A(3)(l) Data Cores

Section 39-2.01A(3)(l) applies if a bid item for a data core is shown on the Bid Item List.

Submit a summary of data cores taken and a photograph of each data core to the Engineer and to:

Coring@dot.ca.gov

For each data core, the summary must include:

1. Project identification number
2. Date cored
3. Core identification number
4. Type of materials recovered
5. Type and approximate thickness of unstabilized material not recovered
6. Total core thickness
7. Thickness of each individual material to within:
   7.1. 1/2 inch for recovered material
   7.2. 1.0 inch for unstabilized material
8. Location, including:
   8.1. County
   8.2. Route
   8.3. Post mile
   8.4. Lane number
   8.5. Lane direction
   8.6. Station

Each data core digital photograph must include a ruler laid adjacent to the data core. Each photograph must include:

1. Core
2. Project identification number
3. Core identification number
4. Date cored
5. County
6. Route
7. Post mile
8. Lane number
9. Lane direction

39-2.01A(3)(m)–39-2.01A(3)(o) Reserved

39-2.01A(4) Quality Assurance

39-2.01A(4)(a) General

AASHTO T 324 (Modified) is AASHTO T 324 with the following parameters:

1. Target air voids must equal 7.0 ± 1.0 percent
2. Specimen height must be 60 ± 1 mm
3. Number of test specimens must be 4 to run 2 tests
4. Do not average the 2 test results
5. Test specimen must be a 150 mm gyratory compacted specimen
6. Test temperature must be set at:
   6.1. 113 ± 2 degrees F for PG 58
   6.2. 122 ± 2 degrees F for PG 64
   6.3. 131 ± 2 degrees F for PG 70 and above
7. Measurements for impression must be taken at every 100 passes along the total length of the sample
8. Inflection point is the number of wheel passes at the intersection of the creep slope and the stripping slope at maximum rut depth
9. Testing shut off must be set at 25,000 passes
10. Submersion time for samples must not exceed 4 hours

Take samples under California Test 125.

If a WMA technology is used, a technical representative for the WMA technology must attend the preconstruction meeting.

39-2.01A(4)(b) Job Mix Formula Verification

The Engineer verifies the JMF from samples taken from HMA produced by the plant to be used. The production set point at the plant must be within ±0.2 from the asphalt binder percentage TV shown in your Contractor Job Mix Formula Proposal form. Notify the Engineer at least 2 business days before sampling materials. Samples may be taken from a different project including a non-Department project if you make arrangements for the Engineer to be present during sampling.

In the Engineer's presence and from the same production run, take samples of:

1. Aggregates. Coarse, fine, and supplemental fine aggregates must be taken from the combined cold-feed belt or the hot bins. If lime treatment is required, samples must be taken from individual stockpiles before lime treatment. Samples must be at least 120 lb for each coarse aggregate, 80 lb for each fine aggregate, and 10 lb for each type of supplemental fine aggregate. For hot-bin samples, the Department combines these aggregate samples to verify the TV submitted on a Contractor Job Mix Formula Proposal form.
2. Asphalt binder. Take at least two 1 qt samples. Each sample must be in a cylindrical-shaped can with an open top and friction lid. If the asphalt binder is modified or rubberized, the asphalt binder must be sampled with the components blended in the proportions to be used.
3. RAP. Samples must be at least 50 lb from each fractionated stockpile used or 100 lb from the belt.
4. Plant-produced HMA. The HMA samples must be at least 250 lb.

For aggregate, RAP, and HMA, split the samples into at least 4 parts and label their containers. Submit 3 parts and keep 1 part.

After acceptance of the JMF submittal, the Engineer verifies each proposed JMF within 20 days of receiving all verification samples.

For JMF verification, the Engineer tests the following for compliance with the specifications:

1. Aggregate quality
2. Aggregate gradation
3. HMA quality characteristics for Department acceptance

To verify the HMA for air voids, voids in mineral aggregate, and dust proportion, the Engineer uses an average of 3 briquettes. The Engineer tests plant-produced material.

If the Engineer verifies the JMF, the Engineer furnishes you a Hot Mix Asphalt Verification form.

If the Engineer's test results on plant-produced samples do not show compliance with the specifications, the Engineer notifies you. Submit a JMF adjusted after verification failure based on your testing unless the Engineer authorizes reverification without adjustments. Engineer authorized reverification without adjustment is not JMF adjusted after verification failure. A JMF adjusted after verification failure may include a change in:

1. Asphalt binder content TV up to ±0.20 percent from the OBC value submitted on the Contractor Hot Mix Asphalt Design Data form
2. Aggregate gradation TV within the TV limits specified in the aggregate gradation table

You may adjust the JMF only once due to a failed verification test.

For each HMA type and aggregate size specified, the Engineer verifies up to 2 proposed JMF submittals including a JMF adjusted after verification failure. Do not resubmit any of the 2 proposed submittals including a JMF adjusted after verification failure that failed verification on any other Caltrans projects. If you submit more than 2 JMFs for each type of HMA and aggregate size, the Engineer deducts $3,000 from payments for each verification exceeding this limit. This deduction does not apply to verifications initiated by the Engineer or if a JMF expires while HMA production is stopped longer than 30 days.

A verified JMF is valid for 12 months.

39-2.01A(4)(c) Job Mix Formula Authorization

You may start HMA production if:

1. Engineer's review of the JMF shows compliance with the specifications
2. Department has verified the JMF within 12 months before HMA production
3. Engineer authorizes the verified JMF

39-2.01A(4)(d) Job Mix Formula Renewal

For a JMF renewaland upon request, in the Engineer's presence and from the same production run, take samples of:

1. Aggregates. Coarse, fine, and supplemental fine aggregates must be taken from the combined cold-feed belt or the hot bins. If lime treatment is required, samples must be taken from individual stockpiles before lime treatment. Samples must be at least 120 lb for each coarse aggregate, 80 lb for each fine aggregate, and 10 lb for each type of supplemental fines. For hot-bin samples, the Department combines these aggregate samples to verify the TV submitted on a Contractor Job Mix Formula Proposal form.
2. Asphalt binder. Take at least two 1 qt samples. Each sample must be in a cylindrical-shaped can with an open top and friction lid. If the asphalt binder is modified or rubberized, the asphalt binder must be sampled with the components blended in the proportions to be used.
3. RAP. Samples must be at least 50 lb from each fractionated stockpile.
4. Plant-produced HMA. The HMA samples must be at least 250 lb.

Notify the Engineer at least 2 business days before sampling materials. For aggregate, RAP, and HMA, split samples into at least 4 parts. Submit 3 parts and use 1 part for your testing.

Allow the Engineer 5 business days from a complete JMF reverification submittal for document review of the aggregate qualities, mix design, and JMF.

The most recent aggregate quality test results within the past 12 months may be used for verification of JMF renewal or upon request, the Engineer may perform aggregate quality tests for verification of JMF renewal.

The Engineer verifies the JMF for renewal under section 39-2.01A(4)(b) except:

1. Engineer keeps the samples until you provide test results for your part on a Contractor Job Mix Formula Renewal form.
2. Department tests samples of materials obtained from the HMA production unit after you submit test results that comply with the mix design specifications.
3. After completion of the JMF verification renewal document review, the Engineer verifies each proposed JMF within 20 days of receiving the verification renewal samples and the complete Contractor Job Mix Formula Renewal form.
4. You may not adjust the JMF due to a failed verification.
5. For each HMA type and aggregate gradation specified, the Engineer verifies at no cost to you 1 proposed JMF renewal within a 12-month period.

If the Engineer verifies the JMF renewal, the Engineer furnishes you a Hot Mix Asphalt Verification form. The Hot Mix Asphalt Verification form is valid for 12 months.

39-2.01A(4)(e) Job Mix Formula Modification

The Engineer verifies the modified JMF after the modified JMF HMA is placed and verification samples are taken within the first 750 tons. The Engineer tests verification samples for compliance with:

1. Hamburg wheel track mix design specifications
2. Air void content
3. Voids in mineral aggregate on plant-produced HMA mix design specifications
4. Dust proportion mix design specifications

The Engineer may test for moisture susceptibility for compliance with the mix design specifications.

If the modified JMF is verified, the Engineer revises your Hot Mix Asphalt Verification form to include the new asphalt binder source, new liquid antistrip producer, or new liquid antistrip dosage. Your revised form will have the same expiration date as the original form.

If a modified JMF is not verified, stop production and any HMA placed using the modified JMF is rejected.

The Engineer deducts $2,000 from payments for each JMF modification.

39-2.01A(4)(f) Certifications

39-2.01A(4)(f)(i) General

Laboratories testing aggregate and HMA qualities used to prepare the mix design and JMF must be qualified under AASHTO re:source program and the Department's Independent Assurance Program.

39-2.01A(4)(f)(ii) Hot Mix Asphalt Plants

Before production, the HMA plant must have a current qualification under the Department's Material Plant Quality Program.

39-2.01A(4)(f)(iii)–39-2.01A(4)(f)(v) Reserved

39-2.01A(4)(g) Reserved

39-2.01A(4)(h) Quality Control

39-2.01A(4)(h)(i) General

QC test results must comply with the specifications for Department acceptance.

Condition each at-the-plant sample of HMA mixture for AASHTO 324 and AASHTO 283 in compliance with sections 7.1.2, 7.1.3, and 7.1.4 of AASHTO R 30. Condition each at-the-plant sample of HMA mixture when composite aggregate absorption factor is greater than 2.0 percent as indicated by the JMF in compliance with sections 7.1.2, 7.1.3, and 7.1.4 of AASHTO R 30.

Prepare 3 briquettes for air voids content and voids in mineral aggregate determination. Report the average of 3 tests.

Except for smoothness, if 2 consecutive QC test results or any 3 QC test results for 1 day's production do not comply with the materials specifications:

1. Stop HMA production
2. Notify the Engineer
3. Take corrective action
4. Demonstrate compliance with the specifications before resuming production and placement

For QC tests performed under AASHTO T 27, results are considered 1 QC test regardless of number of sieves out of compliance.

Do not resume production and placement until the Engineer authorizes your corrective action proposal.

39-2.01A(4)(h)(ii) Reserved

39-2.01A(4)(h)(iii) Aggregates

39-2.01A(4)(h)(iii)(A) General

Reserved

39-2.01A(4)(h)(iii)(B) Aggregate Lime Treatments

If lime treatment is required, sample coarse and fine aggregates from individual stockpiles before lime treatment. Combine aggregate in the JMF proportions. Test the aggregates under the test methods and frequencies shown in the following table:

Aggregate Quality Control During Lime Treatment

Quality characteristic	Test method	Minimum sampling and testing frequency
Sand equivalent[a, b]	AASHTO T 176	1 per 750 tons of untreated aggregate
Percent of crushed particles	AASHTO T 335	1 per 10,000 tons or 2 per project whichever is greater
Los Angeles Rattler	AASHTO T 96	
Fine aggregate angularity	AASHTO T 304, Method A	
Flat and elongated particles	ASTM D4791	

[a]Report test results as the average of 3 tests from a single sample.
[b]Use of a sand reading indicator is required as shown in AASHTO T 176, Figure 1. Sections 4.7, "Manual Shaker," 7.1.2, "Alternate Method No. 2," and 8.4.3, "Hand Method," do not apply. Prepare the stock solution as specified in section 4.8.1, "Stock solution with formaldehyde," except omit the addition of formaldehyde.

For lime slurry aggregate treatment, determine the aggregate moisture content at least once every 2 hours of treatment. Calculate moisture content under AASHTO T 255 and report it as a percent of dry aggregate weight. Use the moisture content calculations as a set point for the proportioning process controller.

The device controlling lime and aggregate proportioning must produce a treatment data log. The log must consist of a series of data sets captured at 10-minute intervals throughout daily treatment. The data must be a treatment activity register and not a summation. The material represented by a data set is the quantity produced 5 minutes before and 5 minutes after the capture time. Collected data must be stored by the controller for the duration of the Contract.

If 3 consecutive sets of recorded treatment data indicate a deviation of more than 0.2 percent above or below the lime ratio in the authorized JMF, stop treatment and take corrective action.

If a set of recorded treatment data indicates a deviation of more than 0.4 percent above or below the lime ratio in the authorized JMF, stop treatment and do not use the material represented by that set of data in HMA.

If 20 percent or more of the total daily treatment indicates a deviation of more than 0.2 percent above or below the lime ratio in the authorized JMF, stop treatment and do not use that day's treated aggregate in HMA.

The Engineer may order you to stop aggregate treatment activities for any of following:

1. You fail to submit treatment data log.
2. You fail to submit aggregate QC data for marinated aggregate.
3. You submit incomplete, untimely, or incorrectly formatted data.
4. You do not take corrective actions.
5. You take late or unsuccessful corrective actions.
6. You do not stop treatment when proportioning tolerances are exceeded.
7. You use malfunctioning or failed proportioning devices.

If you stop treatment for noncompliance, notify the Engineer of any corrective actions taken and conduct a successful 20-minute test run before resuming treatment.

39-2.01A(4)(h)(iv) Liquid Antistrip Treatment

For continuous mixing or batch-plant mixing, sample asphalt binder before adding liquid antistrip. For continuous mixing, sample the combined asphalt binder and liquid antistrip after the static mixer.

39-2.01A(4)(h)(v) Production Start-up Evaluation

You and the Engineer evaluate HMA production and placement at production start-up.

Within the first 750 tons produced on the 1st day of HMA production, in the Engineer's presence, and from the same production run, take samples of:

1. Aggregates
2. Asphalt binder
3. RAP
4. HMA

Sample aggregates from the combined cold-feed belt or hot bin. Take RAP samples from the RAP system.

For aggregates, RAP, and HMA, split the samples into at least 4 parts and label their containers. Submit 3 parts and keep 1 part.

You and the Engineer must test the samples and report test results, except for AASHTO T 324 (Modified) and AASHTO T 283 test results, within 5 business days of sampling. For AASHTO T 324 (Modified) and AASHTO T 283 test results, report test results within 15 days of sampling. If you proceed before receipt of the test results, the Engineer may consider the HMA placed to be represented by these test results.

Take one 4- or 6-inch diameter density core for each 250 tons or portion thereof of HMA placed. For each density core, the Engineer reports the bulk specific gravity determined under AASHTO T 275, Method A, in addition to the percent of theoretical maximum density.

39-2.01A(4)(h)(vi) Hot Mix Asphalt Density

During HMA placement determine HMA density using a nuclear gauge. On the 1st day of production, develop a correlation factor between cores and nuclear gauge under California Test 375.

Test for in-place density using cores and a nuclear gauge. Test at random locations you select and include the test results in your QC production tests reports.

39-2.01A(4)(h)(vii) Tapered Notched Wedge

Perform QC testing on the completed tapered notched wedge joint as follows:

1. Perform density tests using a calibrated nuclear gauge at a rate of 1 test for every 750-foot section along the joint. Select random locations for testing within each 750-foot section.
2. Perform density tests at the centerline of the joint, 6 inches from the upper vertical notch, after the adjacent lane is placed and before opening the pavement to traffic.
3. Determine theoretical maximum density.
4. Determine percent compaction of the longitudinal joint as the ratio of the daily average density to the maximum density test results.

Determine percent compaction values each day the tapered notched wedge joint is completed. If the percent compaction of 1 day's production is less than 91 percent, that day's notched wedge joint is rejected. Discontinue placement of the tapered notched wedge and notify the Engineer of changes you will make to your construction process to comply with the specifications.

39-2.01A(4)(h)(viii) Density Cores

Except for HMA pavement placed using method compaction, take 4- or 6-inch diameter density cores at least once every 5 business days. Take 1 density core for every 250 tons of HMA from random locations the Engineer selects. Take density cores in the Engineer's presence, and backfill and compact holes with authorized material. Before submitting a density core, mark it with the density core's location and place it in a protective container.

If a density core is damaged, replace it with a density core taken within 1 foot longitudinally from the original density core location. Relocate any density core located within 1 foot of a rumble strip to 1 foot transversely away from the rumble strip.

For a tapered notched wedge joint, take 4- or 6-inch diameter density cores 6 inches from the upper vertical notch of the completed longitudinal joint for every 3,000 feet at locations selected by the Engineer. Take cores after the adjacent lane is placed and before opening the pavement to traffic. Take cores in the presence of the Engineer, and backfill and compact holes with authorized material. Before submitting a density core, mark it with the core's location, and place it in a protective container.

39-2.01A(4)(h)(ix) Reserved

39-2.01A(4)(i) Department Acceptance

39-2.01A(4)(i)(i) General

The Department tests treated aggregate for acceptance before lime treatment except for gradation.

The Engineer takes HMA samples for AASHTO T 283 and AASHTO T 324 (Modified) from any of the following locations:

1. Plant
2. Truck
3. Windrow

The Engineer takes HMA samples for all other tests from any of the following locations:

1. Plant
2. Truck
3. Windrow
4. Mat behind the paver

To obtain workability of the HMA sample for splitting, the Engineer reheats each sample of HMA mixture not more than 2 cycles. Each reheat cycle is performed by placing the loose mixture in a mechanical forced-draft oven for 2 hours or less after the sample reaches 140 degrees F.

The Engineer conditions each at-the-plant sample of HMA mixture for AASHTO 324 and AASHTO 283 in compliance with sections 7.1.2, 7.1.3, and 7.1.4 of AASHTO R 30. The Engineer conditions each at-the-plant sample of HMA mixture when composite aggregate absorption factor is greater than 2.0 percent as indicated by the JMF in compliance with sections 7.1.2, 7.1.3, and 7.1.4 of AASHTO R 30.

No single aggregate or HMA test result may represent more than 750 tons or one day's production, whichever is less, except AASHTO T 283 and AASHTO T 324 (Modified).

Except for smoothness, if 2 consecutive Department acceptance test results or any 3 Department acceptance test results for 1 day's production do not comply with the specifications:

1. Stop HMA production
2. Take corrective action
3. Demonstrate compliance with the specifications before resuming production and placement

For Department acceptance tests performed under AASHTO T 27, results are considered 1 Department acceptance test regardless of the number of sieves out of compliance.

The Engineer accepts HMA based on:

1. Authorized JMF
2. Authorized QC plan
3. Asphalt binder compliance
4. Asphalt emulsion compliance
5. Visual inspection
6. Pavement smoothness

39-2.01A(4)(i)(ii) In-Place Density

Except for HMA pavement placed using method compaction, the Engineer tests the density core you take from each 250 tons of HMA. The Engineer determines the percent of theoretical maximum density for each density core by determining the density core's density and dividing by the theoretical maximum density.

Density cores must be taken from the final layer, cored through the entire pavement thickness shown. Where OGFC is required, take the density cores before placing OGFC.

If the percent of theoretical maximum density does not comply with the specifications, the Engineer must accept the HMA and take a payment deduction as shown in the following table:

Reduced Payment Factors for Percent of Maximum Theoretical Density

HMA percent of maximum theoretical density	Reduced payment factor	HMA percent of maximum theoretical density	Reduced payment factor
91.0	0.0000	97.0	0.0000
90.9	0.0125	97.1	0.0125
90.8	0.0250	97.2	0.0250
90.7	0.0375	97.3	0.0375
90.6	0.0500	97.4	0.0500
90.5	0.0625	97.5	0.0625
90.4	0.0750	97.6	0.0750
90.3	0.0875	97.7	0.0875
90.2	0.1000	97.8	0.1000
90.1	0.1125	97.9	0.1125
90.0	0.1250	98.0	0.1250
89.9	0.1375	98.1	0.1375
89.8	0.1500	98.2	0.1500
89.7	0.1625	98.3	0.1625
89.6	0.1750	98.4	0.1750
89.5	0.1875	98.5	0.1875
89.4	0.2000	98.6	0.2000
89.3	0.2125	98.7	0.2125
89.2	0.2250	98.8	0.2250
89.1	0.2375	98.9	0.2375
89.0	0.2500	99.0	0.2500
<89.0	Remove and replace	>99.0	Remove and replace

For acceptance of a completed tapered notched wedge joint, the Engineer determines density from cores you take every 3,000 feet.

39-2.01A(4)(i)(iii) Pavement Smoothness

For areas that require pavement smoothness determined using an inertial profiler, the pavement surface must:

1. Have no areas of localized roughness with an International Roughness Index greater than 160 in/mi

2. Comply with the Mean Roughness Index requirements shown in the following table for a 0.1 mile section:

HMA Pavement Smoothness Acceptance Criteria

HMA thickness	Mean Roughness Index requirement
> 0.25 foot	60 in/mi or less
≤ 0.25 foot	75 in/mi or less

Note: These requirements do not apply to the OGFC surface. Smoothness requirements for OGFC are specified in section 39-2.04A(4)(c)(iii).

The final surface of HMA must comply with the Mean Roughness Index requirements before placing OGFC. Correct pavement to the Mean Roughness Index specifications. Areas of localized roughness greater than 160 in/mi must be corrected regardless of the Mean Roughness Index values of a 0.1-mile section.

39-2.01A(4)(i)(iv) Dispute Resolution

You and the Engineer must work together to avoid potential conflicts and to resolve disputes regarding test result discrepancies. Notify the Engineer within 5 business days of receiving a test result if you dispute the test result.

If you or the Engineer dispute the other's test results, submit your test results and copies of paperwork including worksheets used to determine the disputed test results. An independent third party performs referee testing. Before the third party participates in a dispute resolution, it must be qualified under AASHTO re:source program, and the Department's Independent Assurance Program. The independent third party must have no prior direct involvement with this Contract. By mutual agreement, the independent third party is chosen from:

1. Department laboratory in a district or region not in the district or region the project is located
2. Transportation Laboratory
3. Laboratory not currently employed by you or your HMA producer

If the Department's portion of the split QC samples or acceptance samples are not available, the independent third party uses any available material representing the disputed HMA for evaluation.

For a dispute involving JMF verification, the independent third party performs referee testing as specified in the 5th paragraph of section 39-2.01A(4)(b).

If the independent third party determines the Department's test results are valid, the Engineer deducts the independent third party's testing costs from payments. If the independent third party determines your test results are valid, the Department pays the independent third party's testing costs.

39-2.01B Materials

39-2.01B(1) General

Reserved

39-2.01B(2) Mix Design

39-2.01B(2)(a) General

The HMA mix design must comply with the superpave HMA mix design as described in *MS-2 Asphalt Mix Design Methods* by the Asphalt Institute.

The Contractor Hot Mix Asphalt Design Data form must show documentation on aggregate quality.

39-2.01B(2)(b) Hot Mix Asphalt Treatments

If the proposed JMF indicates that the aggregate is being treated with dry lime or lime slurry with marination, or the HMA with liquid antistrip, then testing the untreated aggregate under AASHTO T 283 and AASHTO T 324 is not required.

If HMA treatment is required or being used by the Contractor, determine the plasticity index of the aggregate blend under California Test 204.

Do not use an aggregate blend with a plasticity index greater than 10.

If the plasticity index is from 4 to 10, treat the aggregate blend with dry lime with marination or lime slurry with marination.

If the plasticity index is less than 4, treat the aggregate blend with dry lime or lime slurry with marination, or treat the HMA with liquid antistrip.

39-2.01B(2)(c) Warm Mix Asphalt Technology

For HMA with WMA additive technology, produce HMA mix samples for your mix design using your methodology for inclusion of WMA admixture in laboratory-produced HMA. Cure the samples in a forced-air draft oven at 275 degrees F for 4 hours ± 10 minutes.

For WMA water injection foam technology, the use of foamed asphalt for mix design is not required.

39-2.01B(3) Asphalt Binder

Asphalt binder must comply with section 92.

For a leveling course, the grade of asphalt binder for the HMA must be PG 64-10 or PG 64-16.

39-2.01B(4) Aggregates

39-2.01B(4)(a) General

Aggregates must be clean and free from deleterious substances.

The aggregates for a leveling course must comply with the gradation specifications for Type A HMA in section 39-2.02B.

39-2.01B(4)(b) Aggregate Gradations

Aggregate gradation must be determined before the addition of asphalt binder and must include supplemental fine aggregates. Test for aggregate gradation under AASHTO T 27. Do not wash the coarse aggregate. Wash the fine aggregate only. Use a mechanical sieve shaker. Aggregate shaking time must not exceed 10 minutes for each coarse and fine aggregate portion.

Choose a TV within the TV limits shown in the tables titled "Aggregate Gradations."

Gradations are based on nominal maximum aggregate size.

39-2.01B(4)(c) Aggregate Lime Treatments

39-2.01B(4)(c)(i) General

If aggregate lime treatment is required as specified in section 39-2.01B(2)(b), the virgin aggregate must comply with the aggregate quality specifications.

Lime for treating aggregate must comply with section 24-2.02.

Water for lime treatment of aggregate with lime slurry must comply with section 24-1.02B.

Notify the Engineer at least 24 hours before the start of aggregate treatment.

Do not treat RAP.

The lime ratio is the pounds of dry lime per 100 lb of dry virgin aggregate expressed as a percentage. Water content of slurry or untreated aggregate must not affect the lime ratio.

Coarse and fine aggregate fractions must have the lime ratio ranges shown in the following table:

Aggregate fractions	Lime ratio percent
Coarse	0.4–1.0
Fine	1.5–2.0
Combined	0.8–1.5

The lime ratio for fine and coarse aggregate must be within ±0.2 percent of the lime ratio in the accepted JMF. The lime ratio must be within ±0.2 percent of the authorized lime ratio when you combine the individual aggregate sizes in the JMF proportions. The lime ratio must be determined before the addition of RAP.

If marination is required, marinate treated aggregate in stockpiles from 24 hours to 60 days before using in HMA. Do not use aggregate marinated longer than 60 days.

Treated aggregate must not have lime balls or clods.

39-2.01B(4)(c)(ii) Dry Lime

If marination is required:

1. Treat and marinate coarse and fine aggregates separately
2. Treat the aggregate and stockpile for marination only once
3. Treat the aggregate separately from HMA production

Proportion dry lime by weight with an automatic continuous proportioning system.

If you use a batch-type proportioning system for HMA production, control proportioning in compliance with the specifications for continuous mixing plants. Use a separate dry lime aggregate treatment system for HMA batch mixing including:

1. Pugmill mixer
2. Controller
3. Weigh belt for the lime
4. Weigh belt for the aggregate

If a continuous mixing plant for HMA production without lime-marinated aggregates is used, use a controller that measures the blended aggregate weight after any additional water is added to the mixture. The controller must determine the quantity of lime added to the aggregate from the aggregate weigh belt input in connection with the manually input total aggregate moisture, the manually input target lime content, and the lime proportioning system output. Use a continuous aggregate weigh belt and pugmill mixer for lime treatment in addition to the weigh belt for the aggregate proportioning to asphalt binder in the HMA plant. If you use a water meter for moisture control for lime treatment, the meter must comply with Department's *MPQP* manual.

When mixing dry lime with aggregate, the aggregate moisture content must ensure complete lime coating. The aggregate moisture content must not cause aggregate to be lost between the point of weighing the combined aggregate continuous stream and the dryer. Add water to the aggregate for mixing and coating before dry lime addition. Immediately before mixing lime with aggregate, water must not visibly separate from the aggregate.

Mix aggregate, water, and dry lime with a continuous pugmill mixer with twin shafts. Immediately before mixing lime with aggregate, water must not visibly separate from the aggregate. Store dry lime in a uniform and free-flowing condition. Introduce dry lime to the pugmill in a continuous process. The introduction must occur after the aggregate cold feed and before the point of proportioning across a weigh belt and the aggregate dryer. Prevent loss of dry lime.

The pugmill must be equipped with paddles arranged to provide sufficient mixing action and mixture movement. The pugmill must produce a homogeneous mixture of uniformly coated aggregates at mixer discharge.

If the aggregate treatment process is stopped longer than 1 hour, clean the equipment of partially treated aggregate and lime.

Aggregate must be completely treated before introduction into the mixing drum.

39-2.01B(4)(c)(iii) Lime Slurry

For lime slurry aggregate treatment, treat aggregate separate from HMA production. Stockpile and marinate the aggregate.

Proportion lime and water with a continuous or batch mixing system.

Add lime to the aggregate as slurry consisting of mixed dry lime and water at a ratio of 1 part lime to from 2 to 3 parts water by weight. The slurry must completely coat the aggregate.

Immediately before mixing lime slurry with the aggregate, water must not visibly separate from the aggregate.

Proportion lime slurry and aggregate by weight in a continuous process.

39-2.01B(5) Liquid Antistrip Treatment

Liquid antistrip must be from 0.25 to 1.0 percent by weight of asphalt binder. Do not use liquid antistrip as a substitute for asphalt binder.

Liquid antistrip total amine value must be 325 minimum when tested under ASTM D2074.

Use only 1 liquid antistrip type or brand at a time. Do not mix liquid antistrip types or brands.

Store and mix liquid antistrip under the manufacturer's instructions.

39-2.01B(6)–39-2.01B(7) Reserved

39-2.01B(8) Hot Mix Asphalt Production

39-2.01B(8)(a) General

Do not start HMA production before verification and authorization of JMF.

The HMA plant must have a current qualification under the Department's Material Plant Quality Program.

Weighing and metering devices used for the production of HMA modified with additives must comply with the Department's *MPQP*. If a loss-in-weight meter is used for dry HMA additive, the meter must have an automatic and integral material delivery control system for the refill cycle.

Calibrate the loss-in-weight meter by:

1. Including at least 1 complete system refill cycle during each calibration test run
2. Operating the device in a normal run mode for 10 minutes immediately before starting the calibration process
3. Isolating the scale system within the loss-in-weight feeder from surrounding vibration
4. Checking the scale system within the loss-in-weight feeder for accuracy before and after the calibration process and daily during mix production
5. Using a minimum 15 minute or minimum 250 lb test run size for a dry ingredient delivery rate of less than 1 ton per hour.
6. Complying with the limits of Table B, "Conveyor Scale Testing Extremes," in the Department's *MPQP*

Proportion aggregate by hot or cold-feed control.

Aggregate temperature must not be more than 375 degrees F when mixed with the asphalt binder.

Asphalt binder temperature must be from 275 to 375 degrees F when mixed with aggregate.

Mix HMA ingredients into a homogeneous mixture of coated aggregates.

HMA must be produced at the temperatures shown in the following table:

HMA Production Temperatures

HMA compaction	Temperature (°F)
HMA	
Density based	≤ 325
Method	305–325
HMA with WMA technology	
Density based	240–325
Method	260–325

If you stop production for longer than 30 days, a production start-up evaluation is required.

39-2.01B(8)(b) Liquid Antistrip

If 3 consecutive sets of recorded production data show that the actual delivered liquid antistrip weight is more than ±1 percent of the authorized mix design liquid antistrip weight, stop production and take corrective action.

If a set of recorded production data shows that the actual delivered liquid antistrip weight is more than ±2 percent of the authorized mix design liquid antistrip weight, stop production. If the liquid antistrip weight exceeds 1.2 percent of the asphalt binder weight, do not use the HMA represented by that data.

The continuous mixing plant controller proportioning the HMA must produce a production data log. The log must consist of a series of data sets captured at 10-minute intervals throughout daily production. The data must be a production activity register and not a summation. The material represented by the data is the quantity produced 5 minutes before and 5 minutes after the capture time. For the duration of the Contract, the collected data must be stored by the plant controller or a computer's memory at the plant.

The Engineer orders proportioning activities stopped for any of the following reasons:

1. You fail to submit data
2. You submit incomplete, untimely, or incorrectly formatted data
3. You fail to take corrective actions
4. You take late or unsuccessful corrective actions
5. You fail to stop production when proportioning tolerances are exceeded
6. You use malfunctioning or failed proportioning devices

If you stop production, notify the Engineer of any corrective actions taken before resuming.

39-2.01B(8)(c) Warm Mix Asphalt Technology

Proportion all ingredients by weight. The HMA plant process controller must be the sole source of ingredient proportioning control and be fully interfaced with all scales and meters used in the production process. The addition of the HMA additive must be controlled by the plant process controller.

Liquid ingredient additive, including a normally dry ingredient made liquid, must be proportioned with a mass flow meter at continuous mixing plants. Use a mass flow meter or a container scale to proportion liquid additives at batch mixing plants.

Continuous mixing plants using HMA additives must comply with the following:

1. Dry ingredient additives for continuous production must be proportioned with a conveyor scale or a loss-in-weight meter.
2. HMA plant process controller and ingredient measuring systems must be capable of varying all ingredient-feed rates proportionate with the dry aggregate delivery at all production rates and rate changes.
3. Liquid HMA additive must enter the production stream with the binder. Dry HMA additive must enter the production stream at or before the mixing area.
4. If dry HMA additives are used at continuous mixing HMA plants, bag-house dust systems must return all captured material to the mix. This requirement is waived for lime-treated aggregates.
5. HMA additive must be proportioned to within ±0.3 percent of the target additive rate.

Batch mixing plants using HMA additives must comply with the following:

1. Metered HMA additive must be placed in an intermediate holding vessel before being added to the stream of asphalt binder as it enters the pugmill.
2. If a container scale is used, weigh additive before combining with asphalt binder. Keep the container scale separate from other ingredient proportioning. The container scale capacity must be no more than twice the volume of the maximum additive batch size. The container scale's graduations must be smaller than the proportioning tolerance or 0.001 times the container scale capacity.
3. Dry HMA additive proportioning devices must be separate from metering devices for the aggregates and asphalt binder. Proportion dry HMA additive directly into the pugmill, or place in an intermediate holding vessel to be added to the pugmill at the appropriate time in the batch cycle. Dry ingredients for batch production must be proportioned with a hopper scale.

4. Zero tolerance for the HMA additive batch scale is ±0.5 percent of the target additive weight. The indicated HMA additive batch scale weight may vary from the preselected weight setting by up to ±1.0 percent of the target additive weight.

39-2.01B(9) Geosynthetic Pavement Interlayer

Geosynthetic pavement interlayer must comply with the specifications for pavement fabric, paving mat, paving grid, paving geocomposite grid, or geocomposite strip membrane as shown.

The asphalt binder for geosynthetic pavement interlayer must be PG 64-10, PG 64-16, or PG 70-10.

39-2.01B(10) Tack Coat

Tack coat must comply with the specifications for asphaltic emulsion or asphalt binder. Choose the type and grade of emulsion or binder.

39-2.01B(11) Miscellaneous Areas and Dikes

For miscellaneous areas and dikes:

1. Choose the aggregate gradation from:
   1.1. 3/8-inch Type A HMA aggregate gradation
   1.2. 1/2-inch Type A HMA aggregate gradation
   1.3. dike mix aggregate gradation
2. Choose asphalt binder Grade PG 64-10, PG 64-16 or PG 70-10.
3. Minimum asphalt binder content must be:
   3.1. 6.40 percent for 3/8-inch Type A HMA aggregate gradation
   3.2. 5.70 percent for 1/2-inch Type A HMA aggregate gradation
   3.3. 6.00 percent for dike mix aggregate gradation

If you request and the Engineer authorizes, you may reduce the minimum asphalt binder content.

Aggregate gradation for dike mix must be within the TV limits for the specified sieve size shown in the following table:

Dike Mix Aggregate Gradation
(Percentage Passing)

Sieve size	Target value limit	Allowable tolerance
1/2"	100	--
3/8"	---	95 - 100
No. 4	73–77	TV ± 10
No. 8	58–63	TV ± 10
No. 30	29–34	TV ± 10
No. 200		0 - 14

For HMA used in miscellaneous areas and dikes, sections 39-2.01A(3), 39-2.01A(4), 39-2.01B(2), 39-2.01B(4)(c), and 39-2.01B(5)–(10) do not apply.

39-2.01C Construction

39-2.01C(1) General

Do not place HMA on wet pavement or frozen surface.

You may deposit HMA in a windrow and load it in the paver if:

1. Paver is equipped with a hopper that automatically feeds the screed
2. Loading equipment can pick up the windrowed material and deposit it in the paver hopper without damaging base material
3. Activities for depositing, pickup, loading, and paving are continuous
4. For method compaction:
   4.1. The temperature of the HMA and the HMA produced with WMA water injection technology in the windrow does not fall below 260 degrees F

4.2. The temperature of the HMA produced using WMA additive technology in the windrow does not fall below 250 degrees F

HMA placed in a windrow on the roadway surface must not extend more than 250 feet in front of the loading equipment or material transfer vehicle.

You may place HMA in 1 or more layers on areas less than 5 feet wide and outside the traveled way, including shoulders. You may use mechanical equipment other than a paver for these areas. The equipment must produce uniform smoothness and texture.

HMA handled, spread, or windrowed must not stain the finished surface of any improvement, including pavement.

Do not use petroleum products such as kerosene or diesel fuel to release HMA from trucks, spreaders, or compactors.

HMA must be free of:

1. Segregation
2. Coarse or fine aggregate pockets
3. Hardened lumps
4. Marks
5. Tearing
6. Irregular texture

Complete finish rolling activities before the pavement surface temperature is:

1. Below 150 degrees F for HMA with unmodified binder
2. Below 140 degrees F for HMA with modified binder

39-2.01C(2) Spreading and Compacting Equipment

39-2.01C(2)(a) General

Paving equipment for spreading must be:

1. Self-propelled
2. Mechanical
3. Equipped with a screed or strike-off assembly that can distribute HMA the full width of a traffic lane
4. Equipped with a full-width compacting device
5. Equipped with automatic screed controls and sensing devices that control the thickness, longitudinal grade, and transverse screed slope

Install and maintain grade and slope references.

The screed must be heated and produce a uniform HMA surface texture without tearing, shoving, or gouging.

The paver must not leave marks such as ridges and indentations unless you can eliminate them by rolling.

Rollers must be equipped with a system that prevents HMA from sticking to the wheels. You may use a parting agent that does not damage the HMA or impede the bonding of layers.

In areas inaccessible to spreading and compacting equipment:

1. Spread the HMA by any means to obtain the specified lines, grades, and cross sections
2. Use a pneumatic tamper, plate compactor, or equivalent to achieve thorough compaction

39-2.01C(2)(b) Material Transfer Vehicle

If a material transfer vehicle is specified, the material transfer vehicle must have sufficient capacity to prevent stopping the paver and must be capable of:

1. Either receiving HMA directly from trucks or using a windrow pickup head to load it from a windrow deposited on the roadway surface
2. Remixing the HMA with augers before transferring into the paver's receiving hopper or feed system
3. Transferring HMA directly into the paver's receiving hopper or feed system

39-2.01C(2)(c) Method Compaction Equipment

For method compaction, each paver spreading HMA must be followed by at least one of each of the following 3 types of rollers:

1. Breakdown roller must be a vibratory roller specifically designed to compact HMA. The roller must be capable of at least 2,500 vibrations per minute and must be equipped with amplitude and frequency controls. The roller's gross static weight must be at least 7.5 tons.
2. Intermediate roller must be an oscillating-type pneumatic-tired roller at least 4 feet wide. Pneumatic tires must be of equal size, diameter, type, and ply. The tires must be inflated to 60 psi minimum and maintained so that the air pressure does not vary more than 5 psi.
3. Finishing roller must be a steel-tired, 2-axle tandem roller. The roller's gross static weight must be at least 7.5 tons.

Each roller must have a separate operator. Rollers must be self-propelled and reversible.

39-2.01C(2)(d)–39-2.01C(2)(f) Reserved

39-2.01C(3) Surface Preparation

39-2.01C(3)(a) General

Before placing HMA, remove loose paving particles, dirt, and other extraneous material by any means including flushing and sweeping.

39-2.01C(3)(b) Subgrade

Prepare subgrade to receive HMA under the sections for the material involved. Subgrade must be free of loose and extraneous material.

39-2.01C(3)(c) Reserved

39-2.01C(3)(d) Prepaving Inertial Profiler

Section 39-2.01C(3)(d) applies to existing asphalt concrete surfaces receiving an HMA overlay if a bid item for prepaving inertial profiler is shown on the Bid Item List.

Before starting paving activities, perform prepaving inertial profiler measurements. Prepaving inertial profiler work includes taking profiles of the existing pavement and analyzing the data with ProVAL to determine existing pavement International Roughness Index, Mean Roughness Index, and areas of localized roughness.

If the Contract includes cold planing, take prepaving inertial profiler measurements before cold planning.

If the Contract includes replace asphalt concrete surfacing, take prepaving inertial profiler measurements after replacing the asphalt concrete surfacing.

39-2.01C(3)(e) Prepaving Grinding

Section 39-2.01C(3)(e) applies to existing asphalt concrete surfaces:

1. That will not be cold planned or milled
2. That will receive an HMA overlay less than or equal to 0.25 foot exclusive of OGFC
3. If a bid item for prepaving grinding day is shown on the Bid Item List

After performing prepaving inertial profiling, correct areas of localized roughness greater than 180 in/mi.

Notify the Engineer of those areas of localized roughness that cannot be corrected by prepaving grinding according to the ProVAL smoothness assurance analysis grinding report. The Engineer responds to your notification within 5 business days.

For those areas of localized roughness that cannot be corrected by grinding, the Engineer may order you to either (1) not correct the areas of localized roughness or (2) correct areas of localized roughness by a

different method and take profiles of the corrected areas with an inertial profiler. Corrective work performed by a different method, taking profiles of the corrected areas, the associated traffic control is change order work.

If ordered not to correct areas of localized roughness, the smoothness specifications do not apply to the final pavement surface placed in those areas.

After correcting areas of localized roughness, take profiles of the corrected area and submit profile data as specified in section 36-3.01C(3).

Dispose of grinding residue.

Pave within 7 days of correcting areas.

The final pavement surface must comply with section 39-2.01A(4)(i)(iii).

If the Engineer determines more time is required for prepaving grinding than the Contract allows for and if prepaving grinding is a controlling activity, the Engineer makes a time adjustment.

39-2.01C(3)(f) Tack Coat

Apply a tack coat:

1. To existing pavement including planed surfaces
2. Between HMA layers
3. To vertical surfaces of:
   3.1. Curbs
   3.2. Gutters
   3.3. Construction joints

Equipment for the application of tack coat must comply with section 37-1.03B.

Before placing HMA, apply a tack coat in 1 application at the minimum residual rate shown in the following table for the condition of the underlying surface:

Tack Coat Application Rates for HMA

HMA over:	Minimum residual rates (gal/sq yd)		
	CSS1/CSS1h, SS1/SS1h and QS1h/CQS1h asphaltic emulsion	CRS1/CRS2, RS1/RS2 and QS1/CQS1 asphaltic emulsion	Asphalt binder and PMRS2/PMCRS2 and PMRS2h/PMCRS2h asphaltic emulsion
New HMA (between layers)	0.02	0.03	0.02
Concrete pavement and existing asphalt concrete surfacing	0.03	0.04	0.03
Planed pavement	0.05	0.06	0.04

If a stress absorbing membrane interlayer as specified in section 37-2.05 is applied, the tack coat application rates for new HMA apply.

Notify the Engineer if you dilute asphaltic emulsion with water. The weight ratio of added water to asphaltic emulsion must not exceed 1 to 1.

Measure added water either by weight or volume under section 9-1.02 or use water meters from water districts, cities, or counties. If you measure water by volume, apply a conversion factor to determine the correct weight.

With each dilution, submit:

1. Weight ratio of water to bituminous material in the original asphaltic emulsion
2. Weight of asphaltic emulsion before diluting
3. Weight of added water

4. Final dilution weight ratio of water to asphaltic emulsion

Apply a tack coat to vertical surfaces with a residual rate that will thoroughly coat the vertical face without running off.

If authorized, you may:

1. Change tack coat rates
2. Omit tack coat between layers of new HMA during the same work shift if:
   2.1. No dust, dirt, or extraneous material is present
   2.2. Surface is at least 140 degrees F

Immediately in advance of placing HMA, apply additional tack coat to damaged areas or where loose or extraneous material is removed.

Close areas receiving tack coat to traffic. Do not allow the tracking of tack coat onto pavement surfaces beyond the job site.

If you use an asphalt binder for tack coat, the asphalt binder temperature must be from 285 to 350 degrees F when applied.

39-2.01C(3)(g) Geosynthetic Pavement Interlayer

Where shown, place geosynthetic pavement interlayer over a coat of asphalt binder and in compliance with the manufacturer's instructions. Do not place the interlayer on a wet or frozen surface. If the interlayer, in compliance with the manufacturer’s instructions, does not require asphalt binder, do not apply asphalt binder before placing the interlayer.

Before placing the interlayer or asphalt binder:

1. Repair cracks 1/4 inch and wider, spalls, and holes in the pavement. This repair is change order work.
2. Clean the pavement of loose and extraneous material.

If the interlayer requires asphalt binder, immediately before placing the interlayer, apply asphalt binder at a rate specified by the interlayer manufacturer; at 0.25±0.03 gal per square yard of interlayer; or at a rate that just saturates the interlayer; whichever is greater. Apply asphalt binder the width of the interlayer plus 3 inches on each side. At an interlayer overlap, apply asphalt binder on the lower interlayer the same overlap distance as the upper interlayer.

If asphalt binder tracked onto the interlayer or brought to the surface by construction equipment causes interlayer displacement, cover it with a small quantity of HMA.

If the interlayer placement does not require asphalt binder, apply tack coat prior to placing HMA at the application rates specified under section 39-2.01C(3)(f) based on the condition of the underlying surface on which the interlayer was placed.

Align and place the interlayer with no overlapping wrinkles, except a wrinkle that overlaps may remain if it is less than 1/2 inch thick. If the overlapping wrinkle is more than 1/2 inch thick, cut the wrinkle out and overlap the interlayer no more than 2 inches.

Overlap the interlayer borders between 2 to 4 inches. In the direction of paving, overlap the following roll with the preceding roll at any break.

You may use rolling equipment to correct distortions or wrinkles in the interlayer.

Before placing HMA on the interlayer, do not expose the interlayer to:

1. Traffic, except for crossings under traffic control and only after you place a small HMA quantity
2. Sharp turns from construction equipment
3. Damaging elements

Pave HMA on the interlayer during the same work shift. The minimum HMA thickness over the interlayer must be 0.12 foot including at conform tapers.

39-2.01C(4) Longitudinal Joints

39-2.01C(4)(a) General

Longitudinal joints in the top layer must match lane lines. Alternate the longitudinal joint offsets in the lower layers at least 0.5 foot from each side of the lane line. Other longitudinal joint placement patterns are allowed if authorized.

A vertical longitudinal joint of more than 0.15 foot is not allowed at any time between adjacent lanes open to traffic.

For an HMA thickness of 0.15 foot or less, the distance between the ends of the adjacent surfaced lanes at the end of each day's work must not be greater than can be completed in the following day of normal paving.

For an HMA thickness greater than 0.15 foot, you must place HMA on adjacent traveled way lanes or shoulder such that at the end of each work shift the distance between the ends of HMA layers on adjacent lanes is from 5 to 10 feet. Place additional HMA along the transverse edge at each lane's end and along the exposed longitudinal edges between adjacent lanes. Hand rake and compact the additional HMA to form temporary conforms. You may place kraft paper or other authorized release agent under the conform tapers to facilitate the taper removal when paving activities resume.

If placing HMA against the edge of existing pavement, saw cut or grind the pavement straight and vertical along the joint and remove extraneous material.

39-2.01C(4)(b) Tapered Notched Wedge

For divided highways with an HMA lift thickness greater than 0.15 foot, you may construct a 1-foot wide tapered notched wedge joint as a longitudinal joint between adjacent lanes open to traffic. A vertical notch of 0.75 inch maximum must be placed at the top and bottom of the tapered wedge.

The tapered notched wedge must keep its shape while exposed to traffic. Pave the adjacent lane within 1 day.

Construct the tapered portion of the tapered notched wedge with an authorized strike-off device. The strike-off device must provide a uniform slope and must not restrict the main screed of the paver.

You may use a device attached to the screed to construct longitudinal joints that will form a tapered notched wedge in a single pass. The tapered notched wedge must be compacted to a minimum of 91 percent compaction.

39-2.01C(5) Pavement Edge Treatments

Construct edge treatment on the HMA pavement as shown.

Where a tapered edge is required, use the same type of HMA used for the adjacent lane or shoulder.

The edge of roadway where the tapered edge is to be placed must have a solid base, free of debris such as loose material, grass, weeds, or mud. Grade the areas to receive the tapered edge as required.

The tapered edge must be placed monolithic with the adjacent lane or shoulder and must be shaped and compacted with a device attached to the paver.

The device must be capable of shaping and compacting HMA to the required cross section as shown. Compaction must be accomplished by constraining the HMA to reduce the cross sectional area by 10 to 15 percent. The device must produce a uniform surface texture without tearing, shoving, or gouging and must not leave marks such as ridges and indentations. The device must be capable of transitioning to cross roads, driveways, and obstructions.

For the tapered edge, the angle of the slope must not deviate by more than ±5 degrees from the angle shown. Measure the angle from the plane of the adjacent finished pavement surface.

If paving is done in multiple lifts, the tapered edge must be placed with each lift.

Short sections of hand work are allowed to construct tapered edge transitions.

39-2.01C(6) Widening Existing Pavement

If widening existing pavement, construct new pavement structure to match the elevation of the existing pavement's edge before placing HMA over the existing pavement.

39-2.01C(7) Shoulders, Medians, and Other Road Connections

Until the adjoining through lane's top layer has been paved, do not pave the top layer of:

1. Shoulders
2. Tapers
3. Transitions
4. Road connections
5. Driveways
6. Curve widenings
7. Chain control lanes
8. Turnouts
9. Turn pockets

If the number of lanes changes, pave each through lane's top layer before paving a tapering lane's top layer. Simultaneous to paving a through lane's top layer, you may pave an adjoining area's top layer, including shoulders. Do not operate spreading equipment on any area's top layer until completing final compaction.

If shoulders or median borders are shown, pave shoulders and median borders adjacent to the lane before opening a lane to traffic.

If shoulder conform tapers are shown, place conform tapers concurrently with the adjacent lane's paving.

If a driveway or a road connection is shown, place additional HMA along the pavement's edge to conform to road connections and driveways. Hand rake, if necessary, and compact the additional HMA to form a smooth conform taper.

39-2.01C(8) Leveling

Section 39-2.01C(8) applies if a bid item for hot mix asphalt (leveling) is shown on the Bid Item List.

Fill and level irregularities and ruts with HMA before spreading HMA over the base, existing surfaces, or bridge decks. You may use mechanical equipment other than a paver for these areas. The equipment must produce uniform smoothness and texture. HMA used to change an existing surface's cross slope or profile is not paid for as hot mix asphalt (leveling).

39-2.01C(9) Miscellaneous Areas and Dikes

Prepare the area to receive HMA for miscellaneous areas and dikes, including excavation and backfill as needed.

Spread the HMA in miscellaneous areas in 1 layer and compact to the specified lines and grades.

In median areas adjacent to slotted median drains, each layer of HMA must not exceed 0.20 foot maximum compacted thickness.

The finished surface must be:

1. Textured uniformly
2. Compacted firmly
3. Without depressions, humps, and irregularities

39-2.01C(10)–39-2.01C(14) Reserved

39-2.01C(15) Compaction

39-2.01C(15)(a) General

Rolling must leave the completed surface compacted and smooth without tearing, cracking, or shoving.

If a vibratory roller is used as a finish roller, turn the vibrator off.

Do not open new HMA pavement to traffic until its mid depth temperature is below 160 degrees F.

If the surface to be paved is both in sunlight and shade, pavement surface temperatures are taken in the shade.

39-2.01C(15)(b) Method Compaction

Use method compaction for any of the following conditions:

1. HMA pavement thickness shown is less than 0.15 foot
2. Replace asphalt concrete surfacing
3. Leveling courses
4. Areas the Engineer determines conventional compaction and compaction measurement methods are impeded

HMA compaction coverage is the number of passes needed to cover the paving width. A pass is 1 roller's movement parallel to the paving in either direction. Overlapping passes are part of the coverage being made and are not a subsequent coverage. Do not start a coverage until completing the prior coverage.

Method compaction must consist of performing:

1. Breakdown compaction of each layer with 3 coverages using a vibratory roller. The speed of the vibratory roller in miles per hour must not exceed the vibrations per minute divided by 1,000. If the HMA layer thickness is less than 0.08 foot, turn the vibrator off.
2. Intermediate compaction of each layer of HMA with 3 coverages using a pneumatic-tired roller at a speed not to exceed 5 mph.
3. Finish compaction of HMA with 1 coverage using a steel-tired roller.

Start rolling at the lower edge and progress toward the highest part.

The Engineer may order fewer coverages if the layer thickness of HMA is less than 0.15 foot.

The compacted lift thickness must not exceed 0.25 foot.

39-2.01C(15)(c)–39-2.01C(15)(e) Reserved

39-2.01C(16) Smoothness Corrections

If the pavement surface does not comply with section 39-2.01A(4)(i)(iii), grind the pavement to within specified tolerances, remove and replace the pavement, or place an overlay of HMA. Do not start corrective work until your method is authorized.

Do not use equipment with carbide cutting teeth to grind the pavement unless authorized.

Smoothness corrections must leave at least 75 percent of the specified HMA thickness. If ordered, core the pavement at the locations selected by the Engineer. Coring, including traffic control, is change order work. Remove and replace deficient pavement areas where the overlay thickness is less than 75 percent of the thickness specified.

Corrected HMA pavement areas must be uniform rectangles, half the lane width, with edges:

1. Parallel to and along the nearest HMA pavement edge or lane line
2. Perpendicular to the pavement centerline

On ground areas not to be overlaid with OGFC, apply a fog seal under section 37-4.02.

Where corrections are made within areas requiring testing with inertial profiler, reprofile the entire lane length with the inertial profiler.

Where corrections are made within areas requiring testing with a 12-foot straightedge, retest the corrected area with the straightedge.

39-2.01C(17) Data Cores

Section 39-2.01C(17) applies if a bid item for data core is shown on the Bid Item List.

Take data cores of the completed HMA pavement, underlying base, and subbase material. Notify the Engineer 3 business days before coring.

Protect data cores and surrounding pavement from damage.

Take 4-inch or 6-inch diameter data cores:

1. At the beginning, end, and every 1/2 mile within the paving limits of each route on the project
2. After all paving is complete
3. From the center of the specified lane

On a 2-lane roadway, take data cores from either lane. On a 4-lane roadway, take data cores from the outermost lane in each direction. On a roadway with more than 4 lanes, take data cores from the innermost lane and the outermost lane in each direction.

Each core must include the stabilized materials encountered. You may choose not to recover unstabilized material but you must identify the material. Unstabilized material includes any of the following:

1. Granular material
2. Crumbled or cracked stabilized material
3. Sandy or clayey soil

Where data core samples are taken, backfill and compact the holes with an authorized material.

After data core summary and photograph submittal, dispose of cores.

39-2.01D Payment

The payment quantity for geosynthetic pavement interlayer is the area measured from the actual pavement covered.

Except for tack coat used in minor HMA, payment for tack coat is not included in the payment for hot mix asphalt.

The Department does not adjust the unit price for an increase or decrease in the tack coat quantity.

The payment quantity for HMA of the type shown on the Bid Item List is measured based on the combined mixture weight. If recorded batch weights are printed automatically, the bid item for HMA is measured by using the printed batch weights, provided:

1. Total aggregate and supplemental fine aggregate weight per batch is printed. If supplemental fine aggregate is weighed cumulatively with the aggregate, the total aggregate batch weight must include the supplemental fine aggregate weight.
2. Total virgin asphalt binder weight per batch is printed.
3. Each truckload's zero tolerance weight is printed before weighing the first batch and after weighing the last batch.
4. Time, date, mix number, load number and truck identification is correlated with a load slip.
5. Copy of the recorded batch weights is certified by a licensed weigh master and submitted.

The payment quantity for place hot mix asphalt dike of the type shown on the Bid Item List is the length measured from end to end. Payment for the HMA used to construct the dike is not included in the payment for place hot mix asphalt dike.

The payment quantity for place hot mix asphalt (miscellaneous areas) is the area measured for the in-place compacted area. Payment for the HMA used for miscellaneous areas is not included in the payment for place hot mix asphalt (miscellaneous areas).

The Engineer does not adjust the unit price for an increase or decrease in the prepaving grinding day quantity.

39-2.02 TYPE A HOT MIX ASPHALT

39-2.02A General

39-2.02A(1) Summary

Section 39-2.02 includes specifications for producing and placing Type A hot mix asphalt.

You may produce Type A HMA using an authorized WMA technology.

39-2.02A(2) Definitions

Reserved

39-2.02A(3) Submittals

39-2.02A(3)(a) General

Reserved

39-2.02A(3)(b) Job Mix Formula

The JMF must be based on the superpave HMA mix design as described in *MS-2 Asphalt Mix Design Methods* by the Asphalt Institute.

39-2.02A(3)(c) Reclaimed Asphalt Pavement

Submit QC test results for RAP gradation with the combined aggregate gradation within 2 business days of taking RAP samples during Type A HMA production.

39-2.02A(3)(d)–39-2.02A(3)(f) Reserved

39-2.02A(4) Quality Assurance

39-2.02A(4)(a) General

Reserved

39-2.02A(4)(b) Quality Control

39-2.02A(4)(b)(i) General

Reserved

39-2.02A(4)(b)(ii) Aggregates

Test the quality characteristics of aggregates under the test methods and frequencies shown in the following table:

Aggregate Testing Frequencies

Quality characteristic	Test method	Minimum testing frequency
Gradation[a]	AASHTO T 27	1 per 750 tons and any remaining part
Sand equivalent[b, c]	AASHTO T 176	
Moisture content[d]	AASHTO T 255	
Crushed particles	AASHTO T 335	1 per 10,000 tons or 2 per project whichever is greater
Los Angeles Rattler	AASHTO T 96	
Flat and elongated particles	ASTM D4791	
Fine aggregate angularity	AASHTO T 304 Method A	

[a]If RAP is used, test the combined aggregate gradation under California Test 384.
[b]Reported value must be the average of 3 tests from a single sample.
[c]Use of a sand reading indicator is required as shown in AASHTO T 176, Figure 1. Sections 4.7, "Manual Shaker," 7.1.2, "Alternate Method No. 2," and 8.4.3, "Hand Method," do not apply. Prepare the stock solution as specified in section 4.8.1, "Stock solution with formaldehyde," except omit the addition of formaldehyde.
[d]Test at continuous mixing plants only. If RAP is used, test the RAP moisture content at continuous mixing plant and batch mixing plant.

For lime treated aggregate, test aggregate before treatment and test for gradation and moisture content during HMA production.

39-2.02A(4)(b)(iii) Reclaimed Asphalt Pavement

Sample and test processed RAP at a minimum frequency of 1 sample per 1,000 tons with a minimum of 6 samples per fractionated stockpile. If the fractionated stockpile has not been augmented, the 3 RAP samples taken and tested for mix design can be part of this minimum sample requirement. If a processed RAP stockpile is augmented, sample and test processed RAP quality characteristics at a minimum frequency of 1 sample per 500 tons of augmented RAP.

The combined RAP sample when tested under AASHTO T 164 must be within ±2.00 percent of the average asphalt binder content reported on page 4 of your Contractor Hot Mix Asphalt Design Data form. If a new processed RAP stockpile is required, the average binder content of the new processed RAP stockpile must be within ±2.00 percent of the average binder reported on page 4 of your Contractor Hot Mix Asphalt Design Data form.

The combined RAP sample when tested under AASHTO T 209 must be within ±0.06 of the average maximum specific gravity reported on page 4 of your Contractor Hot Mix Asphalt Design Data form.

During Type A HMA production, sample RAP twice daily and perform QC testing for:

1. Aggregate gradation at least once a day under California Test 384
2. Moisture content at least twice a day

39-2.02A(4)(b)(iv)–39-2.02A(4)(b)(viii) Reserved

39-2.02A(4)(b)(ix) Type A Hot Mix Asphalt Production

Test the quality characteristics of Type A HMA under the test methods and frequencies shown in the following table:

Type A HMA Production Testing Frequencies

Quality characteristic	Test method	Minimum testing frequency
Asphalt binder content	AASHTO T 308, Method A	1 per 750 tons and any remaining part
HMA moisture content	AASHTO T 329	1 per 2,500 tons but not less than 1 per paving day
Air voids content	AASHTO T 269	1 per 4,000 tons or 2 every 5 paving days, whichever is greater
Voids in mineral aggregate	MS-2 Asphalt Mixture Volumetrics	1 per 10,000 tons or 2 per project whichever is greater
Dust proportion	MS-2 Asphalt Mixture Volumetrics	
Density of core	California Test 375	2 per paving day
Nuclear gauge density	California Test 375	3 per 250 tons or 3 per paving day, whichever is greater
Hamburg wheel track	AASHTO T 324 (Modified)	1 per 10,000 tons or 1 per project, whichever is greater
Moisture susceptibility	AASHTO T 283	

39-2.02A(4)(c)–39-2.02A(4)(d) Reserved

39-2.02A(4)(e) Department Acceptance

The Department accepts Type A HMA based on compliance with:

1. Aggregate quality requirements shown in the following table:

Aggregate Quality

Quality characteristic	Test method	Requirement
Aggregate gradation[a]	AASHTO T 27	JMF ± Tolerance
Percent of crushed particles Coarse aggregate (min, %) One-fractured face Two-fractured faces Fine aggregate (min, %) (Passing No. 4 sieve and retained on No. 8 sieve.) One-fractured face	AASHTO T 335	 95 90 70
Los Angeles Rattler (max, %) Loss at 100 Rev. Loss at 500 Rev.	AASHTO T 96	 12 40
Sand equivalent (min.)[b, c]	AASHTO T 176	47
Flat and elongated particles (max, % by weight at 5:1)	ASTM D4791	10
Fine aggregate angularity (min, %)[d]	AASHTO T 304, Method A	45

[a]The Engineer determines combined aggregate gradations containing RAP under California Test 384.
[b]Reported value must be the average of 3 tests from a single sample.
[c]Use of a sand reading indicator is required as shown in AASHTO T 176, Figure 1. Sections 4.7, "Manual Shaker," 7.1.2, "Alternate Method No. 2," and 8.4.3, "Hand Method," do not apply. Prepare the stock solution as specified in section 4.8.1, "Stock solution with formaldehyde," except omit the addition of formaldehyde.
[d]The Engineer waives this specification if HMA contains 10 percent or less of nonmanufactured sand by weight of total aggregate. Manufactured sand is fine aggregate produced by crushing rock or gravel.

2. If RAP is used, RAP quality requirements shown in the following table:

Reclaimed Asphalt Pavement Quality

Quality characteristic	Test method	Requirement
Binder content (% within the average value reported)	AASHTO T 164	±2.00
Specific gravity (within the average value reported)	AASHTO T 209	±0.06

3. In place Type A HMA quality requirements shown in the following table:

Type A HMA Acceptance In Place

Quality characteristic	Test method	Requirement
Asphalt binder content (%)	AASHTO T 308 Method A	JMF -0.30, +0.50
HMA moisture content (max, %)	AASHTO T 329	1.00
Air voids content at N_{design} (%)[a, b]	AASHTO T 269	4.0 ± 1.5 (5.0 ± 1.5 for 1-inch aggregate)
Voids in mineral aggregate on laboratory-produced HMA (min, %)[d] Gradation: No. 4 3/8-inch 1/2-inch 3/4-inch 1-inch with NMAS = 1-inch with NMAS = 3/4-inch	MS-2 Asphalt Mixture Volumetrics	 16.5–19.5 15.5–18.5 14.5–17.5 13.5–16.5 13.5–16.5 14.5–17.5
Voids in mineral aggregate on plant-produced HMA (min, %)[a] Gradation: No. 4 3/8-inch 1/2-inch 3/4-inch 1-inch with NMAS = 1-inch with NMAS = 3/4-inch	MS-2 Asphalt Mixture Volumetrics[c]	 15.5–18.5 14.5–17.5 13.5–16.5 12.5–15.5 12.5–15.5 13.5–16.5
Dust proportion	MS-2 Asphalt Mixture Volumetrics	0.6–1.3[g]
Density of core (% of max theoretical density)[e, f]	California Test 375	91.0–97.0
Hamburg wheel track (min number of passes at 0.5-inch rut depth) Binder grade: PG 58 PG 64 PG 70 PG 76 or higher	AASHTO T 324 (Modified)	 10,000 15,000 20,000 25,000
Hamburg wheel track (min number of passes at inflection point) Binder grade: PG 58 PG 64 PG 70 PG 76 or higher	AASHTO T 324 (Modified)	 10,000 10,000 12,500 15,000
Moisture susceptibility (min, psi, dry strength)	AASHTO T 283	100
Moisture susceptibility (min, psi, wet strength)	AASHTO T 283	70

[a]Prepare 3 briquettes. Report the average of 3 tests.
[b]The Engineer determines the bulk specific gravity of each lab-compacted briquette under AASHTO T 275, Method A, and theoretical maximum specific gravity under AASHTO T 209, Method A.
[c]Determine bulk specific gravity under AASHTO T 275, Method A.
[d]The Engineer determines the laboratory-prepared Type A HMA value for only mix design verification.
[e]The Engineer determines percent of theoretical maximum density under California Test 375 except the Engineer uses:

1. AASHTO T 275 to determine in-place density of each density core
2. AASHTO T 209, Method A to determine theoretical maximum density instead of calculating test

maximum density

[f]The Engineer determines theoretical maximum density under AASHTO T 209, Method A, at the frequency specified in California Test 375, part 5, section D.

[g]For lime-treated aggregates, the dust proportion requirement is 0.6–1.5.

39-2.02B Materials

39-2.02B(1) General

Reserved

39-2.02B(2) Type A Hot Mix Asphalt Mix Design

The mix design for Type A HMA must comply with the requirements shown in the following table:

Type A HMA Mix Design Requirements

Quality characteristic	Test method	Requirement
Air voids content (%)	AASHTO T 269[a]	$N_{initial}$ > 8.0 N_{design} = 4.0 (N_{design} = 5.0 for 1-inch aggregate) N_{max} > 2.0
Gyration compaction (no. of gyrations)	AASHTO T 312	$N_{initial}$ = 8 N_{design} = 85.0 N_{max} = 130
Voids in mineral aggregate (min, %)[b] Gradation: No. 4 3/8-inch 1/2-inch 3/4-inch 1-inch with NMAS = 1-inch with NMAS = 3/4-inch	MS-2 Asphalt Mixture Volumetrics	 16.5–19.5 15.5–18.5 14.5–17.5 13.5–16.5 13.5–16.5 14.5–17.5
Dust proportion	MS-2 Asphalt Mixture Volumetrics	0.6–1.3
Hamburg wheel track (min number of passes at 0.5-inch rut depth) Binder grade: PG 58 PG 64 PG 70 PG 76 or higher	AASHTO T 324 (Modified)[c]	 10,000 15,000 20,000 25,000
Hamburg wheel track (min number of passes at the inflection point) Binder grade: PG 58 PG 64 PG 70 PG 76 or higher	AASHTO T 324 (Modified)[c]	 10,000 10,000 12,500 15,000
Moisture susceptibility, dry strength (min, psi)	AASHTO T 283[c]	100
Moisture susceptibility, wet strength (min, psi)	AASHTO T 283[c, d]	70

[a]Calculate the air voids content of each specimen using AASHTO T 275, Method A, to determine bulk specific gravity. Use AASHTO T 209, Method A, to determine theoretical maximum specific gravity. Use a digital manometer and pycnometer when performing AASHTO T 209.

[b]Measure bulk specific gravity using AASHTO T 275, Method A.

[c]Test plant-produced Type A HMA.

[d]Freeze thaw required.

For Type A HMA mixtures using RAP, the maximum allowed binder replacement is 25.0 percent in the upper 0.2 foot exclusive of OGFC and 40.0 percent below. The binder replacement is calculated as a percentage of the approved JMF target asphalt binder content.

For Type A HMA with a binder replacement percent less than or equal to 25 percent of your specified OBC, you may request that the performance graded asphalt binder grade with upper and lower temperature classifications be reduced by 6 degrees C from the specified grade.

For Type A HMA with a binder replacement greater than 25 percent of your specified OBC and less than or equal to 40 percent of OBC, you must use a performance graded asphalt binder grade with upper and lower temperature classifications reduced by 6 degrees C from the specified grade.

39-2.02B(3) Asphalt Binder

Reserved

39-2.02B(4) Aggregates

39-2.02B(4)(a) General

Before the addition of asphalt binder and lime treatment, the aggregates must comply with the requirements shown in the following table:

Aggregate Quality

Quality characteristic	Test method	Requirement
Percent of crushed particles:		
Coarse aggregate (min, %)		
One-fractured face	AASHTO T 335	95
Two-fractured faces		90
Fine aggregate (min, %)		
(Passing No. 4 sieve and retained on No. 8 sieve.)		
One-fractured face		70
Los Angeles Rattler (max, %)		
Loss at 100 Rev.	AASHTO T 96	12
Loss at 500 Rev.		40
Sand equivalent (min)[a]	AASHTO T 176	47
Flat and elongated particles (max, % by weight at 5:1)	ASTM D4791	10
Fine aggregate angularity (min, %)[b]	AASHTO T 304, Method A	45

[a]The reported value must be the average of 3 tests from a single sample. Use of a sand reading indicator is required as shown in AASHTO T 176, Figure 1. Sections 4.7, "Manual Shaker," 7.1.2, "Alternate Method No. 2," and 8.4.3, "Hand Method," do not apply. Prepare the stock solution as specified in section 4.8.1, "Stock solution with formaldehyde," except omit the addition of formaldehyde.

[b]The Engineer waives this specification if the Type A HMA contains 10 percent or less of nonmanufactured sand by weight of total aggregate, except if your JMF fails verification. Manufactured sand is fine aggregate produced by crushing rock or gravel.

39-2.02B(4)(b) Aggregate Gradations

The aggregate gradations for Type A HMA must comply with the requirements shown in the following table:

Aggregate Gradation Requirements

Type A HMA pavement thickness shown	Gradation
0.10 foot	3/8 inch
Greater than 0.10 to less than 0.20 foot	1/2 inch
0.20 to less than 0.25 foot	3/4 inch
0.25 foot or greater	3/4 inch or 1 inch

Aggregate gradation must be within the TV limits for the specified sieve size shown in the following tables:

Aggregate Gradations for Type A HMA
(Percentage Passing)

1 inch

Sieve size	Target value limit	Allowable tolerance
1"	100	--
3/4"	88–93	TV ± 5
1/2"	72–85	TV ± 6
3/8"	55–70	TV ± 6
No. 4	35–52	TV ± 7
No. 8	22–40	TV ± 5
No. 30	8–24	TV ± 4
No. 50	5–18	TV ± 4
No. 200	3.0–7.0	TV ± 2.0

3/4 inch

Sieve size	Target value limit	Allowable tolerance
1"	100	--
3/4"	90–98	TV ± 5
1/2"	70–90	TV ± 6
No. 4	42–58	TV ± 5
No. 8	29–43	TV ± 5
No. 30	10–23	TV ± 4
No. 200	2.0–7.0	TV ± 2.0

1/2 inch

Sieve size	Target value limit	Allowable tolerance
3/4"	100	--
1/2"	95–98	TV ± 5
3/8"	72–95	TV ± 5
No. 4	52–69	TV ± 5
No. 8	35–55	TV ± 5
No. 30	15–30	TV ± 4
No. 200	2.0–8.0	TV ± 2.0

3/8 inch

Sieve size	Target value limit	Allowable tolerance
1/2"	100	--
3/8"	95–98	TV ± 5
No. 4	55–75	TV ± 5
No. 8	30–50	TV ± 5
No. 30	15–35	TV ± 5
No. 200	2.0–9.0	TV ± 2.0

No. 4

Sieve size	Target value limit	Allowable tolerance
3/8"	100	--
No. 4	95–98	TV ± 5
No. 8	70–80	TV ± 6
No. 30	34–45	TV ± 5
No. 200	2.0–12.0	TV ± 4.0

39-2.02B(5) Reclaimed Asphalt Pavement

You may substitute RAP for part of the virgin aggregate in a quantity up to 25 percent of the aggregate blend.

Provide enough space at your plant for complying with all RAP handling requirements. Provide a clean, graded base, well drained area for stockpiles.

If RAP is from multiple sources, blend the RAP thoroughly and completely before fractionating.

For RAP substitution greater than 15 percent of the aggregate blend, fractionate RAP stockpiles into 2 sizes, a coarse fraction RAP retained on 3/8-inch sieve and a fine fraction RAP passing 3/8-inch sieve. For RAP substitution of 15 percent of the aggregate blend or less, fractionation is not required.

The RAP fractionation must comply with the requirements shown in the following table:

RAP Stockpile Fractionation Gradation Requirements

Size	Test method	Requirement
Coarse (% passing the 1-inch sieve)	California Test 202[a]	100
Fine (% passing the 3/8-inch sieve)	California Test 202[a]	98–100

[a]Maximum mechanical shaking time is 10 minutes.

You may use the coarse fractionated stockpile, the fine fractionated stockpile, or a combination of the coarse and fine fractionated stockpiles.

Isolate the processed RAP stockpiles from other materials. Store processed RAP in conical or longitudinal stockpiles. Processed RAP must not be agglomerated or be allowed to congeal in large stockpiles.

39-2.02B(6)–39-2.02B(10) Reserved

39-2.02B(11) Type A Hot Mix Asphalt Production

If RAP is used, the asphalt plant must automatically adjust the virgin asphalt binder to account for RAP percentage and RAP binder.

During production, you may adjust hot- or cold-feed proportion controls for virgin aggregate and RAP. RAP must be within ±3 of RAP percentage described in your Contractor Job Mix Formula Proposal form without exceeding 25 percent.

39-2.02C Construction

Where the pavement thickness shown is 0.30 foot or greater, you may place Type A HMA in multiple lifts not less than 0.15 foot each. If placing Type A HMA in multiple lifts:

1. Table in Section 39-2.02B(4)(b) does not apply
2. Aggregate gradation must comply with the requirements shown in the following table:

Aggregate Gradation Requirements

Type A HMA lift thickness	Gradation
0.15 to less than 0.20 foot	1/2 inch
0.20 foot to less than 0.25 foot	3/4 inch
0.25 foot or greater	3/4 inch or 1 inch

3. Apply a tack coat before placing a subsequent lift
4. The Engineer evaluates each HMA lift individually for compliance

If the ambient air temperature is below 60 degrees F, cover the loads in trucks with tarpaulins. If the time for HMA discharge to truck at the HMA plant until transfer to paver's hopper is 90 minutes or greater and if the ambient air temperature is below 70 degrees F, cover the loads in trucks with tarpaulins, unless the time from discharging to the truck until transfer to the paver's hopper or the pavement surface is less than 30 minutes. The tarpaulins must completely cover the exposed load until you transfer the mixture to the paver's hopper or the pavement surface.

Spread Type A HMA at the ambient air and surface temperatures shown in the following table:

Minimum Ambient Air and Surface Temperatures

Lift thickness (feet)	Ambient air (°F)		Surface (°F)	
	Unmodified asphalt binder	Modified asphalt binder	Unmodified asphalt binder	Modified asphalt binder
Type A HMA and Type A HMA produced with WMA water injection technology				
<0.15	55	50	60	55
≥0.15	45	45	50	50
Type A HMA produced with WMA additive technology				
<0.15	45	45	50	45
≥0.15	40	40	40	40

For Type A HMA and Type A HMA produced with WMA water injection technology placed under method compaction, if the asphalt binder is:

1. Unmodified, complete:
   1.1. 1st coverage of breakdown compaction before the surface temperature drops below 250 degrees F
   1.2. Breakdown and intermediate compaction before the surface temperature drops below 190 degrees F
   1.3. Finish compaction before the surface temperature drops below 150 degrees F
2. Modified, complete:
   2.1. 1st coverage of breakdown compaction before the surface temperature drops below 240 degrees F
   2.2. Breakdown and intermediate compaction before the surface temperature drops below 180 degrees F
   2.3. Finish compaction before the surface temperature drops below 140 degrees F

For Type A HMA produced with WMA additive technology placed under method compaction, if the asphalt binder is:

1. Unmodified, complete:
   1.1 1st coverage of breakdown compaction before the surface temperature drops below 240 degrees F
   1.2. Breakdown and intermediate compaction before the surface temperature drops below 190 degrees F
   1.3. Finish compaction before the surface temperature drops below 140 degrees F
   1.4 You may continue static rolling below 140 degrees F to remove roller marks.
2. Modified, complete:
   2.1. 1st coverage of breakdown compaction before the surface temperature drops below 230 degrees F
   2.2. Breakdown and intermediate compaction before the surface temperature drops below 170 degrees F
   2.3. Finish compaction before the surface temperature drops below 130 degrees F
   2.4. You may continue static rolling below 130 degrees F to remove roller marks.

You may cool Type A HMA with water when rolling activities are complete if authorized.

39-2.02D Payment

Not Used

39-2.03 RUBBERIZED HOT MIX ASPHALT–GAP GRADED

39-2.03A General

39-2.03A(1) Summary

Section 39-2.03 includes specifications for producing and placing rubberized hot mix asphalt–gap graded.

You may produce RHMA-G using a WMA technology.

39-2.03A(2) Definitions

Reserved

39-2.03A(3) Submittals

39-2.03A(3)(a) General

At least 5 business days before use, submit the permit issued by the local air district for asphalt rubber binder blending equipment. If an air quality permit is not required by the local air district for producing asphalt rubber binder, submit verification from the local air district that an air quality permit is not required.

At least 10 days before RHMA-G production, submit the name of an authorized laboratory to perform QC testing for asphalt rubber binder. The authorized laboratory must comply with the Caltrans Independent Assurance Program.

39-2.03A(3)(b) Job Mix Formula

With your proposed JMF, include the SDS for:

1. Base asphalt binder
2. CRM and asphalt modifier
3. Blended asphalt rubber binder components

The JMF must be based on the superpave HMA mix design as described in *MS-2 Asphalt Mix Design Methods* by the Asphalt Institute.

39-2.03A(3)(c) Asphalt Rubber Binder

Submit a proposal for asphalt rubber binder design and profile. In the design, include the asphalt binder, asphalt modifier, and CRM and their proportions.

If you change asphalt rubber binder supplier or any component material used in asphalt rubber binder or its percentage, submit a new JMF.

For the asphalt rubber binder used, submit:

1. Log of production daily.
2. Certificate of compliance with test results for CRM and asphalt modifier with each truckload delivered to the HMA plant. The certificate of compliance for asphalt modifier must represent no more than 5,000 lb.
3. Certified weight slips for the CRM and asphalt modifier furnished.
4. QC test results on viscosity within 2 business days after sampling.
5. QC test results on cone penetration, resilience, and softening point within 3 business days after sampling.

Submit a certificate of compliance for the CRM and asphalt modifier. With the certificate of compliance, submit test results for CRM and asphalt modifier with each truckload delivered to the HMA plant.

39-2.03A(4) Quality Assurance

39-2.03A(4)(a) General

Reserved

39-2.03A(4)(b) Job Mix Formula Verification

If you request, the Engineer verifies RHMA-G quality requirements within 7 days of receiving all verification samples and after the JMF document submittal has been accepted.

39-2.03A(4)(c) Quality Control

39-2.03A(4)(c)(i) General

Reserved

39-2.03A(4)(c)(ii) Asphalt Rubber Binder

39-2.03A(4)(c)(ii)(A) General

The asphalt rubber binder blending plant must be authorized under the Department's Material Plant Quality Program.

Take asphalt rubber binder samples from the feed line connecting the asphalt rubber binder tank to the HMA plant.

39-2.03A(4)(c)(ii)(B) Asphalt Modifier

Test asphalt modifier under the test methods and frequencies shown in the following table:

Asphalt Modifier for Asphalt Rubber Binder

Quality characteristic	Test method	Frequency
Viscosity	ASTM D445	1 per shipment
Flash point	ASTM D92	
Molecular analysis: Asphaltenes Aromatics	ASTM D2007	1 per shipment

39-2.03A(4)(c)(ii)(C) Crumb Rubber Modifier

Sample and test scrap tire crumb rubber and high natural crumb rubber separately. Test CRM under the test methods and frequencies shown in the following table:

Crumb Rubber Modifier for Asphalt Rubber Binder

Quality characteristic	Test method	Frequency
Scrap tire crumb rubber gradation	California Test 385	1 per 10,000 lb
High natural crumb rubber gradation	California Test 385	1 per 3,400 lb
Wire in CRM	California Test 385	1 per 10,000 lb
Fabric in CRM	California Test 385	
CRM particle length	--	
CRM specific gravity	California Test 208	
Natural rubber content in high natural crumb rubber	ASTM D297	1 per 3,400 lb

39-2.03A(4)(c)(ii)(D) Asphalt Rubber Binder

Test asphalt rubber binder under the test methods and frequencies shown in the following table:

Quality characteristic	Test method	Frequency
Cone penetration	ASTM D217	1 per lot[a]
Resilience	ASTM D5329	
Softening point	ASTM D36/D36M	
Viscosity	ASTM D7741/D7741M	15 minutes before use per lot[a]

[a]The lot is defined in the Department's *MPQP*.

Retain the sample from each lot. Test for cone penetration, resilience, and softening point for the first 3 lots and, if all 3 lots pass, the testing frequency may be reduced to once for every 3 lots.

If QC test results indicate that the asphalt rubber binder does not comply with the specifications, take corrective action and notify the Engineer.

39-2.03A(4)(c)(iii) Aggregates

Test the quality characteristics of aggregates under the test methods and frequencies shown in the following table:

Aggregate Testing Frequencies

Quality characteristic	Test method	Minimum testing frequency
Gradation	AASHTO T 27	1 per 750 tons and any remaining part
Sand equivalent[a, b]	AASHTO T 176	
Moisture content[c]	AASHTO T 255	
Crushed particles	AASHTO T 335	1 per 10,000 tons or 2 per project, whichever is greater
Los Angeles Rattler	AASHTO T 96	
Flat and elongated particles	ASTM D4791	
Fine aggregate angularity	AASHTO T 304, Method A	

[a]Reported value must be the average of 3 tests from a single sample.
[b]Use of a sand reading indicator is required as shown in AASHTO T 176, Figure 1. Sections 4.7, "Manual Shaker," 7.1.2, "Alternate Method No. 2," and 8.4.3, "Hand Method," do not apply. Prepare the stock solution as specified in section 4.8.1, "Stock solution with formaldehyde," except omit the addition of formaldehyde.
[c]Test at continuous mixing plants only.

For lime treated aggregate, test aggregate before treatment and test for gradation and moisture content during RHMA-G production.

39-2.03A(4)(c)(iv)–39-2.03A(4)(c)(viii) Reserved

39-2.03A(4)(c)(ix) Rubberized Hot Mix Asphalt–Gap Graded Production

Test the quality characteristics of RHMA-G under the test methods and frequencies shown in the following table:

RHMA-G Production Testing Frequencies

Quality characteristic	Test method	Minimum testing frequency
Asphalt binder content	AASHTO T 308, Method A	1 per 750 tons and any remaining part
HMA moisture content	AASHTO T 329	1 per 2,500 tons but not less than 1 per paving day
Air voids content	AASHTO T 269	1 per 4,000 tons or 2 every 5 paving days, whichever is greater
Voids in mineral aggregate	MS-2 Asphalt Mixture Volumetrics	1 per 10,000 tons or 2 per project whichever is greater
Dust proportion	MS-2 Asphalt Mixture Volumetrics	
Density of core	California Test 375	2 per paving day
Nuclear gauge density	California Test 375	3 per 250 tons or 3 per paving day, whichever is greater
Hamburg wheel track	AASHTO T 324 (Modified)	1 per 10,000 tons or 1 per project, whichever is greater
Moisture susceptibility	AASHTO T 283	

39-2.03A(4)(d) Reserved

39-2.03A(4)(e) Department Acceptance

39-2.03A(4)(e)(i) General

The Department accepts RHMA-G based on compliance with:

1. Aggregate quality requirements shown in the following table:

Aggregate Quality

Quality characteristic	Test method	Requirement
Aggregate gradation	AASHTO T 27	JMF ± Tolerance
Percent of crushed particles Coarse aggregate (min, %) One-fractured face Two-fractured faces Fine aggregate (min, %) (Passing No. 4 sieve and retained on No. 8 sieve.) One-fractured face	AASHTO T 335	 -- 90 70
Los Angeles Rattler (max, %) Loss at 100 Rev. Loss at 500 Rev.	AASHTO T 96	 12 40
Sand equivalent (min)[a, b]	AASHTO T 176	47
Flat and elongated particles (max, % by weight at 5:1)	ASTM D4791	Report only
Fine aggregate angularity (min, %)[c]	AASHTO T 304, Method A	45

[a]Reported value must be the average of 3 tests from a single sample.
[b]Use of a sand reading Indicator is required as shown in AASHTO T 176, Figure 1. Sections 4.7, "Manual Shaker," 7.1.2, "Alternate Method No. 2," and 8.4.3, "Hand Method," do not apply. Prepare the stock solution as specified in section 4.8.1, "Stock solution with formaldehyde," except omit the addition of formaldehyde.
[c]The Engineer waives this specification if RHMA-G contains 10 percent or less of nonmanufactured sand by weight of total aggregate. Manufactured sand is fine aggregate produced by crushing rock or gravel.

2. In-place RHMA-G quality requirements shown in the following table:

RHMA-G Acceptance In Place

Quality characteristic	Test method	Requirement
Asphalt binder content (%)	AASHTO T 308 Method A	JMF -0.40, +0.50
HMA moisture content (max, %)	AASHTO T 329	1.00
Air voids content @ N_{design} (%)[a, b]	AASHTO T 269	4.0 ± 1.5
Voids in mineral aggregate on laboratory-produced HMA[d] (min, %) Gradation: 1/2-inch and 3/4-inch	MS-2 Asphalt Mixture Volumetrics[c]	 18.0–23.0
Voids in mineral aggregate on plant-produced HMA (min, %)[a] Gradation: 1/2-inch and 3/4-inch	MS-2 Asphalt Mixture Volumetrics[c]	 18.0–23.0
Dust proportion[a]	MS-2 Asphalt Mixture Volumetrics	Report only
Density of core (% of max theoretical density)[e, f]	California Test 375	91.0–97.0
Hamburg wheel track (min number of passes at 0.5-inch rut depth) Binder grade: PG 58 PG 64 PG 70	AASHTO T 324 (Modified)	 15,000 20,000 25,000
Hamburg wheel track (min number of passes at inflection point) Binder grade: PG 58 PG 64 PG 70	AASHTO T 324 (Modified)	 10,000 12,500 15,000
Moisture susceptibility (min, psi, dry strength)	AASHTO T 283	100
Moisture susceptibility (min, psi, wet strength)	AASHTO T 283	70

[a]Prepare 3 briquettes. Report the average of 3 tests.
[b]The Engineer determines the bulk specific gravity of each lab-compacted briquette under AASHTO T 275, Method A, and theoretical maximum specific gravity under AASHTO T 209, Method A.
[c]Determine bulk specific gravity under AASHTO T 275, Method A.
[d]The Engineer determines the laboratory-prepared RHMA-G value for only mix design verification.
[e]The Engineer determines percent of theoretical maximum density under California Test 375 except the Engineer uses:

1. AASHTO T 275, Method A, to determine in-place density of each density core instead of using the nuclear gauge
2. AASHTO T 209, Method A to determine theoretical maximum density instead of calculating test maximum density

[f]The Engineer determines theoretical maximum density under AASHTO T 209, Method A, at the frequency specified in California Test 375, part 5, section D.

39-2.03A(4)(e)(ii) Asphalt Rubber Binder

39-2.03A(4)(e)(ii)(A) General

The Department does not use asphalt rubber binder design profile for production acceptance.

39-2.03A(4)(e)(ii)(B) Asphalt Modifier

The Department accepts asphalt modifier based on compliance with the requirements shown in the following table:

Asphalt Modifier for Asphalt Rubber Binder

Quality characteristic	Test method	Requirement
Viscosity at 100 °C ($m^2/s \times 10^{-6}$)	ASTM D445	X ± 3[a]
Flash point (min, °C)	ASTM D92	207
Molecular analysis: Asphaltenes (max, % by mass) Aromatics (min, % by mass)	ASTM D2007	 0.1 55

[a]The symbol *X* is the asphalt modifier viscosity.

39-2.03A(4)(e)(ii)(C) Crumb Rubber Modifier

CRM used must be on the Authorized Materials List for Crumb Rubber Modifier.

CRM must be a ground or granulated combination of scrap tire crumb rubber and high natural scrap tire crumb rubber, CRM must be 75.0 ± 2.0 percent scrap tire crumb rubber and 25.0 ± 2.0 percent high natural scrap tire crumb rubber by total weight of CRM. Scrap tire crumb rubber and high natural scrap tire crumb rubber must be derived from waste tires described in Pub Res Code § 42703.

The Department accepts CRM, scrap tire crumb rubber, and high natural crumb rubber based on compliance with the requirements shown in the following table:

Crumb Rubber Modifier for Asphalt Rubber Binder

Quality characteristic	Test method	Requirement
Scrap tire crumb rubber gradation (% passing No. 8 sieve)	California Test 385	100
High natural crumb rubber gradation (% passing No. 10 sieve)	California Test 385	100
Wire in CRM (max, %)	California Test 385	0.01
Fabric in CRM (max, %)	California Test 385	0.05
CRM particle length (max, in)	--	3/16
CRM specific gravity	California Test 208	1.1–1.2
Natural rubber content in high natural crumb rubber (%)	ASTM D297	40.0–48.0

Scrap tire crumb rubber and high natural crumb rubber are sampled and tested separately.

39-2.03A(4)(e)(ii)(D) Asphalt Rubber Binder

For Department acceptance testing, take samples of asphalt rubber binder in the Engineer's presence every 5 lots or once a day, whichever is greater. Each sample must be in a 6 qt can with open top and friction lid.

The Department accepts asphalt rubber binder based on compliance with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Cone penetration at 25 °C (0.10 mm)	ASTM D217	25–70
Resilience at 25 °C (min, % rebound)	ASTM D5329	18
Softening point (°C)	ASTM D36/D36M	52–74
Viscosity at 190 °C (centipoises)[a]	ASTM D7741/D7741M	1,500–4,000

[a]Prepare sample for viscosity test under California Test 388.

39-2.03A(4)(e)(iii)–39-2.03A(4)(e)(v) Reserved

39-2.03B Materials

39-2.03B(1) General

Reserved

39-2.03B(2) Rubberized Hot Mix Asphalt–Gap Graded Mix Design

For RHMA-G, the mix design must comply with the requirements shown in the following table:

RHMA-G Mix Design Requirements

Quality characteristic	Test method	Requirement
Air voids content (%)	AASHTO T 269[a]	N_{design} = 4.0
Gyration compaction (no. of gyrations)	AASHTO T 312	N_{design} = 50–150[b]
Voids in mineral aggregate (min, %)	SP-2 Asphalt Mixture Volumetrics[c]	18.0–23.0
Dust proportion	SP-2 Asphalt Mixture Volumetrics	Report only
Hamburg wheel track (min, number of passes at 0.5-inch rut depth) Binder grade: PG 58 PG 64 PG 70	AASHTO T 324 (Modified)[d]	 15,000 20,000 25,000
Hamburg wheel track (min, number of passes at the inflection point) Binder grade: PG 58 PG 64 PG 70	AASHTO T 324 (Modified)[d]	 10,000 12,500 15,000
Moisture susceptibility, dry strength (min, psi)	AASHTO T 283[d]	100
Moisture susceptibility, wet strength (min, psi)	AASHTO T 283[d, e]	70

[a]Calculate the air voids content of each specimen using AASHTO T 275, Method A, to determine bulk specific gravity and AASHTO T 209, Method A, to determine theoretical maximum specific gravity. Under AASHTO T 209, use a digital manometer and pycnometer when performing AASHTO T 209.
[b]Superpave gyratory compactor ram pressure may be increased to a maximum of 825kPa, and specimens may be held at a constant height for a maximum of 90 minutes.
[c]Measure bulk specific gravity using AASHTO T 275, Method A.
[d]Test plant produced RHMA.
[e]Freeze thaw required.

Determine the quantity of asphalt rubber binder to be mixed with the aggregate for RHMA-G as follows:

1. Base the calculations on the average of 3 briquettes produced at each asphalt rubber binder content.
2. Plot asphalt rubber binder content versus average air voids content for each set of 3 specimens and connect adjacent points with a best-fit curve.
3. Calculate voids in mineral aggregate for each specimen, average each set, and plot the average versus asphalt rubber binder content.
4. Calculate the dust proportion and plot versus asphalt rubber binder content.
5. From the curve plotted, select the theoretical asphalt rubber binder content at 4 percent air voids.
6. At the selected asphalt rubber binder content, calculate dust proportion.
7. Record the asphalt rubber binder content in the Contractor Hot Mix Asphalt Design Data Form as the OBC.

The OBC must not fall below 7.5 percent by total weight of the mix.

Laboratory mixing and compaction must comply with superpave HMA mix design as described in *MS-2 Asphalt Mix Design Methods* by the Asphalt Institute, except the mixing temperature of the aggregate must be from 300 to 325 degrees F. The mixing temperature of the asphalt rubber binder must be from 375 to 425 degrees F. The compaction temperature of the combined mixture must be from 290 to 320 degrees F.

39-2.03B(3) Asphalt Rubber Binder

39-2.03B(3)(a) General

Asphalt rubber binder must be a combination of:

1. Asphalt binder
2. Asphalt modifier
3. CRM

The combined asphalt binder and asphalt modifier must be 80.0 ± 2.0 percent by weight of the asphalt rubber binder.

39-2.03B(3)(b) Asphalt Modifier

Asphalt modifier must be a resinous, high-flash-point, aromatic hydrocarbon and must comply with the requirements shown in the following table:

Asphalt Modifier for Asphalt Rubber Binder

Quality characteristic	Test method	Requirement
Viscosity at 100 °C ($m^2/s \times 10^{-6}$)	ASTM D445	X ± 3[a]
Flash point (min, °C)	ASTM D92	207
Molecular analysis: Asphaltenes (max, % by mass) Aromatics (min, % by mass)	ASTM D2007	 0.1 55

[a]The symbol *X* is the proposed asphalt modifier viscosity. *X* must be between 19 and 36. A change in *X* requires a new asphalt rubber binder design.

Asphalt modifier must be from 2.0 to 6.0 percent by weight of the asphalt binder in the asphalt rubber binder.

39-2.03B(3)(c) Crumb Rubber Modifier

CRM must be a ground or granulated combination of scrap tire crumb rubber and high natural scrap tire crumb rubber. CRM must be 75.0 ± 2.0 percent scrap tire crumb rubber and 25.0 ± 2.0 percent high natural scrap tire crumb rubber by total weight of CRM. Scrap tire crumb rubber and high natural scrap tire crumb rubber must be derived from waste tires described in Pub Res Code § 42703.

The CRM must comply with the requirements shown in the following table:

Crumb Rubber Modifier for Asphalt Rubber Binder

Quality characteristic	Test method	Requirement
Scrap tire crumb rubber gradation (% passing No. 8 sieve)	California Test 385	100
High natural crumb rubber gradation (% passing No. 10 sieve)	California Test 385	100
Wire in CRM (max, %)	California Test 385	0.01
Fabric in CRM (max, %)	California Test 385	0.05
CRM particle length (max, in)[a]	--	3/16
CRM specific gravity	California Test 208	1.1–1.2
Natural rubber content in high natural crumb rubber (%)	ASTM D297	40.0–48.0

[a]Test at mix design and for certificate of compliance.

CRM must be ground or granulated at ambient temperature. If steel and fiber are cryogenically separated, separation must occur before grinding or granulating. Cryogenically produced CRM particles must be ground or granulated and not pass through the grinder or granulator.

CRM must be dry, free-flowing particles that do not stick together. CRM must not cause foaming when combined with the asphalt binder and asphalt modifier. You may add calcium carbonate or talc up to 3 percent by weight of CRM.

39-2.03B(3)(d) Design and Profile

Design the asphalt rubber binder from testing you perform for each quality characteristic and for the reaction temperatures expected during production. The profile must include the same component sources

for the asphalt rubber binder used. The 24-hour (1,440-minute) interaction period determines the design profile. At a minimum, mix asphalt rubber binder components, take samples, and perform and record the tests shown in the following table:

Asphalt Rubber Binder Reaction Design Profile

Quality characteristic	Test method	Minutes of reaction [a]							Limit
		45	60	90	120	240	360	1440	
Cone penetration at 25 °C (0.10 mm)	ASTM D217	X [b]	--	--	--	X	--	X	25–70
Resilience at 25 °C (min, % rebound)	ASTM D5329	X	--	--	--	X	--	X	18
Field softening point (°C)	ASTM D36/D36M	X	--	--	--	X	--	X	52–74
Viscosity (centipoises)	ASTM D7741/D7741M	X	X	X	X	X	X	X	1,500–4,000

[a]Six hours (360 minutes) after CRM addition, reduce the oven temperature to 275 °F for 16 hours. After the 16-hour (960 minutes) cool down after CRM addition, reheat the binder to the reaction temperature expected during production for sampling and testing at 24 hours (1,440 minutes).
[b]*X* denotes required testing.

39-2.03B(3)(e) Asphalt Rubber Binder Production

39-2.03B(3)(e)(i) General

Deliver scrap tire crumb rubber and high natural crumb rubber in separate bags.

39-2.03B(3)(e)(ii) Mixing

Proportion and mix asphalt binder, asphalt modifier, and CRM simultaneously or premix the asphalt binder and asphalt modifier before adding CRM. If you premix asphalt binder and asphalt modifier, mix them for at least 20 minutes. When you add CRM, the temperature of the asphalt binder and asphalt modifier must be from 375 to 440 degrees F.

After interacting for at least 45 minutes, the asphalt rubber binder must comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Cone penetration at 25 °C (0.10 mm)	ASTM D217	25–70
Resilience at 25 °C (min, % rebound)	ASTM D5329	18
Softening point (°C)	ASTM D36/36M	52–74
Viscosity at 190 °C (centipoises)[a]	ASTM D7741/D7741M	1,500–4,000

[a]Prepare sample for viscosity test under California Test 388.

Do not use the asphalt rubber binder during the first 45 minutes of the reaction period. During this period, the asphalt rubber binder mixture must be between 375 degrees F and the lower of 425 or 25 degrees F below the asphalt binder's flash point shown in the SDS.

If any asphalt rubber binder is not used within 4 hours after the reaction period, discontinue heating. If the asphalt rubber binder drops below 375 degrees F, reheat before use. If you add more scrap tire crumb rubber to the reheated asphalt rubber binder, the binder must undergo a 45-minute reaction period. The added scrap tire crumb rubber must not exceed 10 percent of the total asphalt rubber binder weight. Reheated and reacted asphalt rubber binder must comply with the viscosity specifications. Do not reheat asphalt rubber binder more than twice.

39-2.03B(4) Aggregates

39-2.03B(4)(a) General

For RHMA-G, before the addition of asphalt binder and lime treatment, the aggregates must comply with the requirements shown in the following table:

Aggregate Quality

Quality characteristic	Test method	Requirement
Percent of crushed particles Coarse aggregate (min, %) One-fractured face Two-fractured faces Fine aggregate (min, %) (Passing No. 4 sieve and retained on No. 8 sieve.) One-fractured face	AASHTO T 335	 -- 90 70
Los Angeles Rattler (max, %) Loss at 100 Rev. Loss at 500 Rev.	AASHTO T 96	 12 40
Sand equivalent (min)[a]	AASHTO T 176	47
Flat and elongated particles (max, % by weight at 5:1)	ASTM D4791	Report only
Fine aggregate angularity (min, %)[b]	AASHTO T 304, Method A	45

[a]Reported value must be the average of 3 tests from a single sample. The use of a sand reading indicator is required as shown in AASHTO T 176, Figure 1. Sections 4.7, "Manual Shaker," 7.1.2, "Alternate Method No. 2," and 8.4.3, "Hand Method," do not apply. Prepare the stock solution as specified in section 4.8.1, "Stock solution with formaldehyde," except omit the addition of formaldehyde.

[b]The Engineer waives this specification if the HMA contains 10 percent or less of nonmanufactured sand by weight of total aggregate unless your JMF fails verification. Manufactured sand is fine aggregate produced by crushing rock or gravel.

39-2.03B(4)(b) Aggregate Gradations

The aggregate gradations for RHMA-G must comply with the requirements shown in the following table:

Aggregate Gradation Requirements

RHMA-G pavement thickness shown	Gradation
0.10 to less than 0.20 foot	1/2 inch
0.20 foot or greater	3/4 inch

For RHMA-G, the aggregate gradations must be within the TV limits for the specified sieve size shown in the following tables:

Aggregate Gradations for RHMA-G
(Percentage Passing)

3/4 inch

Sieve size	Target value limit	Allowable tolerance
1"	100	--
3/4"	95–98	TV ± 5
1/2"	83–87	TV ± 6
3/8"	65–70	TV ± 5
No. 4	28–42	TV ± 6
No. 8	14–22	TV ± 5
No. 200	0.0–6.0	TV ± 2.0

1/2 inch

Sieve size	Target value limit	Allowable tolerance
3/4"	100	--
1/2"	90–98	TV ± 6
3/8"	83–87	TV ± 5
No. 4	28–42	TV ± 6
No. 8	14–22	TV ± 5
No. 200	0.0–6.0	TV ± 2.0

39-2.03B(5) Rubberized Hot Mix Asphalt–Gap Graded Production

Asphalt rubber binder must be from 375 to 425 degrees F when mixed with aggregate.

If the dry and wet moisture susceptibility test result for treated plant-produced RHMA-G is less than the RHMA-G mix design requirement for dry and wet moisture susceptibility strength, the minimum dry and wet strength requirement is waived, but you must use one of the following treatments:

1. Aggregate lime treatment using the slurry method
2. Aggregate lime treatment using the dry lime method
3. Liquid antistrip treatment of RHMA-G

39-2.03C Construction

Use a material transfer vehicle when placing RHMA-G.

Do not use a pneumatic tired roller to compact RHMA-G.

Spread and compact RHMA-G and RHMA-G produced with WMA water injection technology at an ambient air temperature of at least 55 degrees F and a surface temperature of at least 60 degrees F.

Spread and compact RHMA-G produced with WMA addititive technology at an ambient air temperature of at least 50 degrees F and a surface temperature of at least 50 degrees F.

If the ambient air temperature is below 70 degrees F, cover loads in trucks with tarps. The tarps must completely cover the exposed load until you transfer the mixture to the paver's hopper or to the pavement surface. Tarps are not required if the time from discharge to truck until transfer to the paver's hopper or the pavement surface is less than 30 minutes.

For RHMA-G and RHMA-G produced with WMA water injection technology placed under method compaction:

1. Complete the 1st coverage of breakdown compaction before the surface temperature drops below 285 degrees F.
2. Complete breakdown and intermediate compaction before the surface temperature drops below 250 degrees F. Use a static steel-tired roller instead of the pneumatic-tired roller for intermediate compaction.
3. Complete finish compaction before the surface temperature drops below 200 degrees F.

For RHMA-G produced with WMA additive technology placed under method compaction:

1. Complete the 1st coverage of breakdown compaction before the surface temperature drops below 260 degrees F
2. Complete breakdown and intermediate compaction before the surface temperature drops below 230 degrees F
3. Complete finish compaction before the surface temperature drops below 180 degrees F
4. You may continue static rolling below 140 degrees F to remove roller marks

Spread sand at a rate between 1 and 2 lb/sq yd on new RHMA-G pavement when finish rolling is complete. Sand must be free of clay or organic matter. Sand must comply with section 90-1.02C(3). Keep traffic off the pavement until spreading of the sand is complete.

39-2.03D Payment

Not Used

39-2.04 OPEN GRADED FRICTION COURSES

39-2.04A General

39-2.04A(1) Summary

Section 39-2.04 includes specifications for producing and placing open graded friction courses. Open graded friction courses include HMA-O, RHMA-O, and RHMA-O-HB.

You may produce OGFC using a WMA technology.

39-2.04A(2) Definitions

Reserved

39-2.04A(3) Submittals

Submit a complete JMF, except do not specify an asphalt binder content.

For RHMA-O and RHMA-O-HB, the JMF submittal must comply with section 39-2.03A(3)(c).

39-2.04A(4) Quality Assurance

39-2.04A(4)(a) General

Reserved

39-2.04A(4)(b) Quality Control

39-2.04A(4)(b)(i) General

Reserved

39-2.04A(4)(b)(ii) Asphalt Rubber Binder

For RHMA-O and RHMA-O-HB, the asphalt rubber binder must comply with the specifications in 39-2.03A(4)(c)(ii).

39-2.04A(4)(b)(iii) Aggregates

Test the quality characteristics of aggregates under the test methods and frequencies shown in the following table:

Aggregate Testing Frequencies

Quality characteristic	Test method	Minimum testing frequency
Gradation	AASHTO T 27	1 per 750 tons and any remaining part
Moisture content[a]	AASHTO T 255	1 per 1500 tons and any remaining part
Crushed particles	AASHTO T 335	1 per 10,000 tons or 2 per project, whichever is greater
Los Angeles Rattler	AASHTO T 96	
Flat and elongated particles	ASTM D4791	

[a]Test at continuous mixing plants only.

For lime treated aggregate, test aggregate before treatment and test for gradation and moisture content during OGFC production.

39-2.04A(4)(b)(iv) Open Graded Friction Course Production

Test the quality characteristics of OGFC under the test methods and frequencies shown in the following table:

OGFC Testing Frequencies

Quality characteristic	Test method	Minimum testing frequency
Asphalt binder content	AASHTO T 308, Method A	1 per 750 tons and any remaining part
HMA moisture content	AASHTO T 329	1 per 2,500 tons but not less than 1 per paving day

39-2.04A(4)(c) Department Acceptance

39-2.04A(4)(c)(i) General

The Department accepts OGFC based on compliance with:

1. Aggregate quality requirements shown in the following table:

Aggregate Quality

Quality characteristic	Test method	Requirement
Aggregate gradation	AASHTO T 27	JMF ± Tolerance
Percent of crushed particles: Coarse aggregate (min, %) One-fractured face Two-fractured faces Fine aggregate (min, %) (Passing No. 4 sieve and retained on No. 8 sieve.) One-fractured face	AASHTO T 335	 90 90 90
Los Angeles Rattler (max, %) Loss at 100 Rev. Loss at 500 Rev.	AASHTO T 96	 12 40
Flat and elongated particles (max, % by weight @ 5:1)	ASTM D4791	Report only

2. In-place OGFC quality requirements shown in the following table:

OGFC Acceptance In Place

Quality characteristic	Test method	Requirement
Asphalt binder content (%)	AASHTO T 308, Method A	JMF -0.40, +0.50
HMA moisture content (max, %)	AASHTO T 329	1.00

39-2.04A(4)(c)(ii) Asphalt Rubber Binder

The Department accepts asphalt rubber binder in RHMA-O and RHMA-O-HB under 39-2.03A(4)(e)(ii).

39-2.04A(4)(c)(iii) Pavement Smoothness

Pavement smoothness of OGFC must comply with the requirements shown in the following table for a 0.1 mile section:

OGFC Pavement Smoothness Acceptance Criteria

OGFC placement on	Mean Roughness Index requirement
New construction or HMA overlay	60 in/mi or less
Existing pavement	75 in/mi or less
Milled surface	75 in/mi or less

39-2.04A(4)(c)(iv)–39-2.04A(4)(c)(v) Reserved

39-2.04B Materials

39-2.04B(1) General

When mixed with asphalt binder, aggregate must not be more than 325 degrees F except aggregate for OGFC with unmodified asphalt binder must be not more than 275 degrees F.

39-2.04B(2) Open Graded Friction Course Mix Design

The Department determines the asphalt binder content under California Test 368 within 20 days of your complete JMF submittal and provides you a Caltrans Hot Mix Asphalt Verification form.

For OGFC, the 1st paragraph of section 39-2.01B(2)(a) does not apply.

39-2.04B(3) Asphalt Binder

Asphalt rubber binder in RHMA-O and RHMA-O-HB must comply with section 39-2.03B(3).

39-2.04B(4) Aggregates

39-2.04B(4)(a) General

Aggregates must comply with the requirements shown in the following table:

Aggregate Quality

Quality characteristic	Test method	Requirement
Percent of crushed particles		
Coarse aggregate (min, %)		
One-fractured face	AASHTO T 335	--
Two-fractured faces		90
Fine aggregate (min, %)		
(Passing No. 4 sieve and retained on No. 8 sieve.)		
One-fractured face		90
Los Angeles Rattler (max, %)	AASHTO T 96	
Loss at 100 Rev.		12
Loss at 500 Rev.		40
Flat and elongated particles (max, % by weight at 5:1)	ASTM D4791	Report only

39-2.04B(4)(b) Aggregate Gradations

The aggregate gradations for HMA-O must comply with the requirements shown in the following table:

Aggregate Gradation Requirements

HMA-O pavement thickness shown	Gradation
0.10 foot or greater to less than 0.15 foot	1/2 inch
0.15 foot or greater	1 inch

The aggregate gradations for RHMA-O and RHMA-O-HB must comply with the requirements shown in the following table:

Aggregate Gradation Requirements

RHMA-O and RHMA-O-HB pavement thickness shown	Gradation
0.10 foot or greater	1/2 inch

For RHMA-O and RHMA-O-HB, the 1-inch aggregate gradation is not allowed.

For OGFC, the aggregate gradations must be within the TV limits for the specified sieve size shown in the following tables:

Aggregate Gradations for OGFC
(Percentage Passing)

1 inch

Sieve size	Target value limit	Allowable tolerance
1 1/2"	100	--
1"	99–100	TV ± 5
3/4"	85–96	TV ± 5
1/2"	55–71	TV ± 6
No. 4	10–25	TV ± 7
No. 8	6–16	TV ± 5
No. 200	0.0–6.0	TV ± 2.0

1/2 inch

Sieve size	Target value limit	Allowable tolerance
3/4"	100	--
1/2"	95–100	TV ± 6
3/8"	78–89	TV ± 6
No. 4	28–37	TV ± 7
No. 8	7–18	TV ± 5
No. 30	0–10	TV ± 4
No. 200	0.0–3.0	TV ± 2.0

If lime treatment is required, you may reduce the lime ratio for the combined aggregates from 1.0 to 0.5 percent for OGFC.

39-2.04B(5) Sand

Sand for spreading over RHMA-O and RHMA-O-HB pavement must be free of clay or organic matter. Sand must comply with section 90-1.02C(3).

39-2.04C Construction

Use a material transfer vehicle when placing OGFC.

If the ambient air temperature is below 70 degrees F, cover loads in trucks with tarps. The tarps must completely cover the exposed load until you transfer the mixture to the paver's hopper or to the pavement surface. Tarps are not required if the time from discharge to truck until transfer to the paver's hopper or the pavement surface is less than 30 minutes.

Apply a tack coat before placing OGFC. The tack coat application rate must comply with the requirements of the following table:

Tack Coat Application Rates for OGFC

OGFC over:	Minimum residual rates (gal/sq yd)		
	CSS1/CSS1h, SS1/SS1h, and QS1h/CQS1h asphaltic emulsion	CRS1/CRS2, RS1/RS2, and QS1/CQS1 asphaltic emulsion	Asphalt binder and PMRS2/PMCRS2 and PMRS2h/PMCRS2h asphaltic emulsion
New HMA	0.03	0.04	0.03
Concrete pavement and existing asphalt concrete surfacing	0.05	0.06	0.04
Planed pavement	0.06	0.07	0.05

Compact OGFC with steel-tired, 2-axle tandem rollers. If placing over 300 tons of OGFC per hour, use at least 3 rollers for each paver. If placing less than 300 tons of OGFC per hour, use at least 2 rollers for each paver. Each roller must weigh from 126 to 172 lb per linear inch of drum width. Turn the vibrator off.

Compact OGFC with 2 coverages. The Engineer may order fewer coverages if the layer thickness of OGFC is less than 0.20 foot.

For HMA-O and HMA-O produced with WMA water injection technology:

1. With unmodified asphalt binder:
   1.1. Spread and compact only if the atmospheric temperature is at least 55 degrees F and the surface temperature is at least 60 degrees F.
   1.2. Complete the 1st coverage using 2 rollers before the surface temperature drops below 240 degrees F.
   1.3. Complete all compaction before the surface temperature drops below 200 degrees F.
2. With modified asphalt binder, except asphalt rubber binder:
   2.1. Spread and compact only if the atmospheric temperature is at least 50 degrees F and the surface temperature is at least 50 degrees F.
   2.2. Complete the 1st coverage using 2 rollers before the surface temperature drops below 240 degrees F.
   2.3. Complete all compaction before the surface temperature drops below 180 degrees F.

For HMA-O produced with WMA additive technology:

1. With unmodified asphalt binder:
   1.1. Spread and compact only if the atmospheric temperature is at least 45 degrees F and the surface temperature is at least 50 degrees F.
   1.2. Complete the 1st coverage using 2 rollers before the surface temperature drops below 230 degrees F.
   1.3. Complete all compaction before the surface temperature drops below 190 degrees F.
2. With modified asphalt binder, except asphalt rubber binder:
   2.1. Spread and compact only if the atmospheric temperature is at least 40 degrees F and the surface temperature is at least 40 degrees F.
   2.2. Complete the 1st coverage using 2 rollers before the surface temperature drops below 230 degrees F.
   2.3. Complete all compaction before the surface temperature drops below 170 degrees F.

Spread sand at a rate between 1 and 2 lb/sq yd on new RHMA-O and RHMA-O produced with WMA water injection technology, and RHMA-O-HB and RHMA-O-HB produced with WMA water injection technology pavement after finish rolling activities are complete. Keep traffic off the pavement until spreading of the sand is complete.

For RHMA-O produced with WMA additive technology and RHMA-O-HB produced with WMA additives technology:

1. Spread and compact if the ambient air temperature is at least 45 degrees F and the surface temperature is at least 50 degrees F
2. Complete the 1st coverage using 2 rollers before the surface temperature drops below 270 degrees F
3. Complete all compaction before the surface temperature drops below 240 degrees F

If you choose to correct OGFC for smoothness, the Engineer determines if the corrective method causes raveling. OGFC that is raveling must be removed and replaced.

39-2.04D Payment

Not Used

39-2.05 BONDED WEARING COURSES

39-2.05A General

39-2.05A(1) General

39-2.05A(1)(a) Summary

Section 39-2.05 includes specifications for producing and placing bonded wearing courses.

Placing a BWC consists of applying a polymer-modified asphaltic emulsion and placing the specified HMA in a single pass with an integrated paving machine.

BWC using RHMA-G, RHMA-O, or HMA-O must comply with the specifications for RHMA-G, RHMA-O, or HMA-O.

39-2.05A(1)(b) Definitions

Reserved

39-2.05A(1)(c) Submittals

With your JMF submittal, include:

1. Asphaltic emulsion target residual rate
2. Weight ratio of water to bituminous material in the original asphaltic emulsion

Within 3 business days following the 1st job site delivery, submit test results for asphaltic emulsion properties performed on a sample taken from the asphaltic emulsion delivered.

Within 1 business day of each job site delivery of asphaltic emulsion, submit to METS a 2-quart sample and a certificate of compliance. Ship each sample so that it is received at METS within 48 hours of sampling.

Each day BWC is placed, submit the residual and application rate for the asphaltic emulsion.

During production, submit certified volume or weight slips for the materials supplied.

39-2.05A(1)(d) Quality Assurance

39-2.05A(1)(d)(i) General

For each job site delivery of asphaltic emulsion, take a 2 qt sample in the presence of the Engineer. Take samples from the delivery truck at mid load from a sampling tap or thief. If the sample is taken from the tap, draw and discard 4 qt before sampling.

If you unload asphalt binder or asphaltic emulsion into a bulk storage tank, do not use material from the tank until you submit test results for a sample taken from the bulk storage tank. Testing must be performed by an AASHTO-accredited laboratory.

39-2.05A(1)(d)(ii) Quality Control

Take two 1 gal samples of BWC in metal containers.

Test the asphaltic emulsion under ASTM D2995 at least once per paving day at the job site.

39-2.05A(1)(d)(iii) Department Acceptance

The Department accepts asphaltic emulsion based on compliance with the requirements shown in the following table:

Asphaltic Emulsion

Quality characteristic	Test method	Requirement
Saybolt Furol viscosity at 25 °C (Saybolt Furol seconds)	AASHTO T 59	20–100
Sieve test on original emulsion at time of delivery (max, %)	AASHTO T 59	0.05
24-hour storage stability (max, %)	AASHTO T 59	1
Residue by evaporation (min, %)	California Test 331	63
Tests on residue from evaporation test:		
Torsional recovery, measure entire arc of recovery at 25 °C (min, %)	California Test 332	40
Penetration at 25 °C (0.01 mm)	AASHTO T 49	70–150

The Department accepts the BWC based on the submitted asphaltic emulsion target residual rate ±0.02 gal/sq yd when tested under ASTM D2995.

39-2.05A(2) Materials

39-2.05A(2)(a) General

Reserved

39-2.05A(2)(b) Asphaltic Emulsion

The asphaltic emulsion must comply with the requirements shown in the following table:

Asphaltic Emulsion

Quality characteristic	Test method	Requirement
Saybolt Furol viscosity at 25 °C (Saybolt Furol seconds)	AASHTO T 59	20–100
Sieve test on original emulsion at time of delivery (max, %)	AASHTO T 59	0.05
24-hour storage stability (max, %)	AASHTO T 59	1
Residue by evaporation (min, %)	California Test 331	63
Tests on residue from evaporation test:		
Torsional recovery, measure entire arc of recovery at 25 °C (min, %)	California Test 332	40
Penetration at 25 °C (0.01 mm)	AASHTO T 49	70–150

39-2.05A(2)(c) Reserved

39-2.05A(3) Construction

39-2.05A(3)(a) General

Do not dilute the asphaltic emulsion.

Do not place BWC if rain is forecast for the project area within 24 hours by the National Weather Service.

39-2.05A(3)(b) Spreading and Compacting Equipment

Use method compaction for placing the BWC.

Use a material transfer vehicle when placing BWC. The material transfer vehicle must receive HMA directly from the truck.

Use an integrated distributor paver capable of spraying the asphaltic emulsion, spreading the HMA, and leveling the mat surface in 1 pass.

Apply asphaltic emulsion at a uniform rate for the full paving width. The asphaltic emulsion must not be touched by any part of the paver including wheels or tracks.

If the spray bar is adjusted for changing pavement widths, the paver must prevent excess spraying of asphaltic emulsion beyond 2 inches of the HMA edge.

39-2.05A(3)(c) Applying Asphaltic Emulsion

Before spreading HMA, apply asphaltic emulsion on dry or damp pavement with no free water.

Apply emulsion at a temperature from 120 to 180 degrees F and in a single application at the residual rate specified for the condition of the underlying surface. Asphaltic emulsion must have a target residual rate for the surfaces to receive the emulsion as shown in the following table:

Asphaltic Emulsion Target Residual Rate

Surface to receive asphaltic emulsion	Target residual rates
Concrete pavement (gal/sq yd)	0.09–0.11
Dense, compacted, new HMA pavement (gal/sq yd)	0.11–0.14
Open textured, dry, aged or oxidized existing asphalt concrete pavement (gal/sq yd)	0.13–0.17

If you request and your request is authorized, you may change the asphaltic emulsion application rates.

39-2.05A(3)(d) Placing and Compacting Hot Mix Asphalt

Construct a transverse joint if the HMA remains in the paver for more than 30 minutes.

Do not reintroduce HMA spread over asphaltic emulsion into the paving process.

Do not overlap or hot lap HMA. Pave through lanes after paving adjacent:

1. Shoulders
2. Tapers
3. Transitions
4. Road connections
5. Driveways
6. Curve widenings
7. Chain control lanes
8. Turnouts
9. Turn pockets
10. Ramps

For BWC placed on areas adjacent to through lanes that extend into the through lanes, cut the BWC to a neat, straight vertical line at the lane line.

If you spill asphaltic emulsion into the paver hopper, stop paving and remove the contaminated material.

39-2.05A(4) Payment

Payment for asphaltic emulsion is not included in the payment for the type of HMA used in a bonded wearing course.

39-2.05B Bonded Wearing Courses–Gap Graded

39-2.05B(1) General

39-2.05B(1)(a) Summary

Section 39-2.05B includes specifications for producing bonded wearing course–gap graded.

39-2.05B(1)(b) Definitions

Reserved

39-2.05B(1)(c) Submittals

Include film thickness and calculations and AASHTO T 305 results with your JMF submittal.

39-2.05B(1)(d) Quality Assurance

39-2.05B(1)(d)(i) General

Reserved

39-2.05B(1)(d)(ii) Quality Control

39-2.05B(1)(d)(ii)(A) General

Reserved

39-2.05B(1)(d)(ii)(B) Aggregates

Test the quality characteristics of the aggregates under the test methods and frequencies shown in the following table:

Aggregate Testing Frequencies

Quality characteristic	Test method	Minimum testing frequency
Gradation	AASHTO T 27	1 per 750 tons and any remaining part
Sand equivalent[a]	AASHTO T 176	
Moisture content[b]	AASHTO T 255	1 per 1500 tons and any remaining part
Crushed particles	AASHTO T 335	1 per 10,000 tons or 2 per project, whichever is greater
Los Angeles Rattler	AASHTO T 96	
Flat and elongated particles	ASTM D4791	
Fine aggregate angularity	AASHTO T 304, Method A	

[a]Reported value must be the average of 3 tests from a single sample. The use of a sand reading indicator is required as shown in AASHTO T 176, Figure 1. Sections 4.7, "Manual Shaker," 7.1.2, "Alternate Method No. 2," and 8.4.3, "Hand Method," do not apply. Prepare the stock solution as specified in section 4.8.1, "Stock solution with formaldehyde," except omit the addition of formaldehyde.
[b]Test at continuous mixing plants only.

For lime treated aggregate, test the aggregate before treatment and test for gradation and moisture content during BWC-G production.

39-2.05B(1)(d)(ii)(C) Bonded Wearing Course–Gap Graded Production

Take two 1 gal samples of BWC-G in metal containers.

Test the quality characteristics of BWC-G under the test methods and frequencies shown in the following table:

BWC-G Testing Frequencies

Quality characteristic	Test method	Minimum testing frequency
Asphalt binder content	AASHTO T 308, Method A	1 per 750 tons and any remaining part
HMA moisture content	AASHTO T 329	1 per 2,500 tons but not less than 1 per paving day

39-2.05B(1)(d)(ii)(D)–39-2.05B(1)(d)(ii)(G) Reserved

39-2.05B(1)(d)(iii) Department Acceptance

The Department accepts BWC-G based on compliance with:

1. Asphalt binder content at JMF -0.40, +0.50 percent when tested under AASHTO T 308, Method A.
2. Aggregate quality requirements shown in the following table:

Aggregate Quality

Quality characteristic	Test method	Requirement
Aggregate gradation	AASHTO T 27	JMF ± Tolerance
Percent of crushed particles Coarse aggregate (min, %) One-fractured face Two-fractured faces Fine aggregate (min, %) (Passing no. 4 sieve and retained on no. 8 sieve.) One fractured face	AASHTO T 335	 -- 90 85
Los Angeles Rattler (max, %) Loss at 100 Rev. Loss at 500 Rev.	AASHTO T 96	 12 35
Sand equivalent (min)[a]	AASHTO T 176	47
Flat and elongated particles (max, % by weight at 5:1)	ASTM D4791	25
Fine aggregate angularity (min, %)	AASHTO T 304, Method A	45

[a]Reported value must be the average of 3 tests from a single sample. The use of a sand reading indicator is required as shown in AASHTO T 176, Figure 1. Sections 4.7, "Manual Shaker," 7.1.2, "Alternate Method No. 2," and 8.4.3, "Hand Method," do not apply. Prepare the stock solution as specified in section 4.8.1, "Stock solution with formaldehyde," except omit the addition of formaldehyde.

39-2.05B(2) Materials

39-2.05B(2)(a) General

Reserved

39-2.05B(2)(b) Bonded Wearing Course–Gap Graded Mix Design

For BWC-G, the 1st paragraph of section 39-2.01B(2)(a) does not apply.

Determine the proposed OBC from a mix design that complies with the requirements shown in the following table:

Hot Mix Asphalt Mix Design Requirements

Quality characteristic	Test method	Requirement
Film thickness (min, μm)	Asphalt Institute MS-2 Table 8.1 [a]	12
Drain down (max, %)	AASHTO T 305 [b]	0.1

[a]Film thickness is calculated based on the effective asphalt content and determined as follows:

$$FT = \left(\frac{P_{be}}{SA \times G_b \times 1000} \right) 10^6$$

where:

FT = Film thickness in μm
P_{be} = Effective asphalt content by total weight of mix using *MS-2 Asphalt Mix Design Methods*
SA = Estimated surface area of the aggregate blend in m^2/kg from Table 8.1 in the Asphalt Institute *MS-2 Asphalt Mix Design Methods*
G_b = Specific gravity of asphalt binder

[b]Combine aggregate and asphalt at the asphalt binder supplier's instructed mixing temperature. Coated aggregates that fall through the wire basket during loading must be returned to the basket before conditioning at 350 °F for 1 hour.

The OBC must be greater than 4.9 percent by total weight of mix.

39-2.05B(2)(c) Asphalt Binder

Reserved

39-2.05B(2)(d) Aggregates

The aggregates must comply with the requirements shown in the following table:

Aggregate Quality

Quality characteristic	Test method	Requirement
Percent of crushed particles		
Coarse aggregate (min, %)		
One-fractured face	AASHTO T 335	--
Two-fractured faces		90
Fine aggregate (min, %)		
(Passing No. 4 sieve and retained on No. 8 sieve.)		
One-fractured face		85
Los Angeles Rattler (max, %)		
Loss at 100 Rev.	AASHTO T 96	12
Loss at 500 Rev.		35
Sand equivalent (min)[a]	AASHTO T 176	47
Flat and elongated particles (max, % by weight @ 5:1)	ASTM D4791	25
Fine aggregate angularity (min, %)	AASHTO T 304, Method A	45

[a]Reported value must be the average of 3 tests from a single sample. The use of a sand reading indicator is required as shown in AASHTO T 176, Figure 1. Sections 4.7, "Manual Shaker," 7.1.2, "Alternate Method No. 2," and 8.4.3, "Hand Method," do not apply. Prepare the stock solution as specified in section 4.8.1, "Stock solution with formaldehyde," except omit the addition of formaldehyde.

The aggregate gradations for BWC-G must comply with the requirements shown in the following table:

Aggregate Gradation Requirements

BWC-G pavement thickness shown	Gradation
less than 0.08 foot	No. 4 or 3/8 inch
0.08 foot or greater	1/2 inch

The proposed aggregate gradation must be within the TV limits for the specified sieve sizes shown in the following tables:

Aggregate Gradations for BWC-G
(Percentage Passing)

1/2 inch

Sieve size	Target value limit	Allowable tolerance
3/4"	100	--
1/2"	80–100	TV ± 6
3/8"	55–80	TV ± 6
No. 4	25–40	TV ± 7
No. 8	19–32	TV ± 5
No. 16	16–22	TV ± 5
No. 30	10–18	TV ± 4
No. 50	8–13	TV ± 4
No. 100	6–10	TV ± 2
No. 200	4.0–7.0	TV ± 2.0

3/8 inch

Sieve size	Target value limit	Allowable tolerance
1/2"	100	--
3/8"	80–100	TV ± 6
No. 4	25–40	TV ± 7
No. 8	19–32	TV ± 5
No. 16	16–22	TV ± 5
No. 30	10–18	TV ± 4
No. 50	8–13	TV ± 4
No. 100	7–11	TV ± 2
No. 200	6.0–10.0	TV ± 2.0

No. 4

Sieve size	Target value limit	Allowable tolerance
1/2"	100	--
3/8"	95–100	TV ± 2
No. 4	42–55	TV ± 7
No. 8	19–32	TV ± 5
No. 16	16–22	TV ± 5
No. 30	10–18	TV ± 4
No. 50	8–13	TV ± 4
No. 100	7–11	TV ± 2
No. 200	6.0–10.0	TV ± 2.0

39-2.05B(3) Construction

Apply asphaltic emulsion when the ambient air and pavement temperatures are above 50 degrees F.

39-2.05B(4) Payment

Not Used

39-2.06 HOT MIX ASPHALT ON BRIDGE DECKS

39-2.06A General

Section 39-2.06 includes specifications for producing and placing hot mix asphalt on bridge decks.

HMA used for bridge decks must comply with the specifications for Type A HMA in section 39-2.02.

39-2.06B Materials

Do not use the 1-inch or 3/4-inch aggregate gradation for HMA on bridge decks.

The grade of asphalt binder for HMA must be PG 64-10 or PG 64-16.

39-2.06C Construction

Spread and compact HMA on bridge decks using method compaction.

If a concrete expansion dam is to be placed at a bridge deck expansion joint, tape oil-resistant construction paper to the deck over the area to be covered by the dam before placing the tack coat and HMA across the joint.

Apply a tack coat at the minimum residual rate specified in section 39-2.01C(3)(f). For HMA placed on a deck seal, use the minimum residual rate specified for concrete pavement.

For HMA placed on a deck seal:

1. Place the HMA within 7 days after installing the deck seal.
2. If a paper mask is placed on the deck under section 54-5.03, place the HMA continuously across the paper mask.
3. Place HMA in at least 2 approximately equal layers.
4. For placement of the 1st HMA layer:
   - 4.1. Comply with the HMA application temperature recommended by the deck seal manufacturer.
   - 4.2. Deliver and place HMA using equipment with pneumatic tires or rubber-faced wheels. Do not operate other vehicles or equipment on the bare deck seal.
   - 4.3. Deposit HMA on the deck seal in such a way that the deck seal is not damaged. Do not use a windrow.
   - 4.4. Place HMA in a downhill direction on bridge decks with grades over 2 percent.
   - 4.5. Self-propelled spreading equipment is not required.

39-2.06D Payment

Not Used

39-2.07 MINOR HOT MIX ASPHALT

39-2.07A General

39-2.07A(1) Summary

Section 39-2.07 includes specifications for producing and placing minor hot mix asphalt.

Minor HMA must comply with section 39-2.02 except as specified in this section 39-2.07.

The inertial profiler requirements in section 36-3 do not apply.

39-2.07A(2) Definitions

Reserved

39-2.07A(3) Submittals

The QC plan and test results in sections 39-2.01A(3)(c) and 39-2.01A(3)(d) do not apply.

39-2.07A(4) Quality Assurance

39-2.07A(4)(a) General

The JMF renewal requirements in section 39-2.01A(4)(d) do not apply.

Test pavement smoothness with a 12 foot straightedge.

39-2.07A(4)(b) Quality Control

Testing for compliance with the following quality characteristics is not required:

1. Flat and elongated particles
2. Fine aggregate angularity
3. Hamburg wheel track
4. Moisture susceptibility

39-2.07A(4)(c) Department Acceptance

The Department accepts minor HMA under section 39-2.02A(4)(e) except for compliance with requirements for the following quality characteristics:

1. Flat and elongated particles
2. Fine aggregate angularity
3. Hamburg wheel track
4. Moisture susceptibility

39-2.07B Materials

39-2.07B(1) General

Reserved

39-2.07B(2) Minor Hot Mix Asphalt Mix Design

The Hamburg wheel track and moisture susceptibility requirements do not apply to the mix design for minor HMA.

39-2.07B(3) Asphalt Binder

The grade of asphalt binder for minor HMA must be PG-64-10 or PG-64-16.

39-2.07B(4) Liquid Antistrip Treatment

Treat minor HMA with liquid antistrip unless you submit AASHTO T 283 and AASHTO T 324 (Modified) test results showing compliance with section 39-2.02B and dated within 12 months of the submittal.

39-2.07C Construction

Not Used

39-2.07D Payment

Not Used

39-2.08–39-2.10 RESERVED

39-3 EXISTING ASPHALT CONCRETE

39-3.01 GENERAL

39-3.01A General

Section 39-3.01 includes general specifications for performing work on existing asphalt concrete facilities.

Work performed on existing asphalt concrete facilities must comply with section 15.

39-3.01B Materials

Not Used

39-3.01C Construction

Before removing a portion of an asphalt concrete facility, make a 2-inch deep saw cut to a true line along the limits of the removal area.

39-3.01D Payment

Not Used

39-3.02 REPLACE ASPHALT CONCRETE SURFACING

39-3.02A General

Section 39-3.02 includes specifications for replacing asphalt concrete surfacing.

39-3.02B Materials

HMA to be used for replacing asphalt concrete surfacing must comply with Type A HMA as specified in section 39-2.02.

The grade of asphalt binder must be PG 64-10 or PG 64-16.

Tack coat must comply with section 39-2.01B(10).

39-3.02C Construction

Where replace asphalt concrete surfacing is shown, remove the full depth of the existing asphalt concrete surfacing and replace with HMA. The Engineer determines the exact limits of asphalt concrete surfacing to be replaced.

Replace asphalt concrete in a lane before the lane is specified to be opened to traffic.

Before removing asphalt concrete, outline the replacement area and cut neat lines with a saw or grind to full depth of the existing asphalt concrete. Do not damage asphalt concrete and base remaining in place.

If you excavate the base beyond the specified plane, replace it with HMA.

Do not use a material transfer vehicle for replacing asphalt concrete surfacing.

Before placing HMA, apply a tack coat as specified in section 39-2.01C(3)(f).

Place HMA using method compaction as specified in section 39-2.01C(2)(c).

39-3.02D Payment

The payment quantity for replace asphalt concrete surfacing is the volume determined from the dimensions shown.

39-3.03 REMOVE ASPHALT CONCRETE DIKES

39-3.03A General

Section 39-3.03 applies to removing asphalt concrete dikes outside the limits of excavation.

39-3.03B Materials

Not Used

39-3.03C Construction

Reserved

39-3.03D Payment

Not Used

39-3.04 COLD PLANING ASPHALT CONCRETE PAVEMENT

39-3.04A General

Section 39-3.04 includes specifications for cold planning asphalt concrete pavement.

Cold planning asphalt concrete pavement includes the removal of pavement markers, traffic stripes, and pavement markings within the area of cold planning.

Schedule cold planing activities such that the pavement is cold planed, the HMA is placed, and the area is opened to traffic during the same work shift.

39-3.04B Materials

HMA for temporary tapers must be of the same quality that is used for the HMA overlay or comply with the specifications for minor HMA in section 39-2.07.

39-3.04C Construction

39-3.04C(1) General

Do not use a heating device to soften the pavement.

The cold planing machine must be:

1. Equipped with a cutter head width that matches the planing width unless a wider cutter head is authorized.
2. Equipped with automatic controls for the longitudinal grade and transverse slope of the cutter head and:
   2.1. If a ski device is used, it must be at least 30 feet long, rigid, and a 1-piece unit. The entire length must be used in activating the sensor.
   2.2. If referencing from existing pavement, the cold planing machine must be controlled by a self-contained grade reference system. The system must be used at or near the centerline of the roadway. On the adjacent pass with the cold planing machine, a joint-matching shoe may be used.
3. Equipped to effectively control dust generated by the planing operation
4. Operated such that no fumes or smoke is produced.

Replace broken, missing, or worn machine teeth.

If you do not complete placing the HMA surfacing before opening the area to traffic, you must:

1. Construct a temporary HMA taper to the level of the existing pavement.
2. Place HMA during the next work shift.
3. Submit a corrective action plan that shows you will complete cold planing and placement of HMA in the same work shift. Do not restart cold planing activities until the corrective action plan is authorized.

39-3.04C(2) Grade Control and Surface Smoothness

Install and maintain grade and transverse slope references. You may adjust the planed depth up to ± 0.03 foot from the depth shown to achieve uniform pavement profile, cross slope, and surface smoothness. The average cold planed depth must be equal to or greater than the depth shown.

The final cut must result in a neat and uniform surface.

The completed surface of the planed pavement must not vary more than 0.02 foot when measured with a 12-foot straightedge parallel with the centerline. With the straightedge at right angles to the centerline, the transverse slope of the planed surface must not vary more than 0.03 foot.

If you encounter delaminations during planing operations notify the Engineer immediately. If authorized, adjust the planed depth up to ± 0.05 foot to eliminate delaminations. Authorized work beyond the ± 0.05 foot range or other authorized mitigation work is change order work.

Where lanes are open to traffic, the drop-off of between adjacent lanes must not be more than 0.15 foot.

39-3.04C(3) Planed Material

Remove cold planed material concurrently with planing activities such that the removal does not lag more than 50 feet behind the planer.

39-3.04C(4) Temporary HMA Tapers

If a drop-off between the existing pavement and the planed area at transverse joints cannot be avoided before opening to traffic, construct a temporary HMA taper.

Completely remove temporary tapers before placing permanent surfacing.

39-3.04D Payment

Not Used

39-3.05 REMOVE BASE AND SURFACING

39-3.05A General

Section 39-3.05 includes specifications for removing base and asphalt concrete surfacing.

39-3.05B Materials

Not Used

39-3.05C Construction

Where base and surfacing are described to be removed, remove base and surfacing to a depth of at least 6 inches below the grade of the existing surfacing. Backfill resulting holes and depressions with embankment material under section 19.

39-3.05D Payment

The payment quantity for remove base and surfacing is the volume determined from the dimensions shown.

39-3.06–39-3.08 RESERVED

40 CONCRETE PAVEMENT

40-1 GENERAL

40-1.01 GENERAL

40-1.01A Summary

Section 40-1 includes general specifications for constructing concrete pavement.

40-1.01B Definitions

action limit: Test results at which corrective actions must be made while production continues.

full-depth crack: Crack other than a working crack that runs from one edge of a slab to the opposite or adjacent side of the slab.

raveling: Progressive disintegration of the concrete pavement surface resulting in dislodged aggregate.

suspension limit: Test results at which production must be suspended while corrections are made.

working crack: Crack that extends through the full depth of a slab and is parallel to and within 0.5 foot of a planned contraction joint.

40-1.01C Submittals

40-1.01C(1) General

At least 15 days before delivery to the job site, submit the manufacturer's instructions for storage and installation of:

1. Splice couplers for threaded tie bars
2. Joint filler

Submit calibration documentation and operational guidelines for frequency measuring devices for concrete vibrators as an informational submittal.

Submit updated QC charts each paving day as an informational submittal.

If repair or replacement of noncompliant concrete is required, submit a repair or replacement plan.

40-1.01C(2) Certificates of Compliance

Submit a certificate of compliance for:

1. Tie bars
2. Splice couplers for threaded tie bars
3. Dowel bars
4. Tie bar baskets
5. Dowel bar baskets
6. Joint filler
7. Epoxy-powder coating

40-1.01C(3) Quality Control Plan

Submit a concrete pavement QC plan. Allow 30 days for review.

40-1.01C(4) Mix Design

At least 15 days before testing for mix proportions, submit a copy of the AASHTO accreditation for the laboratory determining the mix proportions as an informational submittal.

At least 15 days before starting field qualification, submit the proposed concrete mix proportions, the corresponding mix identifications, and laboratory test reports, including measurements of the modulus of rupture, for each trial mixture at 10, 21, 28, and 42 days.

40-1.01C(5) Just-In-Time Training

Reserved

40-1.01C(6) Concrete Field Qualification

Submit field qualification data and test reports, including:

1. Mixing date
2. Mixing equipment and procedures used
3. Batch volume in cubic yards
4. Type and source of ingredients used
5. Penetration of the concrete
6. Air content of the plastic concrete
7. Age and strength at the time of concrete beam testing

The minimum batch size for field qualification is 5 cu yd.

Field qualification test reports must be certified with a signature by an official in responsible charge of the laboratory performing the tests.

40-1.01C(7) Test Strips

You may request to eliminate a test strip if you use paving equipment and personnel from a Department project (1) for the same type of pavement and (2) completed within the past 12 months. Submit supporting documents and the previous project's information with your request to eliminate a test strip.

40-1.01C(8) Cores

Submit the name of the laboratory that will test the cores for air content.

Submit each core in an individual plastic bag marked with a description of the location from which the core was taken.

40-1.01C(9) Coefficient of Thermal Expansion

Submit 4 test specimens fabricated from a single sample of concrete for testing the coefficient of thermal expansion under AASHTO T 336 for field qualification and during production.

Submit your coefficient of thermal expansion test data at:

http://169.237.179.13/cte/

40-1.01C(10)–40-1.01C(15) Reserved

40-1.01D Quality Assurance

40-1.01D(1) General

If the pavement quantity is at least 2,000 cu yd, provide a QC manager.

Core pavement as described for thickness, bar placement, and air content.

Provide material and labor to assist the Engineer in fabricating test beams for the Department's modulus of rupture testing.

Allow at least 25 days for the Department to schedule testing for the coefficient of friction. Notify the Engineer when a lane or lanes are scheduled to be opened to traffic and when the pavement is ready for testing, which is the latter of:

1. 7 days after paving
2. When the pavement has attained a modulus of rupture of at least 550 psi

The Department tests for the coefficient of friction within 7 days of receiving notification that the pavement is ready for testing.

40-1.01D(2) Just-In-Time Training

Reserved

40-1.01D(3) Quality Control Plan

The QC plan must describe the organization and procedures used to:

1. Control the production process
2. Determine whether a change to the production process is needed
3. Implement a change

The QC plan must include action and suspension limits and the details of the corrective action to be taken if any process is outside of those limits. The suspension limits must not exceed the specified acceptance criteria.

The QC plan must address the elements affecting concrete pavement quality, including:

1. Mix proportions
2. Aggregate gradation
3 Materials quality
4. Stockpile management
5. Line and grade control
6. Proportioning
7. Mixing and transportation
8. Placing and consolidation
9. Contraction and construction joints
10. Bar reinforcement placement and alignment
11. Dowel bar placement, alignment, and anchorage
12. Tie bar placement
13. Modulus of rupture
14. Finishing and curing
15. Protecting pavement
16. Surface smoothness

40-1.01D(4) Qualifications

Testing laboratories and their test equipment must be qualified under the Department's Independent Assurance Program.

Use a laboratory that complies with ASTM C1077 to determine the mix proportions for concrete pavement. The laboratory must have a current AASHTO accreditation for:

1. AASHTO T 97 or ASTM C78
2. ASTM C192/C192M

Use an ACI-certified concrete laboratory technician, Grade I, to perform field qualification tests and calculations.

40-1.01D(5) Mix Designs

Make trial mixtures no more than 24 months before field qualification.

Using your trial mixtures, determine the minimum cementitious materials content. Use your value for minimum cementitious material content for *MC* in equation 1 and equation 2 of section 90-1.02B(3).

To determine the minimum content of cementitious materials or the maximum ratio of water to cementitious materials, use modulus of rupture values of at least 570 psi for 28 days age and at least 650 psi for 42 days age.

If you change an aggregate supply source or the mix proportions, produce a trial batch and field qualify the new concrete. The Department does not adjust time for sampling, testing, and qualifying new mix proportions or changing an aggregate supply source.

40-1.01D(6) Test Strips

Construct a test strip for each type of pavement if the quantity is at least 2,000 cu yd. Obtain authorization of test strips before additional paving. Test strips must be:

1. From 700 to 1,000 feet long
2. Same width as the planned paving
3. Constructed using the same equipment to be used for constructing pavement

The Engineer selects from 6 to 12 core locations for dowel bars and up to 6 locations for tie bars for each test strip. If you use mechanical dowel bar inserters, the test strip must demonstrate they do not leave voids, segregations, or surface irregularities such as depressions, dips, or high areas.

Test strips must comply with the acceptance criteria for:

1. Smoothness except an inertial profile is not required

2. Dowel bar and tie bar placement
3. Pavement thickness
4. Final finishing except for the coefficient of friction

Allow 3 business days for evaluation of a test strip. If a test strip is not authorized, submit a plan for changes to your materials, methods, or equipment. Allow 3 business days for authorization of the plan. Construct another test strip under the authorized plan.

Remove test strips that are not authorized.

If a test strip is compliant except for smoothness and final finishing, you may grind the surface. After grinding, retest the smoothness under section 36-3. The Engineer retests the thickness after grinding.

Construct additional test strips if you change any of the following:

1. Paving equipment, including:
   1.1. Paver
   1.2. Dowel bar inserter
   1.3. Tie bar inserter
   1.4. Tining machine
   1.5. Curing equipment
2. Concrete mix proportions

40-1.01D(7) Quality Control

40-1.01D(7)(a) General

During paving, test the concrete pavement under the test methods and at the frequencies shown in the following table:

Concrete Pavement Test Methods and Testing Frequencies

Quality characteristic	Test method	Minimum testing frequency
Cleanness value	California Test 227	2 per day
Sand equivalent	California Test 217	
Aggregate gradation	California Test 202	
Air content (air entrainment specified)	California Test 504	1 per hour
Air content (air entrainment not specified)	California Test 504	1 per 4 hours
Density	California Test 518	
Penetration	California Test 533	
Aggregate moisture meter calibration[a]	California Test 223 or 226	1 per day

[a] Check the calibration of the plant moisture meter by comparing moisture meter readings with California Test 223 or California Test 226 test results.

Maintain control charts to identify potential problems and assignable causes. Post a copy of each control chart at a location determined by the Engineer.

Control charts for individual measurements of quality characteristics must use the target values in the mix proportions as indicators of central tendency.

Develop linear control charts for:

1. Cleanness value
2. Sand equivalent
3. Fine and coarse aggregate gradation
4. Air content
5. Penetration

Control charts must include:

1. Contract number
2. Mix proportions
3. Test number

4. Each test parameter
5. Action and suspension limits
6. Specification limits
7. QC test results

For control charts for fine and coarse aggregate gradation, record the running average of the previous 4 consecutive gradation tests for each sieve and superimpose the specification limits.

For control charts for air content, the action limit is ±1.0 percent of the specified value. If no value is specified, the action limit is ±1.0 percent of the value used for your authorized mix design.

As a minimum, a process requires corrective action if any of the following occurs:

1. 2 consecutive running averages of 4 tests for fine or coarse aggregate gradation are outside the specification limits
2. 1 point falls outside the suspension limit line for individual penetration or air content measurements
3. 2 points in a row fall outside the action limit line for individual penetration or air content measurements

Stop production for processes requiring corrective action.

Before placing concrete pavement each day and at intervals not to exceed 4 hours during production, use a tachometer to test and record the vibration frequency of the concrete vibrators.

40-1.01D(7)(b) Concrete Field Qualification

Before paving, your mix design must be field qualified.

For field qualification, the modulus of rupture at an age of 28 days or earlier must be at least:

1. 550 psi for each single beam
2. 570 psi for the average of 5 beams

40-1.01D(7)(c)–40-1.01D(7)(h) Reserved

40-1.01D(8) Department Acceptance

40-1.01D(8)(a) General

The Department tests the concrete pavement under the test methods and at the frequencies shown in the following table:

Department Acceptance Testing Frequency

Quality characteristic	Test method		Minimum testing frequency[a]
	CRCP	JPCP	
Air content[b]	California Test 504		1 day's paving
Modulus of rupture at 28 days	California Test 523		1,000 cu yd
Dowel bar placement	--	Measurement	700 sq yd
Tie bar placement	--	Measurement	4,000 sq yd
Coefficient of friction	California Test 342		1 day's paving
Thickness	California Test 531		1,200 sq yd

[a]A single test represents no more than the frequency specified.
[b]Tested only if air entrainment is specified.

40-1.01D(8)(b) Verification Testing

40-1.01D(8)(b)(i) General

Reserved

40-1.01D(8)(b)(ii) Air Content

If air-entraining admixtures are specified, the Engineer uses a t-test to compare your QC test results with the Department's test results. The t-value for test data is determined using the following equation:

$$t = \frac{|\overline{X}_c - \overline{X}_v|}{S_p\sqrt{\frac{1}{n_c} + \frac{1}{n_v}}} \qquad \text{and} \qquad S_p^2 = \frac{S_c^2(n_c - 1) + S_v^2(n_v - 1)}{n_c + n_v - 2}$$

where:

n_c = number of your QC tests (minimum of 6 required)
n_v = number of Department's tests (minimum of 2 required)
$\overline{X}_c$ = mean of your QC tests
$\overline{X}_v$ = mean of the Department's tests
S_p = pooled standard deviation
S_c = standard deviation of your QC tests
S_v = standard deviation of the Department's tests

Your QC test results are compared with the Department's test results at a level of significance of $\alpha = 0.01$. The t-value is compared to t_{crit} for the degrees of freedom shown in the following table:

Degrees of freedom (n_c+n_v-2)	tcrit (for $\alpha = 0.01$)
1	63.657
2	9.925
3	5.841
4	4.604
5	4.032
6	3.707
7	3.499
8	3.355
9	3.250
10	3.169

If the calculated t-value is less than or equal to t_{crit}, your QC test results are verified. If the calculated t-value is greater than t_{crit}, your QC test results are not verified.

If your QC test results are not verified, core at least 3 specimens from the concrete pavement under section 40-1.03M. The Engineer selects the core locations. The authorized laboratory must test these specimens for air content under ASTM C457. The Engineer compares these test results with your QC test results using the t-test method. If your QC test results are verified based on this comparison, the Engineer uses the QC test results for acceptance of concrete pavement for air content. If your QC test results are not verified based on this comparison, the Engineer uses the air content of core specimens determined by the authorized laboratory under ASTM C457 for acceptance.

40-1.01D(8)(c) Acceptance Testing

40-1.01D(8)(c)(i) General

The Department accepts concrete pavement based on compliance with the requirements shown in the following table:

Concrete Pavement Requirements for Acceptance

Quality characteristic	Test method		Requirement
	CRCP	JPCP	
Air content	California Test 504		±1.5 % of the specified value[a]
Modulus of rupture at 28 days (min, psi)	California Test 523		570[b]
Bar reinforcement depth tolerance at joints (min)	Field measurement		1/2 inch below the saw cut depth
Dowel bar placement tolerances[c]: Horizontal offset (inch) Longitudinal translation (inch) Horizontal skew (max, inch) Vertical skew (max, inch) Vertical depth	--	Field measurement	±1 ±2 5/8 5/8 The minimum distance measured from the concrete pavement surface to any point along the top of the dowel bar must be: DB + 1/2 inch where: DB = 1/3 of the pavement thickness or the saw cut depth in inches, whichever is greater The maximum distance below the depth shown must be 5/8 inch.
Tie bar placement tolerances[c]: Horizontal and vertical skew (max, inches) Longitudinal translation (inches) Horizontal offset (embedment, inches) Vertical depth	--	Field measurement	5 1/4 ±2 ±2 1. At least 1/2 inch below the bottom of the saw cut 2. At least 2 inches from any point along the bar to the pavement surface or bottom
Coefficient of friction (min): Concrete pavement Ramp termini	California Test 342		0.30 0.35
Pavement smoothness	California Test 387, AASHTO R 57, and AASHTO R 56		1. No area of localized roughness with an International Roughness Index greater than 120 in/mi 2. Mean Roughness Index of 60 in/mi or less within a 0.1 mile section
Thickness tolerance[d] (max, foot)	California Test 531		0.01 foot deficient of the thickness shown

[a]If no value is specified, the air content must be within ±1.5 % of the value used for your authorized mix design.
[b]Average of the individual test results of 2 test beams.
[c]Placement tolerance is measured relative to the completed joint.
[d]See section 40-1.01D(8)(c)(iv) for additional thickness requirements.

40-1.01D(8)(c)(ii) Dowel and Tie Bar Placement

Core each day's paving within 2 business days. The Engineer identifies the joint and dowel or tie bar to be tested. Each dowel or tie bar test consists of 2 cores, 1 on each end of the bar to expose both ends for measurement. If the initial cores show that dowel or tie bars are within alignment tolerances and the Engineer orders more coring, the additional cores are change order work.

If the coring indicates the dowel or tie bars are not placed within the specified tolerances or if unconsolidated concrete is around the dowel or tie bars, perform additional coring as ordered to determine the limits of unacceptable work. The Engineer determines the limits for removal and replacement.

40-1.01D(8)(c)(iii) Pavement Smoothness

The Department may accept pavement smoothness based on your inertial profiler testing in the absence of its own testing.

40-1.01D(8)(c)(iv) Thickness

Drill cores for the Department's acceptance testing for thickness under section 40-1.03M. Drill the cores in the primary area, which is the area placed in 1 day for each thickness. Core at the locations determined by the Engineer and in the Engineer's presence.

If grinding is required, do not core until grinding has been completed.

The core specimen diameter must be 4 inches. To identify the limits of concrete pavement deficient in thickness by more than 0.05 foot, you may divide primary areas into secondary areas. The Engineer measures cores under California Test 531 to the nearest 0.01 foot.

You may request additional thickness measurements to determine the average thickness variation. The Engineer determines the locations with random sampling methods.

If each thickness measurement in a primary area is deficient by less than 0.05 foot, the Engineer calculates the average thickness deficiency in that primary area. The Engineer uses 0.02 foot for a thickness difference more than 0.02 foot over the specified thickness.

The thickness of the concrete pavement must not be deficient by more than 0.05 foot. For each thickness measurement in a primary area deficient by more than 0.05 foot, the Engineer determines a secondary area where the thickness deficiency is more than 0.05 foot. The Engineer determines this secondary area by measuring the thickness of each concrete pavement slab adjacent to the measurement found to be more than 0.05 foot deficient. The Engineer continues to measure the thickness until an area that is bound by slabs with a thickness deficient by 0.05 foot or less is determined.

Slabs without bar reinforcement are defined by the areas bound by longitudinal and transverse joints and concrete pavement edges. Slabs with bar reinforcement are defined by the areas bound by longitudinal joints and concrete pavement edges and 15-foot lengths. The thickness measurements for a secondary area in a slab determine that entire slab thickness.

The Engineer measures the remaining primary area thickness after removing the secondary areas from consideration for determining the average thickness deficiency.

The minimum thickness is not reduced for specifications that may affect concrete pavement thickness such as allowable tolerances for subgrade construction.

The Engineer determines the areas of noncompliant pavement, thickness deficiencies, and limits where removal is required.

Pavement with an average thickness deficiency less than 0.01 foot is acceptable. If the thickness deficiency is 0.01 foot or more and less than 0.05 foot, you may request authorization to leave the pavement in place and accept a payment adjustment. If the deficiency is more than 0.05 foot, you must remove and replace the pavement.

The deduction for pavement thickness deficiency in each primary area is as shown in the following table:

Deduction for Thickness Deficiency

Average thickness deficiency[a]	Deduction
0.01 foot	$0.90/sq yd
0.02 foot	$2.30/sq yd
0.03 foot	$4.10/sq yd
0.04 foot	$6.40/sq yd
0.05 foot	$9.11/sq yd

[a]Values greater than 0.01 foot are rounded to the nearest 0.01 foot.

40-1.01D(8)(c)(v)–40-1.01D(8)(c)(viii) Reserved

40-1.02 MATERIALS

40-1.02A General

Tack coat must comply with section 39.

40-1.02B Concrete

40-1.02B(1) General

Concrete placed for tapered edges after the pavement has been placed may be minor concrete.

40-1.02B(2) Cementitious Material

Concrete must contain from 505 pounds to 675 pounds of cementitious material per cubic yard. The specifications for reducing cementitious material content in section 90-1.02E(2) do not apply.

40-1.02B(3) Aggregate

The specifications for a reduction in the operating range and contract compliance for cleanness value and sand equivalent specified in section 90-1.02C(2) and section 90-1.02C(3) for aggregate do not apply.

For coarse aggregate in high desert and high mountain climate regions, the loss must not exceed 25 percent when tested under California Test 211 with 500 revolutions.

For the combined aggregate gradation, the difference between the percent passing the 3/8-inch sieve and the percent passing the no. 8 sieve must not be less than 16 percent of the total aggregate.

40-1.02B(4) Air Entrainment

The specifications for air-entraining admixtures in the 2nd paragraph of section 90-1.02I(2)(a) do not apply.

The air content must be within ±1.5 percent of the specified value. If no value is specified, the air content must be within ±1.5 percent of the value used for your authorized mix design.

For a project in the low or south mountain climate region, add an air-entraining admixture to the concrete at the rate required to produce an air content of 4 percent in the freshly mixed concrete.

For a project in a high desert or high mountain climate region, add an air-entraining admixture to the concrete at the rate required to produce an air content of 6 percent in the freshly mixed concrete.

40-1.02B(5)–40-1.02B(8) Reserved

40-1.02C Reinforcement, Bars, and Baskets

40-1.02C(1) General

Reserved

40-1.02C(2) Bar Reinforcement

Bar reinforcement must be deformed bars complying with section 52 unless the project is shown to be in a high desert or any mountain climate region, in which case, it must be one of the following:

1. Epoxy-coated bar reinforcement under section 52-2.03B except bars must comply with either ASTM A706/A706M; ASTM A996/A996M; or ASTM A615/A615M, Grade 40 or 60. Bars must be handled under ASTM D3963/D3963M and section 52-2.02C.
2. Low-carbon chromium steel bar complying with ASTM A1035/A1035M.

40-1.02C(3) Dowel Bars

For a project not shown to be in a high desert or any mountain climate region, dowel bars must be plain bars complying with section 52 and must be one of the following:

1. Epoxy-coated bars. Bars must comply with ASTM A615/A615M, Grade 40 or 60. The epoxy coating must comply with either section 52-2.02B or 52-2.03B.
2. Stainless-steel bars. Bars must be descaled, solid stainless-steel bars under ASTM A955/A955M, UNS Designation S31603 or S31803.
3. Low carbon, chromium-steel bars under ASTM A1035/A1035M.

For a project shown to be in a high desert or any mountain climate region, dowel bars must be plain bars complying with section 52 and be one of the following:

1. Epoxy-coated bars. Bars must comply with ASTM A615/A615M, Grade 40 or 60. Epoxy coating must comply with section 52-2.03B.
2. Stainless-steel bars. Bars must be descaled, solid stainless-steel bars under ASTM A955/A955M, UNS Designation S31603 or S31803.

Fabricate, sample, and handle epoxy-coated dowel bars under ASTM D3963/D3963M and section 52-2.03C except each sample must be 18 inches long.

40-1.02C(4) Tie Bars

Tie bars must be deformed bars.

For a project not shown to be in a high desert or any mountain climate region, tie bars must be one of the following:

1. Epoxy-coated bar reinforcement. Bars must comply with section 52-2.02B or 52-2.03B except bars must comply with ASTM A706/A706M; ASTM A996/A996M; or ASTM A615/A615M, Grade 40 or 60.
2. Stainless-steel bars. Bars must be descaled, solid stainless-steel bars under ASTM A955/A955M, UNS Designation S31603 or S31803.
3. Low carbon, chromium-steel bars under ASTM A1035/A1035M.

For a project shown to be in a high desert or any mountain climate region, tie bars must be one of the following:

1. Epoxy-coated bar reinforcement. Bars must comply with section 52-2.03B except bars must comply with either ASTM A706/A706M; ASTM A996/A996M; or ASTM A615/A615M, Grade 40 or 60.
2. Stainless-steel bars. Bars must be descaled, solid stainless-steel bars under ASTM A955/A955M, UNS Designation S31603 or S31803.

Fabricate, sample, and handle epoxy-coated tie bars under ASTM D3963/D3963M, section 52-2.02 or section 52-2.03.

Do not bend tie bars.

40-1.02C(5) Dowel and Tie Bar Baskets

For dowel and tie bar baskets, wire must comply with ASTM A1064/A1064M and be welded under ASTM A185/A185M, section 7.4. Assemblies must be either U-frame or A-frame shaped assemblies.

Wire intersections must be resistance welded.

For a project not shown to be in the high desert or any mountain climate region, baskets may be epoxy-coated. The epoxy coating must comply with section 52-2.02B or 52-2.03B.

For a project shown to be in the high desert or any mountain climate region, the wire for dowel bar and tie bar baskets must be one of the following:

1. Epoxy-coated wire complying with section 52-2.03B.

2. Stainless-steel wire. Wire must be descaled solid stainless-steel. Wire must comply with (1) the chemical requirements in ASTM A276/A276M, UNS Designation S31603 or S31803, and (2) the tension requirements in ASTM A1022/A1022M.

Handle epoxy-coated tie bar and dowel bar baskets under ASTM D3963/D3963M and either section 52-2.02 or 52-2.03.

Fasteners must be driven fasteners as specified in ASTM F1667. Fasteners on LCB or asphalt concrete must have a minimum shank diameter of 3/16 inch and a minimum shank length of 2-1/2 inches. For ATPB or CTPB, the shank diameter must be at least 3/16 inch and the shank length must be at least 5 inches.

Fasteners, clips, and washers must have a minimum 0.2-mil-thick zinc coating applied by either electroplating or galvanizing.

40-1.02D Dowel Bar Lubricant

Dowel bar lubricant must be curing compound no. 3 or paraffin based. Paraffin-based lubricant must be Bradley Coatings Group BCG 6116 or Valvoline Tectyl 506 or an authorized equal and must be factory-applied.

40-1.02E Joint Filler

Joint filler for an isolation joint must be a preformed, bituminous-type, expansion joint filler for concrete complying with ASTM D994.

40-1.02F Nonshrink Hydraulic-Cement Grout

Nonshrink hydraulic-cement grout must comply with ASTM C1107/C1107M. You may use clean, uniform, rounded aggregate filler to extend the grout. Aggregate filler must not exceed 60 percent of the grout mass or the maximum described in the manufacturer's instructions, whichever is less. The moisture content of the aggregate filler must not exceed 0.5 percent when tested under California Test 223 or California Test 226. When tested under California Test 202, aggregate filler must comply with the gradation requirements shown in the following table:

Aggregate Filler Gradation

Sieve size	Percentage passing
1/2-inch	100
3/8-inch	85–100
No. 4	10–30
No. 8	0–10
No. 16	0–5

40-1.02G–40-1.02N Reserved

40-1.03 CONSTRUCTION

40-1.03A General

Proportion aggregate and bulk cementitious material by weight using an authorized automatic proportioning device.

For widenings and lane reconstruction, construct only the portion of the pavement where the work will be completed during the same closure. If you do not complete the construction during the same closure, construct temporary roadway pavement under section 41-1.02E.

40-1.03B Joints

40-1.03B(1) General

Do not bend tie bars or reinforcement in existing concrete pavement joints.

For contraction joints and isolation joints, saw cut a groove with a power-driven saw equipped with a diamond blade. After cutting, immediately wash slurry from the joint with water below 100 psi gauge pressure.

Keep joints free from foreign material, including soil, gravel, concrete, and asphalt. To keep foreign material out of the joint, you may use filler material. The filler material must not react adversely with the concrete or damage the pavement. After sawing and washing, install the material such that it keeps moisture in the adjacent concrete during the 72 hours after paving. If you install filler material, the specifications for spraying the sawed joint with additional curing compound in section 40-1.03I do not apply. If you use absorptive filler material, moisten the filler immediately before or after installation.

40-1.03B(2) Construction Joints

Construction joints must be vertical.

Before placing fresh concrete against hardened concrete, existing concrete pavement, or structures, apply curing compound no. 1 or 2 to the vertical surface and allow it to dry.

At joints between concrete pavement and asphalt concrete pavement, apply a tack coat between the two pavements.

Use a metal or wooden bulkhead to form transverse construction joints. If dowel bars are described, the bulkhead must allow dowel bar installation.

40-1.03B(3) Contraction Joints

Saw contraction joints before cracking occurs and after the concrete is hard enough to saw without spalling, raveling, or tearing.

Except for longitudinal joints parallel to a curving centerline, saw the contraction joints such that they are no more than 0.1 foot from either side of a 12-foot straight line.

Cut transverse contraction joints within 0.5 foot of the spacing described. Adjust spacing if needed such that slabs are at least 10 feet long.

For widenings, do not match transverse contraction joints with existing joint spacing or skew unless described.

Cut transverse contraction joints straight across the full width of the concrete pavement between isolation joints and edges of pavement. In areas of converging and diverging pavements, space transverse contraction joints such that the joint is continuous across the maximum pavement width. Longitudinal contraction joints must be parallel with the concrete pavement centerline except where lanes converge or diverge.

40-1.03B(4) Isolation Joints

Before placing concrete at isolation joints, saw cut the existing concrete face to make a clean, flat, vertical surface and secure the joint filler. Make the saw cut the same depth as the depth of the new pavement.

40-1.03C Bar Reinforcement

Place bar reinforcement under section 52.

Bar reinforcement must be more than 1/2 inch below the saw cut depth at concrete pavement joints.

40-1.03D Dowel Bar Placement

Dowel bar placement must comply with the tolerances shown in the following table:

Dowel Bar Placement

Dimension	Tolerance
Horizontal offset (inch)	±1
Longitudinal translation (inch)	±2
Horizontal skew (max, inch)	5/8
Vertical skew (max, inch)	5/8
Vertical depth	The minimum distance measured from the concrete pavement surface to any point along the top of the dowel bar must be: DB + 1/2 inch where: DB = 1/3 of the pavement thickness or the saw cut depth in inches, whichever is greater The maximum distance below the depth shown must be 5/8 inch.

NOTE: Tolerances are measured relative to the completed joint.

If you are using curing compound as a lubricant, apply the curing compound to the dowels:

1. In 2 separate applications. Apply the last application no more than 8 hours before placing the dowels.
2. Such that each dowel is completely lubricated before placement.
3. At a rate of 1 gallon per 150 square feet.

Install dowel bars using one of the following methods:

1. Drill and bond the bars under section 41-10.
2. Mechanically insert the bars. Eliminate evidence of the insertion by reworking the concrete over the dowels.
3. Use dowel bar baskets to hold the dowels at the specified depth and alignment before concrete placement. Anchor the baskets with at least 1 fastener per foot of basket section and at least 200 feet in advance of the pavement placement activity. You may request not to perform advance anchoring due to construction limitations or restricted access. After anchoring the baskets and before placing the concrete, cut and remove the temporary spacer wires and demonstrate the dowel bars do not move from their specified depth and alignment during concrete placement.

If installation of dowel bars is noncompliant, stop paving, demonstrate your correction, and obtain verbal authorization.

40-1.03E Tie Bar Placement

Tie bar placement must comply with the tolerances shown in the following table:

Tie Bar Placement

Dimension	Tolerance
Horizontal and vertical skew (max, inch)	5 1/4
Longitudinal translation (inch)	±2
Horizontal offset (embedment, inch)	±2
Vertical depth	1. At least 1/2 inch below the bottom of the saw cut 2. At least 2 inches from any point along the bar to the pavement surface or bottom

NOTE: Tolerances are measured relative to the completed joint.

Install tie bars at longitudinal joints using one of the following methods:

1. Drill and bond the bars under section 41-10.
2. Mechanically insert the bars into plastic slip formed concrete before finishing. Ensure there is full contact between the inserted bar and the concrete. Eliminate evidence of the insertion by reworking the concrete over the tie bars.

3. Use threaded couplers to splice the tie bars. The couplers must be fabricated from deformed bar reinforcement and free of external welding or machining.
4. Use tie bar baskets to hold the tie bars at the specified depth and alignment before concrete placement. Use fasteners to anchor tie bar baskets. Anchor the baskets at least 200 feet in advance of the pavement placement activity. You may request not to perform advanced anchoring due to construction limitations or restricted access. After anchoring the baskets and before placing the concrete, demonstrate the tie bars do not move from their specified depth and alignment during concrete placement.

If installation of tie bars is noncompliant, stop paving, demonstrate your correction, and obtain verbal authorization.

40-1.03F Placing Concrete

40-1.03F(1) General

Immediately before placing concrete, the surface to receive the concrete must be:

1. Within the compaction and elevation tolerances
2. Free of loose and extraneous material
3. Uniformly moist but free of standing or flowing water

Place concrete pavement with stationary side forms or slip form paving equipment.

Place consecutive concrete loads within 30 minutes of each other. Construct a transverse construction joint if the concrete placement is interrupted by more than 30 minutes. The transverse construction joint must be at the same longitudinal location as the contraction joint in the adjacent lane location, or you must remove the concrete pavement to the preceding transverse joint.

Place the concrete pavement in full-lane widths separated by construction joints or monolithically with contraction joints.

Do not retemper concrete.

If the surface width is constructed as shown, you may construct the pavement sides on a batter not flatter than 6:1 (vertical:horizontal).

40-1.03F(2) Paving Adjacent to Existing Concrete Pavement

Wherever pavement is placed adjacent to existing concrete pavement:

1. Grind the adjacent pavement before placing the new pavement.
2. Use paving equipment with padded crawler tracks or rubber-tired wheels with enough offset to prevent damage.
3. Match the pavement grade with the elevation of the existing concrete pavement after grinding.

40-1.03F(3) Concrete Pavement Transition Panel

For concrete pavement placed in a transition panel, texture the surface with a drag strip of burlap, broom, or spring steel tine device that produces scoring in the finished surface. Scoring must be either parallel or transverse to the centerline. Texture at the time that produces the coarsest texture.

40-1.03F(4) Stationary Side-Form Construction

Stationary side forms must be straight and without defects, including warps, bends, and indentations. Side forms must be metal except at end closures and transverse construction joints where other materials may be used.

You may build up side forms by attaching a section to the top or bottom. If they are attached to the top of metal forms, the attached section must be metal.

The side form base width must be at least 80 percent of the shown concrete pavement thickness.

Side forms, including interlocking connections with adjoining forms, must be rigid enough to prevent springing from (1) subgrading and paving equipment and (2) concrete pressure.

Construct the subgrade to the final grade before placing the side forms. The forms must bear fully on the foundation throughout their length and base width. Place the forms to the grade and alignment of the finished concrete pavement edge. Support the forms during concrete placement, compaction, and finishing.

After completing the subgrade and immediately before placing the concrete, true up the side forms and set to the line and grade for a distance that avoids delays due to form adjustment.

Clean and oil the forms before each use.

Side forms must remain in place for at least 1 day after placing the concrete and until the pavement edge no longer requires protection from the forms.

Spread, screed, shape, and consolidate concrete with 1 or more machines. The machines must uniformly distribute and consolidate the concrete. The machines must operate to place the concrete to the shown cross section with minimal hand work.

Consolidate the concrete without segregation. If you use concrete vibrators:

1. Vibration rate must be at least 3,500 cycles per minute for surface vibrators and 5,000 cycles per minute for internal vibrators. Use a calibrated device to measure the frequency of vibration.
2. Amplitude of vibration must cause perceptible concrete surface movement at least 1 foot from the vibrating element.
3. Vibrators must not rest on side forms or new concrete pavement.
4. Power to vibrators must automatically cease if forward or backward motion of the paving machine is stopped.
5. High-frequency internal vibrators must be used within 15 minutes of depositing concrete on the subgrade to uniformly consolidate the concrete across the paving width, including the area adjacent to the forms.
6. Mass of concrete must not be shifted with the vibrators.

40-1.03F(5) Slip form Construction

If you use slip form construction, spread, screed, shape, and consolidate the concrete to the shown cross section with slip form machines and minimal hand work. Slip form paving machines must be equipped with traveling side forms and must not segregate the concrete.

Do not deviate from the pavement alignment by more than 0.1 foot.

Slip form paving machines must use high-frequency internal vibrators to consolidate concrete. You may mount the vibrators with their axes parallel or normal to the pavement alignment. If vibrators are mounted with their axes parallel to the pavement alignment, space the vibrators no more than 2.5 feet center-to-center. If vibrators are mounted with their axes normal to the pavement alignment, space vibrators with a maximum 0.5-foot lateral clearance between individual vibrators.

Each vibrator must have a vibration rate from 5,000 to 8,000 cycles per minute. The amplitude of vibration must cause perceptible concrete surface movement at least 1 foot from the vibrating element. Use a calibrated tachometer to measure the frequency of vibration.

40-1.03G Edge Treatment

If required, regrade the area for the preparation of tapered edge treatment.

Sections 40-1.03H(2) and 40-1.03H(3) do not apply to tapered edges.

For tapered edges placed after the concrete pavement is complete, install connecting bar reinforcement under section 52.

You may construct the tapered edges by saw cutting or grinding.

The angle of the tapered edge slope must not deviate by more than ±5 degrees from the angle shown measured from the plane of the adjacent finished pavement surface.

40-1.03H Finishing

40-1.03H(1) General

Reserved

40-1.03H(2) Preliminary Finishing

40-1.03H(2)(a) General

Preliminary finishing must produce a smooth and true-to-grade finish. After preliminary finishing, mark each day's paving with a stamp approximately 1 by 2 feet. The stamp must be authorized before paving starts. The stamp must form a uniform mark from 1/8 to 1/4 inch deep. Locate the mark 20 ± 5 feet from the transverse construction joint formed at the start of paving each day and 1 ± 0.25 foot from the outside edge of the pavement. The mark must show the month, day, and year of placement and the station of the transverse construction joint. Orient the mark such that it can be read from the outside edge of the pavement.

Do not apply water to the pavement surface before float finishing.

40-1.03H(2)(b) Stationary Side Form Finishing

If you use stationary side-form construction, apply a preliminary finish to the pavement by machine-float or hand method.

For the machine-float method:

1. Use self-propelled machine floats.
2. Determine the number of machine floats required to perform the work at a rate equal to the pavement placement. If the time from paving to machine-float finishing exceeds 30 minutes, stop pavement placement. When machine floats are in proper position, you may resume pavement placement.
3. Run machine floats on side forms or adjacent pavement lanes. If running on adjacent pavement, protect the adjacent pavement surface under section 40-1.03J. Floats must be hardwood, steel, or steel-shod wood and equipped with devices that adjust the underside to a true flat surface.

For the hand method, finish the pavement smooth and true to grade with manually operated floats or powered finishing machines.

40-1.03H(2)(c) Slip form Finishing

For slip form construction, the slip form paver must give the pavement a preliminary finish. You may supplement the slip form paver with machine floats.

Before the pavement hardens, correct the slump of the pavement edge in excess of 0.02 foot except for the edge rounding.

40-1.03H(3) Final Finishing

After completing preliminary finishing, round the edges of the initial paving widths to a 0.04-foot radius. Round the transverse and longitudinal construction joints to a 0.02-foot radius.

Texture the pavement before curing it. Perform the initial texturing with a burlap drag or broom device that produces striations parallel to the centerline. Perform the final texturing with a spring-steel tined device that produces grooves parallel with the centerline.

Construct longitudinal grooves with a self-propelled machine designed specifically for grooving and texturing pavement. The machine must have tracks to maintain constant speed, provide traction, and maintain accurate tracking along the pavement surface. The machine must have a single row of rectangular spring steel tines. The tines must be from 3/32 to 1/8 inch wide, spaced on 3/4-inch centers, and have enough length, thickness, and resilience to form grooves approximately 3/16 inch deep. The machine must have horizontal and vertical controls. The machine must apply a constant downward pressure on the surface of the pavement during texturing. The operation must not cause raveling.

Construct grooves over the entire pavement width in a single pass except do not construct grooves 3 inches from the pavement edges and longitudinal joints. The final texture must be uniform and smooth. Use a guide to properly align the grooves. The grooves must be parallel and aligned to the pavement edge across its width. The grooves must be from 1/8 to 3/16 inch deep after the pavement has hardened.

For irregular areas and areas inaccessible to the grooving machine, you may construct grooves using the hand method. Hand-constructed grooves must comply with the specifications for machine-constructed grooves.

Initial and final texturing must produce a coefficient of friction of at least 0.30. Do not open a lane or lanes to traffic unless the coefficient of friction is at least 0.30.

For ramp termini, use heavy brooming normal to the ramp centerline to produce a coefficient of friction of at least 0.35.

40-1.03I Curing

Cure the concrete pavement exposed area using the waterproof membrane method or curing compound method with curing compound no. 1 or 2. If you remove the side forms within 72 hours of the start of curing, also cure the pavement edges.

Apply curing compound with mechanical sprayers. Reapply curing compound to saw cuts and disturbed areas.

40-1.03J Protecting Concrete Pavement

Maintain the concrete pavement surface temperature at not less than 40 degrees F for the initial 72 hours.

Protect the surface from activities that cause damage and reduce the texture or coefficient of friction. Prevent soil, gravel, petroleum products, concrete, or asphalt mixes from being deposited on the pavement surface.

Construct crossings for traffic convenience. You may use RSC for crossings if authorized. Do not open crossings until the Department determines that the pavement modulus of rupture is at least 550 psi under California Test 523 or California Test 524.

Do not allow traffic on concrete pavement or use equipment on it (1) for 10 days after paving and (2) before the concrete has attained a modulus of rupture of 550 psi based on the Department's testing unless:

1. Equipment is for sawing contraction joints
2. One side of the paving equipment tracks may be on the concrete pavement after a modulus of rupture of 350 psi has been attained if:
   2.1. Unit pressure exerted on the pavement by the paver does not exceed 20 psi
   2.2. You change the paving equipment tracks to prevent damage, or the paving equipment tracks travel on protective material, such as planks
   2.3. No part of the track is closer than 1 foot to the concrete pavement edge
   2.4. Authorized

If visible cracking or other damage occurs to the concrete pavement, stop operating the paving equipment on the pavement and repair the damage.

40-1.03K Early Use of Concrete Pavement

To request early use of concrete pavement:

1. Furnish molds and machines for the modulus of rupture testing
2. Sample the concrete
3. Fabricate beam specimens
4. Test the beams for the modulus of rupture under California Test 523

The pavement must have a modulus of rupture of at least 350 psi. Protect the pavement under section 40-1.03J.

40-1.03L Reserved

40-1.03M Drilling Cores

Drill concrete pavement cores under ASTM C42/C42M. Use diamond-impregnated drill bits.

Clean, dry, and fill core holes with nonshrink, hydraulic-cement grout or concrete. Coat hole walls with epoxy adhesive for bonding new concrete to old concrete. Finish the fill to match the adjacent surface elevation and texture.

40-1.03N Correcting Noncompliant Pavement Work

40-1.03N(1) General

Correct noncompliant pavement as follows:

1. Replace the pavement
2. Repair spalls, ravels, and working cracks
3. Correct the smoothness and coefficient of friction
4. Treat partial-depth cracks
5. Replace damaged joint seals under section 41-5

In addition to removing pavement for other noncompliance, remove and replace JPCP slabs that have either of the following:

1. 1 or more full-depth cracks
2. Combined raveled areas more than 5 percent of the total slab area or a single raveled area more than 4 sq ft

Replace JPCP for 3 feet on both sides of a joint with a rejected dowel bar.

40-1.03N(2) Spall and Ravel Repair

Repair spalled or raveled areas that are:

1. Deeper than 0.05 foot
2. Wider than 0.10 foot
3. Longer than 0.30 foot

Repair spalls or ravels under section 41-4 and complete the repairs before opening a lane or lanes to traffic.

40-1.03N(3) Crack Repair

Treat partial-depth cracks in JPCP under section 41-3.

If the joints are sealed, repair working cracks by routing and sealing. Use a router mounted on wheels with a vertical shaft and a routing spindle that casters as it moves along the crack. Form a reservoir 3/4 inch deep by 3/8 inch wide in the crack. The equipment must not cause raveling or spalling.

Treat the contraction joint adjacent to the working crack by either of the following methods:

1. Applying epoxy resin under ASTM C881/C881M, Type IV, Grade 2
2. Pressure injecting epoxy resin under ASTM C881/C881M, Type IV, Grade 1

40-1.03O Smoothness and Friction Correction

Correct pavement that is noncompliant for:

1. Smoothness by grinding under section 42-3
2. Coefficient of friction by grooving or grinding under section 42

Do not start corrective work until:

1. Pavement has cured 10 days
2. Pavement has at least a 550 psi modulus of rupture
3. Corrective method is authorized

Correct the entire lane width. Start and end grinding at lines perpendicular to the roadway centerline. The corrected area must have a uniform texture and appearance.

If corrections are made within areas where testing with an inertial profiler is required, retest the entire lane length with an inertial profiler.

If corrections are made within areas where testing with a 12-foot straightedge is required, retest the corrected area with a straightedge.

Allow 25 days for the Department's coefficient of friction retesting.

40-1.03P–40-1.03U Reserved

40-1.04 PAYMENT

The payment quantity for any type of concrete pavement is the volume determined by the dimensions shown.

The Department does not pay for additional coring that you request to check dowel or tie bar alignment.

If the Engineer authorizes a test strip that remains in place as part of the pavement, the payment quantity for any type of concrete pavement includes the volume of the test strip.

The Department does not pay for additional tie bars required due to the curvature of the pavement slab.

Payment for grinding existing pavement is not included in the payment for concrete pavement.

40-2 CONTINUOUSLY REINFORCED CONCRETE PAVEMENT

40-2.01 GENERAL

40-2.01A Summary

Section 40-2 includes specifications for constructing continuously reinforced concrete pavement.

Constructing continuously reinforced concrete pavement includes terminal joints, expansion joints, wide flange beam terminals and pavement anchors.

40-2.01B Definitions

Reserved

40-2.01C Submittals

For field qualification, submit the test data for the coefficient of thermal expansion of the concrete.

If you request to use plastic chairs to support the transverse bars, submit a sample of the plastic chair, including:

1. Manufacturer's instructions for the applicable use and load capacity
2. Chair spacing
3. Your calculation for the load on a chair for the area of bar reinforcement it supports

During production, submit the test data for the coefficient of thermal expansion as an informational submittal.

40-2.01D Quality Assurance

For field qualification, test the coefficient of thermal expansion of the concrete under AASHTO T 336. The coefficient of thermal expansion must not exceed 6.0 microstrain/degree F.

During the evaluation of the test strip, the Engineer visually checks the reinforcement and dowel and tie bar placement.

During production, test the coefficient of thermal expansion of the concrete at a frequency of 1 test for each 5,000 cu yd of paving but not less than 1 test for a project with less than 5,000 cu yd of concrete.

40-2.02 MATERIALS

40-2.02A General

Class 1 permeable material, filter fabric, and slotted plastic-pipe cross drain for pavement anchors must comply with section 68.

40-2.02B Transverse Bar Assembly

Transverse bar assemblies may be used to support longitudinal bars instead of transverse bars and other support devices.

40-2.02C Wide Flange Beam

Wide flange beams and studs must be either rolled structural steel shapes complying with ASTM A36/A36M or structural steel complying with ASTM A572/A572M.

Polyethylene foam board for wide flange beams must be commercial quality.

Inorganic zinc primer must comply with AASHTO M 300, Type I or II.

40-2.02D Joints

Joint seals for wide flange beam terminals and for transverse expansion joints must comply with section 51-2.02.

Expanded polystyrene for transverse expansion joints, Types WF and AN, must comply with section 51-2.01B(1).

Polyethylene bond breaker for wide flange beam terminal and expansion joint support slabs must comply with section 36-2.

40-2.03 CONSTRUCTION

40-2.03A General

Reserved

40-2.03B Bar Reinforcement

Place bar reinforcement under section 52-1.03D except you may request to use plastic chairs. Plastic chairs will be considered only for support directly under the transverse bars. You must demonstrate the vertical and lateral stability of the bar reinforcement and plastic chairs during the construction of the test strip.

For a transverse bar in a curve with a radius under 2,500 feet, place the reinforcement in a single continuous straight line across the lanes and aligned with the radius point as shown.

Lap splice bar reinforcement under section 52-6. For low carbon, chromium-steel bar reinforcement, the length of lap splice must be at least 30 inches.

40-2.03C Construction Joints

Transverse construction joints must be perpendicular to the lane line. Construct the joints to allow for lap splices of the longitudinal bar.

Clean joint surfaces before placing concrete against the surfaces. Remove laitance, curing compound, and other foreign materials.

40-2.03D Wide-Flange Beams

All welding must comply with AWS D1.1. Weld stud ends with an electric arc welder completely fusing the studs to the wide flange beam.

Replace studs dislodged in shipping or that can be dislodged with a hammer.

Clean surface of wide flange beam to receive prime coat under section 59-2.01C(3)(b)(ii). The thickness of the prime coat must be 6 mils.

40-2.03E Correcting Noncompliant Pavement Work

40-2.03E(1) General

The specifications for repairing cracks in section 40-1.03N do not apply to CRCP. Do not apply high-molecular-weight methacrylate to cracks in CRCP.

CRCP that develops raveling areas of 6 by 6 inches or greater requires partial depth repair. CRCP that develops one or more full-depth transverse cracks with faulting greater than 0.25 inch or one or more full-depth longitudinal cracks with faulting greater than 0.50 inch requires full-depth repair.

40-2.03E(2) Partial Depth Repair

Partial depth repair must comply with section 41-4 except:

1. Determine a rectangular boundary which extends 6 inches beyond the damaged area. The depth of the saw cut must be between 2 inches from the surface to 1/2 inch above the longitudinal bars.
2. Provide additional reinforcement if each length of the repair boundaries is equal to or greater than 3 feet.

40-2.03E(3) Full-Depth Repair

40-2.03E(3)(a) General

Remove the full-depth of CRCP except for the portion of reinforcement to remain in place. Provide continuity of the reinforcement. For low carbon, chromium-steel bar reinforcement, the length of lap splice must be at least 30 inches. Splicing must comply with section 52-6. Do not damage the base, concrete, and reinforcement to remain in place. Place concrete in the area where you removed CRCP.

40-2.03E(3)(b) Transverse Cracks

Make initial full-depth transverse saw cuts normal to the lane line a distance of 3 feet on each side of the transverse crack.

40-2.03E(3)(c) Longitudinal Cracks

Remove the cracked area normal to the lane line for the full width of the lane a distance of 1 foot beyond each end of the crack. You may propose alternate limits with your repair plan.

40-2.03F Reserved

40-2.04 PAYMENT

Not Used

40-3 RESERVED

40-4 JOINTED PLAIN CONCRETE PAVEMENT

40-4.01 GENERAL

40-4.01A Summary

Section 40-4 includes specifications for constructing jointed plain concrete pavement.

40-4.01B Definitions

Reserved

40-4.01C Submittals

At least 24 hours before each paving shift, submit the following information as an informational submittals:

1. Early age stress and strength predictions
2. Schedule of sawing and curing activities
3. Contingency plan if cracking occurs

Submit the test data for the coefficient of thermal expansion of the concrete as an informational submittal.

40-4.01D Quality Assurance

The QC plan must include a procedure for identifying the locations of transverse contraction joints relative to the dowel bars longitudinal centers and a procedure for consolidating concrete around the dowel bars.

Develop and implement a system for predicting stresses and strength during the initial 72 hours after paving. The system must include:

1. Subscription to a weather service to obtain forecasts for wind speed, ambient temperatures, humidity, and cloud cover
2. Portable weather station with an anemometer, temperature, and humidity sensors to be located at the paving site
3. Early-age concrete pavement stress and strength prediction plan
4. Methods for analyzing, monitoring, updating, and reporting predictions

Test for coefficient of thermal expansion of the concrete under AASHTO T 336. Test at field qualification and at a frequency of 1 test for each 5,000 cu yd of paving but not less than 1 test for a project with less than 5,000 cu yd of concrete.

40-4.02 MATERIALS

Not Used

40-4.03 CONSTRUCTION

40-4.03A General

Transverse contraction joints on a curve must be on a single straight line through the radius point of the curve. If transverse joints do not align in a curve, drill a full-depth 2-inch-diameter hole under ASTM C42/C42M where the joint meets the adjacent slab. Fill the hole with joint filler. If joints are not sealed, do not allow joint filler to penetrate the joint.

40-4.03B Correcting Noncompliant Pavement Work

To replace the JPCP, saw cut and remove it full depth. Saw cut full slabs at the longitudinal and transverse joints. Saw cut partial slabs at the joints and at locations determined by the Engineer. The saw cut must be vertical.

After lifting the slab, paint the cut ends of dowels and tie bars.

Construct transverse and longitudinal construction joints between the new slab and the existing concrete. If slabs are constrained at both longitudinal edges by the existing pavement, use dowel bars instead of tie bars. For longitudinal joints, offset dowel bar holes from original tie bars by 3 inches. For transverse joints, offset dowel bar holes from the original dowel bar by 3 inches.

Drill and bond bars to the existing concrete under section 41-10. Clean loose material and contaminants from the faces of joints and the underlying base. Coat the faces with a double application of pigmented curing compound under section 28-2.03F. For partial slab replacements, place preformed sponge-rubber expansion joint filler at new transverse joints under ASTM D1752. Place concrete in the area where you removed JPCP.

40-4.03C–40-4.03G Reserved

40-4.04 PAYMENT

Not Used

40-5–40-15 RESERVED

41 EXISTING CONCRETE PAVEMENT

41-1 GENERAL

41-1.01 GENERAL

41-1.01A General

Section 41-1 includes general specifications for performing work on existing concrete pavement.

Section 36-3 does not apply.

41-1.01B Definitions

Reserved

41-1.01C Submittals

At least 15 days before delivering fast-setting concrete, polyester resin binder, or bonding agent to the job site, submit the manufacturer's instructions, SDS, and certificates of compliance. Notify the Engineer if polyester resin binder will be stored in containers over 55 gallons.

41-1.01D Quality Assurance

Before using polyester concrete:

1. Allow 14 days for sampling and testing of the polyester resin binder
2. Arrange for a representative from the manufacturer to provide training for:
   2.1. Cleaning and preparing the area
   2.2. Mixing and applying the bonding agent
   2.3. Mixing, placing, and curing polyester concrete

Do not use polyester concrete until your personnel and the Department's personnel have been trained.

41-1.02 MATERIALS

41-1.02A General

Water for washing aggregates, mixing concrete, curing, and coring must comply with section 90-1.02D.

41-1.02B Fast-Setting Concrete

Fast-setting concrete must be one of the following:

1. Magnesium phosphate concrete that is either:
   1.1. Single component water activated
   1.2. Dual component with a prepackaged liquid activator
2. Modified high-alumina based concrete
3. Portland cement based concrete

Store fast-setting concrete in a cool and dry environment.

If retarders are used, add them under the manufacturer's instructions.

You may use any accelerating chemical admixtures complying with ASTM C494/C494M, Type C and section 90-1.02E.

Fast-setting concrete must comply with the requirements shown in the following table:

Fast-Setting Concrete Requirements

Quality characteristic	Test method	Requirement
Compressive strength[a] (min, psi)		
at 3 hours	California Test 551	3,000
at 24 hours	California Test 551	5,000
Flexural strength[a] (min, psi, at 24 hours)	California Test 551	500
Bond strength[a] (min, psi, at 24 hours)		
Saturated surface dry concrete	California Test 551	300
Dry concrete	California Test 551	400
Water absorption (max, %)	California Test 551	10
Abrasion resistance[a] (max, g, at 24 hours)	California Test 550	25
Drying shrinkage (max, %, at 4 days)	ASTM C596	0.13
Water soluble chlorides[b] (max, %, by weight)	California Test 422	0.05
Water soluble sulfates[b] (max, %, by weight)	California Test 417	0.25
Thermal stability (min, %)	California Test 553	90

[a]Perform testing with aggregate filler if used.
[b]Perform testing on a cube specimen, fabricated under California Test 551, cured at least 14 days, and then pulverized to 100% passing the no. 50 sieve.

Aggregate filler may be used to extend prepackaged concrete. Aggregate filler must:

1. Be clean and uniformly rounded.
2. Have a moisture content of 0.5-percent by weight or less when tested under California Test 226.
3. Comply with sections 90-1.02C(2) and 90-1.02C(3).
4. Not exceed 50 percent of the concrete volume or the maximum percent in the manufacturer's instructions for the fast-setting concrete, whichever is less.

Aggregate filler must comply with the gradation shown in the following table:

Aggregate Filler Gradation

Sieve size	Percentage passing
3/8 inch	100
No. 4	50–100
No. 16	0–5

41-1.02C Polyester Concrete

Polyester concrete consists of polyester resin binder and dry aggregate. The polyester resin binder must be an unsaturated isophthalic polyester-styrene copolymer.

Polyester resin binder must comply with the requirements shown in the following table:

Polyester Resin Binder Requirements

Quality characteristic	Test method	Requirement
Viscosity[a] (Pa·s) RVT, No. 1 spindle, 20 RPM at 25 °C	ASTM D2196	0.075–0.200
Specific gravity[a] (25 °C)	ASTM D1475	1.05–1.10
Elongation (min, %) Type I specimen, 6.3±0.76 mm (0.25 ± 0.03 inch) thick Speed of testing = 11.4 mm/min (0.45 inch/minute) Condition 18/25/50+5/70: T—23/50	ASTM D638 ASTM D618	35
Tensile strength (min, MPa) Type I specimen, 6.3±0.76 mm (0.25 ± 0.03 inch) thick Speed of testing = 11.4 mm/min (0.45 inch/minute) Condition 18/25/50+5/70: T—23/50	ASTM D638 ASTM D618	17.24 (2,500 psi)
Styrene content[a] (%, by weight)	ASTM D2369	40–50
Silane coupler (min, %, by weight of polyester resin binder)	--	1.0
PCC saturated surface-dry bond strength at 24 hours and 70 ± 2 °F (min, psi)	California Test 551	500
Static volatile emissions[a] (max, g/sq m)	South Coast Air Quality Management District, Method 309-91	60

[a]Perform the test before adding initiator.

Silane coupler must be an organosilane ester, gamma-methacryloxypropyltrimethoxysilane. Promoter must be compatible with suitable methyl ethyl ketone peroxide and cumene hydroperoxide initiators.

Aggregate for polyester concrete must comply with sections 90-1.02C(1), 90-1.02C(2), and 90-1.02C(3).

The combined aggregate gradation must comply with one of the gradations shown in the following table:

Combined Aggregate Gradation

Sieve size	Percentage passing		
	A	B	C
1/2"	100	100	100
3/8"	83–100	100	100
No. 4	65–82	62–85	45–80
No. 8	45–64	45–67	35–67
No. 16	27–48	29–50	25–50
No. 30	12–30	16–36	15–36
No. 50	6–17	5–20	5–20
No. 100	0–7	0–7	0–9
No. 200	0–3	0–3	0–6

Aggregate retained on the no. 8 sieve must have a maximum of 45 percent crushed particles under California Test 205. Fine aggregate must be natural sand.

The weighted average absorption must not exceed 1 percent when tested under California Tests 206 and 207.

You may submit an alternative gradation or request to use manufactured sand as fine aggregate but 100 percent of the combined gradation must pass the 3/8 inch sieve. Allow 21 days for review.

Polyester concrete must have a minimum compressive strength of 1250 psi at 3 hours and 30 minutes under California Test 551 or ASTM C109.

41-1.02D Bonding Agent

Bonding agent must comply with the concrete manufacturer's instructions.

41-1.02E Temporary Pavement Structure

Temporary pavement structure consists of RSC or HMA over AB. RSC not complying with section 41-9 may be used as temporary pavement structure if:

1. Modulus of rupture is at least 200 psi before opening to traffic
2. RSC thickness is greater than or equal to the existing concrete pavement surface layer
3. RSC is replaced during the next paving shift

AB used for temporary pavement structure must comply with the 3/4-inch maximum gradation specified in section 26-1.02B.

HMA must comply with the specifications for minor HMA in section 39.

41-1.02F Reserved

41-1.03 CONSTRUCTION

41-1.03A General

Construct only the portion of pavement where the work will be completed during the same closure. If removal is required, remove only the portion of pavement where the work will be completed during the same closure. Concrete pavement work is complete when cured material attains the specified minimum properties required before opening to traffic.

If you fail to complete the concrete pavement work during the same closure, construct temporary pavement structure before opening the lane to traffic.

Except for saw cutting, the equipment, materials, and personnel for constructing temporary pavement structure must be at the job site or an approved location before starting concrete pavement work. If HMA can be delivered to the job site within 1 hour, you may request delivery as an alternative to having HMA at the job site.

Maintain the temporary pavement structure and replace it before you resume concrete pavement work.

After removing temporary pavement structure, you may stockpile that AB at the job site and reuse it for another temporary pavement structure.

41-1.03B Mixing and Applying Bonding Agent

Mix and apply the bonding agent at the job site under the manufacturer's instructions and in small quantities.

Apply bonding agent after cleaning the surface and before placing concrete.

Apply a thin, even coat of bonding agent with a stiff bristle brush until the entire work surface is scrubbed and coated with bonding agent.

41-1.03C Mixing Concrete

41-1.03C(1) General

Mix concrete under the manufacturer's instructions. For repairing spalls, mix in a small mobile drum or paddle mixer. The quantity of aggregate filler, water, and liquid activator must comply with the manufacturer's instructions.

Mix the entire contents of prepackaged dual-component magnesium phosphate concrete as supplied by the manufacturer. Use the full amount of each component and do not add water to dual-component magnesium phosphate concrete. Do not mix magnesium phosphate concrete in containers containing zinc, cadmium, aluminum, or copper or work it with tools containing these materials.

For concrete other than dual-component magnesium phosphate concrete, use the minimum amount of water to produce workable concrete and comply with the manufacturer's instructions.

Do not mix modified high-alumina based concrete in containers containing aluminum or work it with tools containing aluminum.

41-1.03C(2) Polyester Concrete

When mixing with resin, the moisture content of the combined aggregate must not exceed 1/2 of the average aggregate absorption when tested under California Test 226.

Proportion the polyester resin and aggregate to produce a mixture with suitable workability for the intended work. Only a minimal amount of resin may rise to the surface after finishing.

41-1.03D Placing Concrete

The pavement surface temperature must be at least 40 degrees F before placing concrete. You may propose methods to heat the surfaces.

Place polyester concrete on surfaces treated with a HMWM bonding agent.

Place magnesium phosphate concrete on a dry surface.

Place portland cement and modified high-alumina concrete on surfaces treated with a bonding agent recommended by the concrete manufacturer. If no bonding agent is recommended by the manufacturer, place concrete on damp surfaces that are not saturated.

Do not retemper concrete. Use dry finishing tools cleaned with water before working the concrete.

41-1.03E Curing Concrete

Cure concrete under the manufacturer's instructions. When curing compound is used, comply with section 90-1.03B for curing compound no. 1 or 2.

41-1.03F Reserved

41-1.04 PAYMENT

Not Used

41-2 SUBSEALING AND JACKING

41-2.01 GENERAL

41-2.01A Summary

Section 41-2 includes specifications for subsealing and jacking using grout to fill voids under existing concrete pavement.

Subsealing and jacking includes:

1. Drilling holes through existing concrete pavement
2. Injecting grout
3. Cleaning
4. Filling the drilled holes with mortar or concrete

Jacking includes raising pavement to grade using injected grout.

Section 36-1.01D(2) does not apply.

41-2.01B Definitions

Reserved

41-2.01C Submittals

Submit shipping invoices with packaged or bulk fly ash and cement.

Before grouting activities begin, submit a proposal for the materials to be used. Include authorized laboratory test data for the grout indicating:

1. Time of initial setting under ASTM C266
2. Compressive strength results at 1, 3, and 7 days for 10, 12, and 14-second grout efflux times

To request a substitution of grout materials, submit a proposal that includes test data.

41-2.01D Quality Assurance

41-2.01D(1) General

Reserved

41-2.01D(2) Quality Control

Test grout compressive strength under California Test 551, Part 1 at 7-days with 12 seconds efflux time. Follow the procedures for moist cure. The 7-day compressive strength must be at least 750 psi.

41-2.01D(3) Department Acceptance

For Department acceptance, the final pavement elevation must be within 0.01 foot of the required grade.

41-2.02 MATERIALS

41-2.02A General

Reserved

41-2.02B Grout

Grout must consist of Type II portland cement, fly ash, and water. Use from 2.4 to 2.7 parts fly ash to 1 part portland cement by weight. Use enough water to produce the following grout efflux times determined under California Test 541, Part D:

1. From 10 to 16 seconds for subsealing
2. From 10 to 26 seconds for jacking

Cement for grout must comply with the specifications for Type II portland cement in section 90-1.02B(2).

Fly ash must comply with AASHTO M 295, Class C or Class F. Fly ash sources must be on the Authorized Material List for cementitious materials for use in concrete.

You may use chemical admixtures and calcium chloride. Chemical admixtures must comply with section 90-1.02E(2). Calcium chloride must comply with ASTM D98.

41-2.02C Mortar

Mortar must be a prepackaged fast-setting mortar that complies with ASTM C928.

41-2.02D Reserved

41-2.03 CONSTRUCTION

41-2.03A General

Drill holes in the pavement, inject grout, plug the holes, and finish the holes with mortar.

Drill holes through the pavement and underlying base to a depth from 15 to 18 inches below the pavement surface. The hole diameter must match the fitting for the grout injecting equipment.

41-2.03B Injecting Grout

41-2.03B(1) General

Inject grout within 2 days of drilling holes.

Immediately before injecting grout, clean the drilled holes with water at a minimum pressure of 40 psi. The cleaning device must have at least 4 jets that direct water horizontally at the slab-base interface.

Do not inject grout whenever the atmospheric or subgrade temperature is below 40 degrees F or during inclement weather. If water is present in the holes, obtain authorization before injecting grout.

Do not inject grout until at least 2 consecutive slabs requiring subsealing are drilled ahead of the grouting activities.

The grout plant must have a positive displacement cement injection pump and a high-speed colloidal mixer capable of operating from 800 to 2,000 rpm. The injection pump must sustain 150 psi if pumping grout with a 12-second efflux time. A pressure gauge must be located immediately adjacent to the grout hose supply valve and positioned for easy monitoring.

If using bulk dry cement and fly ash, weigh each item before mixing them. If the materials are packaged, each container must weigh the same.

Introduce water to the mixer through a meter or scale.

Inject grout under pressure until the voids under the pavement slab are filled. The injection nozzle must not leak. Do not inject grout if the nozzle is below the bottom of the slab. Inject grout 1 hole at a time.

Stop injecting grout in a hole if either of the following occurs:

1. Grout does not flow under a sustained pump gauge pressure of 150 psi after 7 seconds and there is no indication the slab is moving
2. Injected grout rises to the surface at a joint or crack or flows into an adjacent hole

Dispose of unused grout within 1 hour of mixing.

41-2.03B(2) Subsealing

If a slab raises more than 1/16 inch due to grout injection during subsealing work, stop injecting grout in that hole.

41-2.03B(3) Jacking

The positive displacement pump used for grout injection for jacking work must be able to provide a sustained gauge pressure of 200 psi. Gauge pressures may be from 200 to 600 psi for brief periods to start slab movement.

You may add additional water to initiate pressure injection of grout. Do not reduce the grout efflux time below 10 seconds.

Raise the slabs uniformly. Use string lines to monitor the pavement movement.

Do not move adjacent slabs not shown to be jacked. If you move adjacent slabs, correct the grade within the tolerances for final pavement elevation.

41-2.03C Finishing

Immediately after removing the injection nozzle, plug the hole with a round, tapered wooden plug. Do not remove plugs until adjacent holes are injected with grout and no grout surfaces through the previously injected holes.

After grouting, remove grout from drilled holes to at least 4 inches below the pavement surface. Clean the holes and fill with mortar. Finish filled holes flush with the pavement surface.

41-2.03D Tolerances

The final pavement elevation must be within 0.01 foot of the required grade. If the final pavement elevation is from 0.01 to 0.10 foot higher than the required grade, grind the noncompliant pavement surface under section 42 to within 0.01 foot of the required grade.

If the final pavement elevation is higher than 0.10 foot from the required grade, remove and replace the noncompliant pavement under section 41-9.

41-2.04 PAYMENT

The payment quantity for subsealing is the sum of the dry weights of cement and fly ash used in placed grout. The payment quantity for jacking is the sum of the dry weights of cement and fly ash in the placed grout.

The Department does not pay for wasted grout.

The Department does not adjust the unit price for an increase or decrease in the subsealing or jacking quantity.

41-3 CRACK TREATMENT

41-3.01 GENERAL

41-3.01A Summary

Section 41-3 includes specifications for applying high-molecular-weight methacrylate to partial-depth concrete pavement surface cracks.

Section 36-1.01D(2) does not apply.

41-3.01B Definitions

Partial-depth crack: Crack that does not extend the full concrete slab depth from one edge of the slab to the opposite or adjacent side of the slab.

41-3.01C Submittals

41-3.01C(1) General

Submit HMWM samples 20 days before use.

Submit the proposed removal method at least 7 days before sealant removal.

41-3.01C(2) Public Safety and Application Plans

Before starting crack treatment, submit a public safety plan and an application plan for applying HMWM as shop drawings.

The public safety and application plans must identify the materials, equipment, and methods to be used.

In the public safety plan, include the SDS for each component of HMWM and details for:

1. Shipping
2. Storage
3. Handling
4. Disposal of residual HMWM and containers

If the project is in an urban area adjacent to a school or residence, the public safety plan must also include an airborne emissions monitoring plan prepared by a CIH certified in comprehensive practice by the American Board of Industrial Hygiene. Submit a copy of the CIH's certification. The CIH must monitor the emissions at a minimum of 4 points including the mixing point, the application point, and the point of nearest public contact. At work completion, submit a report by the CIH with results of the airborne emissions monitoring plan.

The application plan must include:

1. Crack treatment and coefficient of friction testing schedules
2. Methods and materials including:
   2.1. Description of equipment for applying HMWM
   2.2. Description of equipment for applying sand
   2.3. Gel time range and final cure time for resin

Revise and resubmit rejected plans. With each plan rejection, the Engineer gives revision directions including detailed comments.

41-3.01C(3) Reserved

41-3.01D Quality Assurance

41-3.01D(1) General

Use test tiles to evaluate the HMWM cure time. Coat at least one 4-by 4-inch smooth glazed tile for each batch of HMWM. Place the coated tile adjacent to the area being treated. Do not apply sand to the test tiles.

Use the same type of crack treatment equipment for testing and production.

41-3.01D(2) Test Area

Before starting crack treatment, treat a test area of at least 500 square feet within the project limits at a location authorized by the Engineer. Use test areas outside the traveled way if available.

Treat the test area under weather and pavement conditions similar to those expected during crack treatment production.

The Engineer evaluates the test area based on the Department's acceptance criteria. Do not begin crack treatment until the Engineer authorizes the test area.

41-3.01D(3) Department Acceptance

The Engineer accepts a treated area if:

1. Corresponding test tiles are dry to the touch
2. Treated surface is tack-free and not oily
3. Sand cover adheres enough to resist hand brushing
4. Excess sand is removed
5. Coefficient of friction is at least 0.30 when tested under California Test 342

41-3.02 MATERIALS

HMWM consists of compatible resin, promoter, and initiator. HWMW resin may be prepromoted by mixing promoter and resin together before filling containers. Identify prepromoted resin on the container label.

Adjust the gel time to compensate for temperature changes throughout the application.

The quality characteristics of HMWM resin must comply with the requirements shown in the following table:

High-Molecular-Weight Methacrylate Quality Characteristics

Quality characteristic	Test method	Requirement
Viscosity [a] (max, cP, Brookfield RVT with UL adapter, 50 RPM at 25 °C)	ASTM D2196	25
Specific gravity[a] (min, at 25 °C)	ASTM D1475	0.90
Flash point [a] (min, °C)	ASTM D3278	82.2
Vapor pressure[a] (max, mm Hg, at 25 °C)	ASTM D323	1.0
Tack-free time (max, minutes at 77 °F)	Specimen prepared under California Test 551	400
Volatile content[a] (max, %)	ASTM D2369	30
PCC saturated surface-dry bond strength (min, psi, at 24 hours and 77 ± 2 °F)	California Test 551	500

[a]Perform the test before adding initiator.

Sand must be commercial quality dry blast sand. At least 95 percent of the sand must pass the no. 8 sieve and at least 95 percent must be retained on the no. 20 sieve when tested under California Test 202.

41-3.03 CONSTRUCTION

Before applying HMWM, clean the pavement surface by abrasive blasting and blow loose material from visible cracks with high-pressure air. Remove concrete curing seals from the pavement to be treated. The pavement must be dry when blast cleaning is performed. If the pavement surface becomes contaminated before applying the HMWM, clean the pavement surface by abrasive blasting.

Protect existing facilities from HMWM. During pavement treatment, protect pavement joints, working cracks, and surfaces not being treated. Repair or replace existing facilities contaminated with HMWM at your expense.

The equipment applying HMWM must combine the components by either static in-line mixers or by external intersecting spray fans. The pump pressure at the spray bars must not cause atomization. Do not use compressed air to produce the spray. Use a shroud to enclose the spray bar apparatus.

You may apply HMWM manually to prevent overspray onto adjacent traffic. If applying resin manually, limit the batch quantity of HMWM to 5 gallons.

Apply HMWM at a rate of 90 sq ft/gal. The prepared area must be dry and the surface temperature must be from 50 to 100 degrees F while applying HMWM. Do not apply HMWM if the ambient relative humidity is more than 90 percent.

Flood the treatment area with HMWM to penetrate the pavement and cracks. Apply HMWM within 5 minutes after complete mixing. Mixed HMWM viscosity must not increase. Redistribute excess material with squeegees or brooms within 10 minutes of application. Remove excess material from tined grooves.

Wait at least 20 minutes after applying HMWM before applying sand. Apply sand at a rate of approximately 2 pounds per square yard or until refusal. Remove excess sand by vacuuming or sweeping.

Do not allow traffic on the treated surface until:

1. Treated surface is tack-free and not oily
2. Sand cover adheres enough to resist hand brushing
3. Excess sand is removed
4. Coefficient of friction is at least 0.30 determined under California Test 342

41-3.04 PAYMENT

Not Used

41-4 SPALL REPAIR

41-4.01 GENERAL

41-4.01A Summary

Section 41-4 includes specifications for repairing spalls in concrete pavement.

Section 36-1.01D(2) does not apply.

41-4.01B Definitions

Reserved

41-4.01C Submittals

Reserved

41-4.01D Quality Assurance

The Engineer accepts spall repairs based on authorized saw cut dimensions and visual inspection.

41-4.02 MATERIALS

Bonding agent must comply with the requirements for HMWM in section 41-3.02 except the tack-free time requirements do not apply and the HMWM must not contain wax.

Caulk must be at least 50 percent silicone, designated as a concrete sealant, and comply with ASTM C834.

Form board must be single-wall, double-face corrugated cardboard or paperboard covered with a bond breaker on each face. For existing joints or cracks less than 45 mils wide, use paperboard.

41-4.03 CONSTRUCTION

41-4.03A General

Prepare spall repair areas by removing concrete and cleaning the underlying surface.

Repair spalls using polyester concrete with a HMWM bonding agent.

After completing spall repairs do not allow traffic on the repairs for at least 2 hours after the time of final setting under ASTM C403/403M.

41-4.03B Remove Pavement

The Engineer determines the rectangular limits of unsound concrete pavement. Before removing pavement, mark the saw cut lines and spall repair area on the pavement surface.

Do not remove pavement until the Engineer verbally authorizes the saw cut area.

Use a power-driven saw with a diamond blade.

Remove pavement as shown and:

1. From the center of the repair area towards the saw cut
2. To the full saw cut depth
3. At least 2 inches beyond the saw cut edge to produce a rough angled surface

Produce a rough surface by chipping or other removal methods that do not damage the pavement remaining in-place. Completely remove any saw overcuts. Pneumatic hammers used for concrete removal must weigh 15 pounds or less.

If you damage concrete pavement outside the removal area, enlarge the area to remove the damaged pavement.

If dowel bars are exposed during removal, remove concrete from the exposed surface and cover with duct tape.

41-4.03C Cleaning

Clean the exposed faces of the concrete by:

1. Sand or water blasting. Water blasting equipment must be capable of producing a blast pressure from 3,000 to 6,000 psi.
2. Blowing the exposed concrete area with compressed air free of moisture and oil to remove debris. Air compressors must deliver air at a minimum of 120 cfm and develop 90 psi of nozzle pressure.

41-4.03D Compression Relief at Joints and Cracks

41-4.03D(1) General

Provide compression relief at joints and cracks by using a form board or saw cutting.

41-4.03D(2) Form Board Installation

Before placing concrete, place the form board to match the existing joint or crack alignment and width. Extend the form board at least 3 inches beyond each end of the repair and at least 1 inch deeper than the repair.

After placing concrete, remove the form board before sealing joints or cracks.

41-4.03D(3) Saw Cut Method

After cleaning, seal exposed joints or cracks with caulk at the bottom and sides of the repair area. Any surface receiving caulk must be clean and dry. Place caulk a minimum of 1/2 inch beyond the edges of the repair area into the existing joint or crack.

Saw cut the polyester concrete to the full depth along the existing joint or crack alignment within 2 hours from time of final setting. Use a power-driven saw with a diamond blade.

41-4.03E–41-4.03H Reserved

41-4.04 PAYMENT

The payment quantity for spall repair is the authorized saw cut area.

The Department does not adjust the unit price for an increase or decrease in the spall repair quantity.

41-5 JOINT SEALS

41-5.01 GENERAL

41-5.01A Summary

Section 41-5 includes specifications for sealing concrete pavement joints or replacing concrete pavement joint seals. Pavement joints include isolation joints.

Section 36-1.01D(2) does not apply.

41-5.01B Definitions

Reserved

41-5.01C Submittals

At least 15 days before delivery to the job site, submit a certificate of compliance, SDS, manufacturer's recommendations, and instructions for storage and installation of:

1. Liquid joint sealant.
2. Backer rods. Include the manufacturer data sheet verifying compatibility with the liquid joint sealant.
3. Preformed compression joint seal. Include the manufacturer data sheet used to verify the seal for the joint dimensions shown.
4. Lubricant adhesive.

Upon delivery of asphalt rubber joint sealant to the job site, submit a certified test report for each lot based on testing performed within 1 year.

Submit a work plan for removing pavement and joint materials. Allow 10 days for review. Include descriptions of the equipment and methods for removal of existing pavement and joint material.

41-5.01D Quality Assurance

41-5.01D(1) General

Before sealing joints, arrange for a representative from the manufacturer to provide training on cleaning and preparing the joint and installing the liquid joint sealant or preformed compression joint seal. Do not seal joints until your personnel and the Department's personnel have been trained.

41-5.01D(2) Department Acceptance

The Engineer accepts joint seals based on constructed dimensions and visual inspection of completed seals for voids.

41-5.02 MATERIALS

41-5.02A General

Joint seal materials must be either silicone joint sealant, asphalt rubber joint sealant, or preformed compression joint seal.

Silicone or asphalt rubber joint sealant must not bond or react with the backer rod.

41-5.02B Silicone Joint Sealant

Silicone joint sealant must be on the Authorized Material List for silicone joint sealant.

41-5.02C Asphalt Rubber Joint Sealant

Asphalt rubber joint sealant must:

1. Be asphalt binder mixed with not less than 10 percent ground rubber by weight. Ground rubber must be vulcanized or a combination of vulcanized and devulcanized materials that pass a no. 8 sieve.
2. Comply with ASTM D6690 for Type II.
3. Be capable of melting at a temperature below 400 degrees F and applied to cracks and joints.
4. Be delivered in containers complying with ASTM D6690.

41-5.02D Backer Rods

Backer rods must:

1. Comply with ASTM D5249:

1.1. Type 1 for asphalt rubber joint sealant
1.2. Type 1 or Type 3 for silicone joint sealant
2. Be expanded, closed-cell polyethylene foam
3. Have a diameter at least 25 percent greater than the saw cut joint width

41-5.02E Preformed Compression Joint Seals

Preformed compression joint seals must:

1. Comply with ASTM D2628
2. Have 5 or 6 cells, except seals 1/2 inch wide or less may have 4 cells

Lubricant adhesive used to install seals must comply with ASTM D2835.

41-5.02F–41-5.02K Reserved

41-5.03 CONSTRUCTION

41-5.03A General

If joint seals are shown for new concrete pavement, seal new concrete pavement joints at least 7 days after the concrete pavement is placed.

Before sealing joints, complete pavement repairs and grinding and grooving.

Remove existing pavement and joint material by sawing, rectangular plowing, cutting, or manual labor. Saw cut the reservoir as shown before cleaning the joint. Use a power-driven saw with a diamond blade.

41-5.03B Joint Cleaning

41-5.03B(1) General

Clean the joint after removing existing pavement and before installing joint seal material. Cleaning must be completed no more than 4 hours before installing backer rods, liquid joint seal, or preformed compression seals using the following sequence:

1. Removing debris
2. Drying
3. Sandblasting
4. Air blasting
5. Vacuuming

Clean in 1 direction to minimize contamination of surrounding areas.

41-5.03B(2) Removing Debris

Remove debris including dust, dirt, and visible traces of old sealant from the joint after sawing, plowing, cutting, or manual removal. Do not use chemical solvents to wash the joint.

41-5.03B(3) Drying

After removing debris, allow the reservoir surfaces to dry or remove moisture and dampness at the joint with compressed air that may be moderately hot.

41-5.03B(4) Sandblasting

After the joint is dry, sandblast the reservoir to remove remaining residue using a 1/4-inch diameter nozzle and 90 psi minimum pressure. Do not sandblast straight into the reservoir. Angle the sandblasting nozzle between 1 to 2 inches from the concrete and make at least 1 pass to clean each reservoir face.

41-5.03B(5) Air Blasting

After sandblasting, air blast the reservoir to remove sand, dirt, and dust 1 hour before sealing the joint. Use compressed air free of oil and moisture delivered at a minimum rate of 120 cfm and 90 psi nozzle pressure.

41-5.03B(6) Vacuuming

After air blasting, use a vacuum sweeper to remove debris and contaminants from the pavement surfaces surrounding the joint.

41-5.03B(7) Reserved

41-5.03C Installing Liquid Joint Sealant

Before installing liquid joint sealant, the pavement and reservoir surfaces must be dry and the ambient air temperature must be at least 40 degrees F and above the dew point. Before installing asphalt rubber joint sealant, the pavement surface temperature must be at least 50 degrees F.

Where backer rods are shown, place the rods before installing liquid joint sealant. Place backer rods under the manufacturer's instructions unless otherwise specified. The reservoir surface must be free of residue or film. Do not puncture the backer rod.

Immediately after placing the backer rod, install liquid joint sealant under the manufacturer's instructions unless otherwise specified. Before installing, demonstrate that fresh liquid sealant is ejected from the nozzle free of cooled or cured material.

Pump liquid joint sealant through a nozzle sized for the width of the reservoir so that liquid joint sealant is placed directly onto the backer rod. The installer must draw the nozzle toward his body and extrude liquid joint sealant evenly. Liquid joint sealant must maintain continuous contact with the reservoir walls during extrusion.

Within 10 minutes of placing liquid joint sealant, recess it to the depth shown before a skin begins to form.

After each joint is sealed, remove excess liquid joint sealant on the pavement surface. Do not allow traffic over the sealed joints until the liquid joint sealant is set, tack free, and firm enough to prevent embedment of roadway debris.

41-5.03D Installing Preformed Compression Joint Seals

Install preformed compression joint seals as shown and under the manufacturer's instructions. Use lubricant adhesive.

Install longitudinal seals before transverse seals. Longitudinal seals must be continuous except splicing is allowed at intersections with transverse seals. Transverse seals must be continuous for the entire transverse length of concrete pavement except splices are allowed for widening and staged construction. With a sharp instrument, cut across the longitudinal seal at the intersection with transverse construction joints. If the longitudinal seal does not relax enough to properly install the transverse seal, trim the longitudinal seal to form a tight seal between the 2 joints.

Any authorized splicing must comply with the manufacturer's instructions.

Use a machine specifically designed for preformed compression joint seal installation. The machine must install the seal:

1. To the specified depth
2. To make continuous contact with the joint walls
3. Without cutting, nicking, or twisting the seal
4. Without stretching the seal more than 4 percent

Cut preformed compression joint seal material to the exact length of the pavement joint to be sealed. The Engineer measures this length. After you install the preformed compression joint seal, the Engineer measures the excess length of material at the joint end. The Engineer divides the excess length by the measured cut length to determine the stretch percentage.

Seals must be compressed from 30 to 50 percent of the joint width when complete in place.

41-5.03E Reserved

41-5.04 PAYMENT

Not Used

41-6 RESERVED

41-7 TRANSITION TAPERS

41-7.01 GENERAL

Section 41-7 includes specifications for constructing transition tapers in existing concrete pavement.

Section 36-1.01D(2) does not apply.

41-7.02 MATERIALS

Not Used

41-7.03 CONSTRUCTION

Construct transition tapers by either grinding or removing and replacing the existing concrete. Do not allow flying debris during the construction of tapers.

Grinding must comply with section 42-3.

If you replace the existing concrete, comply with section 41-9 except taper the surface to the level shown and finish it with a coarse broom.

If the transition taper will be overlaid with HMA that is not placed before opening to traffic and there is a grade difference of more than 0.04 foot, construct a temporary taper by placing HMA that complies with section 39-2.07. Remove the temporary HMA taper before constructing the transition taper.

41-7.04 PAYMENT

The payment quantity for pavement transition taper is determined from the dimensions shown.

The Department does not pay for temporary HMA tapers.

41-8 DOWEL BAR RETROFIT

Reserved

41-9 INDIVIDUAL SLAB REPLACEMENT WITH RAPID STRENGTH CONCRETE

41-9.01 GENERAL

41-9.01A Summary

Section 41-9 includes specifications for constructing individual slab replacement with rapid strength concrete.

41-9.01B Definitions

concrete raveling: Disintegration of the concrete surface layer from aggregate loss.

early age: Any age less than 10 times the time of final setting for concrete determined under ASTM C403/C403M.

full-depth crack: Crack that runs from one edge of the concrete slab to the opposite or adjacent side of the slab.

opening age: Age when the minimum modulus of rupture specified for opening to traffic and equipment is attained.

time of final setting: Elapsed time required to develop a concrete penetration resistance that is at least 4,000 psi under ASTM C403/C403M.

41-9.01C Submittals

41-9.01C(1) General

At least 15 days before delivery to the job site, submit the SDS and manufacturer's instructions for storage and installation of joint filler material.

You may request to use surface finish additives. Submit the surface finish additive manufacturer's instructions with your request. Allow 10 days for review.

At least 45 days before starting individual slab replacement work submit a sample of cement from each proposed lot and samples of proposed admixtures in the quantities ordered.

During individual slab replacement operations, submit uniformity reports for hydraulic cement at least once every 30 days to the Engineer and METS, Attention: Cement Laboratory. Uniformity reports must comply with ASTM C917 except testing age and water content may be modified to suit the particular material.

Except for modulus of rupture tests, submit QC test result forms within 48 hours of the paving shift. Submit modulus of rupture results within:

1. 15 minutes of completing the opening age test completion
2. 24 hours of completing 3-day test completion

41-9.01C(2) Quality Control Plan

If the quantity of RSC is at least 300 cu yd, submit a QC plan at least 20 days before placing trial slabs. If the quantity of RSC is less than 300 cu yd, submit proposed forms for inspection, sampling, and testing.

The QC plan must describe the organization and procedures used to:

1. Control the production process
2. Determine whether a change to the production process is needed
3. Implement a change

The QC plan must include:

1. Names, qualifications, and certifications of QC personnel, including:
   - 1.1. QC manager
   - 1.2. Assistant QC managers
   - 1.3. Samplers and testers
2. Outline of procedure for the production, transportation, placement, and finishing of RSC
3. Outline of procedure and forms for RSC QC, sampling, and testing to be performed during and after RSC placement, including the testing frequencies for modulus of rupture of RSC
4. Contingency plan for identifying and correcting problems in production, transportation, placement, or finishing RSC including:
   - 4.1. Action limits
   - 4.2. Suspension limits that do not exceed specified material requirements
   - 4.3. Detailed corrective action if limits are exceeded
   - 4.4. Temporary pavement structure provisions, including:
     - 4.4.1. Quantity and location of standby material
     - 4.4.2. Determination of need
5. Location of your QC testing laboratory and testing equipment during and after paving operations
6. List of testing equipment to be used, including the date of last calibration
7. Production target values for material properties that impact concrete quality or strength including cleanness value and sand equivalent
8. Outline of procedure for placing and testing trial slabs, including:
   - 8.1. Locations and times
   - 8.2. Production procedures
   - 8.3. Placing and finishing methods
   - 8.4. Sampling methods, sample curing, and sample transportation
   - 8.5. Testing and test result reporting
9. Name of source plant with an approved material plant quality program
10. Procedures or methods for controlling pavement quality including:
    - 10.1. Materials quality
    - 10.2. Constructing contraction and construction joints
    - 10.3. Protecting pavement before opening to traffic

41-9.01C(3) Mix Design

At least 10 days before constructing a trial slab, submit a mix design. The maximum ambient temperature range for a mix design is 18 degrees F. Submit more than 1 mix design based on ambient temperature variations anticipated during RSC placement. Each mix design must include:

1. Mix design identification number
2. Aggregate source
3. Opening age
4. Aggregate gradation
5. Types of cement and chemical admixtures
6. Mix proportions

7. Maximum time allowed between batching and placing
8. Range of effective ambient temperatures
9. Time of final setting
10. Data for the modulus of rupture development from laboratory-prepared samples, including test results at:
    10.1. 1 hour before opening age
    10.2. Opening age
    10.3. 1 hour after opening age
    10.4. 1 day
    10.5. 3 days
    10.6. 7 days
    10.7. 28 days
11. Shrinkage test data
12. Any special instructions or conditions such as water temperature requirements

41-9.01C(4) Reserved

41-9.01D Quality Assurance

41-9.01D(1) General

Provide a QC manager and assistant QC managers to administer the QC plan. Each QC manager must hold current ACI certification as a Concrete Field Testing Technician-Grade I and a Concrete Laboratory Testing Technician-Grade II, except the assistant QC managers may hold a certification as a Concrete Laboratory Testing Technician-Grade I instead of Grade II.

The QC manager responsible for the production period involved must review and sign the sampling, inspection, and test reports before submitting them. The QC manager must be present for:

1. Each stage of mix design
2. Trial slab construction
3. RSC production and placement
4. Meetings with the Engineer relating to production, placement, or testing

The QC manager must not be a member of this project's production or paving crews, an inspector, or a tester. The QC manager must have no duties during the production and placement of RSC except those specified.

Testing laboratories and equipment must comply with the Department's Independent Assurance Program. At the time of the QC plan submittal, the Department evaluates the QC samplers and testers.

41-9.01D(2) Just-In-Time Training

Reserved

41-9.01D(3) Preconstruction Meeting

The following additional personnel must attend the preconstruction meeting:

1. Concrete plant inspectors
2. Personnel performing saw cutting and joint sealing

Discuss the pavement structure removal as an additional topic during the preconstruction meeting.

41-9.01D(4) Trial Slabs

Before starting individual slab replacement work, complete 1 trial slab for each mix design.

Place trial slabs near the job site at a mutually-agreed location that is neither on the roadway nor within the project limits. Trial slabs must be 10 by 20 feet and at least 10 inches thick.

During trial slab construction, sample and split the aggregate for gradation, cleanness value, and sand equivalent testing.

Fabricate and test beams under California Test 524 to determine the modulus of rupture values.

Cure beams fabricated for early age testing such that the monitored temperatures in the beams and the slab are always within 5 degrees F of each other.

Monitor and record the internal temperatures of trial slabs and early age beams at intervals of at least 5 minutes. Install thermocouples or thermistors connected to strip-chart recorders or digital data loggers to monitor the temperatures. Temperature recording devices must be accurate to within 2 degrees F. Measure the internal temperatures at 1 inch from the top, 1 inch from the bottom, and no closer than 3 inches from any edge until early age testing is completed.

Cure beams fabricated for 3-day testing under California Test 524 except place them into sand (1) at a time that is from 5 to 10 times the time of final setting measured under ASTM C403/403M or (2) at 24 hours, whichever is earlier.

Trial slabs must have an opening age modulus of rupture of not less than 400 psi and a 3-day modulus of rupture of not less than 600 psi.

After authorization, remove and dispose of trial slabs and testing materials.

41-9.01D(5) Quality Control

41-9.01D(5)(a) General

Provide continuous process control and QC sampling and testing throughout RSC production and placement. Notify the Engineer at least 2 business days before any sampling and testing. Establish a testing facility at the job site or at an authorized location.

Sample RSC under California Test 125.

41-9.01D(5)(b) Rapid Strength Concrete

Test RSC under the test methods and at the frequencies shown in the following table:

RSC Testing Frequencies

Quality characteristics	Test method	Minimum testing frequency[a]
Cleanness value	California Test 227	650 cu yd or 1 per shift
Sand equivalent	California Test 217	650 cu yd or 1 per shift
Aggregate gradation	California Test 202	650 cu yd or 1 per shift
Air content	California Test 504	130 cu yd or 2 per shift
Yield	California Test 518	2 per shift
Slump or penetration	ASTM C143 or California Test 533	1 per 2 hours of paving
Unit weight	California Test 518	650 cu yd or 2 per shift
Aggregate moisture meter calibration[b]	California Test 223 or California Test 226	1 per shift
Modulus of rupture	California Test 524	Comply with section 41-9.01D(6)(c)

[a]Test at the most frequent interval.
[b]Check plant moisture meter calibration by comparing moisture meter readings with California Test 223 or California Test 226 test results

Maintain control charts to identify potential problems and causes. Post a copy of each control chart at a location determined by the Engineer.

Use the mix proportion target values as indicators of central tendency in the control charts.

Develop linear control charts for:

1. Cleanness value
2. Sand equivalent
3. Fine and coarse aggregate gradation
4. Air content
5. Penetration

Control charts must include:

1. Contract number
2. Mix proportions
3. Test number
4. Each test parameter
5. Action and suspension limits:
   5.1. For air content, the action limit is ±1.0 percent and the suspension limit is ±1.5 percent of the specified values. If no value is specified, apply the air content value used in the approved mix design.
6. Specification limits:
   6.1. For fine and coarse aggregate gradation, record the running average of the previous 4 consecutive gradation tests for each sieve and superimpose the specification limits.
7. QC test results

A process requires corrective action if any of the following occurs:

1. For fine and coarse aggregate gradation, 2 consecutive running averages of 4 tests are outside the specification limits
2. For individual penetration or air content measurements if either:
   2.1. 1 point falls outside the suspension limit line
   2.2. 2 points in a row fall outside the action limit line

Stop production and take corrective action for out of control processes or the Engineer rejects subsequent RSC.

Use a tachometer to test and record the vibration frequency of the concrete vibrators (1) before placing RSC each day and (2) at least every 4 hours during production.

41-9.01D(5)(c) Modulus of Rupture

During RSC placement, sample and fabricate beams for testing the modulus of rupture testing within the first 30 cu yd, at least once every 130 cu yd, and within the final truckload. Submit split samples and fabricate test beams for the Department's testing unless ordered otherwise.

Determine the modulus of rupture at opening age under California Test 524, except beam specimens may be fabricated using an internal vibrator under ASTM C31. Cure the beams under the same conditions as the pavement until 1 hour before testing. Test 3 beam specimens in the presence of the Engineer and average the results. A single test represents no more than that day's production or 130 cu yd, whichever is less.

Determine the modulus of rupture at other ages using beams cured and tested under California Test 524 except place them in sand (1) at a time from 5 to 10 times the time of final setting under ASTM C403/C403M or (2) at 24 hours, whichever is earlier.

41-9.01D(6) Department Acceptance

41-9.01D(6)(a) General

The final surface texture of the individual slab replacement must pass visual inspection and have a coefficient of friction of at least 0.30 determined under California Test 342.

Allow at least 25 days for the Department to schedule for coefficient of friction testing. Notify the Engineer when the pavement is scheduled to be opened to traffic.

41-9.01D(6)(b) Modulus of Rupture

The Department accepts RSC based on your test results for modulus of rupture at opening age and the Department's test results for modulus of rupture at 3 days.

RSC must have a modulus of rupture at opening age that is at least 400 psi and a modulus of rupture at 3 days that is at least 600 psi.

Modulus of rupture is calculated based on the test result average from testing 3 beams for each sample.

For RSC with a modulus of rupture at opening age that is at least 400 psi and a modulus of rupture at 3 days that is greater than or equal to 500 psi but less than 550 psi, the Department deducts 10 percent of the payment for individual slab replacement—RSC.

For RSC with a modulus of rupture at opening age that is at least 400 psi and a modulus of rupture at 3 days that is greater than or equal to 550 psi but less than 600 psi, the Department deducts 5 percent of the payment for individual slab replacement—RSC.

41-9.01D(6)(c) Concrete Pavement Smoothness

The Department tests for concrete pavement smoothness using a 12-foot straightedge. Straightedge smoothness specifications do not apply to the pavement surface placed within 12 inches of existing concrete pavement except parallel to the centerline at the midpoint of a transverse construction joint.

The concrete pavement surface must not vary from the lower edge of a 12-foot straightedge by more than:

1. 0.01 feet when parallel to the centerline
2. 0.02 feet when perpendicular to the centerline extending from edge to edge of a traffic lane

41-9.01D(6)(d) Cracking and Raveling

The Department rejects an RSC slab within 1 year of contract acceptance if there is either of the following:

1. Partial or full-depth cracking
2. Concrete raveling consisting of either:
   2.1. Combined raveled areas more than 5 percent of each RSC slab area
   2.2. Any single raveled area of more than 4 sq ft

41-9.01D(6)(e) Reserved

41-9.02 MATERIALS

41-9.02A General

Reserved

41-9.02B Rapid Strength Concrete

Use either the 1-1/2 inch maximum or the 1-inch maximum combined gradation specified in section 90-1.02C(4)(d).

Air content must comply with the minimum requirements in section 40-1.02B(4).

41-9.02C Dowel Bars

Dowel bars must comply with section 40-1.

41-9.02D–41-9.02E Reserved

41-9.03 CONSTRUCTION

41-9.03A General

Complete individual slab replacement adjacent to new pavement or existing pavement shown for construction before constructing the other pavement work. Replace individual slabs damaged during construction before placing final pavement delineation.

41-9.03B Removing Existing Pavement

Remove pavement under section 41-11. The Engineer determines the exact individual slab replacement limits after overlying layers are removed.

After removing pavement to the depth shown, grade the subgrade to a uniform plane. Water as needed and compact the material remaining in place to a firm and stable base. The finished surface of the remaining material must not extend above the grade established by the Engineer.

41-9.03C Placing Dowel Bars

Drill existing concrete and bond dowel bars under section 41-10 for Type 1 individual slab replacement. Do not install dowel bars in contraction joints.

41-9.03D Placing Rapid Strength Concrete

Do not place RSC whenever the ambient air temperature is forecast by the National Weather Service to be less than 40 degrees F within 72 hours of final finishing.

Before placing RSC against existing concrete, place 1/4-inch thick commercial quality polyethylene flexible foam expansion joint filler across the original transverse and longitudinal joints. Place the top of the joint filler flush with the top of the pavement and extend to the top of the base layer. Secure joint filler to the joint face of the existing pavement to prevent the joint filler from moving during the placement of RSC.

Use metal or wood side forms. Wood side forms must not be less than 1-1/2 inches thick. Side forms and connections must be of sufficient rigidity that movement will not occur under forces from equipment or RSC. Clean and oil side forms before each use. Side forms must remain in place until the pavement edge no longer requires the protection of forms.

After you place RSC, consolidate it using high-frequency internal vibrators adjacent to forms and across the full paving width. Place RSC as nearly as possible to its final position. Do not use vibrators for extensive shifting of concrete pavement.

Spread and shape RSC with powered finishing machines supplemented by hand finishing. After you mix and place RSC, do not add water to the surface to facilitate finishing. You may request authorization to use surface finishing additives.

Place consecutive concrete loads without interruption. Do not allow cold joints where a visible lineation forms after concrete is placed, sets, and hardens before additional concrete is placed.

41-9.03E Joints

41-9.03E(1) General

Joints must be vertical.

41-9.03E(2) Construction Joints

Before placing fresh concrete against hardened concrete, existing concrete pavement, or structures, apply curing compound no. 1 or 2 to the vertical surface of the hardened concrete, existing concrete pavement, or structures and allow it to dry.

At joints between concrete pavement and HMA, apply tack coat between the concrete pavement and HMA.

41-9.03E(3) Contraction Joints

Saw contraction joints before cracking occurs and after the RSC is hard enough to saw without spalling, raveling, or tearing. Cut contraction joints to a minimum of 1/3 the slab depth. Use a power-driven saw with a diamond blade.

Match transverse contraction joints with existing joint spacing and skew unless otherwise described. Where the existing transverse joint spacing in an adjacent lane exceeds 15 feet, construct an additional transverse contraction joint midway between the existing joints.

Cut transverse contraction joints across the full slab replacement width. After cutting, immediately wash slurry from the joint with water at less than 100 psi pressure.

Longitudinal contraction joints must be parallel with the concrete pavement centerline, except when lanes converge or diverge. Transverse and longitudinal contraction joints must not deviate by more than 0.1 foot from either side of a 12-foot straight line. For longitudinal joints parallel to a curved centerline radius less than 7000 feet, compensate for curvature.

Keep joints free from foreign material including soil, gravel, concrete, and asphalt.

41-9.03F Final Finishing

After preliminary finishing, round the edges of the initial paving width to a 0.04-foot radius. Round transverse and longitudinal construction joints to a 0.02-foot radius. Mark each individual slab replacement area with a stamp. The stamp must show the month, day, and year of placement and

contract number. Level the location of the stamp with a steel trowel below the pavement texture. Orient the stamp mark so it can be read from the outside edge of the individual slab replacement area.

Before curing, texture the pavement. Perform initial texturing with a burlap drag or broom device that produces striations parallel to the centerline. Perform final texturing with a steel-tined device that produces grooves parallel with the centerline.

Tines must be from 3/32 to 1/8 inch wide on 3/4-inch centers and have enough length, thickness, and resilience to form grooves from 1/8 to 3/16 inch deep after the concrete has hardened. Grooves must extend over the entire pavement width except do not construct grooves 3 inches from longitudinal pavement edges or joints.

Final texture must be uniform and smooth. Grooves must be parallel and aligned to the pavement edge across the pavement width. The groove alignment must not vary more than 0.1 foot for every 12 feet of length.

41-9.03G Temporary Pavement Structure

Temporary pavement structure must be RSC or 3-1/2-inch-thick HMA over AB.

41-9.03H Noncompliant Individual Slab Replacement

Replace an individual slab replacement slab that has any of the following defects:

1. One or more full-depth cracks.
2. Concrete raveling.
3. Noncompliant smoothness except you may request authorization for grinding under section 40 and retesting. Grinding that causes a depression will not be authorized. Smoothness must be corrected within 48 hours of placing RSC.
4. Noncompliant modulus of rupture.

If the modulus of rupture at opening age is at least 400 psi and the modulus of rupture at 3 days is at least 500 psi but less than 600 psi, you may request authorization to leave the RSC in place and accept the specified deduction.

If pavement is noncompliant for coefficient of friction, groove or grind the pavement under section 42. Comply with section 40-1.03N and groove or grind before the installation of any required joint seal or edge drains adjacent to the areas to the noncompliant area.

Treat an individual-slab-replacement slab with partial-depth cracking using HMWM under section 41-3.

41-9.03I Replace Pavement Delineation

Replace traffic stripes, pavement markings, and markers that are removed, obliterated, or damaged by individual slab replacement under sections 81 and 84.

41-9.03J Reserved

41-9.04 PAYMENT

Payment for replacing base is not included in the payment for individual slab replacement—rapid strength concrete.

Payment for placing dowel bars is not included in the payment for individual slab replacement—rapid strength concrete.

41-10 DRILL AND BOND BARS

41-10.01 GENERAL

41-10.01A Summary

Section 41-10 includes specifications for drilling, installing, and bonding tie bars and dowel bars in concrete pavement.

Section 36-1.01D(2) does not apply.

41-10.01B Definitions

Reserved

41-10.01C Submittals

Submit a certificate of compliance for:

1. Tie bars
2. Dowel bars
3. Dowel bar lubricant
4. Chemical adhesive
5. Epoxy powder coating

At least 15 days before delivery to the job site, submit the manufacturer's instructions for storage, handling, and use of chemical adhesive.

41-10.01D Quality Assurance

41-10.01D(1) General

Reserved

41-10.01D(2) Quality Control

Reserved

41-10.01D(3) Department Acceptance

The Department accepts drill and bond bars based on the Engineer's inspection before placing concrete.

41-10.01D(4) Reserved

41-10.02 MATERIALS

41-10.02A General

Dowel bar lubricant must comply with section 40-1.02D.

Chemical adhesive for drilling and bonding bars must be on the Authorized Material List for chemical adhesives that indicates the appropriate chemical adhesive system for concrete temperature and installation conditions.

Each chemical adhesive system container must clearly and permanently show the:

1. Manufacturer's name
2. Model number of the system
3. Manufacture date
4. Batch number
5. Expiration date
6. Current International Conference of Building Officials Evaluation Report number
7. Directions for use
8. Storage requirement
9. Warnings or precautions required by State and federal laws and regulations

41-10.02B Reserved

41-10.03 CONSTRUCTION

41-10.03A General

Drill holes for bars. Clean drilled holes under the chemical adhesive manufacturer’s instructions. Holes must be dry at the time of placing the chemical adhesive and bars. Use a grout retention ring when drilling and bonding dowel bars. Immediately after inserting the bar into the chemical adhesive, support the bar to prevent movement until chemical adhesive has cured the minimum time recommended by the manufacturer.

Apply dowel bar lubricant to the entire exposed portion of the dowel bar.

If the Engineer rejects a bar installation: stop paving, drilling, and bonding activities. Adjust your procedures and obtain the verbal authorization before resuming paving, drilling, and bonding.

Cut the rejected bar flush with the pavement joint surface and coat the exposed end of the bar with chemical adhesive. Offset the new hole 3 inches horizontally from the rejected hole’s center.

41-10.03B Tie Bar Tolerance

Place tie bars within the tolerances shown in the following table:

Tie Bar Tolerances

Dimension	Tolerance
Horizontal skew (horizontal skew: bar length)	1:6
Vertical skew (vertical skew: bar length)	1:6
Longitudinal translation (inch)	± 1
Horizontal offset (embedment, inch)	± 1
Height relative to the adjacent bar	± 1
Vertical depth (clearance from the pavement surface or bottom, inches, min)	3

41-10.03C Dowel Bar Tolerance

Place dowel bars within the tolerances specified in section 40-1.03D.

41-10.03D Reserved

41-10.04 PAYMENT

Not Used

41-11 REMOVING CONCRETE PAVEMENT AND BASE

41-11.01 GENERAL

Section 41-11 includes general specifications for removing concrete pavement and base.

Remove concrete pavement or concrete pavement and base to the depth shown.

Before placing subsequent layers of subbase, base, pavement, or other material, the subgrade must comply with section 19-1.03C.

Section 36-1.01D(2) does not apply.

41-11.02 MATERIALS

Not Used

41-11.03 CONSTRUCTION

41-11.03A General

Reserved

41-11.03B Remove Concrete Pavement

If there is overlying material on the concrete pavement, remove it with the pavement.

Saw cut using a diamond blade and make cuts perpendicular to the pavement surface. Saw cutting is not required where concrete pavement is adjacent to asphalt concrete pavement.

Saw cut no more than 2 days before removing pavement such that traffic will not dislodge any pavement piece or segment. Saw cut perpendicular to the traveled way except you may cut parallel or diagonal to the traveled way when saw cutting and removing the pavement during the same closure.

You may make additional saw cuts within the sawed outline.

Saw cuts must be the full pavement depth unless otherwise shown.

Saw cut at longitudinal and transverse joints to remove entire slabs. For partial-slab areas, the Engineer determines the exact saw-cut locations.

Do not impact the surface within 18 inches of pavement remaining in place. Slab-lifting equipment must attach to the pavement.

41-11.03C Remove Base

Before removing any type of asphalt treated, cement treated, or concrete base, saw-cut the outline of the base removal area using a power-driven saw with a diamond blade. Cut asphalt treated base at least 2 inches deep on a neat line perpendicular to the base surface. Cut cement treated or concrete base full-depth.

Remove unbonded granular base material by means that will not disturb base to remain in place.

41-11.04 PAYMENT

Not Used

41-12–41-16 RESERVED

42 GROOVE AND GRIND CONCRETE

42-1 GENERAL

42-1.01 GENERAL

Section 42-1 includes general specifications for grooving and grinding concrete roadway surfaces.

Section 36-1.01D(2) does not apply.

42-1.02 MATERIALS

Not Used

42-1.03 CONSTRUCTION

Do not store grooving or grinding residue within the highway.

42-1.04 PAYMENT

Not Used

42-2 GROOVING

42-2.01 GENERAL

42-2.01A Summary

Section 42-2 includes specifications for grooving concrete roadway surfaces.

42-2.01B Definitions

Reserved

42-2.01C Submittals

Reserved

42-2.01D Quality Assurance

42-2.01D(1) General

Reserved

42-2.01D(2) Department Acceptance

The Department accepts grooved areas if at least 95 percent of any 2 by 100 foot longitudinal pavement area is grooved except where prevented by irregularities in the pavement surface.

42-2.02 MATERIALS

Not Used

42-2.03 CONSTRUCTION

At the start of each work shift, grooving machines must be equipped with a full complement of functioning grooving blades.

Grooving blades must be 0.095 ± 0.005 inch wide and spaced on 3/4-inch centers. Set blades and cut to depth at the locations shown in the following table:

Location	Groove depth (inches)
Pavement	1/8 to 1/4
Bridge decks	1/8 to 3/16
Inductive loop detectors	1/16 to 1/8

Begin and end grooving at lines perpendicular to the roadway centerline. Center grooving within the lane width. For new pavement or bridge decks, groove the full lane width.

If a single blade on a grooving machine fails to cut an acceptable groove, you may continue to groove for the remainder of the work shift. Do not regroove because of a single failed blade. If more than a single blade fails, perform either of the following:

1. Discontinue work within 50 feet of the failure. Cutting omitted grooves is not required.

2. Continue grooving until the end of the work shift. You must cut omitted grooves by other means.

42-2.04 PAYMENT

Not Used

42-3 GRINDING

42-3.01 GENERAL

42-3.01A Summary

Section 42-3 includes specifications for grinding concrete roadway surfaces.

42-3.01B Definitions

Reserved

42-3.01C Submittals

Reserved

42-3.01D Quality Assurance

42-3.01D(1) General

Reserved

42-3.01D(2) Quality Control

Test for pavement smoothness under sections 36 and 40 except:

1. At the midpoint of a joint or crack, test smoothness with a straightedge.
2. Straightedge and inertial profiler requirements do not apply to areas abnormally depressed from subsidence or other localized causes. End smoothness testing 15 feet before and resume 15 feet after these areas.

After grinding, the existing pavement must comply with specifications for smoothness and coefficient of friction in section 40 except:

1. At the midpoint of a joint or crack, both sides must have uniform texture.
2. Cross-slope must be uniform and have positive drainage across the traveled way and shoulder.

42-3.01D(3) Department Acceptance

The Department accepts pavement for smoothness and coefficient of friction under section 40-1.01D.

For Department acceptance, the following ground areas must comply with the specifications for smoothness and concrete cover over reinforcing steel in section 51-1.01D(3)(b)(ii):

1. Bridge decks
2. Approach slabs
3. Adjacent 50 feet of approach pavement

After grinding bridge decks, approach slabs, and the adjacent 50 feet of approach pavement, the coefficient of friction must comply with section 51-1.01D(3)(b)(iii).

42-3.02 MATERIALS

Not Used

42-3.03 CONSTRUCTION

42-3.03A General

Grind surfaces in the longitudinal direction of the traveled way and grind the full lane width. Begin and end grinding at lines perpendicular to the roadway centerline.

Grinding must result in a parallel corduroy texture with grooves from 0.08 to 0.12 inch wide and from 55 to 60 grooves per foot of width. Grooves must be from 0.06 to 0.08 inch from the top of the ridge to the bottom of the groove.

Grinding equipment must have diamond cutting blades mounted on a self-propelled machine designed for grinding and texturing concrete pavements.

At joints or cracks, both sides must have a uniform texture.

42-3.03B Pavement

Grind existing concrete pavement that is adjacent to an individual slab replacement. Grind the replaced individual slab and all the existing slabs immediately surrounding it. Grind after the individual slab is replaced.

Grind existing concrete pavement that is adjacent to new lanes of concrete pavement before paving.

As an alternative to grinding existing concrete pavement, you may replace the existing pavement. The new concrete pavement must be the same thickness as the removed pavement. Replace existing pavement between longitudinal joints or pavement edges and transverse joints. Do not remove portions of slabs.

Replacement of existing concrete pavement must comply with specifications for individual slab replacement in section 41-9.

42-3.03C Bridge Decks, Approach Slabs, and Approach Pavement

Grind bridge decks, approach slabs, and approach pavement if described.

42-3.04 PAYMENT

Grinding an existing approach slab and the adjacent 50 feet of approach pavement is paid for as grind existing bridge deck.

42-4–42-9 RESERVED

43–44 RESERVED

DIVISION VI STRUCTURES

45 GENERAL

45-1 GENERAL

45-1.01 GENERAL

Section 45 includes general specifications for constructing structures.

45-1.02 MATERIALS

Not Used

45-1.03 CONSTRUCTION

Not Used

45-1.04 PAYMENT

Not Used

45-2–45-10 RESERVED

46 GROUND ANCHORS AND SOIL NAILS

46-1 GENERAL

46-1.01 GENERAL

46-1.01A Summary

Section 46-1 includes general specifications for constructing ground anchors and soil nails.

46-1.01B Definitions

Not Used

46-1.01C Submittals

46-1.01C(1) General

Submit a certified calibration chart for each jack and its gauge as an informational submittal.

46-1.01C(2) Shop Drawings

46-1.01C(2)(a) General

Submit 5 copies of shop drawings to OSD, Documents Unit. Notify the Engineer of the submittal. Include in the notification the date and contents of the submittal. Allow 30 days for the Department's review. After review, submit from 6 to 12 copies, as requested, for authorization and use during construction.

Shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer in the State.

Shop drawings for ground anchors and soil nails must include:

1. Your name, address, and telephone and fax numbers.
2. Construction schedule and sequence of installing and grouting.
3. Encapsulation details.
4. Repair procedure for damaged sheathing.
5. Drilling methods and equipment, including:
   5.1. Drilled hole diameter.
   5.2. Equipment space requirements.
6. Grout mix design and testing procedures.
7. Grout placement equipment and procedures, including minimum required cure time.
8. Details for providing the bonded and unbonded length. If packers or other similar devices are to be used, include the type.
9. Testing equipment, including:
   9.1. Jacking frame and appurtenant bracing.
   9.2. Method and equipment for measuring movement during testing.

46-1.01C(2)(b) Ground Anchor Shop Drawings

Ground anchor shop drawings must include the following additional information:

1. Details and specifications for the anchorage system and ground anchors.
2. Details for the transition between the corrugated plastic sheathing and the anchorage assembly.
3. If shims are used during lock-off, shim thickness and supporting calculations.
4. Calculations for determining the bonded length. Do not rely on any capacity from the grout-to-ground bond within the unbonded length.

46-1.01C(2)(c) Soil Nail Shop Drawings

Soil nail shop drawings must include the following additional information:

1. Details and specifications for:
   1.1. Anchorage system
   1.2. Production soil nails
   1.3. Test soil nails
2. Drilling methods and equipment, including:
   2.1. Supporting calculations
   2.2. Assumed bond strength

3. Details for isolating installed proof test soil nails during shotcrete application
4. Procedure for extracting grouted soil nails

46-1.01C(3) Test Data

Submit the following data for each ground anchor or soil nail test:

1. Key personnel
2. Test loading equipment
3. Anchor or nail location
4. Time and date of:
   - 4.1. Drilling
   - 4.2. Installation
   - 4.3. Grouting
   - 4.4. Testing
5. Hole diameter and depth
6. Drilling method
7. Soil or rock classification and description
8. Bonded and unbonded length
9. Quantity of groundwater encountered within the bonded length
10. Grout quantity and pressure used within the bonded length
11. Anchor end or nail head movement at each load increment or at each time increment during the load hold period

Submit the test data when ground anchor or soil nail testing is complete or when requested.

46-1.01D Quality Assurance

46-1.01D(1) General

Not Used

46-1.01D(2) Quality Control

46-1.01D(2)(a) General

Stability testing and wall zones must comply with section 19-3.

46-1.01D(2)(b) Load Testing

46-1.01D(2)(b)(i) General

The jacking equipment and the movement measuring system must be stable during all phases of loading.

Do not unload or reposition the test equipment during load testing.

46-1.01D(2)(b)(ii) Jacking Equipment and Calibration

Apply the test loads using a hydraulic jack supported by a reaction frame that can support the test equipment without excessive deformation.

Use a calibrated pressure gauge or a load cell to determine the magnitude of applied test loads.

The pressure gauge must have an accurately reading, clearly visible dial or display. Dial gauges must be graduated in 100 psi increments or less.

Each jack and its gauge must be calibrated as a unit under the specifications for jacks used to tension prestressing steel permanently anchored at 25 percent or more of its specified minimum ultimate tensile strength in section 50-1.01D(2)(b).

The load cell must be calibrated and have an indicator capable of measuring the maximum test load. The load cell range must be such that the lower 10 percent of the manufacturer's rated capacity is not used in determining the jacking force.

46-1.01D(2)(b)(iii) Measuring Movements

The equipment for measuring the movement at the anchor end or nail head must be accurate to 0.001 inch and have enough capacity to complete the test without being reset.

46-1.01D(2)(b)(iv) Procedure

At each load increment, including the ending alignment load, measure the movement at the anchor end or nail head relative to an independent, fixed reference point. Record the movements to the nearest 0.001 inch.

Maintain each test load within 5 percent of the specified load throughout each hold period.

46-1.01D(3) Department Acceptance

The Department may verify the test loads using the Department's load cells. If requested, install and support the Department's testing equipment during testing and remove the equipment after testing is complete.

46-1.02 MATERIALS

46-1.02A General

Not Used

46-1.02B Sheathing

PVC sheathing must comply with ASTM D1784, Class 13464-B.

HDPE sheathing must have a density of from 940 to 960 kg/m^3 when measured under ASTM D792.

Smooth and corrugated sheathing, including joints, must be:

1. Strong enough to prevent damage during construction
2. Watertight
3. Chemically stable without embrittlement or softening
4. Nonreactive with:
    4.1. Concrete
    4.2. Steel
    4.3. Corrosion-inhibiting grease, if used

The corrugation width, the distance between corrugations, and the corrugation height of corrugated plastic sheathing must be approximately equal.

46-1.02C Grout

Grout must consist of cement and water and may contain an admixture if authorized.

Cement must comply with section 90-1.02B(2).

Water must comply with section 90-1.02D. Do not exceed 5 gallons of water per 94 lb of cement.

Admixtures must comply with section 90, except they must not contain chloride ions in excess of 0.25 percent by weight.

46-1.03 CONSTRUCTION

46-1.03A General

Water or grout from ground anchor or soil nail construction must not:

1. Fall on traffic
2. Flow across shoulders or lanes occupied by traffic
3. Flow into landscaping, gutters, or other drainage facilities

Do not use an excessive quantity of water when drilling and installing ground anchors.

46-1.03B Drilling

Drilled holes must not extend beyond the right-of-way or easement limits.

Drilling equipment must produce straight, clean holes.

Use the rotary or rotary percussion drilling method to drill ground anchor or soil nail holes in the foundation material.

At locations where caving is anticipated, keep enough casing and auger lengths on the job site to maintain uninterrupted anchor or nail installation.

At locations where hard drilling conditions, such as rock, cobbles, boulders, or obstructions, are anticipated, keep a down-hole pneumatic hammer drill rig and drill bit available on the job site for drilling holes.

Clean the holes to remove material from drilling activities. Do not use water to clean soil nail holes unless authorized.

Dispose of drill cuttings under section 19-2.03B.

46-1.03C Installation

Before you insert each ground anchor or soil nail into a drilled hole, clean the anchor or nail of oil, grease, dirt, and other extraneous substances and repair or replace any damaged sheathing.

There must be no evidence of distress in the plastic sheathing or crushing of the grout within the pregrouted sheathing.

Do not insert an anchor or nail into a hole until the hole has been inspected by the Engineer.

Install the anchor or nail in the drilled hole promptly so that caving or deterioration of the hole does not occur.

If you cannot insert an anchor or nail into a drilled hole to the required depth without difficulty, remove the anchor or nail and clean or redrill the hole. Do not force or drive a partially inserted anchor or nail into a drilled hole. Partially inserted anchors or nails are rejected.

For open-hole drilling methods, keep hole-cleaning tools on the job site. The tools must be suitable for cleaning drilled holes along their full length just before inserting the anchor or nail.

46-1.03D Grouting

Mix the grout as follows:

1. Add water to the mixer followed by cement and any admixtures or fine aggregate.
2. Mix the grout with mechanical mixing equipment that produces a uniform and thoroughly mixed grout.
3. Agitate the grout continuously until the grout is pumped.
4. Do not add water after the initial mixing.

Grouting equipment must be:

1. Capable of grouting at a pressure of at least 100 psi
2. Equipped with a pressure gauge having a full-scale reading of not more than 300 psi

46-1.03E Research Investigation

Reserved

46-1.04 PAYMENT

Not Used

46-2 GROUND ANCHORS

46-2.01 GENERAL

46-2.01A Summary

Section 46-2 includes specifications for constructing ground anchors.

A ground anchor consists of a steel bar or strand tendon with an anchorage assembly that is placed in a cored, formed, or drilled hole, and then grouted and stressed.

46-2.01B Definitions

lock-off load: Load maintained on the jacks while the anchor head or anchor nuts on the ground anchor are permanently set.

46-2.01C Submittals

Submittals for strand tendons, bar tendons, bar couplers, and anchorage assemblies must comply with section 50-1.01C.

At least 40 days before using the corrosion-inhibiting grease, submit a test sample from the lot to be used and test data showing compliance with the specifications for strand coating and encapsulation.

46-2.01D Quality Assurance

46-2.01D(1) General

Not Used

46-2.01D(2) Quality Control

46-2.01D(2)(a) General

Strand tendons, bar tendons, bar couplers, and anchorage assemblies must comply with section 50-1.01D.

46-2.01D(2)(b) Load Testing

46-2.01D(2)(b)(i) General

Performance test ground anchors as described. Proof test all ground anchors that are not performance tested.

Perform load testing against the completed structural element shown. Do not test directly against the soil.

Do not stress against the concrete until it has attained a compressive strength of at least 2,880 psi or has cured for at least 7 days.

Bearing pads must be a minimum of 1 foot away from the edges of the drilled hole.

If a ground anchor fails to comply with the acceptance criteria, redesign or replace the ground anchor. Do not retest a ground anchor unless you post-grout the anchor bonded length after the unacceptable test.

46-2.01D(2)(b)(ii) Test Procedure

Conduct the performance and proof tests as follows:

1. Incrementally load and unload the anchor as shown in the following table:

Loading Schedules

Performance test		Proof test	
Load increment	Hold time (minutes)	Load increment	Hold time (minutes)
AL	Until stable	AL	Until stable
0.20FTL	1–2	0.20FTL	1–2
AL	Until stable	0.40FTL	1–2
0.20FTL	1–2	0.60FTL	1–2
0.40FTL	1–2	0.80FTL	1–2
AL	Until stable	1.00FTL[a]	10 or 60
0.20FTL	1–2	AL	Until stable
0.40FTL	1–2	--	--
0.60FTL	1–2	--	--
AL	Until stable	--	--
0.20FTL	1–2	--	--
0.40FTL	1–2	--	--
0.60FTL	1–2	--	--
0.80FTL	1–2	--	--
AL	Until stable	--	--
0.20FTL	1–2	--	--
0.40FTL	1–2	--	--
0.60FTL	1–2		
0.80FTL	1–2	--	--
1.00FTL[a]	10 or 60	--	--
AL	Until stable	--	--

NOTE: FTL = factored test load shown
AL = alignment load = 0.10FTL
[a]Maximum test load

2. Apply each load increment in less than 1 minute and hold it for the length of time shown in the table titled "Loading Schedules."
3. Measure and record the applied test load and the anchor end movement at each load increment.
4. When applying the maximum test load:
   4.1. Hold the load constant for 10 minutes.
   4.2. Start the observation period for the load hold when the pump starts to apply the last load increment.
   4.3. Measure and record the anchor end movement at 1, 2, 3, 4, 5, 6, and 10 minutes.
5. If the movement measured from 1 to 10 minutes is greater than 0.04 inch:
   5.1. Hold the load constant for an additional 50 minutes.
   5.2. Measure and record the anchor end movement at 15, 20, 25, 30, 45, and 60 minutes.
   5.3. Plot a creep curve as a function of the logarithm of time, showing the anchor end movement from 6 to 60 minutes.
6. Reduce the load to the ending alignment load and record the residual movement.

46-2.01D(3) Department Acceptance

46-2.01D(3)(a) General

The Department tests the efflux time of the grout under California Test 541.

46-2.01D(3)(b) Load Testing

46-2.01D(3)(b)(i) General

Not Used

46-2.01D(3)(b)(ii) Acceptance Criteria

Ground anchors that are performance- or proof-tested must comply with the following:

1. Total measured movement at the maximum test load minus the measured residual movement at the ending alignment load exceeds 80 percent of the theoretical elastic elongation of the sum of the unbonded length and the jacking length.
2. Creep movement complies with one of the following:
   2.1. For a 10-minute load hold, the creep movement measured from 1 to 10 minutes is less than 0.04 inch.
   2.2. For a 60-minute load hold, the creep movement measured from 6 to 60 minutes is less than 0.08 inch and the creep rate is linear or decreasing in time logarithmic scale from the 6- to the 60-minute reading.

46-2.02 MATERIALS

46-2.02A General

If a bond breaker is shown near the bearing plate, use a 1/4-inch premolded joint filler that complies with section 51-2.01B(1).

46-2.02B Steel

Strand tendons, bar tendons, and bar couplers must comply with section 50-1.02B.

The anchorage enclosure and the steel tube and bearing plate of the anchorage assembly must be galvanized steel complying with section 55. Section 11-2 does not apply to the anchorage enclosure welds or to the weld between the steel tube and the bearing plate.

The permanent bearing plate must effectively distribute the factored test load uniformly to the concrete such that:

1. Concrete bearing stress does not exceed 2,400 psi
2. Bending stress of the plate does not exceed:
   2.1. 0.90 of the yield strength for steel
   2.2. 0.55 of the yield strength for cast steel or cast iron

46-2.02C Sheathing

46-2.02C(1) General

Polypropylene sheathing must have a density of from 900 to 910 kg/m^3 when measured under ASTM D792.

46-2.02C(2) Smooth Plastic Sheathing

Smooth sheathing for bar tendons must be PVC or HDPE.

Smooth sheathing for encapsulating individual strands of strand tendons must be HDPE or polypropylene and must have a minimum wall thickness of 40 mils.

46-2.02C(3) Corrugated Plastic Sheathing

Corrugated plastic sheathing must be PVC or HDPE.

PVC corrugated sheathing must have a nominal wall thickness of 40 mils.

HDPE corrugated sheathing with an outside diameter of 3 inches or greater must have a nominal wall thickness of 60 mils. HDPE corrugated sheathing with an outside diameter of less than 3 inches must have a nominal wall thickness of 40 mils.

46-2.02D Strand Coating and Encapsulation

Within the unbonded length of strand tendons, fully coat each individual strand with corrosion-inhibiting grease and encapsulate it with a smooth HDPE or polypropylene sheath.

Hot melt extrude or shop apply the sheath onto the strand using a method that ensures all spaces between the sheath, strand, and strand wires are filled with corrosion-inhibiting grease.

The corrosion-inhibiting grease must:

1. Fill all space between the strand wires

2. Encapsulate the strand, giving an encasement diameter at least 5 mils greater than the diameter of the bare strand
3. Provide a continuous, nonbrittle film of corrosion protection to the prestressing steel
4. Provide lubrication between the strand and the sheathing
5. Resist flow from the sheathing
6. Be chemically stable and nonreactive with the prestressing steel, sheathing material, and concrete
7. Be organic
8. Have appropriate polar, moisture-displacing, and corrosion-inhibiting additives
9. Have the physical properties shown in Table 1 of Specification for Unbonded Single Strand Tendons published by the Post-Tensioning Institute

46-2.02E Grout

The efflux time of the grout immediately after mixing must be at least 11 seconds.

For drilled holes 8 inches or larger in diameter, you may add fine aggregate to the grout used outside of the corrugated sheathing. The fine aggregate must comply with section 90-1.02C. Grout with fine aggregate must contain at least 845 pounds of cement per cubic yard.

46-2.03 CONSTRUCTION

46-2.03A General

Ground anchor installation must comply with the manufacturer's instructions unless otherwise specified.

Determine the bonded length necessary to comply with the specified acceptance criteria.

Sheathe the tendons in the unbonded length with smooth plastic sheathing that extends into the steel tube of the permanent anchorage assembly. Sheathe the tendons full length with corrugated plastic sheathing.

The transition between the corrugated plastic sheathing and the anchorage assembly must allow stressing to the maximum test load without evidence of distress in the corrugated plastic sheathing.

Select a ground anchor installation method that achieves the loadings specified.

Do not drill for ground anchors in a wall zone until any required stability testing is complete and the test results are authorized.

Drill the holes for ground anchors in the foundation material deep enough to provide the necessary bonded length beyond the minimum unbonded length shown.

If coring through concrete structures, core the holes using methods that do not shatter or damage the concrete adjacent to the hole.

The diameter of the drilled hole must be large enough to provide a minimum grout cover of 1 inch over the corrugated sheathing for the full length of the tendon.

Before installing a ground anchor, repair or replace any damaged portions of the sheathing.

Place centralizers at 10-foot maximum intervals for the full length of the tendon, with the uppermost centralizer located 2 feet from the end of the steel tube and the deepest centralizer located 2 feet from the end of the anchor.

Pregrout each tendon at least 48 hours before you place the tendon in the drilled hole.

At each grouting stage, inject the grout at the low end of the void to be filled. Place the grout using grout tubes. Do not place grout in the unbonded length under pressure. Record the quantity of grout and the grout pressures.

If hot weather conditions will contribute to quick stiffening of the grout, cool the grout by authorized methods as necessary to prevent blockages during pumping activities.

After initial grouting, the anchor must remain undisturbed until the grout is strong enough to provide anchorage during load testing.

Protect the anchorage assembly against rust, corrosion, and physical damage until the enclosure is grouted or the assembly is encased in concrete.

For ground anchors installed inside driven structural elements such as pipe, casing, shells, and pipe piles, construct the drilled hole in the foundation material as follows:

1. Use construction methods that do not reduce the compression or tension capacity of the driven element.
2. After the driven element is installed, advance the anchor hole with a drill casing using rotary methods to at least 10 feet beyond the tip of the driven element. Do not use percussion drilling until the casing is in place.
3. Do not extract the casing until the tendon is installed, and the portion of the initial grout outside the corrugated sheathing and within the bonded length has been placed.

46-2.03B Bar Tendons

For bar tendons, provide a seal between the smooth sheathing and the corrugated sheathing at the top and bottom of the length of smooth sheathing.

Center the bar in the corrugated sheathing and pregrout the annular space between the bar and the sheathing before placing the tendon in the drilled hole.

You may place the initial grout in the drilled hole before or after inserting the bar tendon.

Stress the bars for multiple-bar tendons simultaneously.

46-2.03C Strand Tendons

Separate the individual strands of strand tendons within the bonded length using spacers such that the entire surface of each strand is bonded in the grout. The spacers must be:

1. Spaced at 5 feet maximum
2. Made of plastic
3. Strong enough to support the individual strands during construction activities

Pregrout the corrugated sheathing a minimum length of 2 feet before inserting the strand tendon in the hole.

After inserting the strand tendon and before placing the initial grout in the hole, inject grout into the corrugated sheathing to the limits shown.

46-2.03D Lock-off

After a successful ground anchor test, tension the anchor and lock it off at the lock-off load shown.

Secure the ends of strand tendons with a permanent-type anchorage system that:

1. Holds the prestressing steel at a force producing a stress of at least 95 percent of the specified ultimate tensile strength of the steel
2. Permanently secures the ends of the prestressing steel

Lock off strand tendons as follows:

1. Stress the tendon to the maximum test load.
2. Fully set the permanent wedges in the anchor head.
3. Remove the shims or use other appropriate means to achieve the lock-off load shown.

Immediately after lock-off, perform a lift-off test to verify that the lock-off load has been attained. If necessary, adjust the shim thickness to achieve the lock-off load.

After lock-off, place grout to the secondary grout level shown. At least 24 hours after the secondary grout has set, fill the remaining void in the steel tube and bearing plate with grout. Maintain a minimum grout head of 2 feet until the grout has set.

If a grouted anchorage enclosure is shown, install the enclosure as follows:

1. Grout the steel tube.
2. Clean the bearing plate surface.
3. Place the sealant.
4. Bolt the anchorage enclosure in place.
5. Fill the void in the anchorage enclosure with grout.
6. Clean and seal any holes in the top of the anchorage enclosure used for grout placement. Use a nonsag polysulfide or polyurethane sealing compound that complies with ASTM C920.

46-2.04 PAYMENT

Not Used

46-3 SOIL NAILS

46-3.01 GENERAL

46-3.01A Summary

Section 46-3 includes specifications for constructing soil nails.

A soil nail consists of steel bar reinforcement with an anchorage assembly that is placed in a drilled hole and then grouted.

46-3.01B Definitions

pullout failure: Occurrence in which attempts to increase the test load result in nail head movement relative to a fixed reference point without an increase in load.

46-3.01C Submittals

46-3.01C(1) General

If a pullout failure occurs, submit the pullout failure load as part of the test data.

If production soil nails are rejected under section 46-3.01D(2)(b)(ii)(3), submit revised shop drawings.

If additional verification soil nails are required under section 46-3.01D(2)(b)(ii)(2), submit revised shop drawings.

46-3.01C(2) Test Boring Report

If additional verification soil nails are required under section 46-3.01D(2)(b)(ii)(2), submit a test boring report for the additional verification soil nails.

The test boring report must include:

1. Summary of drilling methods, drilling equipment, drill platforms, and drilling difficulties encountered
2. Location map of the surveyed position of the new test borings relative to existing and proposed facilities in the California Coordinate System and bridge stationing
3. Bore hole surveying notes
4. Depth increments of borings
5. Soil and rock classifications and descriptions
6. Photographs of cuttings
7. Copies of original daily drilling notes, including dates and weather conditions

Classify soil and rock under the *Soil and Rock Logging, Classification, and Presentation Manual*. For the manual, go to the Geotechnical Services Web site.

The test boring report must be sealed and signed by a geologist or engineer registered as a geologist or civil engineer in the State.

46-3.01D Quality Assurance

46-3.01D(1) General

Not Used

46-3.01D(2) Quality Control

46-3.01D(2)(a) General

Not Used

46-3.01D(2)(b) Load Testing

46-3.01D(2)(b)(i) General

Perform load testing of verification and proof test soil nails to verify the installation methods and pullout resistance.

Load testing must include incrementally loading the soil nail until the maximum test load is held for the specified duration or a pullout failure occurs. If a pullout failure occurs, record the pullout failure load.

46-3.01D(2)(b)(ii) Test Procedure

46-3.01D(2)(b)(ii)(1) General

Determine the test load using the following equation:

$$T = Lb \times Qd$$

where:
T = test load, pounds
Lb = soil nail bonded length, feet, 10 feet minimum
Qd = design pullout resistance shown, pounds/foot

46-3.01D(2)(b)(ii)(2) Verification Test

Perform verification testing in the Engineer's presence.

Install and test 2 verification test soil nails for each wall zone. You may install and test the nails during stability testing.

Conduct the verification test as follows:

1. Incrementally load the test soil nail as shown in the following table:

Verification Test Loading Schedule

Load increment	Hold time (minutes)
AL	Until stable
0.20T	1–2
0.40T	1–2
0.60T	1–2
0.80T	1–2
1.00T[a]	60
1.25T	1–2
1.50T[b]	10
AL	Until stable

NOTE: T = test load
AL = alignment load = 0.10T
[a]Creep test
[b]Maximum test load

2. Apply each load increment in less than 1 minute and hold it for the length of time shown in the table titled "Verification Test Loading Schedule."
3. Measure and record the applied test load and the nail head movement at each load increment.
4. During the creep test:
   4.1. Hold the load constant for 60 minutes.
   4.2. Start the observation period for the load hold when the pump starts to apply the load increment from 0.80T to 1.00T.
   4.3. Measure and record the nail head movement at 1, 2, 3, 4, 5, 6, 10, 20, 30, 40, 50, and 60 minutes.
   4.4. Plot a creep curve as a function of the logarithm of time, showing the nail head movement from 6 to 60 minutes.
5. If the movement measured from 6 to 60 minutes is less than 0.08 inch:
   5.1. Increase the load incrementally to 1.50T.
   5.2. Hold the load constant for 10 minutes.

5.3. Start the observation period for the load hold when the pump starts to apply the load increment from 1.25T to 1.50T.
5.4. Measure and record the nail head movement at 1, 2, 3, 4, 5, 6, and 10 minutes.
5.5. Reduce the load to the ending alignment load and record the residual movement.

6. If the movement measured from 6 to 60 minutes is 0.08 inch or greater, reduce the load to the ending alignment load.

Verification test soil nails that fail to comply with the acceptance criteria are rejected.

Submit revised shop drawings for additional verification test soil nails.

The Engineer determines the cause of failure for each rejected verification test soil nail.

If the Engineer determines that the installation methods are the cause of failure, the installation methods are rejected. Show alternative installation methods on the revised shop drawings.

If the Engineer revises soil nail lengths or design pullout resistance values, any additional verification test soil nails are change order work.

Install and test additional verification test soil nails until they comply with the acceptance criteria.

Log horizontal borings for additional verification test soil nails and submit a test boring report under section 46-3.01C. The logging of horizontal test borings and the submittal of the test boring report is change order work.

46-3.01D(2)(b)(ii)(3) Proof Test

Production soil nails must be represented by proof test soil nails within a given wall zone.

Perform proof testing in the Engineer's presence at the locations shown.

Test against a temporary yoke that bears directly on the shotcrete facing. Test loads transmitted through the temporary yoke must not fracture the shotcrete or cause displacement or sloughing of the soil surrounding the drilled hole.

Conduct the proof test as follows:

1. Incrementally load the test soil nail as shown in the following table:

Proof Test Loading Schedule

Load increment	Hold time (minutes)
AL	Until stable
0.20T	1–2
0.40T	1–2
0.60T	1–2
0.80T	1–2
1.00T[a,b]	10 or 60
1.25T[c]	1–2
1.50T[c]	1–2
AL	Until stable

NOTE: T = test load
AL = alignment load = 0.10T
[a]Creep test
[b]Maximum test load for proof test
[c]Loads for supplemental testing only

2. Apply each load increment in less than 1 minute and hold it for the length of time shown in the table titled "Proof Test Loading Schedule."
3. Measure and record the applied test load and the nail head movement at each load increment.
4. During the creep test:
   4.1. Hold the load constant for 10 minutes.

4.2. Start the observation period for the load hold when the pump starts to apply the load increment from 0.80T to 1.00T.
4.3. Measure and record the nail head movement at 1, 2, 3, 4, 5, 6, and 10 minutes.
5. If the movement measured from 1 to 10 minutes is greater than 0.08 inch:
5.1. Hold the load constant for an additional 50 minutes.
5.2. Measure and record the nail head movement at 20, 30, 40, 50, and 60 minutes.
5.3. Plot a creep curve as a function of the logarithm of time, showing the nail head movement from 6 to 60 minutes.
6. Reduce the load to the ending alignment load and record the residual movement.

Production soil nails represented by proof test soil nails that fail to comply with the acceptance criteria, except those represented by proof test soil nails selected for supplemental testing, are rejected.

Submit revised shop drawings for replacement soil nails that show alternative installation methods, revised production soil nails, or a modified soil nail plan.

46-3.01D(2)(b)(ii)(4) Supplemental Test

The Engineer selects up to 1/2 of proof test soil nails for supplemental testing. Only proof test soil nails with a creep movement less than 0.08 inch measured from 1 to 10 minutes are considered for supplemental testing.

Perform supplemental testing immediately following creep testing. Incrementally load the soil nails as shown in the table titled "Proof Test Loading Schedule." Record the test load and nail head movement as part of the test data.

For proof test soil nails that fail supplemental testing, the Department deducts $1.00 per linear foot of proof test soil nail.

46-3.01D(2)(c) Grout

Before using grout with fine aggregate, produce a test batch to verify the consistency. Produce and deliver the test batch under conditions and in time periods similar to those expected during the grouting of soil nails.

Place the test batch grout in an excavated hole or a container of suitable size to allow testing under California Test 533. The test batch must comply with the specified nominal penetration.

Dispose of the grout after testing.

46-3.01D(3) Department Acceptance

46-3.01D(3)(a) General

The Department tests grout with fine aggregate under California Test 533 before use.

46-3.01D(3)(b) Load Testing

46-3.01D(3)(b)(i) General

Not Used

46-3.01D(3)(b)(ii) Acceptance Criteria

Soil nails that are verification- or proof-tested must comply with the following:

1. For verification tests:
1.1. Creep movement measured from 6 to 60 minutes is less than 0.08 inch.
1.2. Creep rate is linear or decreasing in time logarithmic scale from the 6- to the 60-minute reading.
2. For proof tests, the creep movement complies with one of the following:
2.1. Creep movement measured from 1 to 10 minutes is no more than 0.08 inch.
2.2. Creep movement measured from 6 to 60 minutes is less than 0.08 inch and the creep rate is linear or decreasing in time logarithmic scale from the 6- to the 60-minute reading.
3. Total measured movement at the maximum test load minus the measured residual movement at the ending alignment load exceeds 80 percent of the theoretical elastic elongation of the unbonded length.
4. Pullout failure does not occur.

46-3.02 MATERIALS

46-3.02A General

Each production soil nail must be either a reinforcing bar encapsulated full length in a grouted corrugated plastic sheathing or an epoxy-coated prefabricated reinforcing bar partially encapsulated in a grouted corrugated plastic sheathing.

The epoxy-coated prefabricated reinforcing bar must comply with section 52-2.03, except the epoxy thickness must be from 10 to 12 mils.

Bar reinforcement for test soil nails is not required to be epoxy coated or encapsulated in grouted plastic sheathing.

46-3.02B Steel

Soil nail anchorage assemblies must comply with section 75-2, except galvanizing is not required for nuts, washers, wedges, and bearing plates if they are fully encased in concrete, grout, or shotcrete.

Concrete anchors on bearing plates must comply with the specifications for studs in clause 7 of AWS D1.1.

46-3.02C Bar Reinforcement

Bar reinforcement must comply with section 52.

For bar reinforcement for production soil nails:

1. Grade 60 bar reinforcement must comply with ASTM A615/A615M or A706/A706M.
2. Grade 75 bar reinforcement must comply with ASTM A615/A615M.
3. Reinforcement must have at least a 6-inch length of thread on the anchorage end. Threading must be either continuous spiral deformed ribbing provided by the bar deformations or cut into the bar. For bars with cut threads, use the next larger bar size from that shown and use coarse threads.
4. Epoxy coating at the anchorage end of epoxy-coated bars may be omitted for no more than 6 inches.
5. Metal surfaces of assembled splices of epoxy-coated bars must be epoxy coated.

Choose the bar reinforcement size and grade for test soil nails. Test soil nail bars must not be smaller than the production soil nails they represent.

46-3.02D Sheathing

Corrugated plastic sheathing must be PVC or HDPE and must have a minimum thickness of 25 mils.

46-3.02E Grout

For drilled holes 6 inches or larger in diameter, you may add fine aggregate to the grout. Grout with fine aggregate must:

1. Contain at least 845 pounds of cement per cubic yard of grout
2. Use fine aggregate that complies with section 90-1.02C
3. Have a nominal penetration of at least 3-1/2 inches when measured under California Test 533
4. Have an air content of no more than 2 percent when measured under California Test 504
5. Not contain air-entraining admixtures

46-3.03 CONSTRUCTION

46-3.03A General

Determine the drilled hole diameter and installation method required to achieve the soil nail pullout resistance values shown.

Do not drill for proof test or production soil nails in a wall zone until stability testing, if required, and verification soil nail testing are complete in the wall zone and the test results are authorized.

If you are ordered to lengthen verification or proof test soil nails, the lengthening of test soil nails is change order work.

If you are ordered to lengthen production soil nails or install additional production soil nails, the

lengthening or addition of production soil nails is change order work.

46-3.03B Test Soil Nails

Construct verification and proof test soil nails using the same equipment, methods, nail inclination, and drilled hole diameter as to be used for production soil nails.

Drill, install, and grout verification test soil nails in the Engineer's presence.

You may install verification test soil nails by any of the following means:

1. Through the existing slope face.
2. Through the drill platform work bench.
3. Through the stabilization berm.
4. Through the stability test exposed face.
5. Into slot cuts made for the lift in which verification test soil nails are located. A slot cut must be no larger than is needed to accommodate the drill and test setup equipment.

Install the verification test soil nails within the limits of each wall zone or within the limits of the excavated stability test face. Space the verification test soil nails at least 10 feet apart.

Grout only the bonded length of verification and proof test soil nails.

Do not splice a test soil nail within the bonded length.

Remove each verification and proof test soil nail to 6 inches behind the front face of the shotcrete after testing is complete. Fill the void with grout.

If requested, extract the verification and proof test soil nails and fill the voids with grout.

46-3.03C Installation

Install and grout the soil nails in the same work shift that the holes are drilled.

Use centralizers to support the soil nail in the center of the drilled hole. Space the centralizers at 7.5 feet maximum along the bar length and 1.5 feet from the bar ends. You may use plastic centralizers.

Splice the bar reinforcement only where shown on the authorized shop drawings or at the end of a soil nail that is ordered to be lengthened.

Verify and record the drilled hole length before grouting.

Grout the drilled hole after installing the soil nail. Inject the grout at the low end of the drilled hole. Fill the drilled hole with a dense grout, free of voids and foreign material. Grout the hole in 1 continuous operation. Do not use cold joints in the grout placement.

Fill any void remaining at the open end of the drilled hole of a production soil nail with shotcrete. Secure the soil nail at the face of the shotcrete. The bearing plate must have full bearing on the shotcrete surface.

Hand tighten the nut on the end of the production soil nail bar before the initial set of the shotcrete. Make the nut wrench tight after the shotcrete has set for 24 hours, unless a shorter time is authorized.

After placing the grout, the soil nails must remain undisturbed for the minimum cure time shown on the authorized shop drawings.

46-3.04 PAYMENT

The payment quantity for soil nails is the length measured along the bar centerline from the back face of shotcrete to the tip end shown or ordered.

Verification and proof test soil nails are paid for as soil nails.

46-4–46-10 RESERVED

47 EARTH RETAINING SYSTEMS

47-1 GENERAL

47-1.01 GENERAL

Section 47 includes specifications for constructing earth retaining systems.

47-1.02 MATERIALS

Not Used

47-1.03 CONSTRUCTION

Not Used

47-1.04 PAYMENT

Not Used

47-2 MECHANICALLY STABILIZED EMBANKMENT

47-2.01 GENERAL

47-2.01A Summary

Section 47-2 includes specifications for constructing mechanically stabilized embankments.

Concrete panels must comply with section 51.

Reinforcement must comply with section 52.

Geosynthetic reinforcement must comply with section 96.

Earthwork must comply with section 19.

47-2.01B Definitions

Reserved

47-2.01C Submittals

Submit results from the proposed button-head wire coupler test.

Submit results from each production button-head wire coupler test.

47-2.01D Quality Assurance

47-2.01D(1) General

Coupler test samples must comply with the minimum tensile specifications for plain wire in ASTM A1064A/1064M.

Total wire slip must be at most 3/16 inch when tested as specified for tension testing of round wire test samples under ASTM A370.

If any test samples fail, revise the connection and retest. Do not start face panel installation until tension and slip test results are accepted.

Perform tension and slip tests on the proposed button-head wire soil reinforcement and coupler connection. Test 6 connection test samples. Test samples must consist of two 24-inches long button-head wires connected by a swaged coupler. Testing must be performed by an authorized laboratory.

47-2.01D(2) Quality Control

Perform tension and slip testing on production button-head wire and coupler connections during wall construction. Test 4 connection test samples for each lot of 500 mat wire connections installed. If 2 or more test samples fail, the entire represented lot is rejected. If 1 test sample fails to comply with specified criteria, test an additional 4 test samples. If any of these additional samples fail, the entire represented lot is rejected.

47-2.02 MATERIAL

47-2.02A General

Concrete leveling pads must be constructed with minor concrete.

Soil reinforcement, connecting elements, and other steel components in contact with the earth must be galvanized under section 75-1.02B.

Threaded ends of inspection wires for metallic soil reinforcement may be formed before or after galvanizing. Coat the final 4 inches of the wire with 2 applications of organic zinc-rich primer. Encase the threaded end with a waterproof vinyl enclosure secured with a nylon tie. If the threaded end is galvanized after threading, clean the threads before painting.

Corrugated steel pipe must comply with section 66.

Perforated pipe underdrains and underdrain outlets and risers must comply with section 68-2. Perforated pipe must be steel unless perforated plastic pipe is shown.

Rock for rock slope protection at drain pipe outlets must be small-rock slope protection and must comply with the gradation specified for 7-inch-thick layer in section 72-4.02.

Filter fabric must be Class A.

Adhesive for bonding filter fabric to concrete panels must be commercial grade.

Resin bonded cork for horizontal joints must comply with ASTM D1752, Type II, with a compressive load of at least 100 psi.

Pipe pins must comply with ASTM A53/A53M except the zinc coating of actual surface must average at least 2.0 oz/sq ft and no individual specimen may be less than 1.8 oz/sq ft.

47-2.02B Face Panels

In freeze-thaw areas concrete panels must comply with section 90-1.02I and must contain at least 675 pounds of cementitious material per cubic yard.

If architectural treatment is not required, finish exposed surfaces of concrete members as specified for Class 1 surface finish under section 51-1.03F(3).

47-2.02C Structure Backfill

Structure backfill for mechanically stabilized embankment must:

1. Be free of organic material and substantially free of shale and other soft material of poor durability
2. Not contain slag aggregate or recycled materials such as:
   - 2.1. Glass
   - 2.2. Shredded tires
   - 2.3. Portland cement concrete rubble including asphaltic dust, sand, rock, grindings, slabs, and boulders
   - 2.4. Asphaltic concrete rubble including asphaltic dust, sand, rock, grindings, slabs, and boulders
   - 2.5. Other unsuitable material as determined by the Engineer

For an embankment with metallic soil reinforcement, structure backfill must comply with the requirements shown in the following tables:

Gradation Requirements

Sieve size	Test method	Requirement (percent passing)
6 inch	California Test 202	100
3 inch	California Test 202	78–100
No. 30	California Test 202	0–60
No. 200	California Test 202	0–15

Quality Characteristic Requirements

Quality characteristic	Test method	Requirement
Sand equivalent[a] (min)	California Test 217	12
Plasticity index[a] (max)	California Test 204	6
Minimum resistivity (ohm-cm)	California Test 643	2000
Chlorides (ppm)	California Test 422	< 250
Sulfates (ppm)	California Test 417	< 500
pH	California Test 643	5.5–10.0

[a]Does not apply if 12 percent or less passes the no. 200 sieve and 50 percent or less passes the no. 4 sieve.

For an embankment with geosynthetic soil reinforcement, structure backfill must comply with the requirements shown in the following tables:

Gradation Requirements

Sieve size	Test method	Requirement (percent passing)
2 inch	California Test 202	100
No. 4	California Test 202	50–80
No. 40	California Test 202	0–30
No. 200	California Test 202	0–15

Quality Characteristic Requirements

Quality characteristic	Test method	Requirement
Sand equivalent (min)	California Test 217	12
Plasticity index[a] (max)	California Test 204	6
Durability Index (min)	California Test 229	35
pH	California Test 643	4.5–9.0

47-2.02D Permeable Material

Permeable material must be Class 1, Type B, complying with section 68-2.02F.

Permeable material for an embankment with metallic soil reinforcement must comply with the requirements shown in the following table:

Quality Characteristic Requirements

Quality characteristic	Test method	Requirement
Minimum resistivity (ohm-cm)	California Test 643	2,000
Chlorides (max, ppm)	California Test 422	250
Sulfates (max, ppm)	California Test 417	500
pH	California Test 643	5.5–10.0

Permeable material for an embankment with geosynthetic soil reinforcement must comply with the requirements shown in the following table:

Quality Characteristic Requirements

Quality characteristic	Test method	Requirement
pH	California Test 643	4.5–9.0

47-2.02E Soil Reinforcement

Steel wire must comply with the specifications for plain wire reinforcement in ASTM A1064/A1064M. Welded wire reinforcement must comply with the specifications for plain wire welded wire reinforcement in ASTM A1064/1064M.

For button-headed wires:

1. Buttons must be cold formed symmetrically about the axes of the wires
2. Buttons must develop the minimum guaranteed ultimate tensile strength of the wire
3. Do not use a cold-forming process that causes indentations in the wire
4. Button heads must not contain wide open splits, more than 2 splits per head, or splits nonparallel to the axis of the wire

Steel wire reinforcement hooks and bends must comply with the *Building Code Requirements for Structural Concrete* published by ACI.

Couplers at wire reinforcement connections must be seamless steel sleeves applied over the button-head wires. Couplers must develop the wire minimum tensile strength with a total slip of at most 3/16 inch.

Splice welded wire reinforcement along its length with mechanical couplers that develop the minimum tensile strength of the wire.

Identification, storage, and handling of geosynthetic reinforcement must comply with ASTM D4873 and any alternative system details. Protect the geosynthetic reinforcement from chemicals, flames, welding sparks, and temperatures less than 20 degrees F or greater than 140 degrees F. Do not allow foreign materials to come into contact with or become affixed to the geosynthetic reinforcement.

47-2.03 CONSTRUCTION

47-2.03A General

Water for earthwork or for dust control within 500 feet of structures with metallic soil reinforcement must comply with the specifications for water in reinforced concrete in section 90-1.02D.

Protect the unthreaded portion of the galvanized inspection wire from damage.

47-2.03B Earthwork

47-2.03B(1) General

Grade the foundation level for a width equal to the length of soil reinforcement elements plus 1 foot or as shown. Compact foundation material to a relative compaction of at least 95 percent. Start wall construction activities after the Engineer accepts the compacted foundation area.

If ordered, remove unsuitable material. This work is change order work.

Place structure backfill simultaneously with erection of facing panels. Place and compact material without distorting soil reinforcement or displacing facing panels. Place structure backfill at the front of the wall before backfilling more than 15 feet above the bottom of the lowermost face element.

If a mechanically stabilized embankment with soil reinforcement is to be constructed on an embankment, compact embankment material to a relative compaction of at least 95 percent within the limits established by inclined planes sloping 1.5:1 (horizontal:vertical) from lines 1 foot outside the bottom limits of the mechanically stabilized embankment, including any permeable material.

Start placing and compacting structure backfill 1 foot from the back face of wall panels and progress toward the free end of the soil reinforcement. Operate compaction equipment parallel to the wall facing. Place and compact the remaining width of backfill behind wall panels after covering the soil reinforcement to a depth of 6 inches.

Do not use sheepsfoot or grid-type rollers within the limits of soil reinforcement. Use hand-held or hand-guided compacting equipment within 3 feet of facing panels.

Place structure backfill at each level of soil reinforcement to a plane 2 inches above the elevation of the soil reinforcement connection, starting 3 feet from the back of the face panel and extending for at least the remaining length of soil reinforcement. Complete this grading before placing the next layer of soil reinforcement.

Place permeable material and filter fabric when placing structure backfill. Place permeable material in layers less than 2 feet thick. Compaction of permeable material for the drainage system outside the limits of soil reinforcement is not required. Do not operate equipment directly on the permeable material or filter fabric. If a sloped layer of permeable material is placed to facilitate the work or to satisfy safety considerations, (1) the vertical limits of the permeable material must remain unchanged and (2) the thickness of the layer of permeable material is measured normal to the slope.

Grade backfill to drain away from the wall face at the end of each work shift. Use berms or ditches to direct runoff away from the wall site. Do not allow surface runoff from adjacent areas to enter the wall site.

47-2.03B(2) Soil Reinforcement

Tension soil reinforcement in the direction perpendicular to the wall face. Remove slack in the connection and the soil reinforcement. Secure soil reinforcement in place before and during compaction.

Swage wire reinforcement couplers with a hydraulic press.

Cover soil reinforcement with structure backfill during the same work shift that it is placed.

Do not operate construction equipment directly on soil reinforcement. Maintain a layer of structure backfill at least 6 inches thick between soil reinforcement and any construction equipment.

Place geosynthetic soil reinforcement in full-length sections.

Place structure backfill over geosynthetic soil reinforcement in lifts of at most 6 inches if using hand-operated compaction equipment and 8 inches if using heavy compaction equipment.

47-2.03B(3) Face Panels

Vertical and horizontal panel alignment offset must not exceed 3/4 inch when measured along a 10-foot straightedge. The offset in any panel joint must not exceed 3/4 inch.

After placing backfill 2 feet above inspection elements, dry pack voids in face panels with mortar under section 51-1.03E(2). Mortar must comply with section 51-1.02F except the proportion of cementitious material to sand must be such that the mortar achieves a 28 day compressive strength of 1,000 to 1,500 psi.

47-2.03C Filter Fabric

Immediately before placing filter fabric, the subgrade to receive filter fabric must be free of loose or extraneous material and sharp objects that may damage the filter fabric.

Concrete panel surfaces to receive filter fabric must be dry and thoroughly cleaned.

Handle and place filter fabric under the manufacturer's instructions. Stretch, align, and place fabric without wrinkling.

Adjacent borders of filter fabric must be stitched or overlapped. Overlap rolls 12 to 18 inches. Place the preceding roll over the following roll in the direction the material is being spread. Stitch fabric using yarn of a contrasting color. Yarn size and composition must comply with the filter fabric manufacturer's instructions. Use 5 to 7 stitches per inch of seam.

Repair damaged filter fabric by placing a piece of filter fabric large enough to cover the damaged area and provide at least a 12-inch overlap.

Do not operate equipment, including vehicles, directly on filter fabric. Maintain at least 6 inches of permeable material between filter fabric and equipment during spreading of permeable material. Where structure backfill is to be placed on filter fabric, maintain at least 18 inches of structure backfill material between filter fabric and equipment during placement.

47-2.03D Leveling Pads

Place concrete for leveling pads at least 24 hours before erecting face panels.

47-2.04 PAYMENT

The vertical height of each section is the difference in elevation on the outer face from the bottom of the lowermost face element to the top of wall profile.

47-3 REINFORCED CONCRETE CRIB WALLS

47-3.01 GENERAL

Section 47-3 includes specifications for constructing reinforced concrete crib walls.

Reinforced concrete crib walls must comply with section 51.

Reinforcement must comply with section 52.

Concrete crib walls consist of a series of rectangular cells composed of interlocking, precast, reinforced concrete headers, stretchers, and blocks.

47-3.02 MATERIALS

47-3.02A General

Pads shown to be placed between bearing surfaces must either be (1) neoprene complying with the specifications for strip waterstops in section 51-2.05 or (2) commercial quality no. 30 asphalt felt. The protective board is not required for neoprene pads.

47-3.02B Crib Members

47-3.02B(1) General

All members must be manufactured to no more than an 1/8 inch greater in thickness than the dimensions shown. The thickness of the lowest step must not be less than the dimension shown.

Stretchers must be manufactured to no less than a 1/2 inch in length than the dimensions shown.

If an opening is shown in the face of the wall, special length stretchers and additional headers may be necessary.

For non-tangent wall alignments, special length stretchers may be required.

For non-tangent wall alignments and at locations where filler blocks are required, special length front face closure members may be required.

47-3.02B(2) Reinforcement

Reinforcing wire must comply with the specifications for deformed wire reinforcement in ASTM A1064/A1064M.

For hoops or stirrups use either (1) reinforcing wire or (2) deformed steel welded wire reinforcement. The cross sectional area must be equivalent to that of the reinforcing steel shown. Deformed steel welded wire reinforcement must comply with the specifications for deformed wire welded wire reinforcement in ASTM A1064/A1064M.

47-3.02B(3) Concrete

External vibration resulting in adequate consolidation may be used.

Cure crib members under section 90-4.03.

When removed from forms, the members must present a true surface of even texture, free from honeycombs and voids larger than 1 inch in diameter and 5/16 inch in depth. Clean and fill other pockets with mortar under sections 51-1.02F and 51-1.03E(2).

If the Engineer determines that rock pockets are of the extent or character as to affect the strength of the member or to endanger the life of the steel reinforcement, replace the member.

Concrete test cylinders must comply with section 90-1.01D(5), except if the penetration of fresh concrete is less than 1 inch, the concrete in the test mold must be consolidated by vibrating the mold equivalent to that of the consolidating effort being used to consolidate the concrete in the member.

Finish concrete-to-concrete bearing surfaces to a smooth plane. Section 51-1.03F does not apply to concrete crib members.

47-3.03 CONSTRUCTION

Construct reinforced concrete crib walls to the lines and grades established by the Engineer. The foundation must be accepted by the Engineer before any crib members are placed.

The gap between bearing surfaces must not exceed 1/8 inch.

Where a gap of 1/16 inch to 1/8 inch exists or where shown, place a 1/16-inch pad of asphalt felt or sheet neoprene between the bearing surfaces.

47-3.04 PAYMENT

The payment quantity for reinforced concrete crib wall is the area measured on the batter at the outer face. The height is measured from the bottom of the bottom stretcher to the top of the top stretcher. The length is measured from end to end of each section of wall.

47-4 RESERVED

47-5 TYPE 6 RETAINING WALLS

47-5.01 GENERAL

Section 47-5 includes specifications for constructing Type 6 retaining walls.

Reinforced concrete footings and stems must comply with section 51.

Reinforcement must comply with section 52.

CMU stems must comply with section 58-2.

47-5.02 MATERIALS

Hollow CMUs must comply with the specifications for normal weight CMUs in ASTM C90 and must be of uniform color and size.

Caulking for sealing expansion joints must be a non-sag polysulfide or polyurethane type complying with ASTM C920.

Grout must comply with section 58-2.02D and contain at least 590 lb/cu yd of cementitious material.

47-5.03 CONSTRUCTION

You may construct wall stems of reinforced concrete or reinforced CMUs. Use only 1 stem type for each wall.

CMU construction must be true and plumb.

Provide recesses in the units for horizontal reinforcement.

Provide cleanout openings at the bottom of cells where the wall height is over 4 feet. Seal cleanouts after inspection and before filling cells with grout.

Lay units with full mortar coverage of the face in both vertical and horizontal joints except at weep holes. Shove vertical joints tight. Exposed joints must be concave and tooled smooth.

Fill cells in hollow unit masonry with grout. Consolidate grout while pouring by puddling or vibrating. Place the top lift of grout approximately 1 inch below the top of units. Place a mortar cap above the top lift.

Do not place backfill against the back of Type 6 retaining walls until grout compressive strength has reached 1,500 psi or until the grout has cured for 28 days.

47-5.04 PAYMENT

The payment quantity for retaining wall stem (Type 6) is the area determined from the dimensions shown. The height is the difference in elevation from the top of the footing to the top of the wall.

47-6 ALTERNATIVE EARTH RETAINING SYSTEMS

47-6.01 GENERAL

47-6.01A Summary

Section 47-6 includes specifications for constructing alternative earth retaining systems.

You may use an alternative earth retaining system when specified in the special provisions.

Use only one type of system at any one location.

The alternative earth retaining system must comply with the specifications for the type of wall being constructed.

47-6.01B Definitions

Reserved

47-6.01C Submittals

47-6.01C(1) General

For as-built drawings common to more than one structure, submit the as-built drawings for each structure.

47-6.01C(2) Shop Drawings

Submit shop drawings for the alternative system to OSD, Documents Unit. Submit 5 copies for initial review. Submit from 6 to 12 copies, as requested, of final shop drawings for final authorization. Include the following:

1. All information required for construction of the system at each location
2. Existing ground line at the wall face
3. Design parameters, material notes, and wall construction procedures

Verify existing ground elevations before submitting drawings.

Shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer in the State.

Allow 30 days for the Department's review.

47-6.01C(3) Certificates

Submit certificates of compliance for the alternative system stating the supplied materials comply with the authorization criteria for the system on the Authorized Material List for alternative earth retaining systems.

47-6.01D Quality Assurance

A qualified representative of the alternative system manufacturer must be present during erection and backfill of the first 10 vertical feet of the entire length of the wall. The representative must be available during the remaining installation. The representative must not be your employee.

47-6.02 MATERIALS

The alternative systems specified are taken from the Authorized Material List. Only systems having characteristics suitable for this project are specified. Some systems may be proprietary.

Alternative systems are selected based on data previously furnished by suppliers or manufacturers of each system.

47-6.03 CONSTRUCTION

The structure must comply with the system details authorized on the Authorized Material List. Check vertical and horizontal alignment at each course during erection. Include a drainage system where shown.

Where shown, construct the alternative system to accommodate (1) wall-mounted lighting and drainpipes and (2) panels for future drainage inlets.

The top of wall profile must conform to the profile shown. The bottom of wall elevations must be at or below the elevations shown. Use a minimum height and length of wall adequate for the loading and site conditions described.

The length of soil reinforcement for any system must not be less than that shown.

The coping lip or barrier slab lip must cover the top of face panels at least 7 inches.

Place the top level of soil reinforcement:

1. Parallel to the top of the concrete panel
2. At least 3 inches below the bottom of either the barrier slab lip or the concrete gutter behind the coping
3. At least 5 inches below the top edge of the concrete panel

47-6.04 PAYMENT

Not Used

48 TEMPORARY STRUCTURES

48-1 GENERAL

48-1.01 GENERAL

Section 48-1 includes general specifications for constructing temporary structures.

48-1.02 MATERIALS

Not Used

48-1.03 CONSTRUCTION

Not Used

48-1.04 PAYMENT

Full compensation for work specified in section 48 is included in the payment for the bid items involved unless:

1. Bid item for the work is shown on the Bid Item List
2. Work is specified as change order work

48-2 FALSEWORK

48-2.01 GENERAL

48-2.01A Summary

Section 48-2 includes specifications for constructing falsework.

You must design, construct, and maintain falsework that:

1. Is safe and adequate
2. Provides the necessary rigidity
3. Supports the imposed loads
4. Produces a completed structure that conforms to the lines and grades shown

48-2.01B Definitions

previously welded splice: Splice made in a falsework member in compliance with AWS D1.1 or other recognized welding standard before contract award.

independent support system: Support system that is in addition to the falsework removal system employing methods of holding falsework from above by winches, hydraulic jacks with prestressing steel, HS rods, or cranes.

48-2.01C Submittals

48-2.01C(1) General

Submit a certificate of compliance for each delivery of structural composite lumber used in falsework.

Submit a letter of certification that certifies all components of manufactured assemblies are used in compliance with the manufacturer's instructions.

If requested, (1) submit manufacturer's data for manufactured assemblies to verify manufacturer's instructions or (2) perform tests demonstrating adequacy of the proposed assemblies.

Submit field acceptance criteria for falsework piles with a calculated nominal resistance greater than 200 tons. Base acceptance criteria on a wave equation analysis performed on dynamic monitoring of falsework pile driving. Analyses must be signed by an engineer who is registered as a civil engineer in the State. Submit acceptance criteria before falsework erection is complete.

Submit a letter of certification for all falsework members with welded splices. The letter must certify that all welding and NDT, including visual inspection, comply with the Contract and the welding standard shown on the shop drawings. The letter must be signed by an engineer who is registered as a civil engineer in the State. Submit the letter before placing any concrete on the falsework being certified.

Submit a welding certification for falsework members with previously welded splices. The certification must:

1. Itemize the testing, inspection methods, and acceptance criteria used
2. Include tracking and identifying documents for previously welded members
3. Be signed by an engineer who is registered as a civil engineer in the State
4. Be submitted before erecting the members

Submit a falsework lighting plan before starting construction on falsework containing openings for vehicular traffic, pedestrians, or railroad. You may propose a lighting plan that fulfills the light intensity specified using alternative methods. Supply data to allow evaluation of the alternative methods.

48-2.01C(2) Shop Drawings

Submit shop drawings with supporting calculations for falsework.

Shop drawings and calculations must be signed by an engineer who is registered as a civil engineer in the State if any of the following conditions apply:

1. Height of any portion of the falsework measured from the ground line to the soffit of the superstructure is more than 14 feet
2. Any individual falsework clear span is more than 16 feet
3. Provisions for vehicular, pedestrian, or railroad traffic through the falsework are made

Shop drawings and calculations for falsework piles with a calculated loading capacity greater than 100 tons must be designed by an engineer who is registered as a civil or geotechnical engineer in the State.

Submit 6 copies of falsework shop drawings and 2 copies of design calculations. Include with the submittal:

1. Details of erection and removal activities.
2. Methods and sequences of erection and removal, including equipment.
3. Details for the stability of falsework during all stages of erection and removal activities.
4. Superstructure placing diagram showing concrete placing sequence and construction joint locations. If a schedule for placing concrete is shown, no deviation is allowed.
5. Assumed soil bearing values for falsework footings.
6. Maximum horizontal distance falsework piles may be pulled for placement under caps.
7. Maximum deviation of falsework piles from vertical.
8. Anticipated total falsework and form settlements, including footing settlement and joint take-up.
9. Grade (E-value), species, and type of any structural composite lumber. Include manufacturer's tabulated working stress values for the lumber.
10. Design calculations including stresses and deflections in load carrying members.
11. Provisions for complying with temporary bracing requirements.
12. Welding standard used for welded members.

Submit separate drawings and calculations for each single bridge or portion of bridge.

For multi-frame bridges, submit a separate shop drawing for each frame.

You may revise authorized falsework shop drawings if you submit it before the start of the affected work to allow review and corrections without work delays. The additional time will not be more than that originally allowed.

For falsework over railways, comply with any additional requirements of the railway company involved.

The licensed engineer signing the falsework drawings must certify that the falsework is constructed as shown in the authorized shop drawings before concrete is placed. The certification must include any necessary testing to verify the ability of the falsework members to sustain the stresses required by the falsework design. The licensed engineer may assign a representative to perform this certification as follows:

1. Where falsework contains openings for railroads, vehicular traffic, or pedestrians, the assigned representative must (1) have at least 3 years of combined experience in falsework design or supervising falsework construction and (2) be registered as a civil engineer in the State.
2. For other falsework, the assigned representative must have at least 3 years of combined experience in falsework design or supervising falsework construction.

3. The Engineer may request you certify the experience of the assigned representative and submit supporting documentation demonstrating the required experience.

For shop drawings and calculations for falsework removal systems employing methods of holding falsework from above by winches, hydraulic jacks with prestressing steel, HS rods, or cranes, include the following information:

1. Design code used for the analysis of the structural members of the independent support system
2. Provisions for complying with current Cal/OSHA requirements
3. Load tests and ratings within 1 year of intended use of hydraulic jacks and winches
4. Location of the winches, hydraulic jacks with prestressing steel, HS rods, or cranes
5. Analysis showing that the bridge deck and overhang are capable of supporting all loads at all time
6. Analysis showing that winches will not overturn or slide during all stages of loading
7. Location of deck and soffit openings if needed
8. Details of repair for the deck and soffit openings after falsework removal

48-2.01D Quality Assurance

48-2.01D(1) General

Reserved

48-2.01D(2) Welding and Nondestructive Testing

Welding must comply with AWS D1.1 or other recognized welding standard except for fillet welds if the load demands are 1,000 lb or less per inch for each 1/8 inch of fillet weld.

Perform NDT on welded splices using UT or RT. Each weld and any repair made to a previously welded splice must be tested. You must select locations for testing. The length of a splice weld where NDT is to be performed must be a cumulative weld length equal to 25 percent of the original splice weld length. The cover pass must be ground smooth at test locations. Acceptance criteria must comply with the specifications for cyclically loaded nontubular connections subject to tensile stress in clause 6 of AWS D1.1. If repairs are required in a portion of the weld, perform additional NDT on the repaired sections. The NDT method chosen must be used for an entire splice evaluation, including any repairs.

For previously welded splices, perform and document all necessary testing and inspection required to certify the ability of the falsework members to sustain the design stresses.

48-2.02 MATERIALS

48-2.02A General

Reserved

48-2.02B Design Criteria

48-2.02B(1) General

Design falsework to resist the sum of the dead and live vertical loads and an assumed horizontal load.

Anticipated falsework settlement must not exceed 1 inch.

Design footings to carry the imposed loads without exceeding estimated soil bearing values or anticipated settlements.

Falsework spans for T-beam girders must not exceed 14 feet plus 8.5 times the T-beam girder depth.

Design falsework supporting deck slabs and overhangs on girder bridges such that there is no differential settlement between the girders and the deck forms during deck concrete placement.

For individual steel towers with maximum leg loads exceeding 30 kips, design foundations to provide uniform settlement under all legs of each tower.

Design support systems for form panels supporting concrete deck slabs and overhangs on girder bridges as falsework.

Temporary bracing must be designed to withstand all imposed loads during erection, construction, and removal of any falsework. Wind loads must be included in the design of the bracing.

Falsework removal systems employing methods of holding falsework from above, and members of the independent support system, must support the sum of the actual vertical and horizontal loads due to falsework materials, equipment, construction sequence or other causes, and wind loading. Identifiable mechanical devices used in the falsework removal plan must comply with applicable industry standards and manufacturer instructions for safe load carrying capacity. Unidentifiable winches must be capable of carrying twice the design load.

The load used for the analysis of overturning moment and sliding of the winch system must be 150 percent of the design load.

48-2.02B(2) Loads

The design load for falsework must consist of dead and live vertical loads, and an assumed horizontal load. The minimum total design load for any falsework is 100 psf, including members that support walkways for the combined live and dead load.

Dead loads must include the weight of concrete, reinforcing steel, forms, and falsework. Loads due to concrete, reinforcing steel, and forms must be assumed to be at least:

1. 160 pcf for normal concrete
2. 130 pcf for lightweight concrete

Live loads must include:

1. Actual weight of any equipment to be supported by the falsework applied as concentrated loads at the points of contact
2. Uniform load of at least 20 psf applied over the area supported by the falsework
3. Load of 75 lb/ft applied at the outside edge of deck overhangs

The assumed horizontal load the falsework bracing system must resist must be the sum of the actual horizontal loads due to equipment, construction sequence or other causes, and a wind loading. The horizontal load in any direction must be at least 2 percent of the total dead load.

If the concrete is to be prestressed, design the falsework to support any increased or readjusted loads caused by the prestressing forces.

Design the falsework with sufficient rigidity to resist the assumed horizontal load without considering the concrete load.

For heavy-duty steel shoring or steel pipe column falsework with a vertical load capacity greater than 30 kips per leg or column, the minimum horizontal wind loading must be the sum of the products of the wind impact area, shape factor, and wind pressure value for each height zone. The wind impact area is the total projected area of all elements in the tower face or falsework bent normal to the direction of the applied wind. Use a shape factor of 2.2 for heavy-duty steel shoring and 1.0 for pipe column falsework. Use the wind pressure values shown in the following table:

Height zone (feet above ground)	Wind pressure value	
	Shores or columns adjacent to traffic (psf)	At other locations (psf)
0–30	20	15
30–50	25	20
50–100	30	25
Over 100	35	30

For all other falsework, the minimum horizontal wind loading must be the sum of the products of the wind impact area and the wind pressure value for each height zone. The wind impact area is the gross projected area of the falsework and any unrestrained portion of the permanent structure except for the areas between falsework bents or towers where diagonal bracing is not used. Use the wind pressure values shown in the following table:

Height zone (feet above ground)	Wind pressure value	
	For members over and bents adjacent to traffic opening (psf)	At other locations (psf)
0–30	2.0 *Q*	1.5 *Q*
30–50	2.5 *Q*	2.0 *Q*
50–100	3.0 *Q*	2.5 *Q*
Over 100	3.5 *Q*	3.0 *Q*

NOTE:

$Q = 1 + 0.2W$, but not more than 10

where:

W = width of the falsework system in feet, measured in the direction of the wind force

Design falsework to support placement of the entire superstructure cross-section, except railing, at one time. You may consider girder stems and connected bottom slabs self-supporting between falsework posts if:

1. Girder stems and connected bottom slabs are placed more than 5 days before the top slab
2. Distance between falsework posts is at most 4 times the depth of the portion of the girder stem placed in the 1st pour

Falsework for box girder structures with internal falsework bracing systems that use flexible members capable of withstanding only tensile forces must be designed to include (1) the vertical effects caused by elongation of the flexible member and (2) the design horizontal load combined with the dead and live loads imposed by concrete placement for girder stems and connected bottom slabs. This requirement does not apply to falsework composed of individual steel towers that use flexible members capable of withstanding only tensile forces to resist overturning.

48-2.02B(3) Stresses, Loadings, and Deflections

48-2.02B(3)(a) General

Maximum allowable stresses and loadings specified in section 48-2.02B(3) are based on the use of undamaged high-quality materials. Reduce stresses and loadings for materials of lesser quality.

48-2.02B(3)(b) Timber

Design timber connections under the Department's *Falsework Manual*.

The maximum allowable stresses, loadings, and deflections for timber are as shown in the following table:

Quality characteristic	Requirement
Compression perpendicular to the grain (psi)	450
Compression parallel to the grain (psi)	$480{,}000/(L/d)^2$; 1,600 maximum
Flexural stress	1,800 psi; 1,500 psi maximum for members with a nominal depth of 8 inches or less.
Horizontal shear (psi)	140
Axial tension (psi)	1,200
Deflection due to concrete loading only	1/240 of span length[a]
Modulus of elasticity (E) (psi)	1.6×10^6
Timber piles (tons)	45

NOTES:

L = unsupported length, inches

d = least dimension of a square or rectangular column or the width of a square of equivalent cross-sectional area for round columns, inches

[a]Irrespective of deflection compensated for in camber strips

48-2.02B(3)(c) Steel

Except for flexural compressive stresses, design stresses for identified grades of steel must not exceed stresses specified in the AISC *Steel Manual*.

Except for flexural compressive stresses, the design stresses for unidentified steel must not exceed those specified for steel complying with ASTM A36/A36M in the AISC Steel Manual or as shown in the following table:

Quality characteristic	Requirement
Tension, axial and flexural (psi)	22,000
Compression, axial (psi)	$16,000 - 0.38(L/r)^{2}$[a]
Shear on gross section of web of rolled shapes (psi)	14,500
Web yielding for rolled shapes (psi)	27,000
Modulus of elasticity (E) (psi)	30×10^6

NOTES:

L = unsupported length, inches

r = radius of gyration of the member, inches

[a]*L*/*r* must not exceed 120

Design stresses and deflections for all grades of steel must not exceed the requirements shown in the following table:

Quality characteristic	Requirement
Compression, flexural (psi)	$12,000,000/[(L \times d)/(b \times t)]$[a]
Deflection due to concrete loading only	1/240 of the span[b]
Modulus of elasticity (E) (psi)	30×10^6

NOTES:

L = unsupported length, inches

d = least dimension of rectangular columns or the width of a square of equivalent cross-sectional area for round columns, or the depth of beams, inches

b = width of the compression flange, inches

t = thickness of the compression flange, inches

F_y = specified minimum yield stress in psi

[a]Not to exceed (1) 22,000 psi for unidentified steel, (2) 22,000 psi for steel complying with ASTM A36/A36M, or (3) $0.6F_y$ for other identified steel

[b]Irrespective of deflection compensated for in camber strips

48-2.02B(3)(d) Manufactured Assemblies

Do not exceed the manufacturer's instructions for loadings and deflections on jacks, brackets, columns, joists, and other manufactured devices except the dead load deflection of joists at locations other than under deck slabs between girders must not exceed 1/240 of their spans.

48-2.02B(4) Special Locations

Design and construct falsework over or adjacent to roadways or railroads that are open to traffic such that the falsework is stable if subjected to impact by vehicles.

Falsework posts at the following locations are considered adjacent to roadways or railroads:

1. Posts supporting members that cross over a roadway or railroad
2. Posts located in the row of falsework posts nearest to the roadway or railroad and where the horizontal distance from the traffic side of the falsework to the edge of pavement or to a point 10 feet from the centerline of track is less than the total height of the falsework and forms

The falsework design at the above locations must comply with section 48-2.02B and the following requirements:

1. The vertical load used for the design of falsework posts and towers that support the portion of the falsework over openings must be the greater of:

1.1 150 percent of the design load calculated under section 48-2.02B(2), not including any increased or readjusted loads caused by prestressing forces
1.2 Increased or readjusted loads caused by prestressing forces

2. Falsework posts must be steel with a minimum section modulus about each axis of 9.5 cubic inches or sound timbers with a minimum section modulus about each axis of 250 cubic inches.
3. Each falsework post must be mechanically connected to the support footing at its base or laterally restrained to withstand a force of at least 2,000 lb applied at the base of the post in any direction except toward the roadway or railroad track. Posts must be mechanically connected to the falsework cap or stringer. The mechanical connection must resist a load in any horizontal direction of at least 1,000 lb.
4. Mechanically connect (1) exterior falsework stringers, (2) stringers adjacent to the ends of discontinuous caps, (3) stringers over points of minimum vertical clearance, and (4) every 5th remaining stringer to the falsework cap or framing. For falsework over railroads, mechanically connect all stringers to caps. Mechanical connections must resist at least a 500 lb load in any direction, including uplift on the stringer. Install connections before traffic passes under the span.
5. Connect timber bracing to falsework using at least 5/8-inch-diameter bolts or coil rod with a root diameter equal to that of the shank of a 5/8-inch-diameter bolt.
6. Falsework member clearances must be at least those shown in the following table:

Falsework member	Clearance	
	To railing members, barriers, and anchored temporary railings	To unanchored temporary railings
Footings	0'-3"	2'-0"
Piles	1'-0"	2'-9"
Other members	2'-0"	2'-9"

7. Falsework bents within 20 feet of the centerline of a railroad track must be sheathed solid from 3 to 17 feet above the track on the side facing the track. Sheathing must be plywood at least 5/8 inch thick or lumber at least 3/4 inch thick. Brace these bents to resist the required assumed horizontal load or 5,000 lb, whichever is larger.
8. Provide clear openings through falsework as described.

48-2.03 CONSTRUCTION

48-2.03A General

Install temporary bracing as necessary to withstand all imposed loads during erection, construction, and removal of any falsework.

The materials used in the falsework construction must be of the quality necessary to sustain the stresses required by the falsework design.

Where falsework for multiple level bridges is supported on the deck of a structure:

1. Falsework must bear either directly on girder stems or bent caps of the supporting structure or on falsework sills that transmit the load to the stems or cap without stress to the deck slab.
2. Additional falsework must be in place beneath the supporting structure when construction loads are imposed on the supporting structure. Design and construct additional falsework to support all construction loads imposed on the supporting structure from the upper structure.

48-2.03B Foundations

Construct falsework on solid footings capable of supporting falsework loads. Protect footings from softening and undermining. The Engineer determines if you must verify that the design soil bearing values do not exceed the soil capacity using load testing.

You may place falsework foundation pads and piles before shop drawings are authorized.

Falsework piles must be driven and the actual nominal pile resistance assessed under section 49.

48-2.03C Erection

Construct falsework to support the loads imposed without settlement or take-up beyond that shown on the falsework drawings.

Install the final bracing system before placing falsework members above stringers.

If falsework is over or adjacent to roadways or railroads, all details of the falsework system that contribute to horizontal stability and resistance to impact, except for bolts in bracing, must (1) be installed when each element of the falsework is erected and (2) remain in place until the falsework is removed.

If ordered, use camber strips to compensate for falsework deflection, vertical alignment, and anticipated structure deflection. The Engineer furnishes the amount of camber to be used in constructing falsework.

Install tell-tales that (1) are attached to the soffit forms and (2) can be read from the ground. Provide sufficient tell-tales to allow the total settlement where concrete is being placed to be determined.

Construct deck slab forms between girders with no allowance for settlement relative to the girders.

Do not apply dead loads other than forms and reinforcing steel to falsework until authorized.

If (1) events occur that the Engineer determines will result in a structure that does not comply with the structure as described or (2) settlements occur that are more than ±3/8 inch greater than those shown on the falsework drawings, stop concrete placement and apply corrective measures. If the measures are not provided before initial concrete set occurs, stop concrete placement at the location ordered.

48-2.03D Removal

Remove falsework such that portions of falsework not yet removed remain stable at all times.

Falsework removal includes lowering the falsework, blowing sand from sand jacks, turning screws on screw jacks, and removing wedges.

Except for concrete above the deck, do not release falsework supporting any span of a:

1. Simple span bridge before 10 days after the last concrete has been placed
2. Continuous or rigid frame bridge before 10 days after the last concrete has been placed:
   2.1. In that span
   2.2. In adjacent portions of each adjoining span for a length equal to one-half of the span where falsework is to be released
3. Simple span, continuous, or rigid frame bridge until the supported concrete has attained a compressive strength of 2,600 psi or 80 percent of the specified strength, whichever is greater

Do not release falsework for prestressed portions of structures until prestressing steel has been tensioned.

Do not remove falsework supporting any span of a continuous or rigid frame bridge until all required prestressing is complete (1) in that span and (2) in adjacent portions of each adjoining span for a length equal to at least one half of the span where falsework is to be released.

Release falsework supporting spans of CIP girders, slab bridges, or culverts before constructing or installing railings or barriers on the spans unless authorized.

Remove falsework for arch bridges uniformly and gradually. Start at the crown and work toward the springing. Remove falsework for adjacent arch spans concurrently.

Do not release falsework that supports overhangs, deck slabs between girders, or girder stems that slope 45 degrees or more from vertical before 7 days after deck concrete has been placed.

You may release falsework supporting the sides of girder stems that slope less than 45 degrees from vertical before placing deck concrete if you install lateral supports. Lateral supports must be:

1. Designed to resist rotational forces on the girder stem, including forces due to concrete deck placement
2. Installed immediately after each form panel is removed
3. Installed before releasing supports for the adjacent form panel

Do not release falsework for bent caps supporting steel or PC concrete girders before 7 days after placing bent cap concrete. Do not erect girders onto bent caps until bent cap concrete has attained a compressive strength of 2,600 psi or 80 percent of the specified strength, whichever is greater.

Remove falsework for structural members subject to bending as specified for simple span bridges.

Do not release falsework for box culverts and other structures with decks lower than the roadway pavement and span lengths of 14 feet or less until the last placed concrete has attained a compressive strength of 1,600 psi. Curing of the concrete must not be interrupted. Falsework removal for other box culverts must comply with the specifications for the release of bridge falsework.

Do not release falsework for arch culverts sooner than 40 hours after concrete has been placed.

Remove falsework piling to at least 2 feet below the original ground or streambed. Remove falsework piling driven within ditch or channel excavation limits to at least 2 feet below the bottom and side slopes of the excavated areas.

Dispose of falsework materials and work debris.

Falsework removal system employing methods of holding falsework by winches, hydraulic jacks with prestressing steel, HS rods, or cranes must also be supported by an independent support system when the falsework removal system is not actively lowering the falsework at vehicular, pedestrian, or railroad traffic openings.

Bridge deck openings used to facilitate falsework removal activities must be formed and located away from the wheel path. The formed openings must be wedge shaped with a 5-inch maximum diameter at the top and a 3-inch maximum diameter at the bottom.

Anchor 10-inch-square aluminum or galvanized steel wire, 1/4-inch-mesh hardware cloth with a 0.025-inch minimum wire diameter firmly to the inside of the soffit openings. Construct a 1/2-inch drip groove to the outside of soffit openings.

Clean and roughen openings made in the bridge deck. Fill the deck openings with rapid setting concrete complying with section 60-3.02B(2).

48-2.03E Falsework Lighting

48-2.03E(1) General

Falsework lighting includes lighting to illuminate the pavement, portals, and pedestrian walkways at or under openings in the falsework required for traffic.

Falsework lighting components must comply with section 86.

Lighting for pedestrian walkway illumination must be installed at all pedestrian openings through or under the falsework.

Design falsework lighting so that required maintenance can be performed with a minimum of inconvenience to traffic. Closing of traffic lanes for routine maintenance is not allowed on roadways with posted speed limits greater than 25 mph.

Illuminate the following only during hours of darkness as provided in division 1, section 280, of the California Vehicle Code: (1) Falsework portals and (2) pavement under falsework with portals less than 150 feet apart. Photoelectric switches must be used to control falsework lighting systems. Pavement under falsework with portals 150 feet or more apart and all pedestrian openings through falsework must be illuminated 24 hours per day.

Lighting fixtures must be aimed to avoid glare to oncoming motorists.

Type NMC cable with no. 12 minimum conductors with ground wire must be used. Fasten cable to the supporting structure at sufficient intervals to adequately support the cable and within 12 inches from every box or fitting. Conductors within 8 feet of ground must be enclosed in a 1/2-inch or larger Type 1 conduit.

Each illumination system must be on a minimum of 1 separate branch circuit at each bridge location. Each branch circuit must be fused, not to exceed 20 A.

For falsework lighting, arrange with the service utility to complete service connections. You pay for energy, line extension, service, and service hookup costs.

48-2.03E(2) Pavement Illumination

Illumination of pavement at vehicular openings through falsework must comply with the following requirements:

1. Fixture must include R/FL commercial-type flood lamp holder with protective covers.
2. Fixture must be fully adjustable with brackets and locking screws and allow mounting directly to a standard metal junction box.
3. Lamp must be medium-base 120 V(ac), 120 W, minimum, PAR-38 quartz-halogen flood lamp.
4. A continuous row of fixture types required must be installed at locations and spacing specified. Fixtures must be installed beneath falsework structure with the end fixtures not further than 10 feet inside portal faces. Fixtures must be installed and energized immediately after the members supporting them have been erected.
5. Fixtures along the sides of the opening must be placed not more than 4 feet behind or 2 feet in front of the roadway face of the temporary railing. Mounting heights of fixtures must be between 12 and 16 feet above the roadway surface and must present an unobstructed light pattern on the pavement.

48-2.03E(3) Portal Illumination

Illumination of falsework portals must comply with the following requirements:

1. On each side of each entrance portal, plywood sheet clearance guides must:
   1.1. Be 4 feet wide by 8 feet high.
   1.2. Be fastened vertically, facing traffic, with the bottom of the panel 3 to 4 feet above the roadway.
   1.3. Have the center of the panel located approximately 3 feet horizontally behind the roadway face of the railing.
   1.4. Have freshly painted panels for each installation with not less than 2 applications of flat white paint. Paint testing will not be required.
2. If ordered, repaint the designated areas to improve the general appearance of the painted surfaces. Repainting is change order work.
3. Falsework portals must be illuminated on the side facing traffic with 150 W, minimum, PAR floodlamps mounted on the structure directly over each vertical support adjacent to the traveled way, as needed to uniformly illuminate the exterior falsework beam, the clearance guides, and the overhead clearance sign. Each lamp must be supported approximately 16 feet above the pavement and approximately 6 feet in front of the portal face.
4. Portal lighting and clearance guides must be installed on the day the vertical members are erected.

48-2.03E(4) Pedestrian Walkway Illumination

Illumination of pedestrian openings through or under the falsework must comply with the following requirements:

1. Fixtures must be flush mounted in the overhead protection shield and equipped with a damage-resistant, clear, polycarbonate diffuser lens. Lamps must be standard incandescent 100 W, 120 V(ac).
2. Fixtures must be centered over the passageway at intervals of not more than 15 feet with the end fixtures not more than 7 feet inside the end of the pedestrian openings.
3. Pedestrian passageway light systems must be installed immediately after the overhead protection shield is erected.

48-2.04 PAYMENT

Not Used

48-3 TEMPORARY SUPPORTS

48-3.01 GENERAL

48-3.01A Summary

Section 48-3 includes specifications for providing temporary supports for existing structures during retrofit, reconstruction, and removal activities.

Temporary supports include jacking assemblies and accessories required to jack and support structures.

48-3.01B Definitions

frame: Portion of a bridge between expansion joints.

48-3.01C Submittals

48-3.01C(1) General

Submit 2 copies of the initial location survey of the existing structure signed by an engineer who is registered as a civil engineer in the State.

Submit a copy of the displacement monitoring record after completing reconstruction of each bent.

48-3.01C(2) Shop Drawings

Submit shop drawings with design calculations for the temporary support system. Submit 6 copies of shop drawings and 2 copies of design calculations. Include with the submittal:

1. Descriptions and values of all loads, including construction equipment loads.
2. Descriptions of equipment to be used.
3. Details and calculations for jacking and supporting the existing structure.
4. Stress sheets, anchor bolt layouts, shop details, and erection and removal plans for the temporary supports.
5. Assumed soil bearing values and design stresses for temporary support footings, including anticipated foundation settlement.
6. Maximum distance temporary support piles may be pulled for placement under footing caps.
7. Maximum deviation of temporary support piles from a vertical line through the point of fixity.
8. Details for use of permanent piles. Include any additional loads imposed on the piles.
9. Details for additional bracing required during erection and removal of temporary supports.
10. Details of the displacement monitoring system, including equipment, location of control points, and methods and schedule for taking measurements.
11. Details for jacking the structure if settlement occurs in the temporary supports.

Calculations must show a summary of computed stresses in (1) temporary supports, (2) connections between temporary supports and the existing structure, and (3) existing load-supporting members. The computed stresses must include the effect of the jacking sequence. Calculations must include a lateral stiffness assessment of the temporary support system.

Shop drawings and calculations must be signed by an engineer who is registered as a civil engineer in the State.

For temporary supports over railways, comply with any additional requirements of the railway company involved.

48-3.01D Quality Assurance

48-3.01D(1) General

Welding, welder qualification, and welding inspection for temporary supports must comply with AWS D1.1.

Calibrate each jack within 6 months of use and after each repair. Each jack and its gauge must (1) be calibrated as a unit with the cylinder extension in the approximate position that it will be at the final jacking force and (2) accompanied by a certified calibration chart. Each load cell must be calibrated. Calibration must be performed by an authorized laboratory.

Before starting bridge removal activities, an engineer who is registered as a civil engineer in the State must inspect and certify that (1) the temporary supports, jacking system, and displacement monitoring system comply with the authorized shop drawings and (2) the materials and workmanship are satisfactory for the work. A copy of this certification must be available at the job site at all times.

An engineer who is registered as a civil engineer in the State must:

1. Be present during jacking activities or adjustments and during bridge removal activities.

2. Inspect jacking and removal activities and report daily on the progress of the operation and the status of the remaining structure. The daily report must be available at the job site at all times.
3. Immediately submit proposed procedures to correct or remedy unplanned occurrences.

48-3.01D(2) Displacement Monitoring

Perform an initial survey to record the location of the existing structure before starting work.

Monitor and record vertical and horizontal displacements of the temporary supports and the existing structure. Use vandal-resistant displacement monitoring equipment. Perform monitoring continuously during jacking activities and at least weekly during removal and reconstruction activities. Make monitoring records available at the job site during normal work hours. Monitoring records must be signed by an engineer who is registered as a civil engineer in the State.

As a minimum, monitor the existing structure at the supported bent and at the midspan of both adjoining spans. Locate control points at each location near the center and at both edges of the superstructure. As a minimum, record elevations at the following times:

1. Before starting jacking activities
2. Immediately after completing jacking
3. After completing bridge removal
4. Before connecting the reconstructed or retrofitted superstructure to the substructure
5. After removing temporary supports

48-3.02 MATERIALS

48-3.02A General

Manufactured assemblies must comply with section 48-2.02B(3)(d).

48-3.02B Design Criteria

The Engineer does not authorize temporary support designs based on allowable stresses greater than those specified in section 48-2.02B(3).

If falsework loads are imposed on temporary supports, the temporary supports must also satisfy the deflection criteria in section 48-2.02B(3).

The temporary support system must support the initial jacking loads and the minimum temporary support design loads and forces shown. Adjust vertical design loads for the weight of the temporary supports and jacking system, construction equipment loads, and additional loads imposed by jacking activities. Construction equipment loads must be at least 20 psf of deck surface area of the frame involved.

Temporary supports must resist the described lateral design forces applied at the point where the column to be removed meets the superstructure. If the temporary support lateral stiffness exceeds the described minimum stiffness, increase the lateral design forces to be compatible with the temporary support stiffness.

Place temporary supports resisting transverse lateral loads within 1/2 of the span length from the existing bent. Place temporary supports resisting longitudinal lateral loads within the frame where columns are to be removed.

You may use the permanent piles as part of the temporary support foundation. Do not move or adjust permanent piles from the locations shown. If you install permanent piles longer than described to support the temporary supports above the top of the footing and later cut off the piles at their final elevation, you must use shear devices adequate to transfer all pile reactions into the footing.

Design temporary support footings to carry the loads imposed without exceeding the estimated soil bearing values or anticipated settlements. You must determine soil bearing values.

Where temporary supports are placed on the deck of an existing structure:

1. Temporary supports must bear either:
   1.1. Directly on girder stems or bent caps of the supporting structure
   1.2. On falsework sills that transmit the load to the stems or cap without overstressing any member of the new or existing structure

2. Temporary supports must not induce permanent forces into the completed structure or produce cracking.
3. Place additional temporary supports beneath the existing structure where temporary support loads are imposed on the existing structure. Design and construct the additional temporary supports to support all loads from the upper structure and construction activities.

Provide additional bracing as required to withstand all imposed loads during each phase of temporary support erection and removal. Include wind loads complying with section 48-2.02B(2) in the design of additional bracing.

Mechanically connect (1) the existing structure to the temporary supports and (2) the temporary supports to their foundations. Mechanical connections must be capable of resisting the lateral design forces. Friction forces developed between the existing structure and temporary supports (1) are not considered an effective mechanical connection and (2) must not be used to reduce lateral forces.

Design mechanical connections to accommodate adjustments to the temporary support frame during use.

If the concrete is to be prestressed, design temporary supports to support changes to the loads caused by prestressing forces.

Temporary supports must comply with the specifications for falsework in section 48-2.02B(4).

48-3.03 CONSTRUCTION

Where described, install temporary crash cushion modules under section 12-3.22 before starting temporary support activities. Remove crash cushion modules when authorized.

Construct temporary supports under the specifications for falsework in section 48-2.03C.

Equip each jack with a pressure gauge or load cell for determining the jacking force. Each pressure gauge must have an accurately reading dial at least 6 inches in diameter. Each load cell must be provided with an indicator to determine the jacking force.

Provide a redundant system of supports during jacking activities. The redundant system must include stacks of steel plates added as necessary to maintain the redundant supports at each jack location within 1/4 inch of the jacking sill or corbels.

Before starting bridge removal work at a location being supported, the temporary support system must (1) apply a force to the structure that is equal to the initial jacking load or the dead load shown and (2) hold that load until all initial compression and settlement of the system is completed.

Apply jacking loads simultaneously. Control and monitor jacking operations to prevent distortion and stresses that would damage the structure. Maintain total vertical displacements at control points to less than 1/4 inch from elevations recorded before jacking or as authorized.

Stop jacking activities if unanticipated displacements, cracking, or other damage occurs. Apply corrective measures before resuming jacking activities.

After reconstruction activities, the monitored control points must not deviate by more than 1/4 inch from the initial vertical survey elevations or other authorized elevations.

Remove temporary supports under the specifications for falsework in section 48-2.03D. If traffic is carried on the structure on temporary supports, do not release temporary supports until the supported concrete has attained 100 percent of the described strength.

Remove attachments from the existing structure. Restore concrete surfaces to original conditions except where permanent alterations are shown.

48-3.04 PAYMENT

Payment for crash cushion modules is not included in the payment for temporary support.

48-4 TEMPORARY DECKING

48-4.01 GENERAL

48-4.01A Summary

Section 48-4 includes specifications for temporary decking for joint or deck reconstruction.

If you are unable to complete bridge reconstruction activities before the bridge is to be opened to traffic, furnish and maintain temporary decking until that portion of the work is complete.

Temporary decking must comply with the specifications for existing structures in section 60 and the falsework specifications in section 48-2.

48-4.01B Definitions

Reserved

48-4.01C Submittals

Submit shop drawings for temporary decking. Include the following:

1. Description, location, and value of all loads
2. Details of the connection between the temporary decking and the existing structure
3. Storage location of equipment and materials that allows for 1 shift of work and placement of temporary decking within the time allowed
4. Construction sequence and schedule details
5. Cure time for concrete to be placed under a steel plate system
6. Details for removing temporary decking and restoring the existing structure

Shop drawings must be signed by an engineer who is registered as a civil engineer in the State.

48-4.01D Quality Assurance

Temporary decking must comply with the falsework specifications in section 48-2.02B(2), section 48-2.02B(3), and the following:

1. For the design loading shown, deflection must not exceed 1/300 of the temporary decking span.
2. Temporary decking must have a uniform surface with a coefficient of friction of at least 0.35 when measured under California Test 342.
3. Steel plate systems must be mechanically connected to the existing structure and adjacent approaches. If a steel plate spans a joint, the mechanical connection must accommodate at least 50 percent of the movement rating shown for that joint.
4. Temporary decking must not overstress, induce permanent forces into, or produce cracking in the existing structure.

48-4.02 MATERIALS

Not Used

48-4.03 CONSTRUCTION

Temporary decking must consist of one of the following:

1. Steel plate system that spans the incomplete work.
2. Falsework with an asphalt concrete surface that spans the incomplete work. Do not use falsework with an asphalt concrete surface to cover deck concrete that has not cured or to cover partially installed joint materials.

Construct temporary decking under the specifications for falsework in section 48-2 except the first paragraph of section 48-2.03D does not apply.

If there is a horizontal gap of more than 1/2 inch or an elevation difference of more than 1/4 inch between the temporary decking and the adjacent deck, install tapers up to and away from the temporary decking. Use the ratio for tapers specified in the special provisions. If the temporary decking does not extend the entire width of the roadway, taper the sides of the temporary decking at a 12:1 (horizontal: vertical) ratio. Material for tapers must comply with section 60-3.02B(2). Cure tapers at least 3 hours before allowing traffic on the temporary decking.

For ramp locations, tapers may be installed at 12:1 (horizontal: vertical) up to and away from the temporary decking. If the temporary decking does not extend the entire width of the roadway, taper the sides of the temporary decking at 12:1 (horizontal: vertical). Material used at these locations must be sufficiently rigid to support traffic. If unanticipated displacements, cracking, or other damage occurs to the existing structure or to any new components installed in or adjacent to the deck, stop work on the deck and perform corrective measures.

Edges of steel plate systems must be in full contact with the existing deck and the adjacent approach slab. If used, shims must be securely attached to the plate.

For falsework with an asphalt concrete cover, asphalt concrete must be at least 3 inches thick and compacted in place.

Do not allow traffic on deck concrete until it has attained the design compressive strength shown. For RSC, do not allow traffic on deck concrete until it has cured at least 24 hours.

When temporary decking is no longer needed, remove temporary decking materials and connections from the existing structure as soon as possible. Restore modifications to the existing structure except where permanent alterations are shown.

48-4.04 PAYMENT

Not Used

48-5 JACKING SUPERSTRUCTURE

48-5.01 GENERAL

48-5.01A Summary

Section 48-5 includes specifications for lowering the bridge superstructure using a jacking support system.

You must (1) design and construct the temporary jacking support system for the superstructure and (2) determine the methods and equipment for lowering the superstructure.

48-5.01B Definitions

Reserved

48-5.01C Submittals

Submit shop drawings with design calculations for the jacking support system. Submit 6 copies of shop drawings and 2 copies of design calculations. Include with the submittal:

1. Descriptions and values of all loads, including construction equipment loads
2. Descriptions of equipment to be used
3. Details and calculations for jacking and supporting the structure
4. Stress sheets, anchor bolt layouts, shop details, and erection and removal plans for the temporary supports
5. Assumed soil bearing values and design stresses for support footings, including anticipated foundation settlement
6. Details for bracing required during erection and removal
7. Details of the displacement monitoring system, including equipment, location of control points, and methods and schedule of taking measurements
8. Details for jacking the structure if settlement occurs

Calculations must show a summary of computed stresses in the jacking support system and the connections between the support system and the bridge superstructure. The computed stresses must include the effect of the jacking sequence. Calculations must include a lateral stiffness assessment of the jacking support system.

Shop drawings and calculations must be signed by an engineer who is registered as a civil engineer in the State.

For jacking support systems over railways, comply with any additional requirements of the railway company involved.

48-5.01D Quality Assurance

48-5.01D(1) General

Calibrate each jack within 6 months of use and after each repair. Each jack and its gauge must (1) be calibrated as a unit with the cylinder extension in the approximate position that it will be at the final jacking force and (2) accompanied by a certified calibration chart. Each load cell must be calibrated. Calibration must be performed by an authorized laboratory.

48-5.01D(2) Displacement Monitoring

Monitor and record vertical and horizontal displacements of the jacking support system and the existing structure. Use vandal-resistant displacement monitoring equipment. Perform monitoring continuously during jacking activities. Make monitoring records available at the job site during normal work hours. Monitoring records must be signed by an engineer who is registered as a civil engineer in the State.

As a minimum, monitor the existing structure at the supported bent and at the midspan of both adjoining spans. Locate control points at each location near the center and at both edges of the superstructure. As a minimum, record elevations at the following times:

1. Before starting jacking activities
2. Immediately after completing jacking
3. Before connecting the superstructure to the substructure
4. After removing jacking support system

48-5.02 MATERIALS

48-5.02A General

Reserved

48-5.02B Design Criteria

The jacking support system must resist the structure dead load and lateral design forces shown, plus any additional loads from jacking equipment and activities. You must determine soil bearing values for support footings. If the jacking support stiffness exceeds the specified minimum stiffness, increase the lateral design forces to be compatible with the jacking support lateral stiffness.

Systems involving modifications to the bridge that impair the structural integrity, intended serviceability, or design capacity of the bridge are not allowed.

48-5.03 CONSTRUCTION

Construct the jacking support system under the specifications for falsework in section 48-2.03C.

Equip each jack with a pressure gauge or load cell for determining the jacking force. Each pressure gauge must have an accurately reading dial at least 6 inches in diameter. Each load cell must be provided with an indicator to determine the jacking force.

Provide a redundant system of supports during jacking activities. The redundant system must include stacks of steel plates added as necessary to maintain the redundant supports within 1/4 inch of the jacking sill or corbels.

Before removing falsework, the jacking support system must (1) apply a force to the structure that is equal to the initial jacking load or the dead load shown and (2) hold that load until all initial compression and settlement of the system is completed.

Lower the superstructure uniformly to the position shown. Lower the superstructure such that no distortion occurs that would damage the superstructure. Distribute the load uniformly across each hinge, abutment, or bent. If authorized, place galvanized shims as necessary to provide uniform loading at bearing pads.

Stop jacking activities if unanticipated displacements, cracking, or other damage occurs. Corrective measures must be authorized before use.

After lowering, remove the jacking support system under the specifications for falsework in section 48-2.03D. Remove attachments required for lowering from the superstructure and apply the specified finish to concrete surfaces.

48-5.04 PAYMENT

Not Used

48-6 TEMPORARY WOOD POLES

48-6.01 GENERAL

48-6.01A Summary

Section 48-6 includes specifications for constructing, maintaining, and removing temporary wood poles for the support of electrical systems.

Temporary wood poles include attached wire components.

48-6.01B Definitions

Reserved

48-6.01C Submittals

48-6.01C(1) General

Submit a letter of certification that certifies all components of the manufactured assemblies are used in compliance with the manufacturer's recommendations. If requested, (1) submit manufacturer's data for manufactured assemblies to verify manufacturer's recommendations or (2) perform tests demonstrating adequacy of the proposed assemblies and submit the test results.

Submit the letter before installing messenger wires, tether wires, or self-supporting conductors or cables.

You may submit a request to use alternative mounting brackets or wire termination hardware. Your request must include:

1. Structural design calculations and testing data sealed and signed by an engineer who is registered as a civil engineer in the State
2. Manufacturer's instructions

48-6.01C(2) Guy Wire Anchors

Submit the guy wire anchor manufacturer's product information and installation instructions. Do not install anchors unless authorized.

48-6.01D Quality Assurance

48-6.01D(1) General

Reserved

48-6.01D(2) Welding

Welding must comply with AWS D1.1.

48-6.02 MATERIALS

48-6.02A General

Wire used for messenger wires, tether wires, or guy wires must be 7-wire strand complying with ASTM A475, Utilities Grade.

Connection hardware for wires must provide a termination efficiency factor of not less than 0.80.

Wood poles, push braces, and stubs must comply with ANSI O5.1.

Treat wood under AWPA U1, Use Category UC4B, Commodity Specification D.

Except for wire, helical anchors, expanded steel plate anchors, cross plate anchors, and expanding rock anchors, steel components must comply with section 56-3.

48-6.02B Helical Anchors, Expanded Steel Plate Anchors, Cross Plate Anchors, and Expanding Rock Anchors

Fabricate helical anchors, expanded steel plate anchors, and cross plate anchors under section 75.

Fabricate attachable thimble eyes and expanding rock anchors from suitable ferrous material.

Welding must comply with AWS D1.1.

Fabricate as a continuous piece or as separate segments with mechanical connections between segments. Include integral thimble eye or include attachable thimble eye.

Galvanize all helical anchor parts under section 75.

Paint expanded steel plate anchors, cross plate anchors, and expanding rock anchors as specified for repairing damaged galvanized surfaces in section 75-1.02B.

The final assembly must have (1) a minimum ultimate tensile strength greater than the minimum required breaking strength of the guy wire and (2) a minimum ultimate torsional strength greater than twice the minimum installation torque.

48-6.02C Reuse of Materials and Relocation of Temporary Supports

You may reuse structural components and relocate temporary supports provided that the materials remain in acceptable condition for reuse, except do not reuse:

1. Components of high-strength bolt assemblies that have been or are required to be tensioned past snug tight
2. High-strength cap screws that have been or are required to be tensioned past snug tight
3. Tension control bolts

48-6.03 CONSTRUCTION

48-6.03A General

Install construction bracing as necessary to withstand all imposed loads during erection, construction, and removal of any temporary wood poles.

The Engineer may order you to install Type K temporary railing at temporary wood pole locations that are less than 15 feet from the edge of a traffic lane.

Install all temporary railing protecting temporary wood poles before erecting temporary wood poles. Do not remove temporary railing until authorized.

For overhead line construction not specifically covered in the contract documents, comply with Public Utility Commission General Order 95.

48-6.03B Foundations

Verify the design soil parameters before starting construction of temporary wood poles.

Remove any accumulated water from the pole excavation prior to placing granular backfill at the bottom of the pole excavation. Thoroughly compact and level the granular backfill at the bottom of the pole excavation prior to setting the pole.

Backfill around poles with manufactured sand that is free of rocks or other deleterious material. Place the backfill material in 4-inch thick layers. Moisten and thoroughly compact each layer.

Remove accumulated water from the anchor excavation prior to placing an expanded steel anchor. Expand the base of the expanded steel anchor prior to placing backfill. Place backfill around the expanded steel anchor in 4-inch thick layers. Thoroughly compact each layer.

Protect foundations from softening and undermining.

48-6.03C Erection

If temporary wood poles are over or adjacent to roadways or railroads, all construction bracing must (1) be installed at the time each element of the temporary wood pole is erected and (2) remain in place until the temporary wood pole is removed.

Suspend conductors from messenger wire by continuous lashing wire. No spare wire conductors or cables are allowed unless described.

Sag overhead bundles to maintain required clearances over the ambient temperature range of - 30 to 120 degrees F. The sag must be between 4.6 and 5.4 percent of horizontal span unless otherwise shown. Minimum vertical clearance over grade is 25 feet unless otherwise shown.

48-6.03D Attachments

If specific connection details are not shown, mount attachments under the manufacturer's written instructions and such that there is no loss of cross section.

48-6.03E Damping

If at any time during service the temporary structural support exhibits excessive vibration, immediately install dampers. Dampers must be effective in mitigating the vibration and must not compromise the structural supports or the supported hardware.

48-6.03F Removal

Remove temporary structural supports such that portions not yet removed remain stable at all times.

Remove temporary wood poles and helical anchors. Fill the void with excavated material or sand that is free of deleterious material. Place the backfill material in 4-inch thick layers. Moisten and thoroughly compact each layer.

Dispose of surplus excavated material uniformly along the adjacent roadway.

Dispose of temporary structural support materials and work debris.

48-6.03G Guy Wire Helical Anchors

48-6.03G(1) General

Reserved

48-6.03G(2) Installation Parameters

Use the minimum installation torque shown. You may request an alternative minimum installation torque based on a revised value for empirical torque factor.

For alternative minimum installation torque, use the following equation to calculate the installation torque:

$$T = Qa(FS/Kt)$$

where:
T = Minimum installation torque, ft-lb
FS = Factor of safety of 2.0
Qa = Minimum allowable tensile capacity shown, lb
Kt = Empirical torque factor, 1/ft (inverse foot)

Include a geotechnical report sealed and signed by a licensed geotechnical engineer with recommended values for empirical torque factor and alternative minimum installation torque with your request.

Do not start installation unless your alternative installation parameters are authorized.

Verify the installation parameters before the start of anchor installation.

48-6.03G(3) Installation

Install anchors under the manufacturer's written instructions and the following:

1. Do not install anchors underneath utilities or subsurface structures.
2. Maintain horizontal clearances as required by the Engineer.
3. Install to the minimum embedment length.
4. Continuously monitor and record torque during installation. If torque at the minimum embedment length is not equal to or greater than the minimum required, continue installation to greater embedment until the minimum installation torque is achieved for 2 continuous feet.

48-6.03G(4) Removal

After service is complete, remove anchors using reverse torque. Fill the void with excavated material or sand free of deleterious materials. Place the backfill material in 4-inch thick layers. Moisten and thoroughly compact each layer.

48-6.03H Expanded Steel Plate Anchors, Cross Plate Anchors, and Expanding Rock Anchors

48-6.03H(1) General

Reserved

48-6.03H(2) Installation

Install anchors under the manufacturer's written instructions.

Locate and mark all substructures and utilities. Do not install anchors underneath subsurface utilities or structures.

48-6.03H(3) Removal

After service is complete, remove anchors to a depth of at least 3 feet below finished grade. Fill the void with sand free of deleterious materials. Place the backfill material in 4-inch thick layers. Moisten and thoroughly compact each layer.

48-6.04 PAYMENT

Not Used

48-7–48-10 RESERVED

49 PILING

49-1 GENERAL

49-1.01 GENERAL

49-1.01A Summary

Section 49-1 includes general specifications for constructing piles.

49-1.01B Definitions

control zone: Zone that has the same subsurface profile and engineering properties as a corresponding support location.

nominal driving resistance: Sum of (1) nominal resistance required to resist the factored axial loads and (2) driving resistance from unsuitable or scourable penetrated soil layers that do not contribute to the design resistance.

nominal resistance: Design capacity required to resist the factored axial loads.

49-1.01C Submittals

49-1.01C(1) General

Before handling or installing piles at a location closer than the length of the pile being handled or installed to the edge of a traveled way open to public use, submit a work plan of the measures to be used to provide for the safety of traffic and the public.

Submit a VECP for revisions to specified tip elevations shown or installation methods.

49-1.01C(2) Test Borings

If test borings are specified in the special provisions, submit the log of test borings and the test boring report upon completion of all test borings. Submit 4 copies of the test boring report and the log of test borings to OSD, Documents Unit. The submittal must comply with the specifications for shop drawings. Notify the Engineer of the submittal. Include in the notification the date and contents of the submittal.

If corrections to the submittal are required, submit 1 copy of the corrected test boring report and the log of test borings to OSD, Documents Unit.

The test boring report must include:

1. Summary of drilling methods, drilling equipment, drill platforms, and drilling difficulties encountered
2. Location map of the surveyed position of the test borings relative to the new pile locations in the California Coordinate System and bridge stationing
3. Bore hole surveying notes
4. Photographs of rock cores
5. Copies of original daily drilling notes

49-1.01D Quality Assurance

49-1.01D(1) General

Piling must have sufficient length to attain the specified tip elevation shown and extend into the pile cap or footing.

49-1.01D(2) Determination of Length

You may conduct additional foundation investigation, including installing and axial load testing of additional nonproduction indicator piling and performing test borings. Locations of additional foundation testing must be authorized. Notify the Engineer at least 5 business days before starting additional foundation testing.

Complete additional foundation investigation before requesting revised specified pile tip elevations or revisions to the described installation methods.

The following revisions are not authorized:

1. Specified installation methods if settlement or lateral loads control the design tip elevation
2. Specified pile tip elevation above the design tip elevation shown for settlement or lateral loads

3. Specified pile tip elevation if the tip elevation is controlled by liquefaction or scour

The pile structural capacity design is based on the nominal strength as defined in Article 8.1.3 of the *Caltrans Bridge Design Specifications* or the nominal resistance as defined in Article 1.3.2.1 of the *AASHTO LRFD Bridge Design Specifications*.

Indicator compression pile load testing must comply with ASTM D1143/D1143M. The pile must sustain the 1st compression test load applied that is equal to the nominal driving resistance, with no more than 1/2-inch total vertical movement at the top of the pile measured relative to the top of the pile before the start of compression load testing.

Indicator tension pile load testing must comply with ASTM D3689 except do not use the loading apparatus described as "Tensile Load Applied by Hydraulic Jack(s) Acting Upward at One End of Test Beam(s)." The pile must sustain the 1st tension test load applied that is equal to the nominal resistance in tension shown with no more than 1/2-inch total vertical movement at the top of the pile measured relative to the top of the pile before the start of tension load testing.

Remove indicator piling as specified for removing portions of bridges.

49-1.01D(3) Load Test Piles

If load test piles are shown, complete load testing of each load test pile before drilling holes, casting piling, cutting piling to length, driving piling, and fabricating reinforcing steel cages for any piles represented by the load test pile.

Notify the Engineer at least 10 days before drilling or driving piles to be load tested.

Except in cofferdams, the bottom of the footing excavation must be level and dewatered before pile load testing. The excavation must be kept dewatered during load testing.

Install load test piles with the same type of equipment to be used for installation of production piles.

Load test and anchor piles must comply with the specifications for piling as described and Class N steel pipe piling. Locate load test piles such that they may be cut off and become a part of the completed structure.

Remove load test and anchor piles not incorporated in the completed structure as specified for removing portions of bridges.

For load test anchorages in piles used as anchor piles:

1. HS threaded steel rods must comply with ASTM A722/A722M for uncoated, deformed, Type II, HS steel bars, including the supplementary requirements, except the maximum weight requirement does not apply
2. Steel plates must comply with ASTM A709/A709M, Grade 36
3. Anchor nuts must hold the HS steel rods at a load producing a stress of not less than 95 percent of the specified ultimate tensile strength of the HS steel rod
4. Pipe, couplings, and fittings must be commercially available materials of the types and ratings shown
5. Welds that connect the anchor pile and the anchor pile head must be tested under section 49-2.02A(4)(b)(iii)(C)

You may use additional cementitious material in load test and anchor piles.

You may use Type III cement in any load test and anchor pile not used as a part of the completed structure.

Furnish labor, materials, tools, equipment, and incidentals as required to assist the Department in the transportation, installation, operation, and removal of Department-furnished steel load test beams, jacks, bearing plates, drills, and other test equipment. This is change order work.

The Department performs testing of load test piles when the concrete in the load test and anchor piles has developed a compressive strength of at least 2,000 psi.

Allow the Department 15 days to perform pile load tests at each test location. Allow an additional 10 days for the Department to revise the specified tip elevations.

49-1.01D(4) Dynamic Monitoring

Section 49-1.01D(4) applies if dynamic monitoring of driven piling is specified in the special provisions.

The Department determines which piles from a control zone or support location receive dynamic monitoring.

The Department dynamically monitors driven piles using Department-furnished dynamic pile analyzer monitoring instruments.

Section 49-2.01A(4)(c) does not apply to driven piles if dynamic monitoring is required.

The Department conducts penetration and bearing analyses of dynamically monitored piles and develops bearing acceptance criteria curves for these piles. Penetration and bearing analyses are based on a wave equation analysis. Penetration and bearing analyses are specific to a driving submittal. Piles located within specified control zones are represented by the associated dynamically monitored pile for bearing acceptance criteria.

Except for load test piles and anchor piles, drive the 1st production pile in the control zone and perform dynamic monitoring as specified. Do not install any additional production piles until the Engineer provides you with the bearing acceptance criteria curves for any piles represented by the dynamically monitored piles.

Piles to be dynamically monitored must:

1. Have an additional length of 2 times the largest cross-sectional dimension of the pile plus 2 feet.
2. Be available to the Department at least 2 business days before driving.
3. Be safely supported at least 6 inches off the ground in a horizontal position on at least 2 support blocks. If ordered, rotate the piles on the blocks.
4. Be positioned to provide safe access to the entire pile length and circumference for the installation of anchorages and control marks for monitoring.

Prepare and drive piles to be dynamically monitored in the following sequence:

1. Before driving, rotate and align the pile in the driving leads as ordered by the Department.
2. Temporarily suspend driving operations for approximately 15 minutes when the pile tip is 25 feet above the specified tip elevation shown.
3. During the 15 minute suspension, bolt the 1-pound instrument package securely to plugs or expansion anchors previously installed in the pile by the Department. Connect electrical cables to the instrument package as ordered by the Department.
4. Resume driving operations as ordered by the Department. Suspend driving operations approximately 1 foot above the specified tip elevation.
5. Remove the cables and instrument package from the pile and deliver them to the Engineer.
6. The following day, install the instrument package on the pile and attach the cables and resume driving the pile to the specified tip elevation.
7. Remove the cables and instruments from the monitored pile and deliver them to the Engineer. Replace in kind any cables or instruments that are damaged by your activities.

After the pile has been dynamically monitored:

1. Allow 15 days for the Department to revise the specified tip elevations and to provide bearing acceptance criteria curves
2. If pile load testing is performed in addition to dynamic monitoring, allow 25 days for the Department to revise the specified tip elevations and to provide bearing acceptance criteria curves
3. Cut pile to the specified cut-off elevation after bearing acceptance criteria is provided by the Department

49-1.01D(5) Test Borings

Section 49-1.01D(5) applies if test borings are specified in the special provisions.

Notify the Engineer at least 15 days before drilling test borings.

Drill test borings under the job site supervision of, with the log of test borings stamped by, and with the test boring submittal signed by a geologist or civil engineer who is registered in the State and has at least 5 years of geotechnical engineering experience with deep foundations in both soil and rock.

Drill test borings at the center of each pile location shown.

Drill test borings by rotary drilling methods to a depth of at least 20 feet below the specified tip elevation shown. Test borings must be at least 3 inches in diameter.

Perform standard penetration tests in all soil types under ASTM D1586 for each test boring at 5-foot maximum intervals until (1) bedrock is encountered, (2) 10 blows with no discernible sampler advancement is observed, or (3) ordered.

Core the bedrock:

1. Continuously with at least 90 percent core recovery. Rock must not be logged from drill cuttings. Rock quality designation must be made at 5-foot maximum intervals.
2. Using an outer and inner core barrel drilling system. The outer core barrel must be fitted with a diamond impregnated or polycrystalline drill bit and have an outside diameter of at least 3 inches. The split inner tube core barrel must have an inside diameter of at least 2 inches.

Photograph the rock cores:

1. Before removal from the split inner tube barrels and placement into core boxes
2. After core boxes are filled and before boxes are removed from the drilling platform

Rock core photographs must be in color, 5 by 7 inches, and labeled with the borehole number, sample elevation, scale, and date and time of photograph.

Place the rock cores in rock core boxes labeled as specified in the *Soil and Rock Logging, Classification, and Presentation Manual*. Include the support or pile location. Store rock core boxes on or near the job site at an authorized location. Preserve and secure the rock core samples in a weather-protected facility until notified by the Engineer. Dispose of rock cores or transport them to Geotechnical Services, as ordered.

The log of test borings and the classification and description of soils and rock must comply with the *Soil and Rock Logging, Classification, and Presentation Manual* available at the Geotechnical Services website. Use the same version of the *Soil and Rock Logging, Classification, and Presentation Manual* shown. If no version is shown, use the most current version of the manual.

After the test boring report and the log of test borings have been authorized, allow 20 days for the Engineer to notify you of confirmation of or revisions to the specified pile tip elevations. Do not fabricate or manufacture to length steel pipe piling, permanent steel casing, micropiling, and filled and unfilled steel casing until you have been notified.

49-1.02 MATERIALS

Not Used

49-1.03 CONSTRUCTION

If the Contract allows the use of more than 1 pile type, use the same type of pile for all piles within each individual footing.

Dispose of drill cuttings under section 19-2.03B.

49-1.04 PAYMENT

Load test piles and adjacent anchor piles are paid for as the type or class of piling shown in the Bid Item List. The payment quantity is the length used in the load testing.

49-2 DRIVEN PILING

49-2.01 GENERAL

49-2.01A General

49-2.01A(1) Summary

Section 49-2.01 includes general specifications for installing driven piles.

Epoxy-coated bar reinforcing steel used for pile anchors must comply with section 52-2.02.

Furnish piling includes:

1. Furnishing piles to the job site
2. Splicing piles
3. Furnishing and installing pile anchors and lugs

Driving piles includes:

1. Driving and cutting the piles off at the elevations shown
2. Furnishing special driving tips or heavier sections of steel piles
3. Drilling holes or predrilling holes through embankments
4. Disposing of material resulting from drilling holes or predrilling holes

49-2.01A(2) Definitions

Reserved

49-2.01A(3) Submittals

49-2.01A(3)(a) General

For pile driving hammers with no way of visually observing the ram stroke, submit a printed readout as an informational submittal showing hammer energy during driving operations.

49-2.01A(3)(b) Driving System Submittal

Section 49-2.01A(3)(b) applies if a driving system submittal is specified in the special provisions.

The driving system submittal must be sealed and signed by an engineer who is registered as a civil engineer in the State.

Allow 15 days for the Department's review. Allow an additional 15 days for the review of any resubmittals.

Submit a revised driving system submittal if the hammers change from those shown in the submittal.

For the driving system submittal, perform driveability studies as follows:

1. Model the proposed driving system including hammers, cap blocks, and pile cushions based on a wave equation analysis.
2. Use an authorized computer program.
3. If the driveability analysis hammers indicate that open-ended pipe pile and steel shell penetration rates are less than 1 foot per 200 blows and the driving stresses exceed 80 percent of the yield strength of the pipe and steel shell, include assumptions for drilling through the center of the piles and shells.
4. If a follower is used, include (1) an analysis of the driving system with the follower and (2) an analysis of the driving system without the follower.

Include in the driving system submittal:

1. Results of the driveability analysis showing that the proposed driving systems will install piles to the specified tip elevation and nominal driving resistance shown. Driving systems must generate sufficient energy to drive the piles with compressive and tensile stresses not more than 90 percent of the yield strength of the pile as driven. Results must include:
   1.1. Pile compressive stress versus blows per foot.
   1.2. Pile tensile stress versus blows per foot.
   1.3. Nominal driving resistance versus blows per foot.
2. Complete description of:

2.1. Soil parameters used, including soil quake and damping coefficients, skin friction distribution, and ratio of shaft resistance to total resistance.
2.2. Assumptions made regarding the formation of soil plugs, drilling through the center of open-ended steel shells, and the use of closure plates, shoes, and other tip treatment.
3. List of the hammer operation parameters assumed in the analysis, including fuel settings, stroke limitations, and hammer efficiency.
4. Copies of the test results from any previous pile load tests, dynamic monitoring, and all driving records used in the analyses.
5. Completed Pile and Driving Data form.

49-2.01A(4) Quality Assurance

49-2.01A(4)(a) General

Reserved

49-2.01A(4)(b) Quality Control

Reserved

49-2.01A(4)(c) Department Acceptance

For pile acceptance, the required number of hammer blows in the last foot of driving is determined using the following formula:

$$R_u = (1.83 \times (E_r)^{1/2} \times \log_{10}(0.83 \times N)) - 124$$

where:
R_u = *nominal driving resistance, kips*
E_r = manufacturer's rating for foot-pounds of energy developed by the hammer at the observed field drop height
N = number of hammer blows in the last foot, maximum value allowed for N is 96

49-2.01B Materials

Not Used

49-2.01C Construction

49-2.01C(1) General

If the Engineer revises the pile tip elevation for driven piles, the work involved in furnishing, splicing, and driving the additional length of pile is change order work.

If you are ordered to place additional lugs on steel piles, furnishing and placing these lugs is change order work.

49-2.01C(2) Driving Equipment

Install driven piles using an authorized impact hammer. The impact hammer must be:

1. Steam, hydraulic, air, or diesel
2. Able to develop sufficient energy to drive the pile at a penetration rate of not less than 1/8 inch per blow at the nominal driving resistance shown

Do not use vibratory hammers, oscillators, or rotators to install driven piles.

Hammers with an external combustion engine that are not single action must have a transducer that records ram velocity.

Double acting diesel hammers with internal combustion engines must have a transducer that records bounce chamber pressure.

Steam or air hammers must have boiler or air capacity of at least that specified by the manufacturer. The boiler or air compressor must be equipped with an accurate pressure gauge.

Maintain the valve mechanism and other parts of steam, air, or diesel hammers such that the length of stroke and number of blows per minute for which the hammer is designed is attained. Do not use inefficient steam, air, or diesel hammers.

You may use followers or underwater hammers for driving piles if authorized. If using a follower or underwater hammer, verify its efficiency by furnishing the 1st pile in each bent or footing sufficiently long and drive the pile without the use of a follower or underwater hammer.

49-2.01C(3) Drilling

If necessary to attain the specified tip elevation shown and if authorized, you may drill holes with a diameter not greater than the least dimension of the pile to the specified depth before driving the piles.

49-2.01C(4) Predrilled Holes

For piles to be driven through embankments constructed under the Contract, drive piles through predrilled holes where the depth of the new embankment at the pile location is in excess of 5 feet.

The hole diameter must be at least 6 inches larger than the greatest dimension of the pile cross section. After driving the pile, fill the space around the pile to the ground surface with dry sand or pea gravel.

49-2.01C(5) Driving

Use driving heads or driving blocks that hold the pile in position directly under the hammer when driving.

Protect the heads of driven piles from direct impact of the hammer with a cushion driving block. Maintain the cushion in good condition during the entire driving operation. Arrange the cushion driving block such that any reinforcing bars projecting above the pile are not displaced or damaged during driving.

Provide special driving tips or heavier pile sections or take other authorized measures to prevent damage to steel piles, steel shells, or steel casings during installation.

Drive piles to the position and line shown. The Engineer rejects piles materially out of line. Dispose of rejected piles that interfere with the work. You must remove or cut off and abandon in place any rejected piles that do not interfere with the work.

Except for piles to be load tested and sheet piles, drive piles to at least the nominal driving resistance and the specified tip elevation shown.

Drive piles to be load tested and sheet piles to the specified tip elevation shown.

If the pile nominal driving resistance is not shown, drive the pile to the nominal resistance shown.

49-2.01C(6) Pile Cutoff

Cut off driven piles at the elevations shown and anchor them to the structure. Do not damage the pile below cutoff.

Dispose of the cutoff lengths of piles.

49-2.01D Payment

Driven piling is paid for as furnish piling and drive pile of the class, type, size, or alternative shown in the Bid Item List.

If you are ordered to place additional lugs on steel piles, the Department does not pay for the additional work involved in driving piles due to these additional lugs.

The payment quantity for furnish piling is the length measured along the longest side of the pile from the specified tip elevation shown to the plane of pile cutoff.

49-2.02 STEEL PIPE PILING

49-2.02A General

49-2.02A(1) Summary

Section 49-2.02 includes specifications for installing steel pipe piles.

49-2.02A(2) Definitions

shop welding: Welding performed at a plant on the Department's Authorized Facility Audit List.

field welding: Welding not performed at a plant on the Department's Authorized Facility Audit List.

49-2.02A(3) Submittals

49-2.02A(3)(a) General

Reserved

49-2.02A(3)(b) Shop Drawings

Submit shop drawings for attaching handling devices to steel pipe piles. Shop drawings must include the locations, handling and fitting device details, and connection details. Allow 7 days for review of the shop drawings.

49-2.02A(3)(c) Inspection Request Form

Submit an inspection request form at least 10 days before performing any welding of Class N steel pipe piles.

49-2.02A(3)(d) Certificate of Compliance

Submit a certificate of compliance for steel pipe piles. The certificate of compliance must be signed by the plant's QC representative. The QC representative must be on record with the Department's Office of Structural Materials. Include with the certificate of compliance:

1. Statement that the materials and workmanship comply with the Contract and the required tests and inspections have been performed as described.
2. Certified mill test reports for each heat number of steel used in pipe piles being furnished.
3. Test reports for tensile, chemical, and any specified NDT. Test reports must be based on test samples taken from the base metal, steel, coil, or from the manufactured or fabricated piles.
4. Calculated carbon equivalent. The carbon equivalent may be shown on the mill test report.

49-2.02A(4) Quality Assurance

49-2.02A(4)(a) General

Reserved

49-2.02A(4)(b) Quality Control

49-2.02A(4)(b)(i) General

Reserved

49-2.02A(4)(b)(ii) Plant Audit

Fabricate steel pipe piles at a plant on the Department's Authorized Facility Audit List.

49-2.02A(4)(b)(iii) Nondestructive Testing

49-2.02A(4)(b)(iii)(A) General

Section 49-2.02A(4)(b)(iii) applies to NDT of Class N steel pipe piles.

Except for welding performed under API 5L, the acceptance criteria for RT and UT must comply with AWS D1.1 for cyclically loaded nontubular connections for welds subject to tensile stress.

Perform NDT on backing ring welds using RT or UT for a material thickness of 5/16 inch or greater or using RT for a material thickness less than 5/16 inch.

49-2.02A(4)(b)(iii)(B) Shop Welds

Section 49-2.02A(4)(b)(iii)(B) applies to NDT of shop welds.

For welding performed under API 5L:

1. Submit a DVD or VHS videocassette recording of the actual material testing if radiological testing is used or the actual radiographic film if film radiography is used. Submit the recording before shipping the material from the plant.

2. If film radiography is used to inspect pipe ends or repairs, the transmitted film density must be from 2.0 to 4.0 in the area of interest, weld, base metal, and image quality indicators.
3. Reinspect repaired defects using the NDT method that originally detected the defect except you may use film radiography for the inspection of repairs if the defect was originally detected using radiological testing.

For welding performed under AWS D1.1:

1. Perform NDT on 25 percent of each longitudinal, circumferential, or spiral weld using RT or UT.
2. If repairs are required in a portion of the tested weld:
   2.1. Perform NDT on the repaired portion.
   2.2. Perform additional NDT on untested areas on each side of the repaired portion. The length of additional NDT on each side of the repaired portion must equal 10 percent of the pipe's outside circumference.
   2.3. After this additional 20 percent of NDT is performed, and if additional repairs are required, determine and record the total cumulative repair lengths from all NDT. If the cumulative weld repair length is equal to or more than 10 percent of the pipe's outside circumference, then perform NDT on the entire weld.

49-2.02A(4)(b)(iii)(C) Field Welds

Section 49-2.02A(4)(b)(iii)(C) applies to NDT of field welds.

Perform NDT on 25 percent of each field weld by RT or UT at locations selected by the Engineer. The Engineer may select several locations on a given splice. The cover pass must be ground smooth at locations to be tested.

Personnel performing UT for field welds must have their qualifications verified before performing NDT, by both written and practical exams. For UT qualification procedures, go to the METS website.

If repairs are required in a portion of the tested weld:

1. Perform NDT on the repaired portion.
2. Perform additional NDT on untested areas on each side of the repaired portion. The length of additional NDT on each side of the repaired portion must equal 10 percent of the pipe's outside circumference.
3. After this additional 20 percent of NDT is performed, and if additional repairs are required, determine and record the total cumulative repair lengths from all NDT. If the cumulative weld repair length is equal to or more than 10 percent of the pipe's outside circumference, then perform NDT on the entire weld.

49-2.02A(4)(c) Department Acceptance

Reserved

49-2.02B Materials

49-2.02B(1) General

49-2.02B(1)(a) General

Piles not specified as Class N in the special provisions must comply with the specifications for Class R.

The carbon equivalent of steel in steel pipe piles must not exceed 0.47 percent. Use the following formula to calculate the carbon equivalent:

$$CE = C + (Mn + Si)/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$

where:
CE = carbon equivalent, percent

Sulfur content of steel in steel pipe piles must not exceed 0.05 percent.

Seams in steel pipe piles must be CJP welds.

For welding and prequalifying base metal under Table 3.1 of AWS D1.1, treat steel pipe piles complying with ASTM A252 as either ASTM A572/572M, Grade 50, or ASTM A709/709M, Grade 50.

Section 11-2 does not apply to shop welds in steel pipe piles fabricated at a plant on the Department's Authorized Facility Audit List.

For groove welds using submerged arc welding from both sides without backgouging, qualify the WPS under Table 4.5 of AWS D1.1.

Butt welded seams subsequently formed, including skelp end welds, must be 100 percent ultrasonically tested in the final formed and welded condition. The acceptance criteria for UT must comply with one of the following:

1. API 5L for API-licensed facilities
2. AWS D1.1 for cyclically loaded nontubular connections for welds subject to tensile stress

Except for tack welding, do not use gas metal arc welding for welding of steel pipe piles. If gas metal arc welding is used for tack welding, do not deposit filler metal by short circuiting transfer.

49-2.02B(1)(b) Circumferential Welds

Welds must comply with AWS D1.1. Circumferential welds must be CJP welds.

Locate circumferential welds at least 12 inches away from a skelp end weld.

Backing rings must comply with the following:

1. Minimum thickness of the backing ring must be 1/4 inch and the backing ring must be continuous.
2. Splices in the backing ring must be made by CJP welds. These welds must be completed and inspected, including performing any required NDT, before final insertion into a pipe end.
3. Attach backing rings to pipe ends using the minimum size and spacing of tack welds that will securely hold the backing ring in place. Tack weld in the root area of the weld splice. Remove and replace cracked tack welds before subsequent weld passes.
4. Gap between the backing ring and the steel pipe wall must not be greater than 5/64 inch. You may offset 1 localized portion of the backing ring fit-up by a gap equal to or less than 1/4 inch if the localized portion is (1) equal to or less than 20 percent of the outside circumference of the pipe, (2) first seal welded using shielded metal arc E7016 or E7018 electrodes, and (3) marked such that it can be referenced during any required NDT.
5. Backing rings must have enough width such that the backing ring does not interfere with the interpretation of the NDT.

For steel pipe piles with an outside diameter greater than 42 inches and a wall thickness greater than 1 inch, you may increase the root opening tolerances to a maximum of 3/16 inch.

If splicing steel pipe piles using a circumferential weld, the piles must comply with the fit-up requirements of clause 5.22.3.1 of AWS D1.1.

49-2.02B(1)(c) Tolerances

Dimensional tolerances of steel pipe piles must comply with the following:

1. Outside diameter: ±0.75 percent of the outside diameter shown
2. Wall thickness: -5 to +10 percent of the nominal wall thickness shown
3. Straightness: ±1.0 percent over the length of the pipe

49-2.02B(1)(d) Markings

Except for steel pipe piles marked with the API monogram, mark each length of the steel pipe pile as follows:

1. Name and location of the piling manufacturer
2. State Contract number, for Class N only
3. Heat number
4. Welding process
5. Outer diameter, nominal wall thickness, minimum wall thickness, and length

6. Year piling was produced
7. Markings specified for each class of steel pipe piling

Only Department authorized audited facilities are authorized to mark piling for use on a Contract.

49-2.02B(1)(e) Substitutions

Reserved

49-2.02B(2) Class N Steel Pipe Piling

Section 49-2.02B(2) applies to steel pipe piles specified as Class N in the special provisions.

Class N steel pipe piles must comply with one of the following:

1. API 5L, minimum Grade X52, PSL1, and must be:
   1.1. Manufactured, welded, tested, and inspected at a plant licensed to apply the API monogram
   1.2. Marked with the API monogram on each length of steel pipe
2. ASTM A252, Grade 3, and the following:
   2.1. Welding must comply with AWS D1.1.
   2.2. Groove welds using submerged arc welding from both sides without backgouging require a procedure qualification record witnessed by the Engineer.
   2.3. At the start of fabrication and for each thickness of the piling, furnish 3 macroetch cross-section test specimens prepared under clause 4.9.4 of AWS D1.1. Remove specimens at locations selected by the Engineer and in the presence of the Engineer. Test specimens must indicate that the weld is free of cracks and has thorough fusion between adjacent layers of weld metal and between weld metal and base metal. Undercut must not exceed 1/32 inch.
   2.4. Weighing of individual pipe is not required as specified in ASTM A252.
   2.5. Each length of pipe must be marked *Caltrans Class N - A252*.

49-2.02B(3) Class R Steel Pipe Piling

Section 49-2.02B(3) applies to Class R steel pipe piles.

Class R steel pipe piles must comply with one of the following:

1. API 5L, minimum Grade X52, PSL1, and must be:
   1.1. Manufactured, welded, tested, and inspected at a plant licensed to apply the API monogram, except hydrostatic testing, flattening tests, and the API monogram are not required
   1.2. Marked *Caltrans Class R - API* on each length of steel pipe
2. ASTM A252, Grade 3, and the following:
   2.1. Arc welding processes must comply with AWS D1.1
   2.2. Groove welds using submerged arc welding from both sides without backgouging require a procedure qualification record witnessed by the Engineer
   2.3. Underfill is not allowed
   2.4. For electric resistance welded pipe, remove the outer diameter flash to a maximum of 1/32 inch
   2.5. Weld reinforcement must not exceed 1/8 inch
   2.6. Weighing of individual pipe is not required as specified in ASTM A252
   2.7. Each length of pipe must be marked *Caltrans Class R - A 252*

49-2.02C Construction

49-2.02C(1) General

You may retap steel pipe piles to prevent pile set-up if the field welded splice remains at least 3 feet above the work platform until the splice has been authorized.

When attaching handling devices to steel pipe piles, align the welds parallel to the axis of the pile. Welds must comply with the specifications for attaching backing rings in section 49-2.02B(1)(b). Permanent bolted connections must be corrosion resistant.

49-2.02C(2) Field Welds

Field welds must comply with section 49-2.02B(1)(b).

Field welds made in the horizontal position where the longitudinal pipe axis is vertical must be single-bevel groove welds.

Do not water quench field welds. Allow welds to cool unassisted to ambient temperature.

Remove ends of steel pipe piles to be spliced that have been damaged during driving to a sound and uniform section. Pipe ends must comply with the tolerances for diameter, edge alignment, and roundness in section 49-2.02B. Pipe ends must be field cut using automated guided cutting equipment. Do not use manual flame cutting.

49-2.02D Payment

Not Used

49-2.03 STRUCTURAL SHAPE STEEL PILING

49-2.03A General

49-2.03A(1) Summary

Section 49-2.03 includes specifications for installing structural shape steel piling.

49-2.03A(2) Definitions

Reserved

49-2.03A(3) Submittals

Submit a certified material test report and a certificate of compliance that includes a statement that the materials and workmanship comply with the Contract and the required tests and inspections have been performed as described.

49-2.03A(4) Quality Assurance

Reserved

49-2.03B Materials

Structural shape steel piles must comply with ASTM A36/A36M, ASTM A572/A572M, ASTM A709/A709M, or ASTM A992/A992M.

Splices must be CJP groove welds complying with AWS D1.1.

49-2.03C Construction

Field splices must be CJP groove welds complying with AWS D1.1.

49-2.03D Payment

Not Used

49-2.04 PRECAST PRESTRESSED CONCRETE PILING

49-2.04A General

49-2.04A(1) Summary

Section 49-2.04 includes specifications for constructing PC PS concrete piles.

PC PS concrete piles must comply with sections 50, 51, and 52.

49-2.04A(2) Definitions

Reserved

49-2.04A(3) Submittals

If requested, submit 2 copies of shop drawings for PC PS concrete piles for use during construction. Include the following details in the shop drawings:

1. Pile dimensions
2. Material type
3. Prestressing methods
4. Tendon arrangement and working stresses
5. Any addition or rearrangement of reinforcement from that shown

Section 50-1.01C(3) does not apply to prestressing systems used for PC PS concrete piles.

Authorization of the shop drawings is not required.

49-2.04A(4) Quality Assurance

The Department inspects PC PS concrete piles at the fabrication site. Notify the Department at least 10 days before fabricating any piles. Materials to be used must be available to the Department for testing.

49-2.04B Materials

49-2.04B(1) General

Threaded inserts and other fittings must comply with section 75-3.

49-2.04B(2) Fabrication

Place concrete for PC PS concrete piles in smooth, mortar-tight forms. Support the forms to prevent appreciable deformation or settlement during placing or curing.

Finish unformed surfaces to a smooth surface.

Piles in a corrosive environment must be steam or water cured under section 90-4.03.

If piles in a corrosive environment are steam cured, do one of the following:

1. Keep the piles continuously wet for at least 3 days. The 3 days includes the holding and steam curing periods.
2. Apply curing compound under section 90-1.03B(3) immediately after steam curing.

If piles to be placed in a corrosive environment are water cured, the piles must be kept continuously wet by the application of water as specified in section 90-1.03B(2).

When removed from the form, the pile must:

1. Have true, smooth, even surfaces, free from honeycombs and voids
2. Be straight such that a line stretched from butt to tip on any pile face is not more than 1 inch from the face of the pile at any point

Except for PC PS concrete piles to be placed in a corrosive environment, remove lifting anchors and fill holes under section 51-1.03F(2).

For PC PS concrete piles to be placed in a corrosive environment, remove lifting anchors to a depth of at least 1 inch below the concrete surface. Fill holes with epoxy adhesive before delivering piles to the job site. The epoxy adhesive must comply with section 95-1.02C.

If using pile anchor dowels, anchor the dowels in cast or drilled holes in the concrete pile with neat cement paste. The diameter of the holes must be the minimum consistent with placing the neat cement paste and dowel.

Use methods for drilling holes that do not damage the concrete, reinforcement, or prestressing steel.

The drilled hole must be free of dust and other deleterious material when placing the neat cement paste. Neat cement paste and dowel must completely fill the drilled hole. The dowels must be left undisturbed until the paste has hardened.

49-2.04B(3) Substitutions

Reserved

49-2.04C Construction

49-2.04C(1) General

PC PS concrete piles must not be driven until at least 14 days after casting.

49-2.04C(2) Handling

When handling or transporting PC PS concrete piles, provide slings or other equipment to avoid bending the pile or cracking the concrete. Replace piles materially damaged in handling or during driving.

49-2.04C(3) Splicing Precast Prestressed Concrete Piles

Reserved

49-2.04D Payment

Not Used

49-2.05 STEEL SHEET PILING

49-2.05A General

Section 49-2.05 includes specifications for installing permanent steel sheet piles.

49-2.05B Materials

Steel sheet piles must be interlocking steel sheet complying with ASTM A328/A328M.

The minimum section modulus per linear foot of wall must be the section modulus shown.

You may install used sheet piles if the piles are in good condition and no alterations have been made to reduce the section modulus. Interlocks must be straight, true, and have no gouges or kinks.

Furnish piles in lengths measured from the specified tip elevation shown to the cutoff elevation. Splices in steel sheet piles must be CJP welds complying with AWS D1.1.

49-2.05C Construction

Drive steel sheet piles to the specified tip elevation shown. Remove and redrive or replace piles that are materially out of line.

49-2.05D Payment

Not Used

49-3 CAST-IN-PLACE CONCRETE PILING

49-3.01 GENERAL

49-3.01A General

Section 49-3.01 includes general specifications for constructing CIP concrete piles.

CIP concrete piles include:

1. CIDH concrete piles
2. CIDH concrete pile rock sockets
3. CISS concrete piles

Concrete must comply with section 51.

Bar reinforcing steel must comply with section 52.

49-3.01B Materials

49-3.01B(1) General

Unless otherwise shown, concrete must have a minimum 28-day compressive strength of 3,600 psi.

Prequalify the concrete under section 90-1.01D(5)(b).

The combined aggregate gradation must comply with the 1-inch, 1/2-inch, or 3/8-inch maximum gradation specified in section 90-1.02C(4).

49-3.01B(2) Mass Concrete

Section 49-3.01B(2) applies to CIP concrete piles with a diameter greater than 8 feet.

The quantity of cementitious material must comply with the values shown in the following table:

Pile diameter (D) (feet)	Maximum quantity of cementitious material (lb/cu yd)
8 < D ≤ 10	750
10 < D ≤ 14	720

Cementitious material must comply with section 90-1.02B(3), except at least 25 percent of the total cementitious material must be fly ash.

For piles with a diameter greater than 14 feet, concrete must comply with the specifications for mass concrete in section 51-6.

49-3.01C Construction

Except for CIDH concrete piles constructed under slurry, construct CIP concrete piles such that the excavation methods and the concrete placement procedures provide for placing the concrete against undisturbed material, casing, or steel shell in a dry or dewatered hole.

Place and secure reinforcement. Securely block the reinforcement to provide the minimum clearance shown between the reinforcing steel cage and the sides of the drilled hole, casing, or steel shell.

Steel shells, casings, and drilled holes must be clean and free of debris before reinforcement and concrete are placed.

Provide a suitable light to the Engineer for inspecting the entire length of the steel shell or drilled hole before placing reinforcement and concrete.

The methods used to place the concrete must prevent segregation.

Concrete must not be allowed to fall from a height greater than 8 feet without the use of adjustable length pipes or tubes unless the flow of concrete is directed into the center of the hole and the concrete is not allowed to strike the reinforcement, reinforcement bracing, and other objects in the hole.

Vibrate concrete in the upper 15 feet of CIP concrete piles.

After placing concrete, cure the temporarily exposed surfaces of the CIP concrete piles under section 51-1.03H.

49-3.01D Payment

Bar reinforcing steel is not included in the payment for CIP concrete piling unless the CIP concrete piling is less than 24 inches in diameter or for overhead sign structures, standards, and poles.

49-3.02 CAST-IN-DRILLED-HOLE CONCRETE PILING

49-3.02A General

49-3.02A(1) Summary

Section 49-3.02 includes specifications for constructing CIDH concrete piles and CIDH concrete pile rock sockets.

Permanent steel casing and driven steel shell must comply with section 49-2.02.

49-3.02A(2) Definitions

dry hole: A drilled hole that requires no work to keep it free of water.

dewatered hole: A drilled hole that:

1. Accumulates no more than 12 inches of water at the bottom during a 1 hour period without any pumping from the hole.
2. Has no more than 3 inches of water at the bottom immediately before placing concrete.
3. Does not require temporary casing to control the groundwater.

49-3.02A(3) Submittals

49-3.02A(3)(a) General

Reserved

49-3.02A(3)(b) Pile Installation Plan

Submit a pile installation plan. Include complete descriptions, details, and supporting calculations for:

1. Concrete mix design, certified test data, and trial batch reports
2. Drilling or coring methods and equipment
3. Proposed method for casing installation and removal, if necessary
4. Methods for placing, positioning, and supporting bar reinforcement
5. Methods and equipment for determining:
   5.1. Depth of concrete
   5.2. Theoretical volume of concrete to be placed, including the effects on volume if casings are withdrawn
   5.3. Actual volume of concrete placed
6. Methods and equipment for verifying the bottom of the drilled hole is clean before placing concrete
7. Methods and equipment for preventing upward movement of reinforcement, including the means of detecting and measuring upward movement during concrete placement operations
8. Drilling plan and sequence
9. Concrete sequence and placement plan
10. If inspection pipes are required, methods for ensuring the inspection pipes remain straight, undamaged, and properly aligned during concrete placement

For concrete placed under slurry, include complete descriptions, details, and supporting calculations in the pile installation plan for:

1. Concrete batching, delivery, and placing systems, including time schedules and capacities. Time schedules must include the time required for each concrete placing operation at each pile.
2. Concrete placing rate calculations. If requested, base calculations on the initial pump pressures or static head on the concrete and losses throughout the placing system, including anticipated head of slurry and concrete to be displaced.
3. Suppliers' test reports on the physical and chemical properties of the slurry and any proposed slurry chemical additives, including SDSs.
4. Slurry testing equipment and procedures.
5. Methods of removal and disposal of excavation, slurry, and contaminated concrete, including removal rates.
6. Methods and equipment for slurry agitating, recirculating, and cleaning.

49-3.02A(3)(c) Inspection Pipe and Reinforcing Cage Coupler Log

If inspection pipes are required, submit a log of the locations of inspection pipe couplers and pile reinforcing cage couplers as an informational submittal within 2 business days of completion of concrete placement in the hole.

49-3.02A(3)(d) Concrete Placement Log

Submit the concrete placement log as an informational submittal within 2 business days of completion of concrete placement in the hole.

The log must:

1. Show the pile location, tip elevation, cutoff elevation, dates of excavation and concrete placement, total quantity of concrete placed, length and tip elevation of any casing, and details of any hole stabilization method and materials used.
2. Include an 8-1/2 by 11 inch graph of concrete placed versus depth of hole filled as follows:
   2.1. Plot the graph continuously throughout concrete placement. Plot the depth of drilled hole filled vertically with the pile tip at the bottom and the quantity of concrete placed horizontally.
   2.2. Take readings at each 5 feet of pile depth, and indicate the time of the reading on the graph.

49-3.02A(3)(e) Coring Logs and Concrete Cores

If coring is performed under section 49-3.02C(5), submit coring logs and concrete cores. Allow 10 days for the review.

49-3.02A(3)(f) Testing Report

If you perform testing on a rejected pile, submit this additional information in a report. The report must be sealed and signed by an engineer who is registered as a civil engineer in the State. Allow 10 days for the review and analysis of this report.

49-3.02A(3)(g) Mitigation Plans

For each rejected pile to be mitigated, submit a mitigation plan for repair, supplementation, or replacement. The mitigation plan must:

1. Comply with the specifications for shop drawings.
2. Be sealed and signed by an engineer who is registered as a civil engineer in the State. This requirement is waived for either of the following conditions:
   2.1. Proposed mitigation will be performed under the current Department-published version of *ADSC Standard Mitigation Plan 'A' - Basic Repair* without exception or modification.
   2.2. Engineer determines that the rejected pile does not require mitigation due to structural, geotechnical, or corrosion concerns, and you elect to repair the pile using the current Department-published version of *ADSC Standard Mitigation Plan 'B' - Grouting Repair* without exception or modification.

Pile mitigation plans must include:

1. Designation and location of the rejected pile.
2. Review of the structural, geotechnical, and corrosion design requirements of the rejected pile.
3. Step by step description of the mitigation work to be performed, including drawings if necessary. If the *ADSC Standard Mitigation Plan* is an acceptable mitigation method, include the most recent version. For the most recent version of the *ADSC Standard Mitigation Plan*, go to:
   http://www.dot.ca.gov/hq/esc/geotech/ft/adscmitplan.htm
4. Assessment of how the proposed mitigation work addresses the structural, geotechnical, and corrosion design requirements of the rejected pile.
5. Methods for preservation or restoration of existing earthen materials.
6. List of any affected facilities. Include methods and equipment to be used for the protection of these facilities during mitigation.
7. Your name and the names of any subcontractors on each sheet.
8. List of materials with quantity estimates for the mitigation work and a list of personnel with their qualifications who will be performing the mitigation work.

For rejected piles to be repaired, include the following in the pile mitigation plan:

1. Assessment of the nature and size of the anomalies in the rejected pile
2. Provisions for access for additional pile testing, if requested

For rejected piles to be replaced or supplemented, include the following in the pile mitigation plan:

1. Proposed location and size of additional piles
2. Structural details and calculations for any modification to the structure to accommodate the replacement or supplemental piles

Replacement piles must comply with the Contract for CIDH concrete piles.

49-3.02A(3)(h) Mitigation Report

If repairs are performed, submit a mitigation report as an informational submittal within 10 days of completion of the repair. The report must state exactly what repair work was performed and quantify the success of the repairs relative to the submitted mitigation plan. The mitigation report must be sealed and signed by an engineer who is registered as a civil engineer in the State. The mitigation report must include your name and the names of any subcontractors on each sheet.

49-3.02A(3)(i) Plastic Spacer Manufacturer's Data and Sample

If plastic spacers are proposed for use, submit the manufacturer's data and a sample of the plastic spacer. Allow 10 days for the review.

49-3.02A(3)(j) Certifications

If synthetic slurry is used, submit as an informational submittal the names and certifications of your employees who are trained and certified by the synthetic slurry manufacturer.

49-3.02A(3)(k) Slurry Test Record

If slurry is used, submit a slurry test record as an informational submittal within 2 business days of completion of concrete placement in the hole.

49-3.02A(4) Quality Assurance

49-3.02A(4)(a) General

Reserved

49-3.02A(4)(b) Preconstruction Meeting

Schedule and hold a preconstruction meeting for CIDH concrete pile construction (1) at least 5 business days after submitting the pile installation plan and (2) at least 10 days before the start of CIDH concrete pile construction. You must provide a meeting facility.

The meeting must include the Engineer, your representatives, and any subcontractors involved in CIDH concrete pile construction.

The purpose of this meeting is to:

1. Establish contacts and communication protocol between you and your representatives, any subcontractors, and the Engineer
2. Review the construction process, acceptance testing, and anomaly mitigation of CIDH concrete piles

The Engineer conducts the meeting. Be prepared to discuss:

1. Pile placement plan, dry and wet
2. Acceptance testing, including gamma-gamma logging, cross-hole sonic logging, and coring
3. Pile Design Data Form
4. Mitigation process
5. Timeline and critical path activities
6. Structural, geotechnical, and corrosion design requirements
7. Future meetings, if necessary, for pile mitigation and pile mitigation plan review
8. Safety requirements, including Cal/OSHA and Tunnel Safety Orders

49-3.02A(4)(c) Quality Control

Section 49-3.02A(4)(c) applies if concrete is placed under slurry.

Before placing concrete under slurry, produce a concrete test batch and transport it to the job site under the same conditions and in the same time frame anticipated during the placement of concrete in the piles.

At the job site, place the test batch concrete in an excavated hole lined with plastic or suitable container to allow for testing. Placing concrete under slurry is not required. The test batch must demonstrate that the proposed mix design will achieve the minimum required slump after the specified set period.

Do not vibrate or agitate the concrete during the set period.

The Engineer tests the concrete for slump under California Test 556. In addition to meeting the specified nominal slump, the slump of the concrete must comply with the requirements shown in the following table:

Slump Requirements

Time required to place concrete[a], T (hours)	Minimum set period before testing[b] (hours)	Slump, after set period (inches)
T ≤ 2	2T	≥ 7
T > 2	T + 2	≥ 7

[a]As described in the pile installation plan
[b]The set period starts at the start of concrete placement.

After testing, dispose of the concrete test batch.

49-3.02A(4)(d) Department Acceptance

49-3.02A(4)(d)(i) General

Section 49-3.02A(4)(d) applies to CIDH concrete piles except for piles (1) less than 24 inches in diameter or (2) constructed in dry or dewatered holes.

The Department performs acceptance testing using GGL to test the concrete density of the pile for homogeneity.

After notification by the Engineer of pile acceptance, fill the inspection pipes and cored holes with grout. Grout must comply with section 50-1.02C. Fill inspection pipes and holes using grout tubes that extend to the bottom of the pipe or hole or into the grout already placed.

49-3.02A(4)(d)(ii) Gamma-Gamma Logging

The Department performs GGL under California Test 233.

Separate reinforcing steel as necessary to allow the Department access to the inspection pipes.

After requesting testing and providing access to the piles, allow 15 days for the Department to perform the testing and to prepare and provide the pile acceptance test report.

During testing, do not perform construction activities within 25 feet of any GGL operation.

If the Department determines a pile is anomalous under California Test 233, part 5C, the pile is rejected.

49-3.02A(4)(d)(iii) Rejected Piles

If a pile is rejected:

1. Suspend concrete placement in the remaining piles
2. Submit a revised pile installation plan
3. Do not resume concrete placement until the revised pile installation plan is authorized

Allow 30 days for the Department to determine whether the rejected pile requires mitigation and to provide this information to you. Day 1 of the 30 days is the 1st day after access has been provided to the Department to perform acceptance testing.

The Department may perform CSL to determine the extent of the anomalies identified by GGL and to further evaluate a rejected pile for the presence of anomalies not identified by GGL. The pile acceptance test report will indicate if the Department intends to perform CSL and when the testing will be performed. Allow the Department 20 additional days for a total of 50 days to perform CSL and to provide supplemental results.

If authorized, you may perform testing on the rejected pile.

The Department determines whether the rejected pile requires mitigation due to structural, geotechnical, or corrosion concerns. The Department considers the estimated size and location of the anomaly and potential effects on the design. The Department provides you with the conclusions of this analysis for developing the mitigation plan.

If a rejected pile does not require mitigation, you may repair the pile under an authorized mitigation plan or the amount shown in the table will be deducted for each anomaly up to the maximum total deduction:

Anomaly location	Anomaly deduction ($)		
	D < 4 feet	4 ≤ D < 6	D ≥ 6
Entirely or partially within the upper 2/3 of the pile length	1,000	2,000	4,000
Entirely within the lower 1/3 of the pile length	500	1,000	2,000
Maximum total deduction	2,000	4,000	8,000

Note:
D = Nominal pile diameter

If a rejected pile requires mitigation or you elect to repair a rejected pile that does not require mitigation, submit a mitigation plan for the repair, supplementation, or replacement of the rejected pile.

If the Engineer determines it is not feasible to use one of ADSC's standard mitigation plans to mitigate the pile, schedule a meeting and meet with the Engineer before submitting a nonstandard mitigation plan.

The meeting attendees must include your representatives and the Engineer's representatives involved in the pile mitigation. The purpose of the meeting is to discuss the type of pile mitigation acceptable to the Department.

Provide the meeting facility. The Engineer conducts the meeting.

If the Engineer determines it is not feasible to repair the rejected pile, submit a mitigation plan for replacement or supplementation of the rejected pile.

49-3.02A(4)(e) Certifications

If synthetic slurry is used, your employees who will be providing technical assistance in the slurry activities must be trained and certified by the synthetic slurry manufacturer to show their competency to perform inspection of slurry operations.

49-3.02B Materials

49-3.02B(1) General

Reserved

49-3.02B(2) Concrete

Concrete placed under slurry must:

1. Have a nominal slump equal to or greater than 7 inches. The nominal and maximum slump and penetration specifications in section 90-1.02G(6) do not apply to concrete placed under slurry.
2. Contain at least 675 pounds of cementitious material per cubic yard and be proportioned to prevent excessive bleed water and segregation.

In a freeze-thaw area, the formed portion of CIDH concrete piles must contain at least 675 pounds of cementitious material per cubic yard.

49-3.02B(3) Aggregate Gradation

For concrete placed under slurry, the combined aggregate gradation must comply with the 1/2-inch maximum gradation or the 3/8-inch maximum gradation specified in section 90-1.02C(4).

49-3.02B(4) Reserved

49-3.02B(5) Grout

Grout must consist of cementitious material and water and may contain an admixture if authorized. Do not exceed 5 gallons of water per 94 lb of cement.

Cementitious material must comply with section 90-1.02B, except SCMs are not required.

Water must comply with section 90-1.02D. If municipally supplied potable water is used, the testing specified in section 90-1.02D is waived.

Admixtures must comply with section 90, except admixtures must not contain chloride ions in excess of 0.25 percent by weight.

Grout used to backfill casings must comply with the following:

1. Aggregate must be used to extend the grout.
2. Aggregate must consist of at least 70 percent fine aggregate and approximately 30 percent pea gravel, by weight.
3. Fine aggregate must comply with section 90-1.02C(3).
4. Size of pea gravel must be such that 100 percent passes the 1/2-inch sieve, at least 85 percent passes the 3/8-inch sieve, and not more than 5 percent passes the no. 8 sieve.
5. Grout must contain at least 845 pounds of cementitious material per cubic yard.

Mix the grout as follows:

1. Add water to the mixer followed by cementitious material, aggregates, and any admixtures.
2. Mix the grout with mechanical mixing equipment that produces a uniform and thoroughly mixed grout.
3. Agitate the grout continuously until the grout is pumped.
4. Do not add water after initial mixing.

49-3.02B(6) Slurry

49-3.02B(6)(a) General

Reserved

49-3.02B(6)(b) Mineral Slurry

Mineral slurry must be mixed and thoroughly hydrated in slurry tanks. Sample and test slurry from the slurry tanks before placement in the drilled hole.

Recirculate or continuously agitate slurry in the drilled hole.

For recirculated slurry:

1. Remove drill cuttings from the slurry before discharging the slurry back into the drilled hole.
2. Sample and test slurry at least every 2 hours after starting its use until tests show that the samples taken from the slurry tank and from within 2 feet of the bottom of the hole have consistent specified properties. Once consistent properties have been achieved, sample slurry at least every 4 hours as long as the specified properties remain consistent.

For nonrecirculated slurry:

1. Sample and test slurry from the drilled hole at least every 2 hours after starting its use. Sample the slurry at mid-height and near the bottom of the hole.
2. Recirculate slurry if tests show samples taken from mid-height and within 2 feet of the bottom of the hole do not have consistent specified properties.

Sample and test slurry before final cleaning of the bottom of the hole and again just before placing concrete. Sample the slurry at mid-height and within 2 feet of the bottom of the hole. Do not start cleaning the bottom of the hole or placing the concrete until tests show that the samples have consistent specified properties.

Mineral slurry must comply with the requirements shown in the following table:

Mineral Slurry Requirements[a]

Quality characteristic	Test method	Requirement
Density Before placement in the drilled hole and during drilling (pcf) Before final cleaning and immediately before placing concrete (pcf)	Mud weight (density), API RP 13B-1 section 4	64.3–69.1[b] 64.3–75.0[b]
Viscosity Bentonite (sec/qt) Attapulgite (sec/qt)	Marsh funnel and cup. API RP 13B-1, section 6.2	28–50 28–40
pH	Glass electrode pH meter or pH paper	8–10.5
Sand content Before final cleaning and immediately before placing concrete (%)	Sand, API RP 13B-1, section 9	≤ 4.0

[a]Slurry temperature must be at least 40 °F when tested.
[b]If authorized, you may use slurry in salt water. The allowable density of slurry in salt water may be increased up to 2 pcf.

49-3.02B(6)(c) Synthetic Slurry

Synthetic slurry material and quality characteristic requirements are specified in the special provisions.

Do not use synthetic slurries in holes drilled in primarily soft or very soft cohesive soils as determined by the Engineer.

Sample and test synthetic slurries:

1. When the slurry temperature is at least 40 degrees F.
2. At mid-height and within 2 feet of the bottom of the hole.
3. During drilling to verify the slurry properties.
4. When drilling is complete but before final cleaning of the bottom of the hole. When samples comply with the requirements shown in the tables for the slurry material selected, clean the bottom of the hole of any loose or settled material.
5. After final cleaning and immediately before placing concrete.

49-3.02B(6)(d) Water Slurry

Reserved

49-3.02B(7) Reserved

49-3.02B(8) Spacers

Spacers must comply with section 52-1.03D, except you may use plastic spacers.

Plastic spacers must:

1. Comply with sections 3.4 and 3.5 of the Concrete Reinforcing Steel Institute's Manual of Standard Practice
2. Have at least 25 percent of their gross plane area perforated to compensate for the difference in the coefficient of thermal expansion between the plastic and concrete
3. Be of commercial quality

49-3.02B(9) Inspection Pipes

Inspection pipes must be schedule 40 PVC pipe complying with ASTM D1785 with a nominal pipe size of 2 inches.

Watertight PVC couplers complying with ASTM D2466 are allowed to facilitate pipe lengths in excess of those commercially available.

49-3.02B(10) Reserved

49-3.02C Construction

49-3.02C(1) General

Unless otherwise authorized, drilling the hole and placing reinforcement and concrete in the hole must be performed in a continuous operation.

Except for CIDH concrete piles for sound walls and retaining walls, you may propose to increase the diameter and revise the pile tip elevation of CIDH concrete piles with a diameter less than 2 feet.

For CIDH concrete piles for sound walls and retaining walls, you may propose to increase the diameter of CIDH concrete piles with a diameter less than 2 feet, except pile tip elevations must not be revised.

49-3.02C(2) Drilled Holes

The axis of the drilled hole must not deviate from plumb more than 1-1/2 inches per 10 feet of length.

For CIDH concrete piles with a pile cap, the horizontal tolerance at the center of each pile at pile cut-off is the larger of 1/24 of the pile diameter or 3 inches. The horizontal tolerance for the center-to-center spacing of 2 adjacent piles is the larger of 1/24 of the pile diameter or 3 inches.

During excavation, do not disturb the foundation material surrounding the pile. Equipment or methods used for excavating holes must not cause quick soil conditions or cause scouring or caving of the hole.

For rock sockets, equipment and drill methods must not result in softened materials on the borehole walls.

If slurry is used during excavation, maintain the slurry level at a height required to maintain a stable hole, but not less than 10 feet above the piezometric head.

After excavation has started, construct the pile expeditiously to prevent deterioration of the surrounding foundation material from air slaking or from the presence of water. Remove and dispose of deteriorated foundation material, including material that has softened, swollen, or degraded, from the sides and the bottom of the hole.

Just before placing reinforcement or concrete, clean the bottom of the hole to remove any loose sand, gravel, dirt, and drill cuttings.

If caving occurs or deteriorated foundation material accumulates on the bottom of the hole, clean the bottom of the hole after placing reinforcement and before placing concrete in the hole. You must verify that the bottom of the hole is clean.

Remove water that has infiltrated the dewatered hole before placing concrete, as required for dewatered hole. Do not allow fluvial or drainage water to enter the hole.

If authorized, to control caving or water seepage, you may enlarge portions of the hole, backfill the hole with slurry cement backfill, concrete, or other material, and redrill the hole to the diameter shown. Backfill material at enlarged piles must be chemically compatible with concrete and steel, be drillable, and have the necessary strength required for the conditions.

Dispose of material resulting from placing concrete.

49-3.02C(3) Temporary Steel Casings

Furnish temporary steel casings where shown and where necessary to control water or to prevent quick soil conditions or caving of the hole. Place temporary casings tight in the hole.

Section 11 does not apply to temporary steel casings.

Temporary casings must be:

1. Watertight and of sufficient strength to withstand the loads from installation, removal, lateral concrete pressures, and earth pressures
2. Noncorrugated with smooth surfaces
3. Clean and free of hardened concrete

Remove the temporary casing during concrete placement. Maintain the concrete in the casing at a level required to maintain a stable hole, but not less than 5 feet above the bottom of the casing, to prevent displacement of the concrete by material from outside the casing.

If slurry is not used, do not withdraw the temporary casing until the concrete head in the casing is greater than the groundwater head outside of the casing. Maintain this positive concrete head during withdrawal of the casing.

You may vibrate or hammer the temporary casing to (1) assist in removal of the casing from the hole, (2) prevent lifting of the reinforcement, and (3) prevent concrete contamination.

The withdrawal of casings must not leave voids or cause contamination of the concrete with soil or other materials.

49-3.02C(4) Reinforcement

Reinforcement for CIDH concrete piles with increased diameters and revised tip elevations must comply with the following:

1. Size and number of the reinforcing bars and hoops, the percentage of bars required to extend to the pile tip, and the size and pitch of spiral reinforcement must be the same as shown for the original piles.
2. Required length of the spiral reinforcement and of any reinforcing bars that do not extend to the pile tip must be at least the length that would have been required for the original specified or ordered tip elevation.
3. Diameter of the spiral or hoop reinforcement must remain the same as required for the original pile or may be increased to provide not less than the concrete cover required for the original pile. Provide positive means to ensure that the reinforcement is centered in the pile.

Unless otherwise shown, the bar reinforcing steel cage must have at least 3 inches of clear cover measured from the outside of the cage to the sides of the hole or casing.

Place spacers at least 5 inches clear from any inspection tubes.

Place plastic spacers around the circumference of the cage and at intervals along the length of the cage under the manufacturer's instructions.

For a single CIDH concrete pile supporting a column:

1. If the pile and the column share the same reinforcing cage diameter, this cage must be accurately placed as shown
2. If the pile reinforcing cage is larger in diameter than the column cage:
   2.1. Maintain a clear horizontal distance of at least 3.5 inches between the two cages, if the concrete is placed under dry conditions
   2.2. Maintain a clear horizontal distance of at least 5 inches between the two cages if the concrete is placed under slurry
   2.3. The offset between the centerlines of the two cages must not exceed 6 inches

49-3.02C(5) Vertical Inspection Pipes

For acceptance testing, install and test vertical inspection pipes as follows:

1. Log the location of the inspection pipe couplers and pile reinforcing cage couplers with respect to the plane of pile cutoff.
2. Cap each inspection pipe at the bottom. Extend the pipe from 3 feet above the pile cutoff to the bottom of the reinforcing cage. Provide a temporary top cap or similar means to keep the pipes clean before testing. If pile cutoff is below the ground surface or working platform, extend inspection pipes to 3 feet above the ground surface or working platform.
3. If any changes are made to the pile tip, extend the inspection pipes to the bottom of the reinforcing cage.
4. Install inspection pipes in a straight alignment and parallel to the main reinforcement. Securely fasten inspection pipes in place and provide protective measures to prevent misalignment or damage to the inspection pipes during installation of the reinforcement and placement of concrete in the hole.

Construct CIDH concrete piles such that the relative distance of inspection pipes to vertical steel reinforcement remains constant.

5. After concrete placement is complete, fill inspection pipes with water to prevent debonding of the pipe.
6. Provide safe access to the tops of the inspection pipes.
7. After placing concrete and before requesting acceptance testing, test each inspection pipe in the Engineer's presence by passing a rigid cylinder through the length of pipe. The rigid cylinder must:
   7.1. Be 1-1/4-inch diameter by 4.5-foot long.
   7.2. Weigh 12 pounds or less.
   7.3. Be able to freely pass down through the entire length of the pipe under its own weight and without the application of force.
8. When performing acceptance testing, inspection pipes must provide a 2-inch-diameter clear opening and be completely clean, unobstructed, and either dry or filled with water as authorized.
9. After acceptance testing is complete, completely fill the inspection pipes with water.

If the rigid cylinder fails to pass through the inspection pipe:

1. Completely fill the inspection pipes in the pile with water immediately.
2. Core a nominal 2-inch-diameter hole through the concrete for the entire length of the pile for each inspection pipe that does not pass the rigid cylinder. Coring must not damage the pile reinforcement.
3. Locate cored holes as close as possible to the inspection pipes they are replacing and no more than 5 inches clear from the reinforcement.

Core holes using a double wall core barrel system with a split tube type inner barrel. Coring with a solid type inner barrel is not allowed.

Coring methods and equipment must provide intact cores for the entire length of the pile.

Photograph and store concrete cores as specified for rock cores in section 49-1.01D(5).

The coring operation must be logged by an engineering geologist or civil engineer licensed in the State and experienced in core logging. Coring logs must comply with the Department's *Soil and Rock Logging, Classification, and Presentation Manual* for rock cores. Coring logs must include core recovery, rock quality designation of the concrete, locations of breaks, and complete descriptions of inclusions and voids encountered during coring.

The Department evaluates the portion of the pile represented by the cored hole based on the submitted coring logs and concrete cores. If the Department determines a pile is anomalous based on the coring logs and concrete cores, the pile is rejected.

49-3.02C(6) Permanent Steel Casing Installation

Section 49-2.01A(4)(c) and the 6th through 8th paragraphs of section 49-2.01C(5) do not apply to permanent steel casings.

For permanent steel casings placed in a drilled hole:

1. Casings must be watertight and of sufficient strength to prevent damage and to withstand the loads from installation, drilling and tooling equipment, lateral concrete pressures, and earth pressures.
2. Use spacers to center the casing inside the drilled hole. You may weld spacers to the outside of the casing.
3. Fill voids in the annular space between the casing and the soil with grout.
4. Place grout from the bottom of the casing using grout tubes. Place grout continuously until all voids have been filled and the grout reaches the top of the casing. Free fall of the grout from the top to the bottom of the casing is not allowed.
5. Pump grout into the annular space such that the grout head is maintained uniformly around the casing and no visible evidence of water or air is ejected at the top of the grout.
6. Place grout tubes along the circumference of the casing with a minimum of 4 grout tubes per casing. The spacing of the grout tubes must not exceed 4 feet.
7. Extend grout tubes to within 1 foot of the bottom of the casing.

If the Engineer lowers the permanent steel casing tip elevation:

1. CIDH concrete pile, including bar reinforcing steel and inspection pipes, must extend to that same elevation
2. Tip elevation of the rock socket must extend to maintain the length of the rock socket into rock as shown

The additional work involved in lowering the permanent steel casing tip elevation is change order work.

49-3.02C(7) Construction Joint

Section 49-3.02C(7) applies to CIDH concrete piles if a construction joint is shown.

If a permanent steel casing is not shown, you must furnish and install a permanent casing. The permanent casing must:

1. Be watertight and of sufficient strength to prevent damage and to withstand the loads from installation procedures, drilling and tooling equipment, lateral concrete pressures, and earth pressures.
2. Extend at least 5 feet below the construction joint. If placing casing into rock or a dry hole, the casing must extend at least 2 feet below the construction joint.
3. Not extend above the top of the drilled hole or final grade, whichever is lower.
4. Not increase the diameter of the CIDH concrete pile more than 2 feet.
5. Be installed by impact or vibratory hammers, oscillators, rotators, or by placing in a drilled hole. Casings placed in a drilled hole must comply with section 49-3.02C(6).

Section 49-2.01A(4)(c) and the 6th through 8th paragraphs of section 49-2.01C(5) do not apply to permanent casings specified in section 49-3.02C(7).

49-3.02C(8) Placing Concrete

Section 51-1.03D(3) does not apply to CIDH concrete piles.

You may construct CIDH concrete piles 24 inches in diameter or larger by excavating and depositing concrete under slurry.

Form, finish, and cure portions of CIDH concrete piles shown to be formed under section 51.

49-3.02C(9) Placing Concrete Under Slurry

49-3.02C(9)(a) General

Section 49-3.02C(9) applies if placing concrete under slurry.

If drill cuttings settle out of the slurry, clean the bottom of the drilled hole after placing reinforcement and before placing concrete in the drilled hole. Verify that the bottom of the drilled hole is clean.

Carefully place concrete in a compact, monolithic mass, using a method that prevents washing of the concrete. Do not vibrate the concrete.

Placing concrete must be a continuous operation lasting no longer than the time specified for each concrete placing operation at each pile in your pile installation plan.

The delivery tube system must consist of one of the following:

1. Tremie tube or tubes, each of which is at least 10 inches in diameter, fed by 1 or more concrete pumps
2. 1 or more concrete pump discharge tubes, each fed by a single concrete pump

The delivery tube system must consist of watertight tubes with sufficient rigidity to keep the tube ends always in the mass of concrete placed. If only 1 delivery tube is used to place the concrete, place the tube near the center of the hole. Multiple tubes must be uniformly spaced in the hole.

Internal bracing for the steel reinforcing cage must accommodate the delivery tube system. Do not use tremies for piles without space for a 10-inch-diameter tube.

During concrete placement, provide a fully operational standby concrete pump and slurry pump at the job site that is adequate to complete the work in the time specified in the pile installation plan.

Do not allow concrete to fall into the slurry during concrete placing operations. Cap the delivery tube with a watertight cap, or plug the tube above the slurry level with a good-quality, tight-fitting, moving plug that expels the slurry from the tube as the tube is charged with concrete. The cap or plug must be designed to release as the tube is charged.

Extend the pump discharge or tremie tube to the bottom of the hole before charging the tube with concrete. After charging the tube with concrete, induce the flow of concrete through the tube by slightly raising the discharge end.

During concrete placement:

1. Embed the tip of the delivery tube within 6 inches of the bottom of the hole until 10 feet of concrete has been placed. Maintain the embedment of the tip at least 10 feet below the top surface of the concrete.
2. Do not rapidly raise or lower the delivery tube.
3. Maintain the slurry level at a height required to maintain a stable hole, but not less than 10 feet above the piezometric head.

If the seal is lost or the delivery tube becomes plugged and must be removed:

1. Withdraw and clean the tube
2. Cap the tip of the tube to prevent slurry from entering
3. Restart the operation by pushing the capped tube 10 feet into the concrete and then reinitiating the flow of concrete

Maintain a log of concrete placement for each drilled hole.

If a temporary casing is used, maintain concrete placed under slurry at a level required to maintain a stable hole, but not less than 5 feet above the bottom of the casing. The withdrawal of the casing must not cause contamination of the concrete with slurry.

The equivalent hydrostatic pressure inside the casing must be greater than the hydrostatic pressure on the outside of the casing to prevent intrusion of water, slurry, or soil into the column of freshly placed concrete.

Remove scum, laitance, and slurry-contaminated concrete from the top of the pile.

Dispose of material resulting from using slurry.

49-3.02C(9)(b) Mineral Slurry

Remove any caked slurry on the sides or bottom of hole before placing reinforcement.

If concrete is not placed immediately after placing reinforcement, the reinforcement must be removed and cleaned of slurry, the sides of the drilled hole must be cleaned of caked slurry, and the reinforcement again placed in the hole for concrete placement.

49-3.02C(9)(c) Synthetic Slurry

A manufacturer's representative must:

1. Provide technical assistance for the use of their material
2. Be at the job site before introduction of the synthetic slurry into the drilled hole
3. Remain at the job site until released by the Engineer

After the manufacturer's representative has been released by the Engineer, your employee certified by the manufacturer must be present during the construction of the pile under slurry.

49-3.02D Payment

Not Used

49-3.03 CAST-IN-STEEL SHELL CONCRETE PILING

49-3.03A General

49-3.03A(1) Summary

Section 49-3.03 includes specifications for constructing CISS concrete piles consisting of driven open-ended or closed-ended steel shells filled with reinforcement and concrete.

Furnish piling includes:

1. Furnishing steel shells at the job site
2. Furnishing concrete
3. Furnishing reinforcement for piles with a diameter of less than 24 inches
4. Splicing steel shells

Driving piles includes:

1. Driving and cutting off the steel shells at the elevations shown
2. Furnishing special driving tips or heavier sections of steel shells
3. Drilling holes or predrilling holes through embankments
4. Cleaning out and disposing of material from open-ended steel shells
5. Placing seal course concrete in open-ended steel shells
6. Dewatering open-ended steel shells
7. Placing reinforcement and concrete
8. Disposing of material resulting from drilling holes, predrilling holes, or cleaning out open-ended steel shells

CISS concrete piles include Class 90 Alternative V and Class 140 Alternative V piles.

49-3.03A(2) Definitions

Reserved

49-3.03A(3) Submittals

Submit a cleanout method for open-ended steel shells as an informational submittal.

Submit a Pile and Driving Data Form under section 49-2.01A(3)(a) if specified in the special provisions.

49-3.03A(4) Quality Assurance

After the steel shell is driven and before placing reinforcement and concrete, the Engineer examines the steel shell for collapse or a reduced diameter at any point. The Engineer rejects any steel shell that is improperly driven, broken, or shows partial collapse to an extent as to materially decrease its nominal resistance.

49-3.03B Materials

Steel shells must comply with the specifications for steel pipe piles in section 49-2.02.

Steel shells must be sufficiently watertight to exclude water during concrete placement.

49-3.03C Construction

49-3.03C(1) General

Drive steel shells under section 49-2.

Remove and replace rejected steel shells, or drive a new shell adjacent to the rejected shell. Fill rejected shells that cannot be removed with concrete. If a new shell is driven to replace a rejected shell, enlarge the footing.

If the Engineer revises the pile tip elevation, the work involved in furnishing, splicing, and driving the additional length of pile is change order work.

49-3.03C(2) Open-Ended Steel Shells

Section 49-3.03C(2) applies to open-ended steel shells.

Internal plates must not be used.

After driving, clean out the steel shell as follows:

1. Do not disturb the foundation material surrounding the pile when cleaning out the steel shell.
2. Equipment or methods used must not cause quick soil conditions or cause scouring or caving around or below the pile.
3. Steel shells must be free of soil, rock, or other material deleterious to the bond between concrete and steel before placing reinforcement and concrete.
4. Bottom 8 feet of the pile must not be cleaned out.

After the steel shell has been cleaned out, construct the pile expeditiously to prevent deterioration of the surrounding foundation material from the presence of water. Remove deteriorated foundation materials from the bottom of the steel shell, including materials that have softened, swollen, or degraded.

Dispose of material resulting from cleaning out the steel shells.

If conditions render it impossible or inadvisable in the Engineer's opinion to dewater the steel shells before placing reinforcement and concrete, seal the bottom of the steel shell under section 51-1.03D(3). After sealing, dewater and clean out the steel shell.

49-3.03C(3) Close-Ended Steel Shells

Reserved.

49-3.03D Payment

Furnish piling is measured along the longest side of the pile from the specified tip elevation shown to the plane of pile cutoff.

49-4 STEEL SOLDIER PILING

49-4.01 GENERAL

Section 49-4 includes specifications for drilling holes and installing steel soldier piles in the holes.

Steel soldier piles must comply with section 49-2.03.

49-4.02 MATERIALS

Concrete anchors must comply with the specifications for studs in clause 7 of AWS D1.1.

49-4.03 CONSTRUCTION

49-4.03A General

Reserved

49-4.03B Drilled Holes

Drill holes for steel soldier piles into natural foundation material. Drilled holes must be accurately located, straight, and true.

Furnish and place temporary casings or tremie seals where necessary to control water or to prevent caving of the hole.

Before placing the steel soldier pile, remove loose materials existing at the bottom of the hole after drilling operations have been completed.

Do not allow surface water to enter the hole. Remove all water in the hole before placing concrete.

If temporary casings are used, they must comply with section 49-3.02C(3).

49-4.03C Steel Soldier Piles

Plumb and align the pile before placing concrete backfill and lean concrete backfill. The pile must be at least 2 inches clear of the sides of the hole for the full length of the hole to be filled with concrete backfill and lean concrete backfill. Ream or enlarge holes that do not provide the clearance around steel piles.

Maintain alignment of the pile in the hole while placing backfill material.

Clean and prepare piles in anticipated heat affected areas before splicing steel piles or welding concrete anchors.

49-4.04 PAYMENT

Not Used

49-5 MICROPILING

Reserved

49-6 ALTERNATIVE PILING

Reserved

49-7–49-10 RESERVED

50 PRESTRESSING CONCRETE

50-1 GENERAL

50-1.01 GENERAL

50-1.01A Summary

Section 50 includes specifications for prestressing concrete.

50-1.01B Definitions

Reserved

50-1.01C Submittals

50-1.01C(1) General

Submit test samples to METS. Notify the Engineer of each submittal. Include in the notification the date and contents of the submittal.

50-1.01C(2) Certifications

Submit the certifications specified in the following to METS:

1. ASTM A416/A416M for uncoated seven-wire steel strand
2. ASTM A722/A722M for uncoated HS-steel bars
3. ASTM A882/A882M for filled epoxy-coated seven-wire prestressing steel strand

Include with each certification:

1. Representative load-elongation curve for each size and grade of strand and for each size of bar
2. Copy of the QC tests performed by the manufacturer

50-1.01C(3) Shop Drawings

Submit shop drawings for the proposed prestressing system to OSD, Documents Unit. Notify the Engineer of the submittal. Include in the notification the date and list of contents of the submittal.

For initial review, submit:

1. 6 copies for railroad bridges unless the project includes a BNSF Railway underpass
2. 8 copies for railroad bridges if the project includes a BNSF Railway underpass
3. 4 copies for structures other than railroad bridges

After initial review, submit from 6 to 12 copies to OSD, Documents Unit, if requested.

The shop drawings must show complete details and substantiating calculations of the method and materials proposed for use in the prestressing activities, including the addition or rearrangement of reinforcing steel.

The details must outline the method and sequence of stressing and include:

1. Complete specifications and details of the prestressing steel and anchorage system.
2. Jacking stresses.
3. Type of ducts.
4. Proposed arrangement of the prestressing steel in the members.
5. Exact location of anchorage system components, ducts, and other related elements. Show duct location data, including elevations, at least every 1/8th point of the span for each span.
6. Elongation calculations.
7. All other data pertaining to the prestressing.

Each shop drawing submittal must consist of drawings for a single bridge or portion of a bridge. For multi-frame bridges, each frame must have a separate shop drawing submittal.

Allow the following time for review of the shop drawings:

1. 60 days for railroad bridges
2. 45 days for structures other than railroad bridges

For railroad bridges, comply with the requirements of the railroad company involved.

Include a grouting plan with your shop drawing submittal. If you propose an alternative prestressing system for a CIP PS box girder bridge, submit shop drawings, including all details and checked calculations.

50-1.01C(4) Alternative Prestressing Systems for Cast-In-Place Prestressed Box Girder Bridges

The details shown for CIP PS box girder bridges are based on a bonded full-length draped tendon prestressing system.You may submit a VECP for an alternative prestressing system using bonded partial-length tendons. The proposed system and associated details must comply with the following requirements:

1. Moment and shear resistances must be at least equal to those used for the design of the structure shown.
2. Concrete strength must be at least that shown.
3. Not less than 35 percent of the total prestressing force at any section must be provided by full-length draped tendons.
4. Anchorage blocks for partial-length tendons must be located such that the blocks will not interfere with the placement of the utility facilities shown or any future utilities to be placed through openings shown.
5. Any temporary prestressing tendons must be detensioned, and the temporary ducts must be filled with grout before completion of the work. Temporary tendons must be either removed or fully encased in grout before completion of the work.

At your request, the Department furnishes you with the demand moments and shears used in the design shown.

50-1.01C(5) Test Samples

Submit test samples for the materials to be used in the work as shown in the following table:

Material	Number of test samples	Test sample description
Uncoated strand[a]	1	4-foot-long sample from each reel or pack
Epoxy-coated strand:		
Uncoated strand[a]	1	4-foot-long sample of uncoated strand removed from each reel or pack before coating
Coated strand[a]	4	5-foot-long sample from each reel or pack of coated strand
Epoxy powder	1	8-ounce sample from each batch[b]
Epoxy patching material	1	8-ounce sample from each batch[b]
Bar[a]	1	7-foot-long sample of each size for each heat
Bar coupler[a]	1	Coupler from each lot of couplers with two 4-foot-long bars[c]
Anchorage assemblies[a]	1	Anchorage assembly from each lot of anchorage assemblies

[a]Randomly selected by the Engineer.
[b]Packaged in an airtight container and identified with the manufacturer's name and batch number.
[c]Submit coupler and bar samples assembled. The bars must be from the same bar heats to be used in the work.

Sampling must comply with the requirements of the ASTM to be used for testing the sample.

With each bar or strand test sample, include a certificate from the manufacturer stating the minimum guaranteed ultimate tensile strength of each sample.

Identify each test sample by location and Contract number with weatherproof markings.

Allow 45 days for the Department's testing.

Obtain the Department's authorization of the material before incorporating it into the work.

50-1.01C(6) Grouting Plan

The grouting plan must include:

1. Detailed grouting procedures
2. Type, quantity, and brand of materials to be used
3. Type of equipment to be used and provisions for backup equipment
4. Types and locations of grout inlets, outlets, and vents
5. Methods to clean ducts before grouting
6. Methods to control the rate of flow within ducts
7. Theoretical grout volume calculations for each duct
8. Duct repair procedures for an air pressure test failure
9. Mixing and pumping procedures
10. Direction of grouting
11. Sequence of use of inlets and outlets
12. Procedure for handling blockages
13. Forms for recording grouting information
14. Procedure for secondary grouting
15. Names of people who will perform grouting activities and their relevant experience and certifications

50-1.01C(7) Daily Grouting Report

Submit a daily grouting report for each day grouting is performed. Submit the report within 3 business days after grouting. The report must be signed by the technician supervising the grouting activity. The report must include:

1. Identification of each tendon
2. Date the grouting occurred
3. Time the grouting started and ended
4. Date of placing the prestressing steel in each duct
5. Date of stressing
6. Type of grout used
7. Injection end and applied grouting pressure
8. Actual and theoretical quantities of grout used to fill each duct
9. Ratio of actual to theoretical grout quantity
10. Records of air, grout, and structure surface temperatures during grouting
11. Summary of tests performed and the results
12. Names of personnel performing the grouting activity
13. Summary of problems encountered and corrective actions taken
14. Summary of void investigation and repairs made

50-1.01C(8) Post-tensioning Jack Calibration Chart

Submit the post-tensioning jack calibration plot.

50-1.01C(9) Pretensioning Jack Calibration Chart

For any pretensioning jack calibrated by an authorized laboratory, submit a certified calibration plot.

50-1.01D Quality Assurance

50-1.01D(1) General

For accurate identification, assign an individual lot number and tag each lot of the following items to be shipped to the job site or casting site:

1. Bars of each size from each heat
2. Strand from each reel or pack
3. Anchorage assemblies
4. Bar couplers

The Department rejects any unidentified prestressing steel, anchorage assemblies, or bar couplers received at the job site or casting site.

50-1.01D(2) Quality Control

50-1.01D(2)(a) General

Reserved

50-1.01D(2)(b) Equipment and Calibration

50-1.01D(2)(b)(i) General

Each jack body must be permanently marked with the ram area.

Each pressure gauge must be fully functional and have an accurately reading, clearly visible dial or display. The dial must be at least 6 inches in diameter and graduated in 100 psi increments or less.

Each load cell must be calibrated and have an indicator that can be used to determine the force in the prestressing steel.

The range of each load cell must be such that the lower 10 percent of the manufacturer's rated capacity is not used in determining the jacking force.

Each jack must be calibrated equipped with its gauges.

Mechanically calibrate the gauges with a dead weight tester or other authorized means before calibration of the jacking equipment.

50-1.01D(2)(b)(ii) Post-tensioning

Equip each hydraulic jack used to tension prestressing steel with 2 pressure gauges or 1 pressure gauge and a load cell. Only 1 pressure gauge must be connected to the jack during stressing.

Each jack used to tension prestressing steel permanently anchored at 25 percent or more of its specified minimum ultimate tensile strength must be calibrated by METS within 1 year of use and after each repair. You must:

1. Schedule the calibration of the jacking equipment with METS.
2. Verify that the jack and supporting systems are complete, with proper components, and are in good operating condition.
3. Provide labor, equipment, and material to (1) install and support the jacking and calibration equipment and (2) remove the equipment after the calibration is complete.
4. Plot the calibration results.

Each jack used to tension prestressing steel permanently anchored at less than 25 percent of its specified minimum ultimate tensile strength must be calibrated by an authorized laboratory within 180 days of use and after each repair.

50-1.01D(2)(b)(iii) Pretensioning

Each jack used to pretension prestressing steel must be calibrated, equipped with its gauges, by a laboratory on the Authorized Laboratories List to perform pretensioning calibrations within 1 year of use and after each repair.

Calibrate pretensioning jacks:

1. Under ASTM E4 using an authorized laboratory. Certification that the calibration is performed to ASTM accuracy is not required.
2. In the presence of the Engineer. Notify the Engineer at least 2 business days before calibrating the jack.
3. Using 3 test cycles. Average the forces from each test cycle at each increment.
4. To cover the load range used in the work.

Gauges for pretensioning jacks may:

1. Be electronic pressure indicators that display either:
   1.1. Pressure in 100 psi increments or less
   1.2. Load to 1 percent of the maximum sensor/indicator capacity or 2 percent of the maximum load applied, whichever is smaller

2. Have a dial less than 6 inches in diameter

Gauges displaying pressure must have been calibrated within 1 year of the jack calibration.

Each hydraulic jack used for pretensioning must be equipped with either 2 gauges or 1 gauge and a load cell or you must have a calibrated standby jack with its gauge present on site during stressing.

50-1.01D(2)(c) Pressure Testing Ducts

For post-tensioned concrete bridges, pressure test each duct with compressed air after stressing. To pressure test the ducts:

1. Seal all inlets, outlets, and grout caps.
2. Open all inlets and outlets on adjacent ducts.
3. Attach an air compressor to an inlet at 1 end of the duct. The attachment must include a valve that separates the duct from the air source.
4. Attach a pressure gauge to the inlet at the end of the duct.
5. Pressurize the duct to 50 psi.
6. Lock-off the air source.
7. Record the pressure loss after 1 minute.
8. Repair the leaks with authorized methods and retest if a pressure loss exceeds 25 psi.

Compressed air used to clear and test the ducts must be clean, dry, and free from oil or contaminants.

50-1.01D(2)(d) Duct Demonstrations for Post-Tensioned Members

Before placing forms for deck slabs of box girder bridges, demonstrate that any prestressing steel placed in the ducts is free and unbonded. If no prestressing steel is in the ducts, demonstrate that the ducts are unobstructed.

If prestressing steel is installed after the concrete is placed, demonstrate that the ducts are free of water and debris immediately before installing the steel.

Before post-tensioning any member, demonstrate that the prestressing steel is free and unbonded in the duct.

Demonstrations must be performed in the presence of the Engineer.

50-1.01D(2)(e) Void Investigation

In the presence of the Engineer, investigate the ducts for voids between 24 and 72 hours after grouting. As a minimum, inspect the inlet and outlet ports at the anchorages and at high points in the tendons for voids after removal of the inlet and outlet pipes. Completely fill any voids found with secondary grout.

50-1.01D(2)(f) Personnel Qualifications

Perform post-tensioning field activities, including grouting, under the direct supervision of a technician certified as a Level 2 Bonded PT Field Specialist through the Post-Tensioning Institute. Grouting activities may be performed under the direct supervision of a technician certified as a Grouting Technician through the American Segmental Bridge Institute.

Perform vacuum grouting under the direct supervision of a person who has been trained and has experience in the use of vacuum grouting equipment and procedures.

50-1.01D(3) Department Acceptance

The Department tests the prestressing steel test samples for compliance with section 50-1.02B.

The Department tests the efflux time of grout under California Test 541.

The Department may verify the prestressing force using the Department's load cells.

The Department determines the reduction of area of each test sample bar with the deformations removed. The deformations are removed by machining the bar no more than necessary to remove the deformations over a length of 12 inches.

If couplers are used to extend bars, the Department rejects the heat of bars and lot of couplers represented by the assembled unit test sample if the sample does not have a tensile strength of at least the manufacturer's minimum guaranteed ultimate tensile strength of the bars.

Prestressing steel that sustained physical damage is rejected.

Prestressing steel is rejected if surface rust either (1) cannot be removed by hand-cleaning with a fine steel wool pad or (2) leaves pits visible to the unaided eye after hand-cleaning.

If non-epoxy-coated prestressing steel is installed in the ducts of post-tensioned members after completion of concrete curing and if tensioning and grouting are completed within 10 days after the installation, then (1) rust that may form during this period is not cause for rejection of the steel and (2) the use of a corrosion inhibitor in the duct is not required after installation.

50-1.02 MATERIALS

50-1.02A General

Post-tensioning prestressing systems must be on the Authorized Material List for post-tensioning systems.

Organic zinc-rich primer must be on the Authorized Material List for organic zinc rich primer.

50-1.02B Prestressing Steel

Uncoated strand must comply with ASTM A416/A416M.

Epoxy-coated strand must comply with ASTM A882/A882M, grit impregnated coating, including annex A1.

Bars must comply with ASTM A722/A722M, Type II, including all supplementary requirements, except the maximum weight requirements do not apply. The reduction of area of bars with deformations removed must be at least 20 percent.

If couplers are used to extend bars:

1. Assembled units must have a tensile strength of at least the manufacturer's minimum guaranteed ultimate tensile strength of the bars
2. Location of couplers in the member must be authorized

Protect the prestressing steel against physical damage and rust or other results of corrosion at all times, from manufacture to grouting or encasing in concrete.

Package the prestressing steel in containers or shipping forms that protect the steel against physical damage and corrosion during shipping and storage. Except for epoxy-coated strand, a corrosion inhibitor that prevents rust or other results of corrosion must be (1) placed in the container or shipping form, (2) incorporated in a corrosion-inhibitor-carrier-type packaging material, or (3) applied directly to the steel if authorized.

Corrosion inhibitors must not have a deleterious effect on the steel, concrete, or bond strength of the steel to concrete.

Clearly mark each shipping container or form with:

1. Statement that the package contains prestressing steel
2. Type of corrosion inhibitor used
3. Date packaged

Immediately replace or restore any damaged container or shipping form to its original condition.

Do not store epoxy-coated strand within 1,000 feet of ocean or tidal water for more than 60 days.

Patching material for epoxy-coated strand must be:

1. Furnished by the manufacturer of the epoxy powder
2. Applied under the manufacturer's instructions

3. Compatible with the original epoxy powder material
4. Inert in concrete

50-1.02C Grout

Grout must consist of cement and water and may contain an admixture if authorized.

Cement must comply with section 90-1.02B(2).

Water must comply with section 90-1.02D.

Admixtures must comply with section 90-1.02E except admixtures must not contain chloride ions in excess of 0.25 percent by weight.

The efflux time of grout immediately after mixing must be at least 11 seconds. Determine the efflux time under California Test 541.

Secondary grout must:

1. Comply with ASTM C1107
2. Not have a deleterious effect on the steel, concrete, or bond strength of the steel to the concrete

50-1.02D Ducts

Ducts for prestressing steel must:

1. Be galvanized rigid ferrous metal.
2. Be fabricated with either welded or interlocked seams except galvanizing of the welded seams is not required.
3. Be mortar tight.
4. Have sufficient strength to maintain their correct alignment during placing of concrete.
5. Have positive metallic connections at joints between sections that do not result in angle changes at the joints.
6. Have waterproof tape at the connections.
7. Have bends that are not crimped or flattened.
8. Have ferrous metal or polyolefin transition couplings connecting the ducts to anchorage system components. Ferrous metal transition couplings need not be galvanized.
9. Have an inside cross-sectional area of at least 2.5 times the net area of the prestressing steel for multistrand tendons.
10. Have an inside diameter of at least 1/2 inch larger than the diameter of the bar.
11. Have an outside diameter not exceeding 50 percent of the girder web width.

Furnish all ducts or anchorage assemblies with pipes or other suitable connections for the injection of grout after prestressing.

50-1.02E Vents

Vent all ducts having a vertical duct profile change of 6 inches or more. Vents must:

1. Be at least 1/2-inch-diameter standard pipe or suitable plastic pipe.
2. Be connected to ducts using metallic or plastic structural fasteners. Plastic components must not react with the concrete or enhance corrosion of the prestressing steel and be free from water soluble chlorides.
3. Be mortar tight and taped as necessary.
4. Provide a means for injection of grout through the vents and for sealing the vents.

50-1.02F Permanent Grout Caps

Permanent grout caps for anchorage systems of post-tensioned tendons must:

1. Be glass-fiber-reinforced plastic with antioxidant additives. The environmental stress-cracking failure time must be at least 192 hours under ASTM D1693, condition C.
2. Completely cover and seal the wedge plate or anchorage head and all exposed metal parts of the anchorage against the bearing plate using neoprene O-ring seals.
3. Have a grout vent at the top of the cap.

4. Be bolted to the anchorage with stainless steel fasteners complying with ASTM F593. All fastener components must be alloy 316.
5. Be pressure rated at or above 150 psi.

50-1.02G Debonding Sheathing

Sheathing for debonding prestressing strand must:

1. Be split or un-split flexible polymer plastic tubing
2. Have a minimum wall thickness of 0.025 inch
3. Have an inside diameter exceeding the maximum outside diameter of the strand by 0.025 to 0.14 inch

Split sheathing must overlap at least 3/8 inch.

Waterproofing tape used to seal the ends of the sheathing must be flexible adhesive tape.

The sheathing and waterproof tape must not react with the concrete, coating, or steel.

50-1.02H Anchorage System

The anchorage system for post-tensioning must:

1. Be capable of holding the prestressing steel at a force producing a stress of at least 95 percent of the specified ultimate tensile strength of the steel
2. Permanently secure the ends of the prestressing steel
3. Be equipped with permanent grout caps

50-1.03 CONSTRUCTION

50-1.03A General

50-1.03A(1) General

If authorized, you may:

1. Apply a portion of the total prestressing force to a PC member before the member has obtained the concrete strength shown
2. Move the member after applying the portion of prestressing force

Except for epoxy-coated strand, prestressing steel installed in members before placing and curing of the concrete must be continuously protected against rust or other results of corrosion until grouted. Protect the steel by using a corrosion inhibitor placed in the ducts or applied to the steel in the duct.

After final fabrication of the strand, do not perform any electric welding on the prestressing steel. If electric welding is performed on or near members containing prestressing steel, attach the welding ground directly to the steel being welded.

50-1.03A(2) Epoxy-Coated Strand

Cover epoxy-coated strand with an opaque polyethylene sheeting or other suitable protective material to protect the strand from exposure to sunlight, salt spray, and weather. For stacked coils, drape the protective covering around the perimeter of the stack. The covering must be adequately secured and allow for air circulation around the strand to prevent condensation under the covering.

Cut epoxy-coated strand using an abrasive saw.

Patch all visible damage to the epoxy coating caused by shipping, job site or casting site handling, installation, or cutting of ends under ASTM A882/A882M.

50-1.03A(3) Ducts

Accurately place prestressing ducts. Securely fasten the ducts in place to prevent movement of the ducts during concrete placement.

After installation, cover the duct ends and vents to prevent water or debris from entering.

Support ducts vertically and horizontally during concrete placement at a maximum spacing of 4 feet.

If prestressing strand is installed using the push-through method, use guide caps at the front end of each strand to protect the duct from damage.

50-1.03A(4) Vents

Place vents at the following locations:

1. Anchorage areas at both ends of the tendon
2. Each high point
3. 4 feet upstream and downstream of each crest of a high point
4. Each change in the cross section of duct

50-1.03B Prestressing

50-1.03B(1) General

Tension the prestressing steel using hydraulic jacks. The force in the prestressing steel must be the value shown in the shop drawings.

After seating, the maximum tensile stress in the prestressing steel must not exceed 75 percent of the minimum ultimate tensile strength shown.

50-1.03B(2) Post-Tensioned Members

50-1.03B(2)(a) General

If requested, for verification of the force in the prestressing steel, furnish the resources necessary to install and support the Department's testing equipment at the prestressing steel location and to remove the equipment after the testing is complete.

Conduct the tensioning process such that the force being applied and the elongation of the prestressing steel can be measured at all times.

The maximum temporary tensile stress in the prestressing steel of post-tensioned members must not exceed 75 percent of the specified minimum ultimate tensile strength of the prestressing steel.

If steam curing is used for PC members, do not install prestressing steel for post-tensioning until the steam curing is completed.

Do not tension the prestressing steel of post-tensioned members until (1) at least 10 days after the last concrete has been placed in the member and (2) the concrete has attained the compressive strength described.

Distribute the prestressing force of post-tensioned bridge girders with an approximately equal quantity in each girder and place the force symmetrically about the centerline of the structure. In slabs, distribute the prestressing force uniformly across the slab.

Sequence the stressing of post-tensioned bridge girders such that no more than 1/2 of the prestressing force in any girder is applied before an equal force is applied in the adjacent girders. The maximum temporary force variation between girders must not exceed the prestressing force of the largest tendon used in all girders. Do not apply an eccentric force about the centerline of the structure that exceeds 1/6 of the total prestressing force at any time during the prestressing.

50-1.03B(2)(b) Losses

Reserved

50-1.03B(2)(c) Anchorages and Distribution

The ends of post-tensioned prestressing steel must be secured with a permanent type anchoring system.

You may omit steel distribution plates or assemblies if you use an anchorage device of a type that is sufficiently large and that is used in conjunction with a steel grillage embedded in the concrete that effectively distributes the compressive stresses to the concrete.

If loop tendon anchorages are used, enclose the anchorages in ducts for their entire length.

Where the end of a post-tensioned assembly is not to be covered by concrete, recess the anchorage system such that the ends of the prestressing steel and all parts of the anchorage system are at least 2

inches inside of the end surface of the members. After post-tensioning, fill the recesses with concrete and finish flush.

The concrete used to fill the recess must be the same as that used for the structure.

The load from the anchorage system must be effectively distributed to the concrete such that:

1. Concrete bearing stress directly underneath the plate or assembly does not exceed 3,300 psi
2. When the prestressing steel is tensioned to 95 percent of its specified ultimate tensile strength:
   2.1. Bending stress in the plate material or assembly material does not exceed the yield point of the material
   2.2. No visible distortion is evident in the anchorage plate

50-1.03B(2)(d) Bonding and Grouting

50-1.03B(2)(d)(i) General

Bond the post-tensioned prestressing steel to the concrete by completely filling the entire void space between the duct and the prestressing steel with grout.

Ducts, vents, and grout caps must be clean and free from water and deleterious materials that would impair bonding of the grout or interfere with grouting procedures. Compressed air used for cleaning must be clean, dry, and free from oil or contaminants.

Prevent the leakage of grout through the anchorage assembly by positive mechanical means.

Before starting daily grouting activities, drain the pump system to remove any water from the piping system.

Break down and thoroughly clean the pump and piping system after each grouting session.

After completing duct grouting activities:

1. Abrasive blast clean and expose the aggregate of concrete surfaces where concrete is to be placed to cover and encase the anchorage assemblies
2. Remove the ends of vents 1 inch below the roadway surface

50-1.03B(2)(d)(ii) Grouting Equipment

Grouting equipment must be:

1. Capable of grouting at a pressure of at least 100 psi
2. Equipped with a pressure gauge having a full-scale reading of not more than 300 psi
3. Able to continuously grout the longest tendon on the project in less than 20 minutes

Grout must pass through a screen with clear openings of 1/16 inch or less before entering the pump.

Fit grout injection pipes, ejection pipes, and vents with positive mechanical shutoff valves capable of withstanding the pumping pressures. If authorized, you may substitute mechanical valves with suitable alternatives after demonstrating their effectiveness.

Provide a standby grout mixer and pump.

50-1.03B(2)(d)(iii) Mixing and Proportioning

Proportion solids by weight to an accuracy of 2 percent.

Proportion liquids by weight or volume to an accuracy of 1 percent.

Mix the grout as follows:

1. Add water to the mixer followed by the other ingredients.
2. Mix the grout with mechanical mixing equipment that produces a uniform and thoroughly mixed grout without an excessive temperature increase or loss of properties of the mixture.
3. Do not exceed 5 gal of water per 94 lb of cement or the quantity of water in the manufacturer's instructions, whichever is less.
4. Agitate the grout continuously until the grout is pumped. Do not add water after the initial mixing.

50-1.03B(2)(d)(iv) Placing

Pump grout into the duct within 30 minutes of the 1st addition of the mix components.

Inject grout from the lowest point of the duct in an uphill direction in one continuous activity maintaining a one-way flow of the grout. You may inject from the lowest anchorage if complete filling is ensured.

Before injecting grout, open all vents.

Pump the grout at a rate of 16 to 50 feet of duct per minute.

Conduct grouting at a pressure range of 10 to 50 psi measured at the grout inlet. Do not exceed maximum pumping pressure of 150 psi at the grout inlet.

As grout is injected, continuously discharge grout from the vent to be closed. Do not close any vent until free water, visible slugs of grout and entrapped air have been ejected, and the consistency of the grout flowing from the vent is equivalent to the injected grout. Close the vents in sequence in the direction of flow starting with the closest vent. Before closing the final vent at the grout cap, discharge at least 2 gal of grout into a clean receptacle.

After closing all vents, bleed all high point vents.

Lock a pressure of 5 psi into the duct by closing the grout inlet valve.

50-1.03B(2)(d)(v) Weather Conditions

If hot weather conditions will contribute to quick stiffening of the grout, cool the grout by authorized methods as necessary to prevent blockages during pumping activities.

If freezing weather conditions are anticipated during and after the placement of grout, provide adequate means to protect the grout in the ducts from damage by freezing.

50-1.03B(2)(d)(vi) Curing

During grouting and for a period of 24 hours after grouting, eliminate vibration from Contractor-controlled sources within 100 feet of the frame in which grouting is taking place, including from moving vehicles, jackhammers, large compressors or generators, pile driving activities, soil compaction, and falsework removal. Do not vary loads on the span.

For PC concrete members, do not move or disturb the members after grouting for 24 hours. If the ambient temperature drops below 50 degrees F, do not move or disturb the members for 48 hours.

Do not remove or open valves until grout has set and cured for at least 24 hours.

50-1.03B(2)(d)(vii) Grout Storage

Store grout in a dry environment.

50-1.03B(2)(d)(viii) Blockages

If the grouting pressure reaches 150 psi, close the inlet and pump the grout at the adjacent vent that has just been or is ready to be closed as long as a one-way flow is maintained. Do not pump grout into a succeeding outlet from which grout has not yet flowed.

When complete grouting of the tendon cannot be achieved by the steps specified, stop the grouting.

50-1.03B(2)(d)(ix) Secondary Grouting

Perform secondary grouting by vacuum grouting.

The vacuum-grouting process must be able to determine the size of the void and measure the volume of grout filling the void.

Vacuum grouting equipment must consist of:

1. Volumeter for the measurement of void volume
2. Vacuum pump with a capacity of at least 10 cfm and equipped with a flow meter capable of measuring the amount of grout being injected

50-1.03B(2)(d)(x) Vertical Tendon Grouting

Provide a standpipe at the upper end of the tendon to collect bleed water and allow it to be removed from the grout. The standpipe must be large enough to prevent the grout elevation from dropping below the highest point of the upper anchorage device. If the grout level drops to the highest point of the upper anchorage device, immediately add grout to the standpipe.

Remove the standpipe after the grout has hardened.

For vertical tendons in excess of 100 feet high or if grouting pressure exceeds 145 psi, inject grout at a higher vent from which grout has already flowed to maintain one-way flow.

50-1.03B(3) Pretensioned Members

50-1.03B(3)(a) General

Anchor the prestressing steel at stresses that will result in the ultimate retention of jacking forces at least equal to those shown.

If prestressing steel for pretensioning is placed in the stressing bed and is to be exposed to the elements for more than 36 hours before encasing in concrete, protect the steel from contamination and corrosion using authorized measures.

Do not cut or release prestressing steel in pretensioned members until the concrete in the member has attained a compressive strength of at least the value shown or 4,000 psi, whichever is greater. If epoxy-coated strand is used, do not cut or release the steel until the temperature of the concrete surrounding the strand is less than 150 degrees F and falling.

If requested, check individually-tensioned strands using authorized methods and equipment for loss of prestress not more than 48 hours before placing concrete for the members. Strands showing a loss of prestress of more than 3 percent must be retensioned to the original computed jacking force.

If prestressing steel in pretensioned members is tensioned at a temperature appreciably lower than the estimated temperature of the concrete and the prestressing steel at the time of initial set of the concrete, the calculated elongation of the prestressing steel must be increased to compensate for the loss in stress.

The maximum temporary tensile stress in the prestressing steel of pretensioned members must not exceed 80 percent of the specified minimum ultimate tensile strength of the prestressing steel.

Cut and release the prestressing steel in pretensioned members in such an order that lateral eccentricity of the prestress force is a minimum.

Cut off pretensioned prestressing steel flush with the end of the member. After cutting the steel, clean and paint the exposed ends of the steel and a 1-inch strip of adjoining concrete as follows:

1. Wire brush or abrasive blast clean to remove all dirt and residue on the metal and concrete surfaces.
2. Immediately after cleaning, apply 1 coat of organic zinc-rich primer to the surfaces except apply 2 coats to surfaces that will not be covered by concrete or mortar. Do not use aerosol cans. Mix the paint thoroughly when applying and work into any voids in the prestressing steel.

50-1.03B(3)(b) Debonding Prestressing Strands

Where debond prestressing strands are shown, debond the strands by encasing the strands in plastic sheathing along the entire length shown and sealing the ends of the sheathing with waterproof tape.

Distribute the debonded strands symmetrically about the vertical centerline of the girder. The debonded lengths of pairs of strands must be equal.

Do not end debonding at any one cross section of the member for more than 40 percent of the debonded strands or 4 strands, whichever is greater.

Thoroughly seal the ends with waterproof tape to prevent the intrusion of water or cement paste before placing the concrete.

50-1.04 PAYMENT

Not Used

51 CONCRETE STRUCTURES

51-1 GENERAL

51-1.01 GENERAL

51-1.01A Summary

Section 51-1 includes general specifications for constructing concrete structures.

Earthwork for the following concrete structures must comply with section 19-3:

1. Sound wall footings
2. Sound wall pile caps
3. Culverts
4. Barrier slabs
5. Junction structures
6. Minor structures
7. Pipe culvert headwalls, endwalls, and wingwalls
8. Pile extensions
9. Drainage inlets

Falsework must comply with section 48-2.

Joints must comply with section 51-2.

Elastomeric bearing pads must comply with section 51-3.02.

Reinforcement for the following concrete structures must comply with section 52:

1. Sound wall footings
2. Sound wall pile caps
3. Barrier slabs
4. Junction structures
5. Minor structures
6. PC concrete members
7. Drainage inlets
8. Pipe culvert headwalls and endwalls for a pipe with a diameter of less than 5 feet

You may use RSC for a concrete structure only where the specifications allow the use of RSC.

51-1.01B Definitions

form panel: Continuous section of form facing material, unbroken by joint marks, against which concrete is placed.

opening age: Minimum age at which an element constructed with RSC may be opened to traffic.

age of break: Age in hours, determined by your testing, at which RSC attains its minimum specified compressive strength.

pier column: Extension of a column or pier into bedrock material.

51-1.01C Submittals

51-1.01C(1) General

Submit a deck placement work plan for concrete bridge decks.

If requested, submit shop drawings for PC members proposed by you. Include construction joint details, foundation bedding, and other requested information.

51-1.01C(2) Permanent Steel Deck Forms

Submit 3 copies of shop drawings for permanent steel deck forms. Include in the submittal:

1. Layout plan
2. Grade of steel
3 Physical and section properties of members

4. Method of support and grade adjustment
5. Method for accommodating skew
6. Methods of sealing against grout leaks

51-1.01C(3) Bonding Materials

Except for a bonding material previously authorized by the Department, submit at least a 45-pound test sample to METS. Allow 45 days for testing. Obtain the Department's authorization of the bonding material before incorporating it into the work.

For a bonding material previously authorized by the Department, submit a certificate of compliance for each shipment of the material.

51-1.01C(4) Rapid Strength Concrete

For RSC, submit the mix design at least 10 days before use. Include in the submittal:

1. Compressive strength test results for prequalification of RSC at age of break, at 3 days, and at 28 days
2. Opening age in hours
3. Proposed aggregate gradation
4. Mix proportions of cementitious material, aggregate, and water
5. Types and quantities of chemical admixtures, if used
6. Range of ambient temperatures over which the mix design will achieve the required minimum compressive strength
7. Source of materials

51-1.01C(5) Chemical Adhesives

Submit chemical adhesive manufacturer's installation procedures and warnings or precautions as an informational submittal at least 2 business days before starting work.

Submit 1 test sample of each chemical adhesive system to be used from each lot to METS for testing at least 25 days before use. The test sample must consist of 1 unit of chemical adhesive, 1 mixing nozzle, and 1 retaining nut. A lot for chemical adhesives is 100 units, or fraction thereof, of the same brand and product name.

Each test sample must be clearly marked with the following:

1. Manufacturer's name and system model number
2. Date of manufacture
3. Lot number
4. Shelf life or expiration date

51-1.01C(6) Colored Concrete

Submit technical data, manufacturer's specifications, and a work plan for mixing, delivery, placement, finishing, and curing of colored concrete.

51-1.01C(7) Hinge Tiedowns

Reserved

51-1.01D Quality Assurance

51-1.01D(1) General

Reserved

51-1.01D(2) Quality Control

51-1.01D(2)(a) General

Reserved

51-1.01D(2)(b) Rapid Strength Concrete

51-1.01D(2)(b)(i) General

Reserved

51-1.01D(2)(b)(ii) Prequalification of Mix Design

Prequalify RSC under section 90-1.01D(5)(b) before use. Prequalification of an RSC mix design includes determining the opening age and attaining the specified minimum 28-day compressive strength.

Determine the opening age of the RSC mix design as follows:

1. Fabricate at least 5 test cylinders to be used to determine the age of break.
2. Immediately after fabrication of the 5 test cylinders, store the cylinders in a temperature medium of 70 ± 3 degrees F until the cylinders are tested.
3. Determine the age of break to attain an average strength of the 5 test cylinders.
4. Opening age is the age of break plus 1 hour.

The average strength of the 5 test cylinders must be at least the minimum specified compressive strength. Not more than 2 test cylinders may have a strength of less than 95 percent of the minimum specified compressive strength.

If compressive strength tests performed in the field show that the RSC has attained the minimum specified compressive strength, you may open the lane to traffic at the age of break. Perform the compressive strength tests under the specifications for sampling and testing cylinders in section 90-1.01D(5)(a). If you choose to use this option, notify the Engineer before starting construction.

51-1.01D(2)(b)(iii) Mock-ups

Reserved

51-1.01D(2)(c) Test Panels

Test panels must be:

1. Constructed at an authorized location
2. At least 4 by 4 feet by 5 inches deep
3. Constructed and finished using the personnel, materials, equipment, and methods to be used in the work
4. Authorized before starting work

The Engineer may request that additional test panels be constructed until the specified finish, texture, and color are attained.

The Engineer uses the authorized test panel to determine acceptability of the work.

51-1.01D(3) Department Acceptance

51-1.01D(3)(a) General

Reserved

51-1.01D(3)(b) Testing Concrete Surfaces

51-1.01D(3)(b)(i) General

The Engineer tests roadway concrete surfaces for smoothness, coefficient of friction, and crack intensity.

The Engineer tests POC concrete deck surfaces for smoothness and crack intensity.

51-1.01D(3)(b)(ii) Surface Smoothness

The Engineer tests the surface smoothness of the following:

1. Completed roadway concrete surfaces of structures and approach slabs and the adjacent 50 feet of approach pavement
2. Surfaces of concrete decks to be covered with another material
3. Completed concrete deck surfaces, including ramps and landings of POCs

You must schedule smoothness testing. Allow 10 days for the Engineer to perform smoothness testing.

Before the testing, clean the test area and remove obstructions.

Except for POCs, surface smoothness is tested using:

1. Bridge profilograph under California Test 547. Two profiles are obtained in each lane approximately 3 feet from the lane lines and 1 profile is obtained in each shoulder approximately 3 feet from the curb or rail face. Profiles are taken parallel to the direction of traffic.
2. 12-foot-long straightedge placed transversely to traffic.

For POCs, surface smoothness is tested using:

1. 12-foot-long straightedge placed parallel to the centerline of the POC
2. 6-foot-long straightedge placed perpendicular to the centerline of the POC

Deck surfaces must comply with the following smoothness requirements:

1. Profile trace having no high points over 0.02 foot
2. Profile count of 5 or less in any 100-foot section for portions within the traveled way
3. Surface not varying more than 0.02 foot from the lower edge of a 12-foot-long straightedge placed transversely to traffic

POC deck surfaces must comply with the following smoothness requirements:

1. Surfaces between grade changes must not vary more than 0.02 foot from the lower edge of a 12-foot-long straightedge placed parallel to the centerline of the POC
2. Surface must not vary more than 0.01 foot from the lower edge of a 6-foot-long straightedge placed perpendicular to the centerline of the POC

Grind surfaces not complying with the smoothness requirements under section 42-3 until the required smoothness is attained. Grinding must not reduce the concrete cover on the reinforcing steel to less than 1-1/2 inches.

Replace portions of decks that cannot be corrected by grinding.

51-1.01D(3)(b)(iii) Coefficient of Friction

After deck surfaces and approach slabs have been textured, the Engineer tests the coefficient of friction of the concrete surfaces under California Test 342.

Deck surfaces and approach slabs must have a uniform surface texture with a coefficient of friction of not less than 0.35 when opened to traffic or before seal coats are placed, whichever occurs first.

If portions of completed deck surfaces or approach slabs have a coefficient of friction of less than 0.35, those portions must be ground or grooved parallel to the center line to produce a coefficient of friction of not less than 0.35. Grinding and grooving must comply with section 42.

The coefficient of friction requirements do not apply for bridge decks to be covered with membrane seals.

51-1.01D(3)(b)(iv) Crack Intensity

The Engineer measures crack intensity of deck surfaces after curing, before prestressing, and before falsework release. Clean the surface for the Engineer to measure surface crack intensity.

In any 500 sq ft portion of a new bridge deck surface, if there are more than 50 feet of cracks having a width at any point of over 0.02 inch, treat the deck with methacrylate resin under section 60-3.03B. Treat the entire deck width between barriers to 5 feet beyond where the furthest continuous crack emanating from the 500 sq ft section is 0.02 inch wide. Treat the deck surface before grinding.

In any 100 sq ft portion of a new POC deck surface, if there are more than 10 feet of cracks having a width at any point of over 0.02 inch, treat the deck with methacrylate resin under section 60-3.03B. Treat the entire deck width between the curbs to 5 feet beyond where the furthest continuous crack emanating from the 100 sq ft section is 0.02 inch wide. Treat the deck surface before grinding.

51-1.02 MATERIALS

51-1.02A General

Reserved

51-1.02B Concrete

Except for minor structures, the cementitious material content per cubic yard of concrete in structures or portions of structures must comply with the content shown in the following table:

Use	Cementitious material content (lb/cu yd)
Deck slabs and slab spans of bridges	675–800
Roof sections of exposed top box culverts	675–800
Pier columns	675–800
Seal courses	675 min
Other portions of structures	590–800
Concrete for PC members	590–925

Except for minor structures, the minimum required 28-day compressive strength for concrete in structures or portions of structures is the compressive strength described or 3,600 psi, whichever is greater.

51-1.02C Bonding Materials

Bonding materials must be magnesium phosphate concrete, modified high-alumina-based concrete, or portland-cement-based concrete.

Magnesium phosphate concrete must be either single component that is water activated or dual component with prepackaged liquid activator.

Modified high-alumina-based concrete and portland-cement-based concrete must be water activated.

Bonding materials must comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Compressive strength (psi, min): at 3 hours at 24 hours	California Test 551	 3000 5000
Flexural strength at 24 hours (psi, min)	California Test 551	500
Bond strength at 24 hours (psi, min): Saturated surface dry concrete Dry concrete	California Test 551	 300 400
Water absorption (percent, max)	California Test 551	10
Abrasion resistance at 24 hours (g, max)	California Test 550	25
Drying shrinkage at 4 days (percent, max)	ASTM C596	0.13
Soluble chlorides by weight (percent, max)	California Test 422	0.05
Water soluble sulfates by weight (percent, max)	California Test 417	0.25

Magnesium phosphate concrete must be formulated for a minimum initial set time of 15 minutes and minimum final set time of 25 minutes at 70 degrees F. Store the materials in a cool, dry environment before use.

The mix water used with water-activated material must comply with section 90-1.02D.

The quantity of water for single-component type or liquid activator for dual-component type to be blended with the dry component, must be within the limits recommended by the manufacturer and must be the least quantity required to produce a pourable batter.

If authorized, you may add retarders to magnesium phosphate concrete. The addition of retarders must comply with the manufacturer's instructions.

Magnesium phosphate concrete must not be mixed in containers or worked with tools containing zinc, cadmium, aluminum, or copper metals. Modified high alumina based concrete must not be mixed in containers or worked with tools containing aluminum.

51-1.02D Rapid Strength Concrete

RSC placed in bridge decks must contain at least 675 pounds of cementitious material per cubic yard.

RSC must have a minimum 28-day compressive strength of 4,000 psi except RSC placed in bridge decks must have a minimum 28-day compressive strength of 4,500 psi.

51-1.02E Colored Concrete

Color pigments for colored concrete must be iron oxides complying with ASTM C979/C979M. The dosage must not exceed 10 percent by weight of cementitious material in the concrete mix design.

When test panels are specified, cementitious materials and aggregates from the same sources used in the authorized test panel must be used for the colored concrete in the completed work.

51-1.02F Mortar

Mortar must be composed of cement, sand, and water. Materials for mortar must comply with section 90. The proportion of sand to cement measured by volume must be 2 to 1. Mortar must contain only enough water to allow placing and packing. Sand particles must be no larger than 1/2 the size of the recess or space in which the mortar is to be placed.

51-1.02G Grout

Grout must consist of portland cement and water, with a water content of at most 4 gallons per 94 pounds of cement.

51-1.02H Chemical Adhesives

Chemical adhesives for bonding dowels must be on the Authorized Material List for chemical adhesive/cartridge epoxies. The chemical adhesive must be appropriate for the installation conditions.

51-1.02I Miscellaneous Metal

Materials for access opening covers for new structures must comply with section 75-3.

Metal frames, covers, grates, and other miscellaneous iron and steel used with drainage inlets must comply with section 75-2.

51-1.02J Miscellaneous Materials

Plastic pipe for deck bleeder drains must be schedule 40 PVC complying with ASTM D1785.

Galvanized wire cloth for deck bleeder drains must be 1/4-inch mesh with 0.047-inch-diameter wire.

51-1.03 CONSTRUCTION

51-1.03A General

Reserved

51-1.03B Methods and Equipment

Vehicles weighing over 1,000 lb are not allowed on any bridge span until the concrete attains a compressive strength of at least 2,400 psi. Vehicles weighing over 4,000 lb are not allowed on any span until the concrete attains a compressive strength of at least 3,250 psi or attains an age of 28 days.

Vehicles exceeding the weight limitations in Veh Code Div 15 that cross bridges as allowed in section 5-1.37B must not make repetitive crossings of any span until the concrete attains an age of 28 days.

Vehicles with a gross weight over 10,000 lb are not allowed on any span of PS concrete structures until the prestressing steel for that span is tensioned.

If authorized, you may precast structural elements not designated as PC members.

You may use the slip form method for constructing pier shafts if (1) the results are equal to those obtained by compliance with these specifications and (2) adequate arrangements are made and carried out for curing, finishing, and protecting the concrete.

When slip forms are used for pier construction, the line and grade furnished by the Engineer is limited to establishing control points and checks of slip form position. You must provide targets, markers, or other devices for the Engineer to determine the pier shaft position.

Shotcrete is not allowed as an alternative construction method for reinforced concrete members.

You may construct warped portions of wingwalls at the ends of culverts using shotcrete complying with section 53-1.

You may use PC drainage inlets as an alternative to CIP drainage inlets.

51-1.03C Preparation

51-1.03C(1) General

Bottom of footing elevations shown are approximate.

The Engineer may order changes in footing dimensions or elevations.

Where a roughened concrete surface is described, roughen the existing concrete surface to a full amplitude of approximately 1/4 inch by abrasive blasting, water blasting, or using mechanical equipment.

Pump water from the interior of foundation enclosures without removing concrete materials. Do not pump water during concrete placement or for 24 hours after placing concrete, unless the pumping is done from a sump separated from the concrete work.

51-1.03C(2) Forms

51-1.03C(2)(a) General

Forms must be:

1. Mortar tight
2. True to the dimensions, lines, and grades of the structure
3. Strong enough to prevent deflection during concrete placement

Face exposed surfaces of concrete structures with form panels.

Form panels for exposed surfaces must be plywood complying with or exceeding the requirements of U.S. Product Standard PS 1 for Exterior B-B (Concrete Form) Class I Plywood or any material that produces a similarly smooth, uniform surface. For exposed surfaces, use only form panels in good condition and free of defects such as scars, dents, or delaminations.

Design and construct forms for exposed surfaces such that surfaces do not undulate more than 3/32 inch or 1/270 of the center-to-center distance between studs, joists, form stiffeners, form fasteners, or wales in any direction. Stop using forms or forming systems that produce excessive undulations until modifications satisfactory to the Engineer are made. The Engineer may reject portions of structures with excessive undulations.

Form exposed surfaces of each element of a concrete structure with the same forming material or with materials that produce similar surface textures, color, and appearance.

Use form panels in uniform widths of at least 3 feet and uniform lengths of at least 6 feet except at the ends of continuously formed surfaces where the final panel length is less than 6 feet. For members less than 3 feet wide, form panels must be the width of the entire member.

Arrange form panels in symmetrical patterns conforming to the general lines of the structure. Place panels for vertical surfaces with the long dimension horizontal and horizontal joints level and continuous.

Form panels for curved column surfaces must be continuous for at least 1/4 of the circumference or 6 feet. For walls with sloping footings that do not abut other walls, you may place panels with the long dimension parallel to the footing.

Align form panels on each side of panel joints with supports or fasteners common to both panels so that a continuous, unbroken concrete plane results. Form filler panels that join prefabricated panels must (1) have a uniform width of at least 1 foot and (2) produce a smooth, uniform surface with consistent longitudinal joint lines between panels.

Construct forms for exposed surfaces with triangular fillets at least 3/4 by 3/4 inch. Attach fillets so as to prevent mortar runs and to produce smooth, straight chamfers at all sharp edges of the concrete.

For drainage inlets, extend the outside forms at least 12 inches below the top of the inlet. You may place concrete against excavated earth below this depth except:

1. You must use full-depth outside forms or other protection when work activities or unstable earth may cause hazardous conditions or contamination of the concrete.
2. You must increase the wall thickness 2 inches if placing concrete against the excavated surface. The interior dimensions must be as shown.

Clean inside form surfaces of dirt, mortar, and foreign material. Thoroughly coat forms to be removed with form oil before placing concrete. Form oil must:

1. Be commercial quality or an equivalent coating
2. Allow the ready release of forms
3. Not discolor the concrete

Do not place concrete in forms until:

1. All form construction work has been completed, including removing foreign material
2. All materials to be embedded in the concrete have been placed
3. Engineer has inspected the forms

Forms for concrete surfaces that will not be completely enclosed or hidden below the permanent ground surface must comply with the specifications for forms for exposed surfaces. Interior surfaces of underground drainage structures are considered completely enclosed surfaces.

Use form fasteners to prevent form spreading during concrete placement. Do not use twisted wire ties to hold forms in position.

Form fasteners and anchors must be of those types that can be removed as specified for form bolts in section 51-1.03F(2) without chipping, spalling, heating or otherwise damaging the concrete surface.

You may cast anchor devices into the concrete for supporting forms or lifting PC members. Do not use driven types of anchorages for fastening forms or form supports to concrete except for interior surfaces of girders in PS box girder bridges where:

1. Girders have more than 2 inches of cover over the reinforcement
2. Anchorages do not penetrate the girder more than 2 inches and have a minimum spacing of 6 inches
3. Anchorages are placed at least 3 inches clear from the edge of concrete

51-1.03C(2)(b) Removing Forms

Remove all forms, except soffit forms for deck slabs of CIP box girders, forms for the interior voids of PC members, and the forms in hollow abutments or piers may remain in place for any of the following conditions:

1. Permanent access into the cells or voids is not shown
2. Utility facilities are not to be installed in the completed cells or voids
3. Utility facilities to be installed in completed cells or voids are to be inserted into casings that are placed before the completion of the cell or void
4. Permanent access is shown or utility facilities other than those in preplaced casings are to be installed in cells or voids, and you:
   - 4.1 Remove the portions of the forms that obstruct access openings or conflict with utility facilities.
   - 4.2 Provide a longitudinal crawl space at least 3 feet high and 2 feet wide throughout the length of these cells or voids
   - 4.3 Use a forming system that leaves no sharp projections into the cells or voids
   - 4.4 Remove forms between the hinge and 5 feet past the access openings in cells of CIP box girder bridges with access openings near the hinges

Clear the inside of the cells or voids of all loose material before completing the forming for the deck of CIP box girders or for the cells or voids of other members when the forms are to remain in place, or after the removal of the forms or portions of forms.

You may remove forms that do not support the dead load of concrete if 24 hours have elapsed after concrete placement and the concrete has sufficient strength to prevent damage to the surface.

You may remove forms for railings or barriers after the concrete has hardened. Protect exposed surfaces from damage.

For drainage inlets, remove exterior forms to at least 12 inches below the final ground surface. Exterior forms below this depth may remain if their total thickness is not more than 1 inch.

51-1.03C(2)(c) Permanent Steel Deck Forms

51-1.03C(2)(c)(i) General

Permanent steel deck forms and supports must comply with ASTM A653/A653M, Designation SS, Grades 33 through 80, coating designation G165.

Permanent steel deck forms are only allowed where shown or if specified as an option in the special provisions.

51-1.03C(2)(c)(ii) Design Requirements

Design permanent steel deck forms based on the combined dead load of forms, reinforcement, and plastic concrete with an allowance for construction loads of at least 50 psf. The combined dead load must be assumed to be at least 160 pcf for normal concrete and 130 pcf for lightweight concrete.

Configure forms such that the weight of deck slab and forms is at most 110 percent of the weight of the deck slab as shown.

Compute the physical design properties under AISI's *North American Specification for the Design of Cold-Formed Steel Structural Members.*

The design span for form sheets is the clear span of the form plus 2 inches, measured parallel to the form flutes.

Maximum allowable stresses and deflections are as follows:

1. Tensile stress must not exceed the lesser of 0.725 times the specified yield strength or 36,000 psi.
2. Dead load deflection must not exceed the lesser of 0.0056 times the form span or 1/2 inch. The dead load for deflection calculations must be at least 120 psf total.
3. You may use form camber based on the actual dead load condition. Do not use camber to compensate for deflection exceeding the allowable limits.

51-1.03C(2)(c)(iii) Installation

Do not weld steel deck forms to flanges of steel girders.

Permanent steel deck forms must not interfere with movement at deck expansion joints.

Clearance between deck forms and bar reinforcement must be at least 1 inch.

Do not use permanent steel deck forms for sections of deck slabs with longitudinal expansion joints unless additional supports are placed under the joint.

Do not rest form sheets directly on top of girder flanges. Fasten sheets securely to form supports. Provide at least 1 inch of bearing at each end. Place form supports in direct contact with girder flanges. Attach supports using bolts, clips, or other authorized means.

Locate transverse deck construction joints at the bottom of flutes. Field drill 1/4-inch weep holes at not less than 12 inches on center along the joint line.

Repair galvanized form surfaces damaged before installation by wire brushing to remove loose and cracked coating and applying 2 coats of zinc-rich primer. Do not use aerosol cans. You do not need to repair minor heat discoloration in welded areas.

51-1.03D Placing Concrete

51-1.03D(1) General

Thoroughly moisten forms and subgrade with water immediately before placing concrete.

Place and consolidate concrete using methods that (1) do not cause segregation of the aggregate and (2) produce dense, homogeneous concrete without voids or rock pockets.

Place concrete while fresh and before initial set. Do not retemper partially hardened concrete with additional water.

Place concrete continuously in each integral part of the structure. Do not start work unless placement can be completed uninterrupted.

Place concrete for girder spans in at least 2 operations. The last operation must consist of placing the deck slab. Allow at least 5 days between operations.

Place concrete as close to its final position as possible. Do not use vibrators for extensive shifting of concrete.

Except for CIP piles, do not allow fresh concrete to fall more than 8 feet without using pipes, tubes, or double belting to prevent segregation. Do not use double belting unless the member thickness is less than 16 inches.

Except for concrete placed as pipe culvert headwalls and endwalls, slope paving and aprons, and concrete placed under water, consolidate concrete using high-frequency internal vibrators within 15 minutes of placing concrete in the forms. Do not attach vibrators to or hold them against forms or reinforcing steel. Do not displace reinforcement, ducts, or prestressing steel during vibrating.

For structure footings over 2.5 feet in depth that have a top layer of reinforcement, reconsolidate the concrete to a depth of 1 foot after placing, consolidating, and initial screeding of the concrete. Reconsolidate the concrete as late as the concrete will respond again to vibration but not less than 15 minutes after the initial screeding.

Vibrators used for concrete with epoxy-coated reinforcement or prestressing steel must have a resilient covering to prevent damage to the epoxy coating.

If concrete is inaccessible for adequate consolidation by other means, external vibrators must be used and the forms must be sufficiently rigid to resist displacement or damage.

Do not place concrete for horizontal members until the concrete in supporting vertical members has been consolidated and settlement due to bleeding is complete.

Where shown, apply a bond breaker to joint surfaces.

Do not construct drainage structures to final grade until adjacent paving or surfacing is complete.

If using a mobile volumetric mixer, before each work shift and after each time the mixer is washed out, discharge at least 2 cubic feet of RSC into a concrete waste container before placing RSC into the work.

51-1.03D(2) Concrete Bridge Decks

For concrete decks placed on continuous steel girders or PC concrete girders, place the portion of deck over the supports last.

For decks on PC concrete girders, place intermediate and end diaphragms at least 5 days before placing the deck concrete.

For decks on structural steel, install cross frames the entire width of the bridge before placing the deck concrete.

Deck closure pours must comply with the following:

1. During primary deck placement and for at least 24 hours after completing the deck placement, reinforcing steel protruding into the closure space must be free from any connection to reinforcing steel, concrete, forms, or other attachments of the adjacent structure.
2. Closure pour forms must be supported from the superstructure on both sides of the closure space.

51-1.03D(3) Concrete Placed Under Water

Only seal course concrete may be placed under water.

If the Engineer determines that it is impossible or inadvisable to dewater excavations before placing concrete, place a seal course under the water using a tremie or a concrete pump. The seal course must be at least 2 feet thick and thick enough to seal the cofferdam.

The tremie must be a watertight tube at least 10 inches in diameter with a hopper at the top. When concrete is deposited into the hopper, flow is induced by raising the discharge end. Equip discharge and tremie tubes with a device to prevent water from entering the tube when charging the tube with concrete. Support the tubes so as to allow for free movement of the discharge end over the entire work surface and rapid lowering of the tube.

Fill the tubes using a method that prevents washing of the concrete. Keep the discharge end submerged in the concrete at all times. The tube must contain enough concrete to prevent water entry.

Place the concrete carefully in a compact mass. Concrete flow must be continuous until completion of the seal course. The seal course must be monolithic and homogeneous. Do not disturb concrete after placement. Maintain still water at the point of placement.

Cure the seal course concrete for at least 5 days before dewatering the cofferdam. Increase the curing time for seal course concrete placed in water that is below 45 degrees F. Periods of time when the water temperature is continuously below 38 degrees F is not considered as curing time.

Dewater the cofferdam after the seal course has adequate strength to resist the hydrostatic load. After dewatering, clean the top of the concrete of all scum, laitance, and sediment. Remove local high spots to provide the specified clearance for reinforcing steel before placing fresh concrete.

51-1.03D(4) Construction Joints

Place construction joints only where described unless authorized.

At horizontal construction joints:

1. Thoroughly consolidate fresh concrete surfaces without completely removing surface irregularities
2. At joints between girder stems and decks, roughen the surfaces of fresh concrete to at least a 1/4-inch amplitude

Abrasive blast clean construction joint surfaces before placing fresh concrete against the joint surfaces. Remove surface laitance, curing compound, and other foreign materials.

Flush construction joint surfaces with water and allow the surfaces to dry to a surface-dry condition immediately before placing concrete.

If authorized in an emergency, you may place a construction joint at a location not described. The Engineer determines the location of the construction joint and the quantity of additional reinforcing steel to be placed across the joint.

Locate longitudinal construction joints in bridge decks along lane lines if a joint location is not shown.

51-1.03D(5) Colored Concrete

When placing colored concrete:

1. Monitor the water content, weight of cementitious materials, and size, weight, and color of aggregate to maintain consistency and accuracy of the mixed colored concrete.
2. Schedule delivery of concrete to provide consistent mix times from batching until discharge. Do not add water after a portion of the batch has been discharged.
3. Use consistent finishing practices to ensure uniformity of texture and color.
4. Protect surrounding exposed surfaces during placement, finishing, and curing activities of colored concrete.

If more than 1 concrete pump is used to place concrete, designate the pumps to receive colored concrete. The designated pumps must receive only colored concrete throughout the concrete placement operation.

Cure colored concrete by the forms-in-place method or the curing compound method.

If the curing compound method is used, the curing compound must be clear or match the color of the colored concrete and must be manufactured specifically for colored concrete. Do not use curing compounds containing calcium chloride. The time between completing surface finishing and applying the curing compound must be the same for each colored concrete component.

51-1.03D(6) Bearing Surfaces

For elastomeric bearing pads, wood float finish the concrete bearing surface to a level plane that varies at most 1/16 inch from a straightedge placed in any direction and is within 1/8 inch of the specified elevation. The bearing area must extend at least 1 inch beyond the limits of the bearing pads.

For bearing assemblies or masonry plates not embedded in concrete, construct the concrete bearing area above grade and grind to a true level plane that (1) does not vary perceptibly from a straightedge placed in any direction and (2) is within 1/8 inch of the elevation shown.

51-1.03D(7) Pier Columns

Place concrete for pier columns against firm, undisturbed foundation material on the bottom and sides of the pier column excavations except place concrete against forms where shown. Immediately before placing concrete, all excavated surfaces against which the concrete is to be placed must be free from standing water, ice, mud, debris, and loose material.

51-1.03E Miscellaneous Construction

51-1.03E(1) General

Where shown, paint the bridge name, bridge number, and bent number in neat, 2-1/2-inch-high black letters and figures.

Where shown and before backfilling to within 3 feet of finished grade, install temporary bumpers at the ends of bridges and grade top culverts.

Where pipes outside the structure join the structure, cast bell recesses in the concrete to receive the pipe or cast sections of the pipe in the concrete. If bell recesses are used, mortar the pipe end into the bell.

51-1.03E(2) Placing Mortar

Place mortar in recesses and holes, on surfaces, under structural members, and at other locations where described.

Clean concrete areas to be in contact with mortar of loose or foreign material that would prevent bonding between the mortar and the concrete surfaces. Flush the concrete areas with water and allow them to dry to a surface-dry condition immediately before placing the mortar.

Tightly pack mortar to completely fill spaces. Locations where mortar can escape must be mortar-tight before placing mortar. Cure mortar for 3 days using the water method under section 90-1.03B.

Do not load mortar until 72 hours after placement unless authorized.

51-1.03E(3) Drill and Bond Dowels

For drill and bond dowels, drill the holes without damaging the adjacent concrete. Holes for bonded dowels must be 1/2 inch larger than the nominal dowel diameter.

If reinforcement is encountered during drilling before the specified depth is attained, notify the Engineer. Unless coring through the reinforcement is authorized, drill a new hole adjacent to the rejected hole to the depth shown.

Coat the surface of any dowel coated with zinc or cadmium with a colored lacquer. Allow the lacquer to dry thoroughly before installing the dowel.

Each drilled hole must be clean and dry when placing the bonding material and dowel. The bonding material and dowel must completely fill the drilled hole. The surface temperature must be at least 40 degrees F when magnesium phosphate concrete is placed.

Thoroughly dry finishing tools cleaned with water before working magnesium phosphate concrete.

Leave dowels undisturbed for 3 hours or until the dowels can be supported by the concrete.

Cure modified high-alumina-based concrete and portland-cement-based concrete using the curing compound method. Do not cure magnesium phosphate concrete.

Replace dowels that fail to bond or are damaged.

51-1.03E(4) Drill and Grout Dowels

Drill the holes under section 51-1.03E(3).

For drill and grout dowels, drill the holes 1/4 inch larger than the nominal dowel diameter. Immediately before placing dowels, holes must be cleaned, be thoroughly saturated with water, have all free water removed, and be dried to a saturated surface dry condition.

Place grout into the holes and insert the dowels. Retempering of grout is not allowed. Cure grout at least 3 days or until the dowels are encased in concrete. Immobilize the dowels during the curing period. Cure using curing compound method or by keeping the surface continuously damp.

Replace dowels that fail to bond or are damaged.

51-1.03E(5) Drill and Bond Dowels (Chemical Adhesive)

For drill and bond dowel (chemical adhesive), install dowels under the chemical adhesive manufacturer's instructions.

Drill the holes without damaging the adjacent concrete. If reinforcement is encountered during drilling before the specified depth is attained, notify the Engineer. Unless coring through the reinforcement is authorized, drill a new hole adjacent to the rejected hole to the depth shown.

Immediately after inserting the dowels into the chemical adhesive, support the dowels as necessary to prevent movement until the epoxy has cured the minimum time specified in the Authorized Material List for chemical adhesive/cartridge epoxies.

Replace dowels that fail to bond or are damaged. Drill new holes adjacent to rejected dowels and install replacement dowels.

51-1.03E(6) Nonskid Abrasive Finish

Where shown, place a nonskid abrasive finish on pedestrian walkways, stair treads, and landings. The nonskid finish must consist of commercial-quality aluminum oxide, silicon carbide, or almandite garnet grit particles, sieve size no. 12 to 30 or no. 14 to 35. Uniformly apply grit particles at a rate of at least 0.3 lb/sq ft onto the floated concrete surface while the concrete is plastic. Bury the particles into the concrete to a depth of approximately 0.7 times the diameter of each particle.

51-1.03E(7) Drains in Walls

Where shown, construct drain holes and weep holes in abutment walls, wingwalls, and retaining walls. Cover retaining wall and abutment wall drains at the back face of the wall with 1/4-inch mesh, 0.025-inch-diameter aluminum or galvanized steel wire hardware cloth. Mount hardware cloth in forms before pouring concrete or fasten the cloth to the exterior concrete surface with masonry nails.

In addition to wall drains, install hydrostatic pressure relief holes 3 inches in diameter at the bottom of walls immediately above footings at approximately 15-foot centers.

51-1.03E(8) Deck Bleeder Drains

The Engineer provides the exact location for each deck bleeder drain.

Drill the holes for drains in existing bridges using a diamond core drill bit. Do not spall hole edges. Holes must be 2 inches in diameter.

Install drains such that the top of the pipe is approximately 1/4 inch below the concrete deck surface. Replace drains out of position as determined by the Engineer.

Secure plastic pipe installed in existing bridges with an epoxy adhesive. Score the outside surfaces of the pipe before installing the pipe. Spread epoxy on both the pipe and hole surfaces. Epoxy must completely fill the space between the pipe and the hole.

Install drains before placing the deck seal. Center the wire cloth above the drains. Place the cloth after placing the deck seal and before placing the HMA. Secure the cloth using an authorized method to prevent movement during HMA placement. Do not damage the deck seal.

51-1.03E(9) Utility Facilities

Where shown, utility facilities will be carried in or on structures.

Install hangers, anchor bolt inserts, manhole frames and covers, sleeves, and other accessories required for the utility facility that must be cast in the concrete. The utility owner will furnish these items.

The utility owner will furnish and install conductors and casings when the structure is ready for the installation and before any work that interferes with installation is started.

Notify the Engineer at least 30 days before the date structures are ready for utility installation. The Engineer will notify the utility owner.

51-1.03E(10) Concrete Headers and Steel Plates

Concrete for concrete headers must comply with the specifications for minor concrete.

Steel plates and attachment hardware must comply with section 75-1 except that galvanizing is not required.

51-1.03E(11) Diaphragm Bolsters

Reserved

51-1.03E(12) Hinge Tiedowns

Reserved

51-1.03F Finishing Concrete

51-1.03F(1) General

Strike off exposed surfaces of consolidated concrete to the lines and grades shown. Provide a uniform surface texture having the specified finish without undulations or irregularities.

The Engineer determines the acceptability of the surface finishes.

Finish sidewalks, curbs, and stairways on structures under section 73-3 except surfaces are not marked.

51-1.03F(2) Ordinary Surface Finish

Apply ordinary surface finish to all concrete surfaces as a final finish or before applying a higher class finish.

Ordinary surface finish must be the final finish for the following surfaces:

1. Undersurfaces of slab spans, box girders, spandrel arch spans, and floor slabs between girders of superstructures
2. Inside vertical surfaces of T girders of superstructures
3. Surfaces to be buried underground or covered with embankment and surfaces of culverts above finished ground that are not visible from the traveled way
4. Interior and top surfaces of drainage inlets

Ordinary surface finish includes:

1. Filling holes or depressions
2. Repairing rock pockets and unsound concrete
3. Removing fins and projections flush to the surface
4. Removing stains and discolorations visible from traveled ways

You do not need to remove fins from surfaces that are buried underground or enclosed.

Remove form bolts and metal placed for your convenience to at least 1 inch below the concrete surface. Clean and fill the resulting holes with mortar. You do not need to remove form bolts in box girder cells except you must remove bolts flush if deck forms are removed from the cells.

Fill bolt holes with mortar under section 51-1.03E(2). Fill depressions and pockets with packed mortar or shotcrete as determined by the Engineer. Cure filler under section 51-1.03H.

For exposed surfaces, add enough white cement to the patching material to match the surrounding concrete after drying.

If the Engineer determines that rock pockets are extensive, remove and replace the affected portions of the structure.

51-1.03F(3) Class 1 Surface Finish

Class 1 surface finish includes finishing concrete surfaces to produce smooth, even surfaces of uniform texture and appearance without bulges, depressions, or other imperfections.

Class 1 surface finish must be the final surface finish for the following surfaces:

1. Except for those surfaces listed in ordinary surface finish, the surfaces of bridge superstructures, including the undersurfaces of deck overhangs
2. Surfaces of bridge piers, piles, columns, and abutments, and retaining walls above finished ground and to at least 1 foot below finished ground
3. Surfaces of open spandrel arch rings, spandrel columns, and abutment towers
4. Surfaces of pedestrian undercrossings, except floors and surfaces to be covered with earth
5. Surfaces of culvert headwalls above finished ground and endwalls visible from a traveled way
6. Interior surfaces of culvert barrels having a height of 4 feet or more for a distance equal to the culvert height where visible from a traveled way
7. Interior surfaces of pump house motor and control rooms and engine-generator rooms
8. Surfaces of railings

Do not apply Class 1 surface finish until a uniform appearance can be attained.

Use power carborundum stones or disks to remove bulges and other imperfections.

Sand areas not complying with the Class 1 surface finish requirements using power sanders or other authorized abrasive means until the specified surface finish is attained.

51-1.03F(4) Class 2 Surface Finish

Where a Class 2 surface finish is described:

1. Apply an ordinary surface finish to the concrete surface.
2. Abrasive blast the surface to a rough texture and then thoroughly wash the surface with water.
3. Pneumatically apply a mortar coat approximately 1/4 inch thick in at least 2 passes to the damp surface. The coating must firmly bond to the concrete surface.

The mortar coat must consist of either (1) sand, portland cement, and water, mechanically mixed before entering the nozzle or (2) premixed sand and portland cement, with water added before leaving the nozzle. The proportion of cement to sand must be at least 1 to 4. Use sand with a grading suitable for the work.

You may substitute cementitious material complying with section 90 for portland cement. You may use admixtures specified in section 90 if authorized.

Do not mortar coat areas where bridge name or other designations are to be painted.

The coating surface must be (1) uniform without unsightly bulges, depressions, or other imperfections and (2) as left by the nozzle. Protect the coating from damage and keep it damp for 3 days after placing. Remove and replace loose areas of coating.

Where a Class 2 surface finish is described for a pedestrian undercrossing, use silica sand and white portland cement.

51-1.03F(5) Finishing Roadway Surfaces

51-1.03F(5)(a) General

Construct concrete roadway surfaces of structures, approach slabs, sleeper slabs, and adjoining approach pavement, and concrete decks to be covered with another material, to the grade and cross section shown. Surfaces must comply with the specified smoothness, surface texture, and surface crack requirements.

The Engineer sets deck elevation control points for your use in establishing the grade and cross section of the deck surface. The grade established by the deck elevation control points includes all camber allowances. Elevation control points will not be closer together than approximately 8 feet longitudinally and 24 feet transversely to the bridge centerline.

Before starting concrete placement for any deck section:

1. Set to grade all rails and headers used to support or control the finishing equipment
2. Check rails and headers to ensure the completed deck complies with smoothness requirements
3. Move the finishing equipment over the length of the section to check steel and bulkhead clearances

For approach slabs, sleeper slabs, and other roadway surfaces of concrete structures, texture the roadway surface as specified for bridge deck surfaces in section 51-1.03F(5)(b).

Finish bridge decks to be covered with membrane seals to a smooth surface free of mortar ridges and other projections.

Where a future widening is shown, strike off deck surfaces under curbs, railings, barriers, and sidewalks to the same plane as the roadway and leave undisturbed.

Deck surfaces must comply with the following smoothness requirements:

1. Profile trace having no high points over 0.02 foot
2. Profile count of 5 or less in any 100-foot section for portions within the traveled way
3. Surface not varying more than 0.02 foot from the lower edge of a 12-foot-long straightedge placed transversely to traffic

Complete the smoothness testing and any required grinding before applying seal coats.

51-1.03F(5)(b) Bridge Deck Surface Texture

51-1.03F(5)(b)(i) General

Except for bridge widenings and bridge decks to be covered with an overlay, texture roadway surfaces of bridge decks, approach slabs, and sleeper slabs, and other roadway surfaces of concrete structures longitudinally by grinding and grooving or by longitudinal tining.

For bridge widenings, texture the roadway surfaces longitudinally by longitudinal tining.

For bridge decks that are to be covered with an overlay, texture the deck using a burlap drag or broom device that produces striations either parallel or transverse to the centerline. If these structures are opened to traffic before the overlay is placed, the deck surface must meet the coefficient of friction requirement in section 51-1.01D(3)(b)(iii).

51-1.03F(5)(b)(ii) Grinding and Grooving

When texturing the deck surface by grinding and grooving, place a 1/4 inch of sacrificial concrete cover on the bridge deck above the finished grade shown. Place items to be embedded in the concrete based on the final profile grade elevations shown. Construct joint seals after completing the grinding and grooving.

Before grinding and grooving, deck surfaces must comply with the smoothness and deck crack treatment requirements.

Grind and groove the deck surface to within 18 inches of the toe of the barrier as follows:

1. Grind the surface under section 42-3. Grinding must not reduce the concrete cover on reinforcing steel to less than 1-3/4 inches.

2. Groove the ground surfaces longitudinally under section 42-2. The grooves must be parallel to the centerline.

51-1.03F(5)(b)(iii) Longitudinal Tining

When texturing the deck surface by longitudinal tining, perform initial texturing with a burlap drag or broom device that produces striations parallel to the centerline. Perform final texturing with spring steel tines that produce grooves parallel with the centerline.

The tines must:

1. Be rectangular in cross section
2. Be from 3/32 to 1/8 inch wide on 3/4-inch centers
3. Have enough length, thickness, and resilience to form grooves approximately 3/16 inch deep

Construct grooves to within 6 inches of the layout line of the concrete barrier toe. Grooves must be from 1/8 to 3/16 inch deep after concrete has hardened.

For irregular areas and areas inaccessible to the grooving machine, you may hand construct grooves. Hand-constructed grooves must comply with the specifications for machine-constructed grooves.

Tining must not cause tearing of the deck surface or visible separation of coarse aggregate at the surface.

51-1.03F(6) Finishing Pedestrian Overcrossing Surfaces

Construct deck surfaces, including ramps and landings of POCs to the grade and cross section shown. Surfaces must comply with the specified smoothness, surface texture, and surface crack requirements.

The Engineer sets deck elevation control points for your use in establishing the grade and cross section of the deck surface. The grade established by the deck elevation control points includes all camber allowances. Except for landings, elevation control points include the beginning and end of the ramp and will not be closer together than approximately 8 feet longitudinally and 4 feet transversely to the POC centerline. Landing elevation control points are at the beginning and the end of the landing.

Broom finish the deck surfaces of POCs. Apply the broom finish perpendicular to the path of travel. You may apply water mist to the surface immediately before brooming.

Clean any discolored concrete by abrasive blast cleaning or other authorized methods.

POC deck surfaces must comply with the following smoothness requirements:

1. Surfaces between grade changes must not vary more than 0.02 foot from the lower edge of a 12-foot-long straightedge placed parallel to the centerline of the POC
2. Surface must not vary more than 0.01 foot from the lower edge of a 6-foot-long straightedge placed perpendicular to the centerline of the POC

51-1.03G Concrete Surface Textures

51-1.03G(1) General

Provide the concrete surface textures shown. The Engineer determines the acceptability of the surface textures.

Construct a test panel for each type of concrete surface texture shown.

Fractured rib texture must consist of straight ribs of concrete with a fractured texture on the raised surface between ribs. Grooves between ribs must be (1) continuous with no apparent curves or discontinuities and (2) straight to within 1/4 inch in 10 feet. The texture must have random shadow patterns. Broken concrete at adjoining ribs and groups of ribs must have a random pattern. The texture must not have repetitive fractured surfaces or secondary shadow patterns.

Heavy blast texture must consist of an abrasive-blasted concrete surface of uniform color and sandy texture with air and water bubbles in the concrete partially exposed.

Formed relief texture must consist of a formed relief constructed to the dimensions and shapes shown with a Class 1 surface finish. Intersecting corners of plane surfaces must be sharp and crisp without easing or rounding.

Cure concrete surface textures by the forms-in-place or water methods.

51-1.03G(2) Form Liners

Use form liners for concrete surface textures except for heavy blast and formed relief textures. Other forming methods must be authorized.

Form liners must (1) be manufactured from an elastomeric material by a manufacturer of commercially available concrete form liners and (2) leave a crisp, sharp definition of the concrete surface texture.

Form liners must comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Shore A hardness	ASTM D2240	50–90
Tensile strength (psi, min)	ASTM D412	1,000

Comply with the form liner manufacturer's instructions for use.

Seal and repair cuts and tears in form liners under the form liner manufacturer's instructions. Do not use form liners that are delaminated or deformed.

Extend form liners the full length of texturing, with transverse joints at 8-foot minimum spacing. Do not use small pieces of form liners. Align grooves straight and true. Grooves must match at joints between form liners. For grooved patterns, joints in the direction of grooves must be located in depressions. Butt adjoining liners together without distortion, open cracks, or offsets. Clean joints between liners and remove mortar before use.

Adhesives must be compatible with the form liner material and the concrete. Adhesives must be recommended by the liner manufacturer and not cause swelling of the liner material.

Cast form liner patterns to prevent recurring textural configurations exhibited by repeating, recognizable shadow patterns. Remove surfaces with recurring textural configurations by reworking using authorized methods or by replacement.

Use a form release agent recommended by the form liner manufacturer. The release agent must not:

1. Cause swelling of the liner material
2. Cause delamination from the forms
3. Stain the concrete
4. React with the liner material

Coat form liners with a thin film of release agent. For textures with longitudinal patterns, apply the release agent using a natural bristle brush in the direction of the pattern. Clean excess release agent from liners using compressed air. Remove release agent buildup due to liner reuse at least every 5 uses.

Form liners must release without leaving pieces of liner on the concrete or removing concrete from the surface.

Except for formed relief textures, abrasive blast concrete surface textures with fine abrasive after removing forms to remove sheen without exposing coarse aggregate.

51-1.03H Curing Concrete Structures

Except for bridge decks, cure newly placed concrete for CIP structures using the water method or the forms-in-place method under section 90-1.03B.

Cure the top surface of bridge decks using both the curing compound method and the water method. The curing compound must be curing compound no. 1.

Cure the top surface of bridge decks to be sealed with butyl rubber membrane using only the water method.

For bridge decks and flat slabs using the water method without a curing medium, keep the entire surface damp by applying water with an atomizing nozzle that forms a mist and not a spray until the concrete has set. After the concrete has set, continuously sprinkle the entire concrete surface with water for at least 7 days.

You may use a pigmented curing compound complying with section 90-1.03B(3) for:

1. Concrete surfaces of construction joints
2. Concrete surfaces that are to be buried underground
3. Concrete surfaces not visible from a public traveled way, where only a ordinary surface finish is to be applied and a uniform color is not required

If you use the curing compound method on the bottom slab of box girder spans, the curing compound must be curing compound no. 1.

If ordered during periods of hot weather, apply water to concrete surfaces being cured by the curing compound method or by the forms-in-place method until the Engineer determines that a cooling effect is no longer required. This work is change order work.

Section 90-3.03 does not apply to curing RSC for bridge decks. Cure bridge decks constructed with RSC as follows:

1. Immediately after strike-off, continually mist the deck with water using atomizing nozzles. Continue misting until the concrete reaches a compressive strength of at least 2000 psi.
2. After misting, apply curing compound no. 1 to the deck under section 90-1.03B(3).

Repair any damage to the film of the curing compound with additional curing compound. Repairing damaged curing compound after the deck is opened to traffic is not required.

51-1.03I Protecting Concrete Structures

Maintain concrete at a temperature of not less than 45 degrees F for 72 hours after placing and at not less than 40 degrees F for an additional 4 days.

51-1.04 PAYMENT

The payment quantity for seal course concrete is the actual volume of seal course concrete placed except the maximum payment quantity is the volume of concrete contained between vertical planes 1 foot outside the neat lines of the seal course shown. The Department does not adjust the unit price for an increase or decrease in the seal course concrete quantity.

The payment quantity for structural concrete, drainage inlet is the volume determined from the dimensions shown for CIP drainage inlets.

51-2 JOINTS

51-2.01 GENERAL

51-2.01A General

51-2.01A(1) Summary

Section 51-2.01 includes general specifications for constructing, sealing, and protecting joints in concrete structures.

51-2.01A(2) Definitions

Reserved

51-2.01A(3) Submittals

Submit a certificate of compliance for polyethylene material for snowplow deflectors.

51-2.01A(4) Quality Assurance

Reserved

51-2.01B Materials

51-2.01B(1) General

Premolded expansion joint filler must comply with ASTM D1751.

Expanded polystyrene must be commercially available polystyrene board with (1) a flexural strength of at least 35 psi when tested under ASTM C203 and (2) a compressive yield strength from 16 to 40 psi at 5 percent compression. Face the surfaces of expanded polystyrene that concrete is placed against with 1/8-inch-thick hardboard complying with ANSI A135.4. You may use other facing materials that provide equivalent protection. Secure the hardboard using nails, waterproof adhesive, or other authorized means.

51-2.01B(2) Snowplow Deflectors

Snowplow deflectors must consist of ultra-high-molecular-weight polyethylene plates with anchorage devices.

Anchorage devices must comply with ASTM A276, UNS designation S32205 or S31803.

Ultra-high-molecular-weight polyethylene plates must be UV stabilized and comply with ASTM D4020 and the requirements shown the following table:

Quality characteristic	Test method	Requirement
Density (pcf, min)	ASTM D792	58
Tensile strength, ultimate (psi, min)	ASTM D638	5,800
Tensile strength, yield (psi, min)	ASTM D638	2,750
Elongation at break (percent)	ASTM D638	290
Hardness (Shore D, min)	ASTM D2240	60

51-2.01C Construction

51-2.01C(1) General

Construct open joints using a suitable material that you subsequently remove. Do not chip or break concrete corners when removing the material. Reinforcement must not extend across an open joint.

For filled joints, place premolded or expanded polystyrene joint filler in position before placing concrete. Fill holes and joints with mastic to prevent the passage of mortar or concrete.

Finish concrete edges at joints using an edger.

51-2.01C(2) Snowplow Deflectors

Drilling and bonding anchorage devices must comply with the specifications for drilling and bonding dowels in section 51-1.03E(3).

Where shown, apply a thread locking system to the anchorage devices under section 75-3.02B.

51-2.01D Payment

Not Used

51-2.02 SEALED JOINTS

51-2.02A General

51-2.02A(1) General

51-2.02A(1)(a) Summary

Section 51-2.02 includes general specifications for fabricating and installing sealed joints.

Sealed joints must:

1. Be in planned position
2. Resist the intrusion of foreign material and water
3. Provide bump-free passage of traffic

MR is measured normal to the longitudinal joint axis.

Use the seal type shown in the following table for the MR shown:

Movement rating	Seal type
MR ≤1 inch	Type A or B
1 inch < MR ≤ 2 inches	Type B
2 inches < MR ≤ 4 inches	Strip seal joint seal assembly
MR > 4 inches	Modular unit joint seal assembly or seismic joint

51-2.02A(1)(b) Definitions

Reserved.

51-2.02A(1)(c) Submittals

Submit a work plan for cleaning expansion joints. Include details for preventing material, equipment, or debris from falling onto traffic or railroad property.

51-2.02A(1)(d) Quality Assurance

Reserved

51-2.02A(2) Materials

You may clean and paint metal surfaces of joint seal assemblies instead of galvanizing. Cleaning and painting must comply with the specifications for new structural steel in section 59-2 except SSPC-QP 1, SSPC-QP 2, and AISC-420-10/SSPC-QP 3 certifications are not required. Finish coats are not required. Do not paint stainless steel or anchorages embedded in concrete.

51-2.02A(3) Construction

The Engineer may order you to install a joint seal larger than required by the MR. This work is change order work.

The joint opening at the time of placement must be that shown adjusted for temperature. Do not impair the joint clearance.

Cover or otherwise protect joints at all times before joint seals are installed. Do not allow debris or foreign material to enter joints.

Clean expansion joints at existing bridges before installing joint seals. Remove all existing seal material, dirt, debris, damaged waterstops, and joint filler. Use methods that do not damage existing sound concrete.

Verify the joint size after cleaning.

Clean existing joints with undamaged waterstops to the top of the waterstop unless the waterstop is to be removed.

Clean existing joints without waterstops and joints with damaged waterstops down to the hinge or bearing seat.

Repair joint damage as ordered.

Cleaning joints below existing waterstops that are damaged and repairing existing joint damage is change order work.

51-2.02A(4) Payment

Joint seals and joint seal assemblies are measured from end to end along the centerline of the completed seal, including return sections and curb faces.

51-2.02B Type A and AL Joint Seals

51-2.02B(1) General

51-2.02B(1)(a) Summary

Section 51-2.02B includes specifications for installing Type A and AL joints seals.

Type A and AL joint seals consist of field-mixed silicone sealant placed in grooves in the concrete.

51-2.02B(1)(b) Definitions

Reserved

51-2.02B(1)(c) Submittals

Submit a certificate of compliance and certified test report for each batch of sealant.

At least 30 days before use, submit 1-quart test samples of the following to METS:

1. Both components from each batch of sealant
2. Manufacturer-required primers

51-2.02B(1)(d) Quality Assurance

51-2.02B(1)(d)(i) General

Reserved

51-2.02B(1)(d)(ii) Department Acceptance

The Department tests sealants under California Test 435.

51-2.02B(2) Materials

The sealant must be a 2-component silicone type that withstands a ±50 percent movement.

The sealant must comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Modulus at 150 percent elongation (psi)	California Test 435	8–75
Recovery (inches, max)	California Test 435	21/32
Notch test	California Test 435	Notched or loss of bond, 1/4 inch max
Water resistance	California Test 435	Notched or loss of bond, 1/4 inch max
Ultraviolet exposure	California Test 435	No more than slight cracking or checking
Cone penetration (mm)	California Test 435	4.5–12.0

The sealant must be self-leveling and cure rapidly enough to not flow on grades up to 15 percent.

Label sealant containers or provide identification tickets for tanks of 2-component material. Include the following:

1. Material designation
2. Lot number
3. Manufacturer's name and instructions for use
4. Dates of manufacture, packing, and expiration

Do not use material that has expired unless it is retested and authorized.

Polyethylene foam or rod stock for retaining sealant must be commercial quality with a continuous, impervious glazed surface.

51-2.02B(3) Construction

51-2.02B(3)(a) General

Do not use sealant or adhesive that has skinned over or cannot be redispersed by hand stirring.

Abrasive blast clean joints and remove foreign material with high-pressure air immediately before installing seals. Protect waterstops during cleaning.

Joint surfaces must be surface dry when seals are placed.

Place the sealant using equipment that mixes and extrudes the sealant into the joint. The equipment and the sealant placement must be as recommended by the sealant manufacturer.

Do not use liquid components that have been exposed to air for more than 24 hours.

51-2.02B(3)(b) Type A Seal Preparation

For Type A joint seals, do not start cutting grooves until joint material is delivered to the job site.

Concrete saws for cutting grooves in the concrete must have diamond blades with a minimum thickness of 3/16 inch. Cut both sides of the groove simultaneously for a minimum 1st pass depth of 2 inches. The completed groove must have:

1. Top width within 1/8 inch of the width shown or ordered
2. Bottom width not varying from the top width by more than 1/16 inch for each 2 inches of depth
3. Uniform width and depth

Cutting grooves in existing decks includes cutting any conflicting reinforcing steel.

Saw cutting grooves is not required at the following locations:

1. Joints armored with metal
2. Joints in curbs, sidewalks, barriers, and railings, if grooves are formed to the required dimensions
3. Existing joints where Type A seals are to be installed

Remove all material from the deck joint to the bottom of the saw cut. Remove foreign material from joints in curbs, sidewalks, barriers, railings, and deck slab overhangs.

The Engineer may order you to saw cut grooves at existing joints to be sealed with a Type A joint seal. This work is change order work.

Repair spalls, fractures, or voids in the grooved surface at least 64 hours before installing the joint seal. Bevel the lips of saw cuts by grinding.

51-2.02B(3)(c) Type AL Seal Preparation

For Type AL joint seals, remove expanded polystyrene and foreign material to the depth of the joint seal. Grind or edge the lip of the joint.

51-2.02B(4) Payment

Not Used

51-2.02C Type B Joint Seals

51-2.02C(1) General

51-2.02C(1)(a) Summary

Section 51-2.02C includes specifications for installing Type B joint seals.

Type B joint seals consist of preformed elastomeric joint seals placed in grooves in the concrete.

51-2.02C(1)(b) Definitions

Reserved

51-2.02C(1)(c) Submittals

Submit a certificate of compliance with certified test report for each lot of elastomeric joint seal and lubricant-adhesive. Test reports must include the seal MR, the manufacturer's minimum uncompressed width, and test results.

Submit each joint seal test sample selected by the Engineer for testing with its certificate of compliance at least 30 days before use.

51-2.02C(1)(d) Quality Assurance

51-2.02C(1)(d)(i) General

Reserved

51-2.02C(1)(d)(ii) Quality Control

The Engineer selects test samples of joint seal material and lubricant-adhesive at random from each lot of material. Test samples are selected from stock at the job site or at a location acceptable to the Engineer and the manufacturer. Joint seal test samples must be at least 3 feet long.

Demonstrate the adequacy of installation procedures for Type B seals before starting installation activities.

51-2.02C(1)(d)(iii) Department Acceptance

Reserved

51-2.02C(2) Materials

Preformed elastomeric joint seals must:

1. Comply with ASTM D2628
2. Consist of a multi-channel, nonporous, homogeneous material furnished in a finished, extruded form
3. Have a minimum seal depth at the contact surface of at least 95 percent of the minimum uncompressed seal width designated by the manufacturer
4. Provide an MR of at least that shown when tested under California Test 673
5. Have the top and bottom edges in continuous contact with the sides of the groove throughout the entire range of joint movement
6. Be furnished full length for each joint with at most 1 shop splice in any 60-foot length

For seals that would admit water or debris, fill each cell to a depth of 3 inches at the open ends with open-cell polyurethane foam or close the cells by other authorized means.

You may make 1 field splice per joint if authorized. Splice location and method must be authorized. Seals must be manufactured full length and then cut at the splice location and rematched before splicing.

Shop and field splices must have no visible offset of exterior surfaces and no evidence of bond failure.

Combination lubricant-adhesive must comply with ASTM D4070.

51-2.02C(3) Construction

Prepare joints under section 51-2.02B(3)(b) except remove all material from the deck joint to the top of the waterstop or to the depth of the seal to be installed plus 3 inches.

Thoroughly clean contact surfaces and the top surface of the seal to within 1/2 inch from either edge immediately before applying the lubricant-adhesive. Liberally apply the lubricant-adhesive to vertical groove surfaces and the sides of the joint seal under the manufacturer's instructions.

Install joint seals full length for each joint using equipment that does not distort or damage the seal or the concrete. The top edges of the installed seal must be in a plane normal to the sides of the groove.

51-2.02C(4) Payment

Not Used

51-2.02D Joint Seal Assemblies with a Movement Rating of 4 inches or Less

51-2.02D(1) General

51-2.02D(1)(a) Summary

Section 51-2.02D includes specifications for fabricating and installing joint seal assemblies with an MR of 4 inches or less.

Joint seal assemblies with an MR of 4 inches or less must consist of metal or metal and elastomeric assemblies placed in recesses over joints. Strip seal joint seal assemblies consist of a 1 joint cell.

If authorized, you may use an alternative joint seal assembly if:

1. Quality of the alternative assembly and its suitability for the intended application are at least equal to that of the joint seal assembly shown. The factors to be considered include the ability of the assembly

to resist the intrusion of foreign material and water throughout the full range of movement for the application and the ability to function without distress to any component.
2. Alternative joint seal assembly has had at least 1 year of proven satisfactory service under conditions similar to those described.

51-2.02D(1)(b) Definitions

Reserved

51-2.02D(1)(c) Submittals

51-2.02D(1)(c)(i) General

For alternative joint seal assemblies, submit a certificate of compliance for each shipment of joint seal materials. The certificate must state that the materials and fabrication involved comply with the specifications and the data submitted in obtaining the authorization for the alternative joint seal assembly.

51-2.02D(1)(c)(ii) Shop Drawings

For alternative joint seal assemblies, submit 5 copies of shop drawings for each joint seal assembly to OSD, Documents Unit. Notify the Engineer of your submittal. Include in the notification the date and contents of the submittal.

After review, submit 6 to 12 copies, as requested, for final authorization and use during construction. Include details of the joint seal assembly and anchorage components, method of installation, blockout details, and additions or rearrangements of reinforcing steel.

If requested, submit supplemental calculations for each proposed alternative joint seal assembly.

Include in the shop drawings the thermal equation for setting the minimum joint opening at installation.

Shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer.

Allow 25 days for the Department's review.

Submit 1 corrected copy to OSD, Documents Unit, for each joint seal assembly within 20 days of final authorization.

51-2.02D(1)(d) Quality Assurance

Reserved

51-2.02D(2) Materials

51-2.02D(2)(a) General

Metal parts must comply with section 75-3.

Bolts, nuts, and washers must comply with ASTM F3125, Grade A325.

Sheet neoprene must comply with the specifications for neoprene in section 51-2.04B. Fabricate sheet neoprene to fit the joint seal assembly accurately.

51-2.02D(2)(b) Alternative Joint Seal Assemblies

Alternative joint seal assemblies must have CIP anchorage components for casting into the deck.

The anchorage components must include anchor studs spaced at a maximum of 4-1/2 inches. The studs must be at least 5/8 inch in diameter and 8 inches long, except the studs may be 6 inches long in the overhang.

Instead of complying with section 75-3, metal parts may comply with ASTM A572/A572M.

Elastomer must be neoprene complying with the requirements shown in Table 1 of ASTM D2628, except recovery and compression-deflection tests are not required, and the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Hardness (points, Type A durometer)	ASTM D2240 (modified)	55–70
Compression set (percent, max, 70 hours at 100 °C)	ASTM D395 (modified)	40

The design loading must be the AASHTO LRFD Bridge Design Specifications Design Truck with 100 percent dynamic load allowance. The tire contact area must be 10 inches measured normal to the longitudinal assembly axis by 20 inches wide. The assembly must provide a smooth-riding joint without slapping of components or tire rumble.

The MR of the assembly must be measured normal to the longitudinal axis of the assembly. Dimensions for positioning the assembly within the MR during installation must be measured normal to the longitudinal axis. Do not consider skew of the deck expansion joint.

The maximum depth and width of the recess must be such that the primary reinforcement providing the necessary strength of the structural members is outside the recess. The maximum depth at abutments and hinges is 10 inches. The maximum width on each side of the expansion joint is 12 inches.

Horizontal angle points and vertical corners at curbs must be premolded sections or standard sections of the assembly that have been miter cut or bent to fit.

51-2.02D(3) Construction

Deck surfaces must comply with section 51-1.03F(5) before placing and anchoring joint seal assemblies. POC deck surfaces must comply with section 51-1.03F(6) before placing and anchoring joint seal assemblies.

Preassemble metal parts of assemblies before installation to verify geometry.

Except for primary reinforcement, continue reinforcement through the recess construction joint into the recess and engage anchorage components of the assembly.

Thoroughly clean joints immediately before installing sheet neoprene. Install sheet neoprene at such time that it will not be damaged by construction activities.

Place the assembly in the blocked-out recess in the concrete deck surface. The depth and width of the recess must allow the installation of the assembly anchorage components or anchorage bearing surface to the lines and grades shown.

For alternative joint seal assemblies, install elastomer under the manufacturer's instructions. Thoroughly clean the joint and blockout immediately before elastomer installation.

51-2.02D(4) Payment

Not Used

51-2.02E Joint Seal Assemblies with a Movement Rating Over 4 inches

51-2.02E(1) General

51-2.02E(1)(a) Summary

Section 51-2.02E includes specifications for fabricating and installing joint seal assemblies with an MR over 4 inches.

Joint seal assemblies and seismic joints consist of metal or metal and elastomeric assemblies anchored or cast into a recess in the concrete over the joint.

51-2.02E(1)(b) Definitions

Reserved

51-2.02E(1)(c) Submittals

51-2.02E(1)(c)(i) General

Reserved

51-2.02E(1)(c)(ii) Shop Drawings

Submit shop drawings for each joint seal assembly to OSD, Documents Unit. Notify the Engineer of your submittal. Include in the notification the date and contents of the submittal.

If requested, submit supplemental calculations for each proposed alternative joint seal assembly.

Shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer.

Allow 30 days for the Department's review.

After review, submit 6 to 12 copies, as requested, for final authorization and use during construction. Include details of the joint seal assembly and anchorage components, method of installation, blockout details, and additions or rearrangements of reinforcing steel.

Submit 1 corrected copy to OSD, Documents Unit, for each joint seal assembly within 20 days of authorization.

51-2.02E(1)(c)(iii) Certificate of Compliance

Submit a certificate of compliance for each shipment of joint seal assembly materials.

51-2.02E(1)(d) Quality Assurance

51-2.02E(1)(d)(i) General

Vertical expansion joints in barriers must be accessible for inspection after recess concrete is placed.

Joint seal assemblies will not be authorized without evidence of 1 year of satisfactory service under similar conditions.

51-2.02E(1)(d)(ii) Quality Control

A qualified representative of the assembly manufacturer must be present during the installation of the 1st assembly and available during remaining installations.

51-2.02E(1)(d)(iii) Department Acceptance

Reserved

51-2.02E(2) Materials

51-2.02E(2)(a) General

Joint seal assemblies must consist of a metal frame system, supporting rails, and support bars with intervening neoprene glands.

Neoprene glands must comply with the requirements shown in Table 1 of ASTM D2628, except recovery and compression-deflection tests are not required, and the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Hardness (points, Type A durometer)	ASTM D2240 (modified)	55–70
Compression set (percent, max, 70 hours at 100 °C)	ASTM D395 (modified)	40

Metal parts of the joint seal assembly must comply with section 75-3 or ASTM A572/A572M. Bolts, nuts, and washers must comply with the specifications for HS steel fastener assemblies in section 75-1.

Anchorage components must include anchor studs spaced at a maximum of 4-1/2 inches. Studs must be at least 5/8 inch in diameter and 8 inches long, except the studs may be 6 inches long in the overhang.

Assemblies must be assembled completely at the fabrication site.

51-2.02E(2)(b) Design Requirements

If the assembly consists of more than 1 component, design the assembly such that the external components can be removed and reinstalled at any position within the larger half of the MR to allow for inspection of the internal components.

Except for components in contact with the tires, the design loading must be the AASHTO LRFD Bridge Design Specifications Design Truck with 100 percent dynamic load allowance. Each component in contact with the tires must support a minimum of 80 percent of the AASHTO LRFD Bridge Design Specifications Design Truck with 100 percent dynamic load allowance. The tire contact area must be 10 inches measured normal to the longitudinal assembly axis by 20 inches wide. The assembly must provide a smooth-riding joint without slapping of components or tire rumble.

The maximum width of unsupported or yielding components or grooves in the roadway surface of the assembly must be 3 inches measured in the direction of vehicular traffic.

Assemblies must be capable of adjustment to the "a" dimension shown.

The assembly must have CIP anchorage components that form a mechanical connection between the joint components and the concrete deck.

51-2.02E(3) Construction

Measure dimensions for positioning the assembly during installation normal to the longitudinal axis of the assembly, disregarding the skew of the deck expansion joint.

Deck surfaces must comply with section 51-1.03F(5) before placing joint seal assemblies and anchorages.

Place each assembly into a blocked-out recess in the concrete deck surface. The depth and width of the recess must allow the installation of the assembly anchorage components or anchorage bearing surface to the lines and grades shown.

Except for primary reinforcement, continue reinforcement through the recess construction joint into the recess and engage anchorage components of the assembly.

Install each assembly with a watertight, continuous return 6 inches up into barriers at the low side of the deck. Neoprene glands must be continuous without field splices or joints.

51-2.02E(4) Payment

Not Used

51-2.02F Asphaltic Plug Joint Seals

51-2.02F(1) General

51-2.02F(1)(a) Summary

Section 51-2.02F includes specifications for constructing asphaltic plug joint seals.

Asphaltic plug joint seals consist of an asphaltic binder and aggregate joint seal system.

51-2.02F(1)(b) Definitions

Reserved

51-2.02F(1)(c) Submittals

51-2.02F(1)(c)(i) General

Reserved

51-2.02F(1)(c)(ii) Shop Drawings

Submit 5 copies of shop drawings for the proposed asphaltic plug joint seal system to OSD, Documents Unit. Notify the Engineer of your submittal. Include in the notification the date and contents of the submittal.

Allow 30 days for the Department's review. After review, submit 6 to 12 copies, as requested, for final authorization and use during construction.

51-2.02F(1)(c)(iii) Product Data

Submit evidence from the manufacturer that 5,000 linear feet of the joint seal has had at least 2 years of satisfactory service under similar conditions.

51-2.02F(1)(c)(iv) Certificate of Compliance

Submit certificates of compliance for materials used in the joint seals.

Submit a copy of the certified test report for binder material.

51-2.02F(1)(c)(v) Samples

Submit a 10-pound test sample of binder material to METS. The test sample must be removed from the same material to be shipped to the job site. Submit the test sample at least 15 days before shipment to the job site.

51-2.02F(1)(d) Quality Assurance

51-2.02F(1)(d)(i) General

Reserved

51-2.02F(1)(d)(ii) Quality Control

Binder material must be tested and certified by an authorized laboratory.

A technical representative of the joint seal manufacturer must be present during installation.

51-2.02F(2) Materials

All joint components must be from a single manufacturer.

The binder must be a thermoplastic, polymeric-modified asphalt; thermoplastic, polymer-modified bitumen; polymer-modified asphalt sealant; or modified elastomeric binder complying with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Asphalt compatibility	ASTM D5329	Pass
Bond, nonimmersed at -20 °F, 50% at 0 °F, 100%	ASTM D5329	 Pass 3 cycles Pass 3 cycles
Cone penetration, nonimmersed (mm) 200 g total weight, 60 seconds at 0 ± 2 °F 150 g total weight, 5 seconds at 77 ± 2 °F	ASTM D5329 (modified)	 1, min 9, max
Ductility (cm, min, at 77 ± 2 °F)	ASTM D113	40
Flexibility (at 10 ± 2 °F)	ASTM D5329[a]	Pass
Flow (mm, max, 5 hours at 140 ± 2 °F)	ASTM D5329	3
Resilience (percent, min, at 77 ± 2 °F)	ASTM D5329	40
Softening point (°F, min)	ASTM D36	180
Tensile adhesion (percent, min)	ASTM D5329	550
Safe heating temperature (°F)		390–410
Recommended pouring temperature (°F)		360–390

[a]Do not oven age specimens. After 24 hours at standard conditions, allow specimens to condition at -10 ± 2 °F for 2 hours before testing.

Binder material delivered to the job site must be labeled with:

1. Manufacturer's name
2. Lot or batch number
3. Dates of manufacturing, packaging, and expiration
4. Manufacturer's instructions for use

Binder material must be retested and recertified for use if the expiration date passes.

Aggregates must comply with:

1. Section 90-1.02C except the results of cleanness value and sand equivalent tests must comply with the requirements for both operating range and contract compliance
2. Asphaltic plug manufacturer's instructions

The polyethylene backer rod must be commercial quality with a continuous, impervious, glazed surface that can withstand the hot liquid binder material and is suitable for retaining the hot liquid binder while it hardens.

The bridging plate must be 8 inches wide and at least 1/4 inch thick and comply with ASTM A36/A36M.

Cut the bridging plate into 48-inch-minimum-length sections. Place holes for locating pins along the longitudinal plate centerline 12 inches on center. The locating pins must be at least 16d common steel nails or equal.

51-2.02F(3) Construction

Uniformly double wash and dry natural aggregates before use.

Remove existing expansion dams and asphaltic concrete to the limits shown. Do not damage the deck or remaining asphaltic concrete.

Steel dowels exposed when removing concrete must be cut off flush with the existing concrete or at the bottom of concrete removal, whichever is lower. Patching around or over dowels in sound concrete is not required. Chip voids back to sound concrete and fill voids with magnesium phosphate concrete.

Clean expansion joints under section 51-2.02C(3). Repair spalls if ordered. Repairing spalls is change order work.

Abrasive blast blockout surfaces to receive the asphaltic plug joint seal.

Clean and dry blockout surfaces and the adjacent 6 inches of roadway immediately before placing the joint seal. Use a hot air lance producing a minimum temperature of 2,500 degrees F and a directional velocity of at least 2,500 ft/sec. There must be no moisture present during installation.

Place the top of the backer rod to a depth of at least 1 inch and at most equal to the width of the existing gap below the bottom of the blockout.

Center bridging plate sections over the existing gap. Place the sections flat on the bottom of the blockout. The sections must be butt jointed. Do not overlap the sections or allow gaps between the plate and blockout.

Install the joint seal under the manufacturer's instructions.

51-2.02F(4) Payment

Not Used

51-2.03 SLIDING JOINTS

51-2.03A General

Section 51-2.03 includes specifications for constructing sliding joints.

Sliding joints consist of neoprene strips lubricated with silicone grease and covered with sheet metal.

51-2.03B Materials

Neoprene strips must comply with the specifications for neoprene in section 51-2.04B.

Silicone grease must comply with Society of Automotive Engineers AS 8660.

Sheet metal must be commercial-quality galvanized sheet steel, smooth and free of kinks, bends, or burrs. Joints must be butt joints sealed with plastic, duct-sealing tape.

51-2.03C Construction

Apply a uniform film of silicone grease to the upper surface of the neoprene strip before placing the sheet metal.

Float the concrete surfaces where neoprene strips are placed to a level plane and finish with a steel trowel.

Do not allow grout or concrete seepage into the sliding joint during concrete placement.

51-2.03D Payment

Not Used

51-2.04 WATERSTOPS

51-2.04A General

51-2.04A(1) Summary

Section 51-2.04 includes specifications for installing waterstops.

51-2.04A(2) Definitions

Reserved

51-2.04A(3) Submittals

Submit a certificate of compliance for waterstop material. The certificate of compliance for PVC waterstop must include a statement that the material complies with item 6 of Army Corps of Engineers CRD-C 572.

51-2.04A(4) Quality Assurance

Reserved

51-2.04B Materials

Waterstops must be manufactured from neoprene or PVC.

Neoprene must (1) be manufactured from a vulcanized elastomeric compound containing neoprene as the only elastomer and (2) comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Tensile strength (min, psi)	ASTM D412	2,000
Ultimate elongation (min, percent)	ASTM D412	300
Compression set (max, percent, 22 hours at 70 °C)	ASTM D395, Method B	30
Tear strength (min, kN/m)	ASTM D624, Die C	26
Hardness, Type A (points)	ASTM D2240	55 ± 5
Ozone resistance (20% strain, 100 hours at 100 ± 2.2 °F)	ASTM D1149 except 100 ± 20 parts per 100,000,000	No cracks
Brittleness temperature at -40 °C	ASTM D746, Section 9.1.2	Pass
Flame propagation	ASTM C542	Must not propagate flame
Change in volume (max, percent, IRM 903, immersed 70 hours at 100 °C)	ASTM D471	80
Change in mass (max, percent, immersed 7 days at 70 °C)	ASTM D471	15

After accelerated aging under ASTM D573 for 70 hours at 100 degrees C, the elastomer must not show quality characteristic changes greater than those shown in the following table:

Quality characteristic	Requirement
Tensile strength (percent)	-15
Elongation at break (percent)	-40
Hardness (points)	+10

PVC waterstops must (1) be manufactured from PVC complying with CRD-C 572 and (2) comply with the ozone resistance requirement for neoprene.

Furnish waterstops full length for straight portions of joints. Manufacturer's shop splices must be fully vulcanized.

51-2.04C Construction

Use spacers, wire, or other authorized methods to secure reinforcing bars supporting waterstops.

If waterstops are out of shape or position after placing concrete, remove the concrete and reset waterstops.

Field splices for neoprene waterstops must be one of the following:

1. Vulcanized
2. Mechanical using stainless steel parts
3. Made with a splicing union of the same stock as the waterstop

Completed field splices must have a full-size tensile strength of 100 pounds per inch of width.

Field splice PVC waterstops by heat sealing under the manufacturer's instructions. Do not burn the plastic when melting.

Cut and splice waterstops at changes in direction as necessary to avoid buckling or distortion of the waterstop.

51-2.04D Payment

Not Used

51-2.05 STRIP WATERSTOPS

51-2.05A General

Section 51-2.05 includes specifications for installing strip waterstops.

51-2.05B Materials

The neoprene sheet must comply with the specifications for neoprene in section 51-2.04B.

The neoprene adhesive must comply with Federal Specification MMM-A-121.

The protective board must be at least 1/2-inch-thick wood or fiberboard that is at least 4 ft long and the width shown.

The neoprene sheet must be smooth and free from pin holes or surface blemishes and show no sign of delamination.

51-2.05C Construction

Join neoprene sheets as follows:

1. Lap the sheets at least 12 inches.
2. Apply the adhesive to both faces at the manufacturer's recommended rate.
3. Let the adhesive dry to an aggressive tack.
4. Bring the sheets together and roll in both directions to obtain a tight bond.

Abrasive blast clean the concrete surfaces to receive a strip waterstop. Allow the cleaned surfaces to air dry 24 hours before applying the adhesive.

Surfaces where adhesive is to be applied must have a cloth finish or a buffed finish. Surfaces must be clean and dry when the adhesive is applied.

Apply the adhesive to the concrete and neoprene sheet at the manufacturer's recommended rate. Let the adhesive dry to an aggressive tack. Apply the sheet to the concrete surface and roll in both directions to obtain a tight bond.

Completely cover the installed strip waterstops with 1 layer of protective board attached with adhesive. The protective board must remain in place until backfilling is complete.

51-2.05D Payment

Not Used

51-3 BEARINGS

51-3.01 GENERAL

51-3.01A General

Section 51-3 includes specifications for fabricating and installing bearings.

51-3.01B Materials

Not Used

51-3.01C Construction

Not Used

51-3.01D Payment

Not Used

51-3.02 ELASTOMERIC BEARING PADS

51-3.02A General

51-3.02A(1) Summary

Section 51-3.02 includes specifications for fabricating and installing elastomeric bearing pads.

51-3.02A(2) Definitions

Reserved

51-3.02A(3) Submittals

51-3.02A(3)(a) General

Reserved

51-3.02A(3)(b) Samples

51-3.02A(3)(b)(i) General

Reserved

51-3.02A(3)(b)(ii) Plain Elastomeric Bearing Pads

For plain elastomeric bearing pads, the Engineer selects a test sample that is at least 8 by 12 inches from each lot of pads or batch of elastomer to be furnished, whichever results in the larger number of test samples.

You may designate that test samples be taken at the point of manufacture or at the job site. Job site test samples are completed pads as shown.

Submit plain elastomeric bearing pad test samples at least 30 days before use. Furnish additional pads to replace the pads selected for testing.

51-3.02A(3)(b)(iii) Steel-Reinforced Elastomeric Bearing Pads

Submit 1 test sample from each lot of steel-reinforced bearing pads at least 20 days before use. The size of the test sample must be as shown in the following table:

Bearing pad thickness	Test sample size
2 inches or less	Smallest complete bearing shown
More than 2 inches	2.25 ± 0.125-inch-thick test sample at least 8 by 12 inches cut by the manufacturer from the center of the thickest complete bearing[a]

[a]Submit the test sample and the remaining parts of the complete bearing.

51-3.02A(3)(c) Certificate of Compliance

51-3.02A(3)(c)(i) General

Reserved

51-3.02A(3)(c)(ii) Plain Elastomeric Bearing Pads

Submit a certificate of compliance with certified test results for the elastomer for plain elastomeric bearing pads.

51-3.02A(3)(c)(iii) Steel-Reinforced Elastomeric Bearing Pads

Submit a certificate of compliance with certified test results from the bearing manufacturer for steel-reinforced elastomeric bearing pads.

51-3.02A(4) Quality Assurance

51-3.02A(4)(a) General

Reserved

51-3.02A(4)(b) Department Acceptance

51-3.02A(4)(b)(i) General

Reserved

51-3.02A(4)(b)(ii) Plain Elastomeric Bearing Pads

The Department takes specimens from the test sample, prepares them by cutting and grinding, and tests them for tensile strength, elongation, tear strength, and ozone resistance under section 51-3.02B(2).

51-3.02A(4)(b)(iii) Steel-Reinforced Elastomeric Bearing Pads

The Department tests a specimen taken from the test sample for tensile strength, elongation, and strength under section 51-3.02B(2). Specimens must show no loss of bond between the steel and elastomer laminates.

51-3.02B Materials

51-3.02B(1) General

Elastomeric bearing pads 1/2 inch or less in thickness must comply with section 51-3.02B(2).

Elastomeric bearing pads over 1/2 inch in thickness must comply with section 51-3.02B(2) or section 51-3.02B(3).

Silicone grease must comply with Society of Automotive Engineers AS 8660.

Sheet metal must be commercial-quality galvanized sheet steel, smooth and free of kinks, bends, or burrs. Joints must be butt joints sealed with plastic duct-sealing tape.

51-3.02B(2) Plain Elastomeric Bearing Pads

For plain elastomeric bearing pads, pads 1/2 inch or less in thickness must be either laminated or all elastomer. Pads over 1/2 inch in thickness must be laminated. The stacking of individually laminated pads to attain thicknesses over 1/2 inch or the cold bonding of individual laminated pads is not allowed.

Elastomeric bearing pads may be cut from large sheets. Cutting must be performed so as to avoid heating of the material, to produce a smooth edge with no tears or other jagged areas, and to cause as little damage to the material as possible.

Neoprene must be the only polymer in the elastomeric compound and must be not less than 60 percent by volume of the total compound. The elastomer must comply with ASTM D4014, Type CR, Grade 3, with a shear modulus of 110 ± 10 psi.

The elastomer must comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Tensile strength (min, psi)	ASTM D412	2,250
Ultimate elongation (min, %)	ASTM D412	350
Compression set (max, %, 22 hours at 70 °C)	ASTM D395, Method B	25
Tear strength (min, kN/m)	ASTM D624, Die C	31.5
Hardness, Type A (points)	ASTM D2240 with 2 kg mass	55 ± 5
Ozone resistance (20% strain, 100 hours at 40 ± 2 °C)	ASTM D1149 except 100 ± 20 parts per 100,000,000	No cracks
Instantaneous thermal stiffening at -40 °C	ASTM D1043	Not more than 4 times the stiffness measured at 23 °C
Low temperature brittleness at -40 °C	ASTM D746, Section 9.1.2	Pass

After accelerated aging under ASTM D573 for 70 hours at 100 degrees C, the elastomer must not show quality characteristic changes greater than those shown in the following table:

Quality characteristic	Requirement
Tensile strength (% loss)	15
Ultimate elongation (% loss)	40; but not less than 300 percent total elongation of the material
Hardness (points)	+10

51-3.02B(3) Steel-Reinforced Elastomeric Bearing Pads

Steel-reinforced elastomeric bearing pads must comply with the specifications for steel-laminated elastomeric bearings in ASTM D4014 and the following:

1. Bearing pads must consist of alternating steel laminates and internal elastomer laminates with top, bottom, and side elastomer covers. Steel laminates must have a nominal thickness of 0.075 inch (14 gauge). Internal elastomer laminates must have a thickness of 1/2 inch. Top and bottom elastomer covers must each have a thickness of 1/4 inch. The combined thickness of internal elastomer laminates and top and bottom elastomer covers must be equal to the bearing pad thickness shown. The elastomer cover to the steel laminates at the sides of the bearing must be 1/8 inch. If guide pins or other devices are used to control the side cover over the steel laminates, any exposed portions of the steel laminates must be sealed by vulcanized patching.
2. Total bearing thickness must be equal to the sum of the thicknesses of the elastomeric laminates and covers and the steel laminates.
3. Elastomer must comply with section 51-3.02B(2).

51-3.02C Construction

Notify the Engineer of the type of bearing pad to be used before constructing the bearing seats. The bearing seat elevation must correspond to the selected bearing thickness.

Where shown, lubricate the upper surface of the elastomeric bearing pad with a uniform film of silicone grease before placing the sheet metal cover.

Do not allow grout or concrete seepage into the sliding surface during concrete placement.

51-3.02D Payment

Not Used

51-3.03 PTFE SPHERICAL BEARINGS

51-3.03A General

51-3.03A(1) Summary

Section 51-3.03 includes specifications for fabricating and installing PTFE spherical bearings.

PTFE spherical bearings consist of PTFE and stainless steel bearing surfaces, stainless steel plates, and anchors. PTFE spherical bearings are either (1) fixed type with spherical bearing surfaces or (2) expansion type with spherical and sliding bearing surfaces.

51-3.03A(2) Definitions

load category: PTFE spherical bearings of differing vertical load capacity within a range defined as follows:

1. Bearings of 500 kips capacity or less
2. Bearings over 500 kips up to and including 2,000 kips capacity
3. Bearings over 2,000 kips capacity

Bearings in 2 different load categories that have vertical load capacities within 180 kips of each other are considered to be in 1 load category for proof testing.

51-3.03A(3) Submittals

51-3.03A(3)(a) General

Submit proof that the bearing manufacturer has furnished PTFE spherical bearings that have had at least 3 years of satisfactory service for 2 projects with similar conditions to this project.

Submit certificates of compliance for the materials used in PTFE bearings.

Submit test reports for proof-tested bearings signed by the personnel conducting the testing. Include bearing numbers of the tested bearings and the names of the personnel interpreting the test results. If proof tests cannot be performed at the specified load, submit a testing plan listing additional physical tests to be performed.

51-3.03A(3)(b) Shop Drawings

Submit shop drawings to OSD, Documents Unit. Notify the Engineer of your submittal. Include in the notification the date and list of contents of the submittal.

For initial review, submit 6 copies for railroad bridges and 4 copies for other structures. After review, submit 6 to 12 copies, as requested, for authorization and use during construction. Allow 55 days for the Department's review for railway bridges and at least 45 days for all other structures.

Shop drawings must include a description of the method of mechanical interlocking of PTFE fabric to the metallic substrate.

At locations other than hinges, shop drawings must include temporary support details for the bearing sole plate during concrete placement.

51-3.03A(4) Quality Assurance

51-3.03A(4)(a) General

The bearing manufacturer must have furnished PTFE spherical bearings that have had at least 3 years of satisfactory service for 2 projects with similar conditions to this project.

A qualified representative of the bearing manufacturer must be present during installation of the 1st bearing and be available during remaining installations.

Templates for the spherical surfaces must be available for inspection.

51-3.03A(4)(b) Quality Control

51-3.03A(4)(b)(i) General

Reserved

51-3.03A(4)(b)(ii) Proof Testing

Proof test the PTFE spherical bearings in the Engineer's presence as follows:

1. Test fixed-type bearings for compression.
2. Test expansion-type bearings for compression and initial static coefficient of friction.

Proof test 1 bearing from each lot of production bearings. A lot of bearings is 25 bearings, or fraction thereof, of the same type within a load category.

The Engineer selects random test samples from each lot of production bearings. Notify the Engineer at least 7 days before starting proof testing.

If proof tests cannot be performed at the specified load, perform the additional physical tests described in the testing plan in the presence of the Engineer. The tests must demonstrate that the requirements for proof testing at the specified load are satisfied.

Before proof testing, the test bearings must be conditioned for 12 hours at 75 ± 5 degrees F. Clean the bearing surfaces before testing.

For compression testing of PTFE spherical bearings:

1. Rotate the bearings at the design rotation or 0.02 radians, whichever is greater, and hold for 1 hour at a load of 1.5 times the maximum vertical load capacity. You may rotate the bearing by inserting a beveled plate between the bearing and the restraining surface before loading.
2. Maintain the bearing in a rotated position during testing.

For coefficient of friction testing of PTFE spherical bearings:

1. Continuously load the bearing to the minimum dead load for 12 hours before testing. Maintain the dead load during testing.
2. Measure the initial static coefficient of friction on the 1st movement of the bearing.
3. Measure the initial static and dynamic coefficients of friction at a sliding speed of not more than 1 inch per minute. The initial static friction must not exceed that specified.
4. Cycle the test bearings for a minimum of 100 movements. Each movement must consist of at least 1 inch of relative movement at a sliding speed of not more than 12 inches per minute. After cycling, measure the initial static and dynamic coefficients of friction at a sliding speed of not more than 1 inch per minute. The initial static friction must not exceed that specified.

Proof-tested bearings must not show any signs of the following:

1. Bond failure of bearing surfaces
2. Separation or lift-off of plates from each other or from PTFE surfaces
3. Excessive transfer of PTFE to the stainless steel surface
4. Other defects

If a proof-tested bearing fails to comply with the above requirements, proof test all the remaining bearings in the lot.

51-3.03B Materials

51-3.03B(1) General

Welding must comply with AWS D1.1 except welding of stainless steel must comply with AWS D1.6.

PTFE spherical bearings must be self-lubricating.

PTFE surfaces must be unfilled fabric made from virgin PTFE oriented multifilament and other fibers. Filament resin must comply with ASTM D4441.

At the highest point of substrate and after compression, the PTFE fabric must have a thickness from 1/16 to 1/8 inch.

Steel plates must comply with ASTM A709/A709M.

Stainless steel plates must comply with ASTM A240/A240M, Type 304, and be at least 1/8 inch thick.

Surfaces of flat stainless steel that mate with PTFE surfacing must have a minimum no. 8 mirror finish. Surfaces of curved stainless steel that mate with PTFE surfacing must have a finish of less than 16 microinches root mean square. Determine the finish under ANSI B46.1.

PTFE spherical bearings must have an initial static coefficient of friction of at most 0.06.

Stud connectors must comply with section 55-1.02.

Protect bearing surfaces from contamination and weather damage.

51-3.03B(2) Fabrication

Flat stainless steel surfaces must be a weld overlay on structural steel plate or a solid or sheet stainless steel.

Curved stainless steel surfaces must be solid stainless steel except curved stainless steel surfaces over 6 inches thick may be a weld overlay on structural steel plate.

If a weld overlay is used for stainless steel surfacing, attach the overlay by submerged arc welding using Type 309L electrodes. The completed overlay must have a 3/32-inch minimum thickness after fabrication.

If stainless steel sheets are used for stainless steel surfacing, attach the sheets by perimeter arc welding using Type 309L electrodes. After welding, the stainless steel surface must be smooth and without waves.

Plate radius dimensional tolerances are from 0.000 to -0.010 inch for convex plates and from +0.010 to 0.000 inch for concave plates.

Use full-size convex and concave metal templates for the spherical surfaces of each bearing radius.

PTFE fabric backing material on bearing surfaces must be epoxy bonded and mechanically interlocked to the steel substrate. Bonding must be performed under controlled factory conditions. The mechanical interlock on the spherical concave surface must be integrally machined into the steel substrate. Welded retention grids are not allowed on the concave surface. Except for the selvage, oversaw or recess edges such that no cut fabric edges are exposed.

During fabrication, the maximum temperature of bonded PTFE surfaces must be 300 degrees F.

After bonding to the substrate, the PTFE surface must be smooth and free from bubbles.

Assemble PTFE spherical bearings at the fabrication site.

The PTFE and stainless steel interfaces must be in full bearing after completing assembly.

Use at least 4 steel straps bolted to threaded holes in the masonry and sole plates to secure each bearing assembly as a unit for shipment. Steel straps must (1) not be welded and (2) be adequate to use for lifting the bearing assembly. Bearings must be shipped as a unit and remain intact when uncrated and installed.

51-3.03C Construction

Prepare concrete surfaces to receive PTFE spherical bearings under section 55-1.03C(3).

The Engineer must be present during the dismantling of each bearing assembly at the job site.

Temporarily support PTFE bearing sole plates during concrete placement. Temporary supports must prevent rotation or displacement of the bearings. Temporary supports must not (1) inhibit the function of the PTFE bearings after concrete is placed or (2) restrict movement at bridge joints due to temperature changes and prestress shortening. Materials for temporary supports must comply with the requirements for form fasteners in section 51-1.03C(2)(a).

Replace or resurface damaged bearings and bearings with scratched mating surfaces. Resurfacing must be performed at the bearing manufacturer's plant.

51-3.03D Payment

The payment quantity for PTFE spherical bearings does not include the test bearings. A PTFE spherical bearing with more than 1 PTFE surface is 1 bearing.

51-3.04–51-3.05 RESERVED

51-4 PRECAST CONCRETE MEMBERS

51-4.01 GENERAL

51-4.01A Summary

Section 51-4 includes specifications for constructing precast concrete members.

Prestressing concrete members must comply with section 50.

Cure PC concrete members under section 90-4.03.

Furnishing PC concrete members includes furnishing members to the job site ready to incorporate into the work.

Erecting PC concrete members includes erecting members into final position in the work.

51-4.01B Definitions

Reserved

51-4.01C Submittals

51-4.01C(1) General

Submit a certificate of compliance signed by the manufacturer's QC representative for each PC concrete box culvert shipment.

For PC PS concrete girders, submit a girder erection work plan. Include procedures, details, and sequences for unloading, lifting, and erecting girders and for temporary bracing installation. The work plan must be signed by an engineer who is registered as a civil engineer in the State.

For PC drainage inlets, submit field repair procedures and a patching material test sample before repairs are made. Allow 10 days for the Engineer’s review.

51-4.01C(2) Shop Drawings

51-4.01C(2)(a) General

Submit shop drawings for PC concrete members.

For drainage inlets with oval or circular cross sections, submit shop drawings with calculations. Shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer in the State. Allow 15 days for the Engineer's review.

51-4.01C(2)(b) Girders

For PC PS concrete girders, shop drawings must include:

1. Anticipated deflections of the girders before deck placement and the methods of accommodation. Include the following anticipated deflections:
   1.1 Upward deflection due to prestressing forces
   1.2 Downward deflection due to girder dead load
   1.3 Deflection due to creep and shrinkage from the time of girder stressing to the planned deck placement
2. Deflection calculations that consider the age of the girder concrete when stressing and the planned placement of the deck. Use the concrete producer's estimated modulus of elasticity at the applicable concrete age for calculating deflections.

For segmental or spliced-girder construction, shop drawings must include the following additional information:

1. Details showing construction joints or closure joints
2. Arrangement of bar reinforcing steel, prestressing tendons, and pressure grouting pipe

3. Materials and methods for making closures
4. Construction joint keys and surface treatment
5. Other requested information

For segmental girder construction, shop drawings must include concrete form and casting details.

51-4.01C(2)(c) Closure Wall Panels

Submit 2 copies of shop drawings for PC concrete closure wall panels as an informational submittal. Include in the submittal:

1. Panel dimensions
2. Materials
3. Prestressing methods
4. Tendon arrangement and stresses
5. Additions or rearrangement of reinforcing steel from that shown

51-4.01C(2)(d) Box Culverts

Shop drawings for PC concrete box culverts must include the construction method, dimensions, reinforcement including splice type and location, and height of earth cover.

51-4.01C(2)(e) Deck Panels

Reserved

51-4.01D Quality Assurance

51-4.01D(1) General

PC materials must be available to the Department for inspection. Allow the Department free access at all times to any portion of the fabrication site where material is stored or work is performed.

51-4.01D(2) Quality Control

Reserved

51-4.01D(3) Department Acceptance

PC concrete members are inspected at the fabrication site. Notify the Department when materials are delivered to the fabrication site. Allow 10 days after notifying the Department before starting fabrication.

The Engineer may reject PC drainage inlets exhibiting any of the following:

1. Cracks more than 1/32 inch wide
2. Nonrepairable honeycombed or spalled areas of more than 6 square inches
3. Noncompliance with reinforcement tolerances or cross sectional area shown
4. Wall, inlet floor, or lid less than minimum thickness
5. Internal dimensions less than dimensions shown by 1 percent or 1/2 inch, whichever is greater
6. Defects affecting performance or structural integrity

51-4.02 MATERIALS

51-4.02A General

Reserved

51-4.02B Delivery, Storage, and Handling

Carefully handle, store, transport, and erect PC concrete members to avoid twisting, racking, or other distortion that would result in cracking or damage to the members.

Handle, store, transport, and erect PC members in an upright position such that the points of support and directions of the reactions with respect to the member are approximately the same as when the member is in its final position.

51-4.02C Materials

For a project in a freeze-thaw area, reinforcement must be epoxy coated under section 52-2.02.

Bearing plates, threaded inserts, and other metal fittings must comply with section 75-3

Concrete for keyways must have a cementitious material content of at least 590 lb/cu yd and a 1-inch maximum grading. Penetration of the concrete must be near the lower limit of the specified nominal penetration.

Grout must comply with ASTM C1107/C1107M.

Deck shear connector rods, shown as tie rods, must comply with the following:

1. Steel fastener components must comply with section 55.
2. Lock washers must be ANSI heavy duty spring washers.
3. All metal must be hot-dip galvanized after fabrication under ASTM A123/A123M.

Materials for PC drainage inlets must comply with the following:

1. Preformed flexible joint sealant must be butyl-rubber complying with ASTM C990
2. Resilient connectors must comply with ASTM C923
3. Sand bedding must comply with section 19-3.02F(2)
4. Bonding agents must comply with ASTM C1059/C1059, Type II

51-4.02D Fabricating Precast Concrete Members

51-4.02D(1) General

Reserved

51-4.02D(2) Girders, Box Girders, and Double T Girders

Before curing activities, the top surface of each PC member must be given a coarse texture by brooming with a stiff bristled broom or by other suitable devices that results in uniform transverse scoring.

The top surface texture of the following PC members must have at least a 1/4-inch amplitude:

1. Girders
2. Box girders with a concrete deck shown
3. T girders with a concrete deck shown

Wood float portions of the top surface of box girders to be covered by expanded polystyrene.

For segmental or spliced-girder construction, materials for construction joints or closure joints at exterior girders must match the color and texture of the adjoining concrete.

At spliced-girder closure joints:

1. If shear keys are not shown, the vertical surfaces of the girder segment ends must be given a coarse texture as specified for the top surface of PC members.
2. Post-tensioning ducts must extend out of the vertical surface of the girder segment closure end sufficiently to facilitate splicing of the duct.

For spliced girders, pretension strand extending from the closure end of the girder segment to be embedded in the closure joint must be free of mortar, oil, dirt, excessive mill scale and scabby rust, and other coatings that would destroy or reduce the bond.

51-4.02D(3) Slabs

Forms for circular voids in concrete slabs must (1) be watertight and constructed of an authorized material that does not break or deform during concrete placement and (2) not increase the span dead load.

Before curing, the top surface of concrete slabs must be given a coarse texture by brooming with a stiff-bristled broom or by other suitable devices that results in uniform transverse scoring. The requirements of the 8th and 9th paragraphs of section 51-1.01D(3)(b)(ii) do not apply.

51-4.02D(4) Closure Wall Panels

Exposed surfaces of closure wall panels must match the adjacent CIP concrete.

Prestressing steel must be (1) placed not more than 6 inches from panel edges and (2) spaced not more than 18 inches on center between edge tendons.

Anchorage hardware must comply with section 75-3. Bolt holes must comply with section 55-1.02E(6)(b) except holes must not be punched full size.

51-4.02D(5) Box Culverts

Reinforcement for PC concrete box culverts may be welded wire reinforcement.

Manufacturing tolerances for PC sections must comply with the tolerances specified in section 11 of AASHTO M 259.

You may use the dry cast method of construction where shown on the authorized shop drawings. Results must be equal to those obtained under section 51. External vibrators must be used. Forms must be sufficiently rigid to resist displacement or damage. Dry casting forms may be removed after consolidating if no slumping of the concrete occurs.

Form the ends of members such that sections can be laid together to make a continuous line of box sections with a smooth interior free of irregularities in the flow line.

Splices in circumferential reinforcement must be lapped. Welded splices for the outside apron of steel are allowed only where shown. Wall reinforcement on the inside of the box may be lapped and welded at any location or connected by welding at the corners to slab reinforcement at the inside of the box.

Handling devices or holes are allowed in members for handling and laying. Clean and fill the resulting holes with mortar.

Exposed spacers, standoffs, or ends of longitudinals used to position reinforcement are not a cause for rejection. Do not weld spacers or standoffs to circumferential reinforcement. You may weld spacers or standoffs to longitudinal reinforcement.

Clearly mark each PC unit. Use indentation, waterproof paint, or other authorized means. Include contract number, date of manufacture, manufacturer, and the design earth cover. Mark each unit by indentation on the inner or outer surface so that the top is evident immediately after stripping forms. Paint the word "TOP" with waterproof paint on the inside and outside surfaces of the tops of each unit.

51-4.02D(6) Lagging

For a project in a freeze-thaw area, concrete for PC concrete lagging must contain at least 675 pounds of cementitious material per cubic yard.

If concrete lagging is steam cured, supports for reinforcement must be stainless steel containing at least 16 percent chromium.

51-4.02D(7) Deck Panels

Reserved

51-4.02D(8) Drainage Inlets

PC units for drainage inlets must be rectangular, round, or oval in cross section, or any combination. Transitions from a rectangular grate opening to a round or oval basin must be made in not less than 8 inches. Provide means for field adjustment to meet final grade, paving, or surfacing.

If oval or circular shape cross-sections are furnished, they must comply with *AASHTO LRFD Bridge Design Specifications, Sixth Edition with California Amendments*.

Wall and slab thicknesses may be less than the dimensions shown by at most 5 percent or 3/16 inch, whichever is greater.

Reinforcement placement must not vary more than 1/2 inch from the positions shown.

51-4.03 CONSTRUCTION

51-4.03A General

Reserved

51-4.03B Girders, Box Girders, and Double T Girders

For girders and box girders or double T girders with a concrete deck shown, clean top surfaces of laitance and curing compound before placing deck concrete.

You may make adjustments to accommodate girder deflections before placing deck concrete, including adjustments to bearing seat elevations. Adjustments are limited by the following:

1. Minimum permanent vertical clearance under the structure is not reduced.
2. Deck profile grade and cross slope cannot be changed.
3. Except for box girders, a minimum of 1 inch of deck slab concrete is maintained between the deck slab reinforcement and the top of the girders.
4. For box girders, a minimum of 1 inch of deck slab concrete is maintained between the top of expanded polystyrene in the area between the girder webs and the deck slab reinforcement.

Adjustments to accommodate girder deflections are not considered a change in dimensions.

Grout keyways after PC members are in final position. Before grouting, abrasive blast clean the keyways to expose clean aggregate. Flush keyways with water and allow them to dry to a surface dry condition immediately before placing the grout.

No equipment or other loads are allowed on spans that have been grouted until 72 hours after the last grout is placed.

Do not tension or tighten transverse post-tensioning tendons until 24 hours after grouting the last keyway.

The specifications for prestressing force distribution and sequencing of stressing in the post-tensioning activity in 50-1.03B(2)(a) do not apply if post-tensioning of spliced girders before starting deck construction is described. The composite deck-girder structure must be post-tensioned in a subsequent stage.

Temporary spliced-girder supports must comply with the specifications for falsework in section 48-2.

Before post-tensioning of spliced girders, remove the forms at CIP concrete closures and intermediate diaphragms to allow inspection for concrete consolidation.

51-4.03C Slabs

For slab spans with a concrete overlay, clean the slab top surfaces under section 51-1.03D(4).

For slab spans with an HMA overlay, removal of laitance and curing compound from the top surfaces is not required.

Where the ends of transverse rods will be exposed, recess exposed nuts and ends of rods at least 1 inch below the member surface. Snug tighten nuts after the deck units are positioned and before placing mortar in the keyways.

Fill the anchor dowel holes with mortar after the slabs are in final position.

Fill keyways with concrete. Keyways must be mortar-tight before placing concrete. Thoroughly consolidate the concrete in keyways.

Tighten nuts 24 hours after concrete in the keyways has been placed. Burr threads at the ends of bolts or rods to prevent loosening. Fill recesses with mortar after tightening nuts.

No equipment or other loads are allowed on spans until 72 hours after the last mortar is placed in anchor dowel holes or the last concrete is placed in keyways.

For slab spans with a concrete overlay, at least 3 slabs adjacent to a span must be in place before the concrete overlay is placed in that span.

51-4.03D Closure Wall Panels

Reserved

51-4.03E Box Culverts

Construct box culverts using PC members where described.

You must select the combination of concrete dimensions and reinforcement if more than 1 allowable combination is shown.

Structure excavation and backfill must comply with section 19-3.

Laying of PC concrete box culverts must comply with the specifications for laying reinforced concrete pipe in section 65-2.03C.

Joints must comply with the specifications for cement mortar or resilient material joints in section 65-2.02F. You may use an external sealing band complying with ASTM C877 instead of joint material.

51-4.03F Lagging

Place concrete lagging for soldier piles walls level. Place a concrete leveling course if required.

Each lagging member must be continuous over 2 piles and cantilever at least 6 inches beyond pile centerlines. Continuity over 3 piles is not allowed.

51-4.03G Deck Panels

Reserved

51-4.03H Drainage Inlets

Repair PC drainage inlet sections to correct damage from handling or manufacturing imperfections before installation.

Center pipes in openings to provide a uniform gap. Seal gaps between the pipe and the inlet opening with nonshrink grout under the grout manufacturer's instructions. For systems designated as watertight, seal these gaps with resilient connectors.

Match fit keyed joints to ensure uniform alignment of walls and lids. Keys are not required at the inlet floor level if the floor is precast integrally with the inlet wall. Seal keyed joint locations with preformed butyl rubber joint sealant. You may seal the upper lid and wall joint with nonshrink grout.

Clean keyed joint surfaces before installing sealant. Joint surfaces must be free of imperfections that may affect the joint. Use a primer if surface moisture is present. Use a sealant size recommended by the sealant manufacturer. Set joints using sealant to create a uniform bearing surface.

Flat drainage inlet floors must have a field-cast topping layer at least 2 inches thick with a slope of 4:1 (horizontal:vertical) toward the outlet. Use a bonding agent when placing the topping layer. Apply the bonding agent under the manufacturer's instructions.

51-4.04 PAYMENT

Payment for diaphragm dowels and bolts in PC concrete members is not included in the payment for any type of furnish or erect PC concrete member.

The payment quantity for PC concrete lagging is the wall area shown without deductions for spacing between lagging or openings for piping.

PC concrete box culvert is measured as specified for concrete pipe in section 65-1.04.

51-5 APPROACH SLABS

51-5.01 GENERAL

51-5.01A Summary

Section 51-5 includes specifications for constructing approach slabs and paving notch extensions.

Structure approach drainage system must (1) consist of geocomposite drain, filter fabric, plastic pipe, treated permeable base, and drainage pads, and (2) comply with section 68-7.

Structure excavation and backfill must comply with section 19-3.

Treated permeable base must comply with section 29.

51-5.01B Definitions

Reserved

51-5.01C Submittals

If using RSC, submit the RSC mix design at least 10 days before constructing the trial slab.

51-5.01D Quality Assurance

51-5.01D(1) General

If woven tape fabric is shown, notify the Engineer of the source of woven tape fabric at least 45 days before use.

Notify the Engineer of the type of treated permeable base to be used under approach slabs at least 30 days before starting placement. After notification, do not change the type of permeable base without authorization.

51-5.01D(2) Quality Control

51-5.01D(2)(a) General

Reserved

51-5.01D(2)(b) Rapid Strength Concrete

Before starting work on approach slabs constructed using RSC, prepare a trial slab for each concrete mix design.

Trial slabs must be:

1. Constructed, finished, and cured within the allowed time with the materials, tools, equipment, personnel, and methods to be used in the work
2. 10 by 20 feet by 9 inches thick
3. Constructed near the job site outside the project limits at an authorized location

Trial slabs must demonstrate that you are capable of producing approach slabs within the anticipated time periods, including delivery, placement, finishing, and curing times, and under similar atmospheric and temperature conditions expected during construction activities. Multiple trial slabs for each concrete mix design may be required to encompass variable atmospheric conditions.

Test the trial slab concrete for compressive strength under section 90-1.01D(5). Trial slab concrete must develop the following minimum compressive strengths:

1. 1,200 psi at the age of break
2. 2,500 psi at 3 days
3. 4,000 psi at 28 days

51-5.02 MATERIALS

51-5.02A General

Hardboard and expanded polystyrene must comply with section 51-2.01B(1).

51-5.02B Fabric

Filter fabric must be Class A.

Woven tape fabric must:

1. Be fabric of woven strips or tapes
2. Retain at least 70 percent tensile strength when tested under ASTM D4355 with 500 hours exposure
3. Comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Weight (min, oz/sq yd)	ASTM D3776	3
Grab breaking load (min, lb)	ASTM D4632	50
Apparent elongation (min, percent)	ASTM D4632	35
Toughness[a] (min, lb)	--	1,200

[a]Percent apparent elongation times the grab breaking load

51-5.02C Concrete

Concrete for approach slabs and paving notch extensions must contain at least 675 pounds of cementitious material per cubic yard and comply with one of the following:

1. Cure for at least 5 days before opening to traffic
2. Comply with the specifications for RSC

For paving notch extensions, you may use magnesium phosphate concrete, modified high-alumina-based concrete, or portland-cement-based concrete, complying with the specifications for bonding materials in section 51-1. The concrete may be extended by using a clean, uniform, rounded aggregate filler with a moisture content of at most 0.5 percent. The quantity of aggregate filler must comply with the manufacturer's instructions. Concrete strengths for the extended concrete must be at least that specified for the bonding materials. The aggregate gradation must comply with the requirements shown in the following table:

Sieve size	Percentage passing
1/2-inch	100
No. 16	0–5

For a project in a freeze-thaw area, concrete for approach slabs and paving notch extensions must comply with section 90-1.02I.

Concrete for drainage pads must comply with the specifications for minor concrete.

51-5.02D Aggregate Base

AB must be produced from commercial-quality aggregates consisting of broken stone, crushed gravel or natural rough-surfaced gravel, and sand, in any combination. Gradation must comply with the 3/4-inch maximum gradation specified in section 26-1.02B.

51-5.02E Bar Reinforcement

Bar reinforcing steel must comply with section 52.

In a freeze-thaw area, epoxy coat bar reinforcement under section 52-2.02.

Galvanize unbonded portions of bar reinforcement under section 52-3.

51-5.02F Miscellaneous Joint Materials

Steel components of abutment ties must comply with section 75-3.

PVC conduit used to encase abutment tie rods must be commercial quality.

Steel angles, plates, and bars at concrete barrier joints must comply with section 75-3.

Type AL joint seals must comply with section 51-2.02B.

The pourable seal between the steel angle and concrete barrier must comply with the specifications for Type A and AL joint seals in section 51-2.02B.

Sealants may be mixed by hand-held, power-driven agitators and placed by hand methods.

Sliding joints for the sleeper slabs must comply with 51-2.03.

Building paper must be commercial-quality, 30-pound asphalt felt.

51-5.02G Hot Mix Asphalt

HMA for a temporary roadway structural section must comply with the specifications for minor HMA in section 39.

51-5.03 CONSTRUCTION

51-5.03A General

Drill and bond bar reinforcement and abutment tie rods under section 51-1.03E(3).

Finish and treat the top surfaces of approach slabs under section 51-1.03F(5). Edger finish the slab edges.

Cure approach slabs using curing compound no. 1.

Abrasive blast clean the concrete surfaces and thoroughly clean joints immediately before placing the joint seals. Joint surfaces must be dry when seals are placed.

51-5.03B Type N Approach Slabs

51-5.03B(1) General

Reserved

51-5.03B(2) Filter Fabric

Place filter fabric immediately after grading and compacting the subgrade. Handle and place filter fabric under the manufacturer's instructions.

Adjacent borders of filter fabric must be overlapped from 12 to 18 inches or stitched. If overlapping the borders, the preceding roll must overlap the following roll in the direction the material is being spread. If stitching the border, use yarn of a contrasting color. Yarn size and composition must be as recommended by the fabric manufacturer. Use 5 to 7 stitches per inch of seam.

Do not operate equipment or vehicles on filter fabric.

51-5.03B(3) Treated Permeable Base

Place and compact ATPB at a temperature from 200 to 250 degrees F. Do not use material stored for more than 2 hours in the work.

Compact ATPB base as soon as the mixture has cooled sufficiently to support the weight of the equipment without undue displacements. Use a vibrating-shoe-type compactor or a roller weighing from 1.5 to 5 tons.

Compact CTPB with a vibrating-shoe-type compactor or with a steel-drum roller weighing from 1.5 to 5 tons. Compaction must start within 1/2 hour of spreading and must consist of 2 complete coverages of the CTPB.

51-5.03C Type EQ Approach Slabs

Reserved

51-5.03D Type R Approach Slabs

51-5.03D(1) General

The Type R approach slab thicknesses shown are minimums. Thicknesses may vary due to material removed.

At locations where the removal of existing materials and approach slab construction is not required to be completed within the same work shift, the requirements for a temporary roadway structural section and trial slab do not apply.

Approach slab (aggregate base) includes using AB to fill voids that remain after removing subsealing material or CTB beneath existing approach slabs.

51-5.03D(2) Removal of Existing Facilities

Remove portions of existing structures, pavement and base, approach slabs, asphalt concrete surfacing, concrete pavement, subsealing material, and cement-treated base, as necessary for the construction of the new approach slab.

Remove portions of seat-type abutments under section 60-2.02.

Saw cut full depth the outline of concrete pavement to be removed using a power-driven saw. Do not use power impact tools within 1.5 feet of pavement to remain in place.

Before removing asphalt concrete, cut the outlines of excavations in asphalt concrete on a neat line to a minimum depth of 0.25 foot using a power-driven concrete saw or wheel-type rock-cutting excavator. These excavations must be permanently or temporarily backfilled to conform to the grade of the adjacent pavement before opening the lane to traffic.

Dispose of materials no longer used in the work.

51-5.03D(3) Existing Base Material

Uniformly grade and compact the existing base material remaining in place after removing the existing pavement and base materials to the required depth. The finished surface of the base material at any point must not extend above the authorized grade.

Fill areas of base material that are low as a result of overexcavation with structure approach slab concrete at the same time that the new concrete is placed.

Where pavement subsealing has been performed under existing approach slabs, remove the full depth of subsealing material. Where removal of CTB is required to construct the approach slab, remove the full depth of the CTB.

Fill voids between the new approach slab and the base material remaining in place that are caused by removal of subsealing material or CTB with either AB or approach slab concrete. If you fill these voids with structure approach slab concrete, fill the voids at the same time that the new concrete is placed.

51-5.03D(4) Aggregate Base

Spread and compact AB for filling voids below the structure approach slab concrete by methods that will produce a well-compacted, uniform base, free from pockets of coarse or fine material, to the authorized grade. Where the required thickness of AB is 8 inches or less, the base may be spread and compacted in 1 layer. Where the required thickness of AB is more than 8 inches, the base must be spread and compacted in 2 or more layers of approximately equal thickness. The maximum compacted thickness of any 1 layer must not exceed 8 inches.

51-5.03D(5) Profile Grade

Establish a grade line for the new approach slab that will provide a smooth profile grade. The profile grade must be authorized.

51-5.03D(6) Temporary Roadway Structural Section

If approach slabs cannot be constructed before the lane is opened to traffic, fill the excavation with a temporary roadway structural section. Temporary structural section must consist of a 0.3-foot-thick layer of commercial quality cold mix over AB.

Keep a standby quantity of cold mix and AB at the job site for a temporary roadway structural section.

Spread and compact the AB and cold mix. Produce a well-compacted, uniform base having a surface of uniform smoothness, texture, and density, without pockets of coarse or fine material. You may spread and compact AB and cold mix in 1 layer each.

The finished surface (1) must not vary more than 0.05 foot from the lower edge of a 12-foot straightedge placed parallel with the centerline and (2) must match the elevation of the existing pavement and structure along the joints between the existing pavement and structure and the temporary surfacing.

Maintain the temporary structural section until it is replaced with the approach slab.

51-5.03E Paving Notch Extensions

The construction joint between the paving notch extension and the existing abutment must comply with the specifications for horizontal construction joints in section 51-1.03D(4). Patch spalls in the existing paving notch when placing the paving notch extension.

The surface temperature must be at least 40 degrees F during concrete placement. Contact surfaces to receive concrete may be damp but not saturated.

Retempering of concrete is not allowed. Finishing tools cleaned with water must be thoroughly dried before working concrete.

The Engineer may require you to use a flow-controlled modified material when placing concrete on slopes over 5 percent.

Except for magnesium phosphate concrete, cure the concrete using the curing compound method.

Allow 12 hours between placing the paving notch extension and placing the approach slab.

If using magnesium phosphate concrete, modified high-alumina-based concrete, or portland-cement-based concrete complying with section 51-1.02C to construct the paving notch extension, allow 1 hour between placing the paving notch extension concrete and placing the approach slab concrete.

If using RSC to construct the paving notch extension, the RSC must have a minimum compressive strength of 1,200 psi before placing the approach slab concrete and a minimum compressive strength of 2,500 psi before opening the overlaying approach slab to traffic.

51-5.04 PAYMENT

The payment quantity of aggregate base (approach slab) is the volume used to fill voids below approach slab concrete. The payment quantity does not include the volume of AB used to fill an overexcavation.

Structural concrete used to fill voids below the approach slab that are caused by removal of subsealing material or CTB is paid for as aggregate base (approach slab). The payment quantity does not include the volume of structure concrete used to fill an overexcavation.

51-6 MASS CONCRETE

51-6.01 GENERAL

51-6.01A Summary

Section 51-6 includes specifications for placing mass concrete elements.

51-6.01B Definitions

Reserved

51-6.01C Submittals

Submit a thermal control plan with design calculations for each mass concrete element. The thermal control plan and the calculations must be sealed and signed by an engineer who is registered as a civil engineer in the State. Submit 6 copies of the control plan and 2 copies of the design calculations. Include the following:

1. Mix design
2. Duration and method of curing
3. Maximum allowable temperature differentials between the hottest point of the concrete and the exterior concrete faces
4. Procedures to control concrete temperature differentials at time of placement
5. Methods of controlling temperature differentials
6. Temperature differential monitoring and recording system details
7. Temperature sensor types and locations
8. Measures to ensure compliance with maximum temperature and temperature differential requirements

Determine the maximum allowable temperature differential assuming cracking due to heat of hydration does not occur.

Submit temperature data daily as an informational submittal.

Submit a daily progress report as an informational submittal. A copy of the daily report must be available at the job site.

Submit a modified thermal control plan to correct deficiencies for replacement mass concrete. Include supporting calculations.

51-6.01D Quality Assurance

51-6.01D(1) General

An engineer who is registered as a civil engineer in the State must:

1. Inspect and test the temperature monitoring and recording systems before concrete placement
2. Be present during mass concrete activities
3. Provide daily progress reports

51-6.01D(2) Quality Control

51-6.01D(2)(a) General

Reserved

51-6.01D(2)(b) Temperature Monitoring

Provide a temperature monitoring and recording system for mass concrete elements. The system must consist of temperature sensors connected to a data acquisition system. The system must be capable of recording, printing, and downloading temperature data to a computer.

Locate temperature sensors within mass concrete elements such that the maximum temperature difference within the element is monitored. At a minimum, monitor temperatures at the following locations:

1. Calculated hottest location
2. 2 outer faces
3. 2 corners except for CIP piling elements
4. Top surfaces

Record temperature readings automatically at least every hour. Install a redundant set of sensors near the primary set with recording capability. Make records using the redundant set if the primary set fails.

You may discontinue hourly temperature recording under the following conditions:

1. Maximum internal temperature is falling
2. Difference between the interior concrete temperature and the average daily air temperature is less than the allowable temperature differential for 3 consecutive days
3. There are no mass concrete elements to be cast adjacent

Protect the temperature sensor wiring to prevent movement during concrete placement. Keep wire runs as short as possible. Do not let the ends of temperature sensors come into contact with concrete supports, forms, or reinforcement.

Do not damage the monitoring and recording system when placing and consolidating concrete.

Correct equipment failures in temperature control and monitoring and recording systems immediately.

The temperature acceptance criteria for mass concrete elements are as follows:

1. Maximum allowable temperature must not exceed 160 degrees F.
2. Maximum temperature differential must not exceed that listed in the thermal control plan.

51-6.02 MATERIALS

Grout for cooling pipes must be a nonshrink grout mix complying with ASTM C1107/C1107M and ASTM C827/C827M for 0.0 percent shrinkage and 0.0 percent minimum and 4.0 percent maximum expansion.

51-6.03 CONSTRUCTION

You may use mechanical cooling systems to control internal concrete temperatures during curing. Mechanical cooling systems must comply with the thermal control plan.

Embed the cooling system within the mass concrete element. Surface connections to cooling pipes must be removable to 4 inches below the concrete surface.

Design the forms such that cooling or temperature monitoring is not disturbed during form removal.

Secure the cooling pipes to prevent movement during concrete placement. Replace damaged cooling pipes immediately.

Pressure test the cooling system for leaks at 30 psi for 30 minutes before placing concrete. Coolant must be circulating when concrete placement starts.

Pressure grout the cooling pipes after cooling is complete. Place the grout under the manufacturer's instructions.

After the surface connections are removed, the holes must be reamed and filled with mortar.

Remove mass concrete elements that do not comply with the temperature acceptance criteria.

51-6.04 PAYMENT

Not Used

51-7 MINOR STRUCTURES

51-7.01 GENERAL

51-7.01A General

Section 51-7 includes specifications for constructing minor structures.

Minor structures include structures described as minor structures.

51-7.01B Materials

Concrete must comply with the specifications for minor concrete.

Nonshrink grout must be a dry, packaged type complying with ASTM C1107/C1107M.

Metal frames, covers, grates, and other miscellaneous iron and steel used with minor structures must comply with section 75-2.

51-7.01C Construction

You may construct minor structures using PC units or a combination of PC and CIP structures as an alternative to CIP construction, provided that the structure in place substantially complies with the specified CIP construction.

Remove exterior forms to at least 5 inches below the final ground surface. Exterior forms below this depth may remain if their total thickness is not more than 1 inch.

Cure concrete surfaces of minor structures using the water method, the forms-in-place method, or the curing compound method.

51-7.01D Payment

The Department does not adjust the payment quantity for minor structures designated as final pay on the Bid Item List if the constructed height of the minor structure is within 6 inches of the vertical dimensions shown.

Metal frames and covers or frames and grates are not included in the payment for minor structures.

51-8–51-15 RESERVED

52 REINFORCEMENT

52-1 GENERAL

52-1.01 GENERAL

52-1.01A Summary

Section 52-1 includes general specifications for fabricating and placing reinforcement.

52-1.01B Definitions

affected zone: Portion of the reinforcing bar where any properties of the bar, including the physical, metallurgical, or material characteristics, have been changed by either:

1. Fabrication or installation of a splice. The weld and 1 inch adjacent to the weld is part of the affected zone.
2. Manufacturing process for headed bar reinforcement.

lot:

1. 150 count, or fraction thereof, of the same type of mechanical splice coupler model for each:
   1.1. Bar size
   1.2. Bar deformation pattern
   1.3. Hoop diameter
2. 150 count, or fraction thereof, of CJP butt-welded splices or resistance-butt-welded splices for each:
   2.1. Bar size
   2.2. Hoop diameter

52-1.01C Submittals

52-1.01C(1) General

Reserved

52-1.01C(2) Shop Drawings

If a portion of an assemblage of bar reinforcing steel exceeds 20 feet in height and is not encased in concrete, submit shop drawings and design calculations for a temporary support system.

Temporary support system shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer in the State.

The temporary support system must be designed to:

1. Resist all expected loads
2. Prevent collapse or overturning of the cage

If form installation or other work requires changes to or the temporary release of any part of the temporary support system, the shop drawings must show the support system to be used during these changes or the temporary release.

The minimum horizontal wind load to be applied to the reinforcing steel assemblage or to a combined assemblage of reinforcing steel and forms must be the sum of the products of the wind impact area and the applicable wind pressure value for each height zone.

The wind impact area is the total projected area of the assemblage normal to the direction of the applied wind. Determine wind pressure values using the following table:

Wind Pressure

Height zone, H (feet above ground)	Wind pressure value (psf)
$0 \leq 30$	20
$30 < H \leq 50$	25
$50 < H \leq 100$	30
$H > 100$	35

52-1.01C(3) Certificates

Submit a certificate of compliance for each shipment of reinforcement.

If requested, submit the following:

1. Copy of the certified mill test report for each heat and size of reinforcing steel showing physical and chemical analysis
2. 2 copies of a list of all reinforcement before starting reinforcement placement

52-1.01D Quality Assurance

Reserved

52-1.02 MATERIALS

52-1.02A General

Reserved

52-1.02B Bar Reinforcement

Reinforcing bars must be deformed bars complying with ASTM A706/A706M, Grade 60, except you may use:

1. Deformed bars complying with ASTM A615/A615M, Grade 60, in:
   1.1. Junction structures
   1.2. Sign and signal foundations
   1.3. Minor structures
   1.4. Concrete crib members
   1.5. Mechanically-stabilized-embankment concrete panels
   1.6. Masonry block sound walls
2. Deformed or plain bars complying with ASTM A615/A615M, Grade 40 or 60, in:
   2.1. Slope and channel paving
   2.2. Concrete barriers Type 50 and 60
3. Plain bars for spiral or hoop reinforcement in structures and concrete piles

You may substitute welded wire reinforcement for reinforcing bars in the following:

1. Slope paving and lined ditches
2. Retaining walls
3. Concrete barriers
4. Sidewalks, curbs, and gutters on structures
5. Nonstructural aesthetic additions
6. Culvert headwalls, end walls, and wing walls
7. Shotcrete
8. Deck overlays
9. Shear reinforcement stirrups in PC girders

Substituted welded wire reinforcement must be on an equivalent area basis. The Engineer determines the exact location. If the welded wire reinforcement does not provide the required area of steel, supplement it with reinforcing bars.

52-1.02C Welded Wire Reinforcement

Welded wire reinforcement must comply with ASTM A1064/A1064M.

52-1.02D Reinforcing Wire

Reinforcing wire must comply with the specifications for plain wire in ASTM A1064/A1064M.

52-1.02E Dowels

Reinforcing steel dowels must be deformed bars complying with section 52-1.02B.

Threaded rods used as dowels must comply with section 75-1.02A.

52-1.03 CONSTRUCTION

52-1.03A General

Reserved

52-1.03B Cleaning

Before concrete is placed, the reinforcement to be embedded must be free of mortar, oil, dirt, excessive mill scale and scabby rust, and other coatings that would destroy or reduce the bond.

52-1.03C Bending

Do not bend or straighten bars in a way that damages the material. Do not use bars with kinks or improper bends.

Hooks and bends must comply with the *Building Code Requirements for Structural Concrete* published by ACI.

52-1.03D Placing

Firmly and securely hold reinforcement in position by:

1. Wiring at intersections and splices.
2. Using precast mortar blocks or ferrous metal chairs, spacers, metal hangers, supporting wires, or other authorized devices of sufficient strength to resist crushing under applied loads. Do not use aluminum, plastic, or wood supports.

Do not place bars on layers of fresh concrete as the work progresses.

Metal supports must have a clear cover of at least 1 inch. Do not consider protective coatings on metal supports when determining clear cover. Where the clear cover to reinforcement shown or determined by the Engineer exceeds the minimum specified clear cover, increase the clear cover for metal supports accordingly.

The center-to-center spacing of parallel bars must be at least 2.5 times the bar diameter.

The clear distance between bundles of bars and adjacent bundles or single bars must be at least:

1. 1.5 times the maximum size of the coarse aggregate
2. 2 times the larger bar diameter for 2-bar bundles
3. 2.5 times the larger bar diameter for 3-bar bundles

Tie bundle bars together at not more than 6-foot centers.

Unless otherwise shown, reinforcement must have a 2-inch clear cover measured from the surface of the concrete to the outside of the reinforcement.

Adjust or relocate reinforcement in post-tensioned concrete during the installation of prestressing ducts or tendons as required to provide described clearances to the prestressing tendons, anchorages, jacks, and equipment. Obtain authorization for any adjustments or relocations.

End each unit of spiral reinforcement at both ends by lapping the spiral reinforcement on itself for at least 80 diameters followed by (1) a 135-degree hook with a 6-inch tail hooked around an intersecting longitudinal bar or (2) a mechanical lap splice coupler. Discontinuities in spiral reinforcement may be made only where shown or authorized. The spiral on each side of a discontinuity or a lap splice is a

separate unit. Where discontinuities in spiral reinforcement are not allowed, splice the spiral reinforcement. Lap splices in spiral reinforcement must be lapped at least 80 diameters followed by (1) a 135-degree hook with a 6-inch tail hooked around an intersecting longitudinal bar or (2) a mechanical lap splice coupler.

Roll welded wire reinforcement flat before placing concrete. Secure welded wire reinforcement in place with devices that prevent the reinforcement's vertical and transverse movement.

Do not tack weld on reinforcing bars unless shown.

For column and pile bar reinforcing cages measuring 4 feet in diameter and larger:

1. Tie all reinforcement intersections with double wire ties on at least 4 vertical bars of each cage equally spaced around the circumference.
2. Tie at least 25 percent of remaining reinforcement intersections in each cage with single wire ties. Stagger tied intersections from adjacent ties.
3. Provide bracing to avoid collapse of the cage during assembly, transportation, and installation.

52-1.04 PAYMENT

The payment quantity of bar reinforcing steel is the calculated weight of the reinforcing bars and wire.

The payment quantity of bar reinforcing steel includes the lap of bars for lap splicing, including locations where you use a continuous bar instead of the splice shown.

The payment quantities are based on the following:

Bar Reinforcing Steel Quantities

Deformed bar designation no.	Weight (pounds per foot)	Nominal diameter (inches)
3	0.376	0.375
4	0.668	0.500
5	1.043	0.625
6	1.502	0.750
7	2.044	0.875
8	2.670	1.000
9	3.400	1.128
10	4.303	1.270
11	5.313	1.410
14	7.650	1.693
18	13.600	2.257

NOTE: Bar numbers approximate the number of eighths of an inch included in the nominal diameter of the bars. The nominal diameter of a deformed bar is equal to the diameter of a plain round bar having the same weight per linear foot as the deformed bar.

The cross sectional area of reinforcing wire, in hundredths of square inches, is equal to its W-size number. The density of reinforcing wire is 0.2833 lb/cu in.

The payment quantity of welded wire reinforcement is determined based on the measured area covered by the reinforcement and does not include laps.

The payment quantity for bar reinforcing steel (bridge) includes diaphragm dowels and bolts in PC concrete members.

If alternative transverse deck reinforcement placement details are shown, the payment quantities are based on the detail that shows truss bars.

Bar reinforcing steel involved in bridge work is paid for as bar reinforcing steel (bridge) or bar reinforcing steel (epoxy coated)(bridge) unless it is included in a separate bid item.

52-2 EPOXY-COATED REINFORCEMENT AND EPOXY-COATED PREFABRICATED REINFORCEMENT

52-2.01 GENERAL

52-2.01A General

52-2.01A(1) Summary

Section 52-2.01 includes general specifications for fabricating and placing epoxy-coated reinforcement and epoxy-coated prefabricated reinforcement.

The substitution of welded wire reinforcement for bar reinforcement specified in 52-1.02B is not allowed for epoxy-coated bar reinforcement or epoxy-coated prefabricated bar reinforcement.

52-2.01A(2) Definitions

Reserved

52-2.01A(3) Submittals

52-2.01A(3)(a) General

Reserved

52-2.01A(3)(b) Samples

52-2.01A(3)(b)(i) General

Reserved

52-2.01A(3)(b)(ii) Epoxy Powder Test Samples

Submit a test sample from each batch of epoxy powder to be used for epoxy coating reinforcement to METS.

Each test sample must be:

1. Weighed to 4 ounces
2. Packaged in an airtight container
3. Identified with the manufacturer's name and batch number

52-2.01A(3)(b)(iii) Patching Material Test Samples

Submit a test sample, from each batch of patching material to be used to repair epoxy coating on reinforcement, to METS.

Each test sample must be:

1. Weighed to 4 ounces
2. Packaged in an airtight container
3. Identified with the manufacturer's name and batch number

52-2.01A(3)(b)(iv) Test Samples

Submit test samples of epoxy-coated reinforcement and epoxy-coated prefabricated reinforcement to METS.

52-2.01A(4) Quality Assurance

Reserved

52-2.01B Materials

Except for field welding of butt splices, complete welding of the reinforcement before epoxy coating.

If a part of a bar or wire is described to be epoxy coated, coat the entire bar unless the bar or wire is spliced outside the limits of epoxy coating, in which case epoxy coating is not required on the part of the bar or wire beyond the splice.

Do not store reinforcement within 1,000 feet of ocean or tidal water for more than 2 months.

Patching material and the patching process must be suitable for field application.

The following must be on the Authorized Material List for fusion bonded epoxy powders and corrosion protection coverings:

1. Epoxy powder
2. Corrosion protection covering for splices

52-2.01C Construction

Except for lap splices, cover splices of reinforcement with a corrosion protection covering. Install covering under the manufacturer's instructions.

52-2.01D Payment

The weight of epoxy coating is not included in the weight of reinforcement.

Bar or wire reinforcement extending beyond the limits for epoxy-coated reinforcement shown is paid for as bar reinforcing steel (bridge).

52-2.02 EPOXY-COATED REINFORCEMENT

52-2.02A General

52-2.02A(1) Summary

Section 52-2.02 includes specifications for fabricating and placing epoxy-coated reinforcement.

In a freeze-thaw area, epoxy coat the following:

1. All longitudinal and transverse reinforcement in a bridge deck 12 inches or less in thickness
2. Longitudinal and transverse reinforcement within 6 inches of the top surface of a bridge deck greater than 12 inches in thickness
3. Reinforcement that extends to within 6 inches of the top surface of the bridge deck
4. Reinforcement within or that extends to within 6 inches of the top surface of abutment backwalls if the top surface of the backwall is at deck level
5. Reinforcement in concrete barriers
6. Reinforcement at locations shown

52-2.02A(2) Definitions

Reserved

52-2.02A(3) Submittals

52-2.02A(3)(a) General

Reserved

52-2.02A(3)(b) Test Samples

For each shipment of epoxy-coated reinforcement to the job site or PC plant, submit two 30-inch-long test samples from each size of reinforcement.

Before transporting test samples:

1. Securely bundle and package the 2 test samples in a way that preserves their condition during transportation
2. Identify each test sample by shipment and Contract number using weatherproof markings
3. Attach a completed Sample Identification Card to the test samples

52-2.02A(3)(c) Certificates

Submit a certificate of compliance for each shipment of epoxy-coated reinforcement. Include the following with the submittal:

1. Certification that the coated reinforcement complies with ASTM A775/A775M for bar reinforcement or ASTM A884/A884M, Class A, Type 1, for wire reinforcement
2. All certifications specified in ASTM A775/A775M for bar reinforcement or ASTM A884/A884M for wire reinforcement

Submit a certificate of compliance for the patching material including a certification that the patching material is compatible with the epoxy powder to be used.

Instead of providing a certification for the patching material, you may identify on the container that the patching material is compatible with the epoxy powder to be used.

52-2.02A(4) Quality Assurance

52-2.02A(4)(a) General

Perform qualification testing and certifications required by ASTM A775/A775M and ASTM A884/A884M at an authorized laboratory

52-2.02A(4)(b) Department Acceptance

Test samples must comply with the requirements for coating thickness and coating adhesion specified in ASTM A775/A775M for bar reinforcement or ASTM A884/A884M Class A, Type 1 for wire reinforcement, as follows:

1. If both test samples comply with the requirements, the Department accepts all epoxy-coated reinforcement represented by the test.
2. If both test samples do not comply with the requirements, the Department performs 1 additional test on the reinforcement of the same size from the same shipment. This additional test consists of testing 2 test samples, randomly selected by the Engineer, for coating thickness and adhesion. If both test samples do not comply with the specified requirements, the Department rejects all epoxy-coated reinforcement represented by the test.

52-2.02B Materials

Epoxy-coated reinforcement must comply with:

1. ASTM A775/A775M for bar reinforcement
2. ASTM A884/A884M, Class A, Type 1, for wire reinforcement

Fabrication and handling of epoxy-coated bar reinforcement at the job site and PC plant must comply with ASTM D3963/D3963M.

Coating must be light green.

52-2.02C Construction

If damage to the coating occurs during field bending, patch the area immediately.

Job site and PC plant practices must comply with sections X1.3.1 through X1.3.15 of appendix X1 of ASTM A884/A884M for wire reinforcement, except replace *should* with *must*.

52-2.02D Payment

Not Used

52-2.03 EPOXY-COATED PREFABRICATED REINFORCEMENT

52-2.03A General

52-2.03A(1) Summary

Section 52-2.03 includes specifications for fabricating and placing epoxy-coated prefabricated reinforcement.

52-2.03A(2) Definitions

Reserved

52-2.03A(3) Submittals

52-2.03A(3)(a) General

Reserved

52-2.03A(3)(b) Test Samples

For each shipment of epoxy-coated prefabricated reinforcement to the job site or PC plant, submit two 30-inch-long test samples from each size of reinforcement.

Before transporting test samples:

1. Securely bundle and package the 2 test samples in a way that preserves their condition during transportation
2. Identify each test sample by shipment and Contract number using weatherproof markings
3. Attach a completed Sample Identification Card to the test samples

52-2.03A(3)(c) Certificates

Submit a certificate of compliance for each shipment of epoxy-coated reinforcement. Include with the submittal:

1. Certification that the coated reinforcement complies with ASTM A934/A934M for bar reinforcement or ASTM A884/A884M Class A, Type 2 for wire reinforcement
2. All certifications specified in ASTM A934/A934M for bar reinforcement or ASTM A884/A884M for wire reinforcement

Submit a certificate of compliance for the patching material including a certification that the patching material is compatible with the epoxy powder to be used.

Instead of providing certification for the patching material, you may identify on the container that the patching material is compatible with the epoxy powder to be used.

52-2.03A(4) Quality Assurance

52-2.03A(4)(a) General

Perform qualification testing and certification required by ASTM A934/A934M and ASTM A884/A884M at an authorized laboratory.

52-2.03A(4)(b) Department Acceptance

Test samples must comply with the requirements for coating thickness and coating adhesion specified in ASTM A934/A934M for bar reinforcement or ASTM A884/A884M Class A, Type 2 for wire reinforcement, as follows:

1. If both test samples comply with the requirements, the Department accepts all epoxy-coated reinforcement represented by the test.
2 If both test samples do not comply with the requirements, the Department performs 1 additional test on the reinforcement of the same size from the same shipment. This additional test consists of testing 2 test samples, randomly selected by the Engineer, for coating thickness and adhesion. If both test samples do not comply with the specified requirements, the Department rejects all epoxy-coated reinforcement represented by the test.

52-2.03B Materials

Epoxy-coated prefabricated reinforcement must comply with:

1. ASTM A934/A934M for bar reinforcement
2. ASTM A884/A884M, Class A, Type 2, for wire reinforcement

Coating must be purple or gray.

52-2.03C Construction

Do not bend epoxy-coated prefabricated bar or wire reinforcement after coating application.

Job site and PC plant practices must comply with sections X2.3.1 through X2.3.15 of appendix X2 of ASTM A934/A934M for bar reinforcement, except replace *should* with *must*.

52-2.03D Payment

Not Used

52-3 GALVANIZED BAR REINFORCEMENT

52-3.01 GENERAL

Section 52-3 includes specifications for fabricating and placing galvanized bar reinforcement.

52-3.02 MATERIALS

Galvanize bar reinforcement under ASTM A767/A767M, Class 1, except chromating is not required.

52-3.03 CONSTRUCTION

Job site and PC plant practices must comply with sections X1.3.1 through X1.3.12 of appendix X1 of ASTM A767/A767M for bar reinforcement, except replace *should* with *must*.

52-3.04 PAYMENT

Not Used

52-4 RESERVED

52-5 HEADED BAR REINFORCEMENT

52-5.01 GENERAL

52-5.01A Summary

Section 52-5 includes specifications for fabricating headed bar reinforcement.

52-5.01B Definitions

lot: 150 count, or fraction thereof, of headed bar reinforcement for each:

1. Bar size
2. Head size
3. Head type
4. Method of manufacture
5. Heat number of bar material
6. Heat number of head material

A reinforcing bar with a head on each end is counted as 2 headed reinforcing bars for establishing and testing production lots.

52-5.01C Submittals

52-5.01C(1) General

If any part of the head is fabricated in the field, submit a prequalification report as specified under section 52-6.01C(6)(c).

52-5.01C(2) Samples

52-5.01C(2)(a) General

Reserved

52-5.01C(2)(b) Test Samples

Submit test samples to METS.

Include copies of the certificates of compliance with the test samples.

52-5.01C(3) Test Reports

Submit a QC test report for each lot.

Each test report must include:

1. Lot number
2. Bar size
3. Type of headed bar reinforcement
4. Physical condition of each test sample
5. Notable defects on any test sample
6. Affected zone limits of each test sample
7. Location of visible necking area on each test sample
8. Ultimate strength of each test sample

52-5.01C(4) Certificates

Submit a certificate of compliance for each shipment of headed bar reinforcement. Include with the submittal copies of:

1. Mill test reports for bar reinforcement and head material
2. QC test reports
3. Daily production logs

52-5.01D Quality Assurance

52-5.01D(1) General

Section 11-3.02 does not apply to headed bar reinforcement.

52-5.01D(2) Qualifications

If any part of the head is fabricated in the field, the operator and procedure must be prequalified as specified for service and ultimate butt splices under section 52-6.01D(2).

Welding, welder qualifications, and inspection of welding must comply with AWS C6.1.

52-5.01D(3) Test Samples

After completing fabrication of a lot of headed bar reinforcement, including preparation for any required epoxy coating, notify the Engineer that the lot is ready for testing.

After receiving notification that lots are ready for QC testing, the Engineer (1) randomly selects department acceptance test samples to be removed from each lot and (2) places tamper-proof markings or seals on the test samples.

Test samples must be 4 feet long for bar reinforcement sizes no. 9 and below and 6 feet long for bar reinforcement sizes no. 10 and above.

Before transporting test samples to an authorized laboratory and METS:

1. Securely bundle and package the 4 test samples for each test in a way that preserves their condition during transportation
2. Identify each test sample by lot number and Contract number using weatherproof markings
3. Attach a completed Sample Identification Card to each bundle

A test sample is rejected if the tamper-proof marking or seal is disturbed before testing.

52-5.01D(4) Quality Control

52-5.01D(4)(a) General

Maintain a daily production log for the fabrication of headed bar reinforcement for each production lot. The log must include:

1. Production lot numbers
2. Number of bars in each production lot
3. Heats of bar and head material used in each production lot
4. Fabrication records, including tracking and production parameters for welds or forgings

52-5.01D(4)(b) Quality Control Testing

A QC test must consist of tensile testing 4 headed bar reinforcement test samples selected from each lot of completed headed bar reinforcement before shipping the lot to the job site or PC plant.

Tensile test headed bar reinforcement test samples:

1. At a laboratory on the Authorized Laboratories List for testing reinforcing steel splices
2. In the condition received
3. Under ASTM A970/A970M

Do not perform tests on test samples from bundles containing fewer than 4 test samples.

At least 5 business days before performing any testing at the authorized laboratory, notify the Engineer of:

1. Date of the testing
2. Location of the authorized laboratory where the tests will be conducted
3. Number of lots to be tested

At fracture, headed bar reinforcement test samples must comply with the requirements specified in section 52-5.02 as follows:

1. If only 1 test sample complies with the requirements, the Department rejects all headed bar reinforcement in the lot.
2. If only 2 test samples comply with the requirements, perform 1 additional test on the same lot of headed bar reinforcement. This additional test must consist of tensile testing 4 test samples, randomly selected by the Engineer and removed by you from the lot. If any of the 4 test samples from this additional test do not comply with the specified requirements, the Department rejects all headed bar reinforcement in the lot.
3. If 3 or more test samples comply with the requirements, the Department accepts all headed bar reinforcement in the lot.

Tag each headed bar in a production lot to be shipped to the job site or PC plant in a way that allows accurate identification at the job site or PC plant.

52-5.01D(4)(c) Quality Control Test Report

The quality control test report must be (1) prepared by the laboratory performing the testing and (2) signed by an engineer representing the laboratory. The engineer must be registered as a civil engineer in the State.

52-5.01D(5) Department Acceptance

The Department tests headed bar reinforcement as specified for QC testing in section 52-5.01D(4)(b).

The Department will notify you of the Department acceptance test results for each bundle of 4 test samples of splices within 3 business days after METS receives the bundle unless more than 1 bundle is received on the same day, in which case allow 2 additional business days for each additional bundle received.

52-5.02 MATERIALS

Headed bar reinforcement must comply with ASTM A970/A970M.

At fracture, headed bar reinforcement must:

1. Comply with the tensile requirements of ASTM A970/A970M, Class A.
2. Show signs of visible necking in the reinforcing bar. The visible necking must be located at least 1 bar diameter away from the affected zone.

Equipment used to perform friction welding must be fitted with an in-process monitoring system to record essential production parameters that describe the process of welding the head onto the reinforcement. Record the following parameters:

1. Friction welding force
2. Forge force
3. Rotational speed
4. Friction upset distance and time
5. Forge upset distance and time

Headed bar reinforcement must have full size heads and must be on the Authorized Material List.

If headed bar reinforcement is to be epoxy coated:

1. Round edges of heads
2. Remove sharp edges, burrs, and weld flash that would prevent proper coating of the headed bar

Do not use threaded heads if headed bar reinforcement is to be epoxy coated.

52-5.03 CONSTRUCTION

Reserved

52-5.04 PAYMENT

The payment quantity for headed bar reinforcement is the quantity of heads.

Reinforcing bar used for headed bar reinforcement is paid for as bar reinforcing steel. The length of bar used in calculating the weight of reinforcing bar is the entire length of the completed headed bar including the head thickness.

52-6 SPLICING

52-6.01 GENERAL

52-6.01A Summary

Section 52-6 includes specifications for splicing bar reinforcement.

Reinforcing bar splices consist of lap splices, service splices, or ultimate butt splices.

52-6.01B Definitions

group: Set of 5 or fewer consecutive lots after the 1st lot.

52-6.01C Submittals

52-6.01C(1) General

Section 52-6.01C applies to service and ultimate butt splices.

52-6.01C(2) Product Data

52-6.01C(2)(a) General

Reserved

52-6.01C(2)(b) Radiographic Film Developing Process Records

If requested, submit records of radiographic film developing processes and any chemical changes to the developing processes.

52-6.01C(3) Samples

52-6.01C(3)(a) General

Reserved

52-6.01C(3)(b) Test Samples

Submit service splice and ultimate butt splice test samples to METS.

Include copies of the certificates of compliance with the test samples for mechanical splices and resistance-butt-welded splices.

52-6.01C(4) Test Reports

52-6.01C(4)(a) General

Reserved

52-6.01C(4)(b) Splicing Quality Control Test Report

Submit a QC test report for each lot of service splices and ultimate butt splices.

Each QC test report must include:

1. Group number, lot number, and location
2. Bar size
3. Splice type
4. Mechanical splice length
5. Location of fracture
6. Physical condition of splice test sample

7. Notable defects
8. Total measured slip
9. Ultimate tensile strength of each splice
10. The following for ultimate butt splices:
    10.1. Location of visible necking area
    10.2. Largest measured strain

Allow 3 business days for the Engineer's review.

52-6.01C(4)(c) Splice Rejection Mitigation Report

For a rejected lot of service splices or ultimate butt splices, submit a splice rejection mitigation report.

Allow 3 business days for the Engineer's review.

52-6.01C(5) Certificates

Submit a certificate of compliance for each shipment of service splice or ultimate butt splice material. Include with the submittal:

1. Type or series identification of the splice material, including tracking information for traceability
2. Grade and size number of reinforcement to be spliced
3. Statement that the splice material complies with the type of mechanical splice on the Authorized Material List for steel reinforcing couplers
4. For resistance-butt-welded material:
    4.1. Heat number
    4.2. Lot number
    4.3. Mill certificates

52-6.01C(6) Qualification Statements

52-6.01C(6)(a) General

Reserved

52-6.01C(6)(b) Welder and Welding Procedures Qualifications

Submit welder and welding procedure qualifications as an informational submittal.

52-6.01C(6)(c) Splice Prequalification Report

For each bar size of each coupler model type of service splice or ultimate butt splice to be used in the work, submit a splice prequalification report that includes:

1. Copy of the manufacturer's product literature giving complete data on the splice material and installation procedures
2. Names of the operators who will be performing the splicing
3. Descriptions of the positions, locations, equipment, and procedures that will be used in the work
4 Certified test results from the authorized laboratory for the prequalification splice test samples
5. Certifications from the fabricator for operator and procedure prequalification
6. Manufacturer's QC Process Manual

52-6.01C(6)(d) Weld Flash Removal Process

If specified, submit a proposed weld flash removal process. The submittal must show that the process produces a smooth profile that can be successfully epoxy coated under section 52-2.

52-6.01D Quality Assurance

52-6.01D(1) General

Section 52-6.01D applies to service and ultimate butt splices.

Assign a splicing QC manager.

Before starting service or ultimate butt splicing activities, select the lots that constitute each group for QA testing.

Before testing resistance-butt-welded splice test samples of reinforcement to be epoxy coated, remove the weld flash using the authorized process for flash removal.

Section 11-2 does not apply to resistance-butt-welded splices.

52-6.01D(2) Qualifications

52-6.01D(2)(a) General

Reserved

52-6.01D(2)(b) Operator and Procedure Prequalification

Before performing any service or ultimate butt splicing, obtain certifications from the fabricator for prequalification of the operators and the procedures to be used in the work.

For each bar size of each splice coupler model type to be used, each operator must prepare 4 prequalification splice test samples.

Splice test samples must have been prepared and tested no more than 2 years before the submittal of the splice prequalification report.

Splice test samples and testing must comply with the QC testing requirements specified in section 52-6.01D(4)(b) for the type of splice to be used in the work.

52-6.01D(2)(c) Welder and Welding Procedure Qualifications

Before performing any CJP butt welds, qualify welders and welding procedures under AWS D1.4.

Qualify welders and welding procedures on splice test samples of the type to be used in the work.

52-6.01D(3) Test Samples

52-6.01D(3)(a) General

Prepare splice test samples under California Test 670.

For splicing new reinforcement to existing reinforcement, make splice test samples using only reinforcement having the deformation pattern of the new reinforcement.

Before transporting splice test samples to an authorized laboratory and METS:

1. Securely bundle and package the 4 test samples for each test in a way that preserves their condition during transportation
2. Identify each splice test sample by location, lot number, and Contract number using weatherproof markings
3. Attach a completed Sample Identification Card to each bundle

When preparing or removing splice test samples for QC testing, concurrently prepare or remove 4 Department acceptance splice test samples from the same lot during:

1. 1st QC test
2. 1 QC test from each group, randomly selected by the Engineer

If splices from a lot will be encased in concrete prior to receiving passing Department acceptance test results, you must prepare additional samples selected by the Engineer from the same lot for additional Department acceptance testing. You may prepare the samples as specified for service splice test samples in section 52-6.01D(4)(b)(iii). The Department will test service splice test samples as specified for service splices and ultimate butt splice test samples as specified for ultimate butt splices.

52-6.01D(3)(b) Ultimate Butt Splice

After completing the ultimate butt splices in a lot, including any required epoxy coating, notify the Engineer that the splices are ready for testing. Except for hoops, the Engineer selects splice test samples at the job site or PC plant. The Engineer selects splice test samples for hoops at the job site, PC plant, or fabrication plant.

After being notified, the Engineer randomly selects the 4 splice test samples to be removed and places tamper-proof markings or seals on the test samples.

A test sample is rejected if the tamper-proof marking or seal is disturbed before testing.

52-6.01D(4) Quality Control

52-6.01D(4)(a) General

Reserved

52-6.01D(4)(b) Quality Control Testing

52-6.01D(4)(b)(i) General

QC testing includes total slip testing, service splice testing, and ultimate butt splice testing.

Test QC splice test samples:

1. In the condition received
2. Under California Test 670
3. At a laboratory on the Authorized Laboratories List for testing reinforcing steel splices

Before performing service splice or ultimate butt splice testing, perform total slip testing on the service splice or ultimate butt splice test samples as specified in section 52-6.01D(4)(b)(ii).

Do not perform tests on splice test samples from bundles containing fewer than 4 test samples.

At least 5 business days before performing any testing at the authorized laboratory, notify the Engineer of:

1. Date of the testing
2. Location of the authorized laboratory where the tests will be conducted
3. Number of lots to be tested
4. Group number of each lot

If a QC test for a lot is rejected, repair or replace reinforcing bars from which test samples were removed before the Engineer selects additional splices from this lot for more testing.

If a lot of splices is rejected, do not use the rejected lot or any subsequent lots until:

1. QC manager has performed a complete review of your QC process for these splices
2. You have prepared a splice rejection mitigation report describing:
   2.1. Cause of the failure
   2.2. Method used to identify the cause of failure
   2.3. Identification of affected lots
   2.4. Provisions for preventing similar failures in future lots
   2.5. Procedure for repairing or replacing the splices in the rejected lot
3. Engineer has notified you that the splice rejection mitigation report is authorized

52-6.01D(4)(b)(ii) Total Slip Testing

Except for mechanical lap, welded, or hoop splices, test 1 of the 4 splice test samples for total slip.

If the splice test sample exceeds the total slip value specified in section 52-6.02B(1), test the 3 remaining test samples for total slip. If any of the 3 remaining test samples exceed the specified total slip value, the Department rejects all splices in the lot.

52-6.01D(4)(b)(iii) Service Splice Testing

A service splice test consists of preparing and testing 4 splice test samples for each lot of completed splices.

Prepare the test samples using the same splice material, position, operators, location, equipment, and procedures to be used in the work.

Splice test samples must comply with the requirements specified in section 52-6.02B(2) as follows:

1. If only 1 splice test sample complies with the requirements, the Department rejects all splices in the lot.

2. If only 2 splice test samples comply with the requirements, perform 1 additional test on the same lot of splices. This additional test must consist of tensile testing 4 splice test samples, randomly selected by the Engineer and removed by you from the lot of completed splices. If any of the 4 splice test samples from this additional test do not attain the specified minimum tensile strength, the Department rejects all splices in the lot.
3. If 3 or more splice test samples comply with the requirements, the Department accepts all splices in the lot.

52-6.01D(4)(b)(iv) Ultimate Butt Splice Testing

An ultimate butt splice test consists of removing and testing 4 splice test samples from each lot of completed splices.

At fracture, splice test samples must comply with the requirements specified in section 52-6.02B(3) as follows:

1. If only 1 splice test sample complies with the requirements, the Department rejects all splices in the lot.
2. If only 2 splice test samples comply with the requirements, perform 1 additional ultimate butt splice test on the same lot of splices. If any of these 4 splice test samples do not comply with the specified requirements, the Department rejects all splices in the lot.
3. If 3 or more splice test samples comply with the requirements, the Department accepts all splices in the lot.

The Department does not require ultimate butt splice testing on repaired splices from a lot unless an additional ultimate butt splice test is required on the same lot of splices. If this additional test is required, the Engineer may select any repaired splice for the additional test.

If splices are made vertically at the job site in or above their final positions for bar reinforcement of columns or CIP concrete piles, instead of removing the splice test samples from the completed lot, you may prepare the samples as specified for service splice test samples in section 52-6.01D(4)(b)(iii). Test the splice test samples as specified for ultimate butt splice test samples.

If test samples for CJP butt-welded splices are not removed from a lot of completed splices, perform RT as follows:

1. Perform RT of CJP butt-welded splices under AWS D1.4:
   2.1. Before tensile testing the splice test samples
   2.2. On 25 percent of CJP butt-welded splices from a production lot
2. Radiographic procedures must comply with AWS D1.1 and D1.4.
3. For field-produced CJP butt welds, do not radiograph more than 1 weld during 1 exposure.
4. Make radiographs by either X-ray or gamma ray. Each radiograph must have a density of from 2.3 to 3.5 in the area of interest. The Department allows a density tolerance of 0.05 for densitometer variations. Gamma rays must be from the iridium 192 isotope, and the emitting specimen must not exceed 0.18 inch in the greatest diagonal dimension.
5. You may add an allowable weld buildup of 0.16 inch to the total material thickness when determining the proper penetrameter selection. The Department does not accept image quality indicator equivalency.
6. Sufficiently shim penetrameters using a radiographically identical material. Penetrameter image densities must be from 2.0 to 3.6.
7. Regardless of the reinforcing bar size, radiographic film must be Class 1.
8. Record the results of radiographic interpretations on a signed certification and keep a copy with the film packet.

For RT:

1. The Department does not allow sight development of film.
2. Technique sheets prepared under ASME Boiler and Pressure Vessel Code, section V, article 2, section T-291, must include the developer temperature, developing time, fixing duration, and all rinse times.

Notify the Engineer 48 hours before performing any RT. The Engineer selects the splices that compose the production lot and the splices within each lot to receive RT.

If more than 12 percent of the splices radiographically tested in a production lot are defective, perform RT on an additional 25 percent of the splices selected by the Engineer from the same production lot. If more than 12 percent of the cumulative total of splices tested from the same production lot are defective, perform RT on all remaining splices in the lot. The Department does not pay for additional RT performed due to the identification of defective splices.

Repair defects under AWS D1.4.

52-6.01D(4)(c) Weld Flash Removal Process

Removal of the weld flash must produce a smooth profile free of any sharp edges that would prevent proper coating of the reinforcement such that:

1. Ultimate tensile strength and elongation properties of the bar are not reduced
2. Outside radius of the flash at any point along the circumference of the bar is not:
   2.1. Less than the nominal radius of the bar
   2.2. Greater than 3/16 inch beyond the nominal radius of the bar

52-6.01D(4)(d) Splicing Quality Control Test Report

The splicing quality control test report must be (1) prepared by the laboratory performing the testing and (2) signed by an engineer representing the laboratory. The Engineer must be registered as a civil engineer in the State.

52-6.01D(5) Department Acceptance

The Department tests service splices and ultimate butt splices as specified for QC testing in section 52-6.01D(4).

If a Department acceptance test result does not comply with the material and QA requirements, the Department rejects all splices in the lot and the group.

For the other lots in the rejected group that pass QC testing, you may request the Engineer to perform additional Department acceptance testing for additional splice samples. If a Department acceptance splice test result complies with the material and QA requirements, the Department accepts all splices in that lot.

If a lot of splices is rejected, prepare a splice rejection mitigation report for that rejected lot as specified in section 52-6.01D(4)(b)(i).

If the QC and the Department acceptance test results have different compliance determinations, the Department will sample and test all subsequent lots until QC and the Department acceptance test compliance determinations are consistent for 2 consecutive lots before resuming sampling and testing of 1 lot from every group.

The Department will notify you of the Department acceptance test results for each bundle of 4 test samples of splices within 3 business days after METS receives the bundle unless more than 1 bundle is received on the same day, in which case allow 2 additional business days for each additional bundle received.

52-6.02 MATERIALS

52-6.02A General

Reserved

52-6.02B Service Splices and Ultimate Butt Splices

52-6.02B(1) General

Section 52-1.02B applies if service splices or ultimate butt splices are used in the work.

The total slip must not exceed the values shown in the following table when tested under California Test 670:

Total Slip

Reinforcing bar no.	Total slip (inch)
4	0.020
5	0.020
6	0.020
7	0.028
8	0.028
9	0.028
10	0.036
11	0.036
14	0.048
18	0.060

The following must be on the Authorized Material List for steel reinforcing couplers:

1. Mechanical couplers
2. Fabricators of resistance-butt-welded splices

52-6.02B(2) Service Splices

Service splices must develop a minimum tensile strength of 80,000 psi.

52-6.02B(3) Ultimate Butt Splices

Ultimate butt splice test samples must demonstrate necking as either of the following:

1. Except for 30-inch and smaller diameter hoops, for *Necking Option I* as specified in California Test 670, the test sample must fracture in the reinforcing bar outside of the affected zone and show visible necking. For 30-inch and smaller diameter hoops, the test sample must show visible necking at fracture at any location.
2. For *Necking Option II* as specified in California Test 670, the largest measured strain must be at least:
   2.1. 6 percent for no. 11 and larger bars
   2.2. 9 percent for no. 10 and smaller bars

52-6.03 CONSTRUCTION

52-6.03A General

Butt-welded or mechanical splices not shown as requiring a service splice or an ultimate butt splice must comply with the specifications for service splices.

Do not place splices at a location shown as a no-splice zone.

Reinforcing bars may be continuous where splices are shown. If splice locations are not shown, determine splice locations using commercial lengths where practicable.

Unless another option is shown, stagger splices in adjacent reinforcing steel. The minimum distance between staggered lap splices or staggered mechanical lap splices must be the same as the length specified for a lap splice in the largest bar. The minimum distance between staggered butt splices must be 2 feet measured between the splice midpoints along a line centered between the axis of the adjacent bars.

For reinforcing bars where splice test samples were removed, replace either of the following:

1. Removed portion of the bar or hoop using mechanical ultimate butt splices
2. Bar or hoop in kind

52-6.03B Lap Splicing

Splices made by lapping must consist of placing reinforcing bars in contact and wiring them together while maintaining the alignment of the bars and the minimum clearances.

Do not splice the following by lapping:

1. No. 14 bars
2. No. 18 bars
3. Hoops
4. Reinforcing bars where you cannot provide a minimum clear distance of 2 inches between the splice and the nearest adjacent bar

For uncoated and galvanized reinforcing bars complying with ASTM A615/A615M, Grade 60, ASTM A706/A706M, or ASTM A767/A767M, Class 1, the length of lap splices must be at least:

1. 45 diameters of the smaller bar spliced for reinforcing bars no. 8 or smaller
2. 60 diameters of the smaller bar spliced for reinforcing bars nos. 9, 10, and 11

For epoxy-coated reinforcing bars and alternatives to epoxy-coated reinforcing bars complying with ASTM A775/A775M, ASTM A934/A934M, ASTM A1035/A1035M, or ASTM A1055/A1055M, the length of lap splices must be at least:

1. 65 diameters of the smaller bar spliced for reinforcing bars no. 8 or smaller
2. 85 diameters of the smaller bar spliced for reinforcing bars nos. 9, 10, and 11

For reinforcing bars complying with ASTM A615/A615M, Grade 40, the length of lap splices must be at least:

1. 30 diameters of the smaller bar spliced for reinforcing bars no. 8 or smaller
2. 45 diameters of the smaller bar spliced for reinforcing bars nos. 9, 10, and 11

For splices in bundled bars, the length of the lap splices must be:

1. Equal to the length of a single bar lap splice for bundles of 2 bars
2. 1.2 times the length of a single bar lap splice for bundles of 3 bars

Lap welded wire reinforcement such that the overlap between the outermost cross wires is at least the larger of the following:

1. 6 inches
2. Spacing of the cross wires plus 2 inches
3. Numerical value of the longitudinal wire size (W-size number) times 4.3 divided by the spacing of the longitudinal wires in inches

52-6.03C Service Splices and Ultimate Butt Splices

52-6.03C(1) General

Service splices and ultimate butt splices must be one of the following:

1. Mechanical splices
2. Resistance-butt-welded splices
3. CJP butt-welded splices

52-6.03C(2) Mechanical Splices

Perform service splicing and ultimate butt splicing of mechanical splices:

1. Under the manufacturer's instructions, unless otherwise specified
2. Using the manufacturer's standard equipment, jigs, clamps, and other required accessories

Splice devices must have a clear cover of at least 1-3/4 inches measured from the surface of the concrete to the outside of the splice device. To provide the specified clear cover to reinforcement:

1. Adjust or relocate stirrups, ties, and other reinforcement
2. Place additional reinforcement, if needed

52-6.03C(3) Resistance-Butt-Welded Splices

If resistance-butt-welded bar reinforcement is to be epoxy coated, remove the weld flash using the authorized process for flash removal.

52-6.03C(4) Complete-Joint-Penetration Butt-Welded Splices

CJP butt-welded splices must comply with AWS D1.4.

Use only the joint details and dimensions shown in Figure 3.2 of AWS D1.4 except do not use the *Single-V-Groove Weld with Split Pipe Backing* detail.

Make butt welds with multiple weld passes without an appreciable weaving motion using a stringer bead having a width at most 2.5 times the diameter of the electrode. Perform slagging between each weld pass. Weld reinforcement must not exceed 0.16 inch in convexity.

Electrodes for welding must have a minimum CVN impact value of 27 J at -4 degrees F.

For welding of bars complying with ASTM A 615/A 615M, Grade 40 or 60, the requirements of Table 5.2 of AWS D1.4 are superseded by the following: The minimum preheat and interpass temperatures must be 400 degrees F for Grade 40 bars and 600 degrees F for Grade 60 bars. Immediately after completing the welding, cover at least 6 inches of the bar on each side of the splice with insulated wrapping to control the rate of cooling. The insulated wrapping must remain in place until the bar has cooled below 200 degrees F.

If welding different grades of reinforcing bars:

1. Electrode must comply with the specifications for Grade 40 bar
2. Preheat must comply with the specifications for Grade 60 bar

If any of the specified preheat, interpass, and post-weld cooling temperatures are not met, remove the weld and heat-affected-zone metal and reweld the splice.

Protect welding from air currents, drafts, and precipitation to prevent loss of heat or loss of arc shielding.

Do not direct butt splice reinforcing bars by thermite welding.

52-6.04 PAYMENT

Not Used

52-7 STRAY CURRENT PROTECTION

52-7.01 GENERAL

52-7.01A Summary

Section 52-7 includes specifications for installing stray current protection.

Stray current protection consists of one or a combination of the following:

1. Prestressing tendon connections
2. Bar reinforcing steel connections
3. Copper cable to bar reinforcing steel connections
4. Pile and concrete epoxy insulation
5. Concrete insulation course
6. Neoprene sheet insulation
7. Joint sealant insulation
8. Membrane insulation
9. Mortar block insulation
10. Epoxy-coated reinforcing steel insulation
11. Plastic end cover insulators
12. Pipe wrapping tape insulation
13. Epoxy for insulation of embedded metal materials

52-7.01B Definitions

Reserved

52-7.01C Submittals

Reserved

52-7.01D Quality Assurance

52-7.01D(1) General

Reserved

52-7.01D(2) Prestressing Tendon Connection

Welding operators must be prequalified by satisfactorily completing a field qualification test weld. The operator must make qualification test welds in the presence of the Engineer using:

1. Materials similar to those in the work
2: The same position and under the same conditions of welding that will be encountered in the work

Visual inspection of completed welds must show no evidence of cracks, lack of fusion, or undercutting.

52-7.01D(3)–52-7.01D(5) Reserved

52-7.02 MATERIALS

52-7.02A General

Reserved

52-7.02B Prestressing Tendon Connection

For prestressing tendon connections, the no. 6 steel wire must comply with ASTM A1064, A510, or A510M.

52-7.02C Bar Reinforcing Steel Connection

Reserved

52-7.02D Copper Cable to Bar Reinforcing Steel Connection

Materials for exothermic welding the copper cable to bar reinforcing steel connections must comply with the manufacturer's instructions for the following:

1. Mold size and shape
2. Powder charge size and alloy mixture

Copper cable must comply with section 86.

Tape must be commercially available vinyl electrical tape with a thickness of at least 7 mils.

Test box cover and anchorage devices must comply with section 75-3. The gasket must be made of commercially available neoprene.

52-7.02E Pile and Concrete Epoxy Insulation

For pile and concrete epoxy insulation, epoxy must be:

1. Commercial quality
2. Nonconductive
3. Suitable for adherence to concrete and steel surfaces

52-7.02F Concrete Insulation Course

Concrete insulation course must comply with section 51 and contain at least 590 pounds of cementitious material per cubic yard of concrete.

52-7.02G Neoprene Sheet Insulation

Fabricate neoprene sheet insulation from sheet neoprene complying with the specifications for neoprene in section 51-2.04.

The sheet must be at least 1/8 inch thick.

52-7.02H Joint Sealant Insulation

The joint sealant insulation must be a single-component, non-sag polyurethane sealant complying with ASTM C 920.

The primer and backing rod must comply with the joint sealant manufacturer's instructions.

52-7.02I Membrane Insulation

Membrane insulation must comply with the specifications for dampproofing or preformed membrane waterproofing in section 54.

52-7.02J Mortar Block Insulation

Mortar block insulation must contain at least 760 pounds of cementitious material per cubic yard. The blocks must be dense, homogeneous, and watertight.

52-7.02K Epoxy-Coated Reinforcing Steel Insulation

Epoxy-coated reinforcing steel insulation must comply with section 52-2.

If a coupling nut is used at an attachment between an approach slab and an abutment, the nut must be epoxy coated either before or after fabrication.

52-7.02L Plastic End Cover Insulators

The plastic end cover insulators must be of the type commercially available to protect workers from protruding reinforcing bars. Bond the covers to the reinforcing bars with commercially available epoxy that is compatible with the plastic covers.

52-7.02M Pipe Wrapping Tape Insulation

For pipe wrapping tape insulation, the tape must be pressure-sensitive PVC or polyethylene tape with a nominal thickness of 20 mils. Use a primer as instructed by the manufacturer of the tape.

52-7.02N Epoxy for Insulation of Embedded Metal Materials

For insulation of embedded metal materials, epoxy must be:

1. Commercial quality
2. Nonconductive
3. Suitable for adhering to metal surfaces

Instead of epoxy coating the hanger rods, you may use commercial quality neoprene bushings around the pipe at strap supports.

Instead of epoxy coating the metal parts of joint seal assemblies in contact with concrete, you may apply a heavy coat of bituminous paint.

52-7.03 CONSTRUCTION

52-7.03A General

Reserved

52-7.03B Prestressing Tendon Connection

Do not perform welding on the prestressing anchorage devices. Do not perform arc welding on the prestressing strand.

Connect the collector wire to the prestressing strand by gas welding. Do not gas weld until the tendons are grouted and have cured for at least 24 hours. You may join 2 wire pigtail ends by gas welding at any stage of the work.

Oxyacetylene welding must comply with the best standards of the industry. Use gas welding rods complying with Class RG45 (steel rods).

52-7.03C Bar Reinforcing Steel Connection

Weld bars and splices by the manual shielded metal-arc process before installing any prestressing strands. Use low-hydrogen electrodes complying with the specifications for E7016 electrodes in AWS A5.1/A5.1M.

52-7.03D Copper Cable to Bar Reinforcing Steel Connection

Fusion weld the copper cable to the bar reinforcing steel by an exothermic type welding process.

Apply commercially available rubber splicing compound to the welded connection.

Apply 2 layers of tape, each half lapped.

52-7.03E Pile and Concrete Epoxy Insulation

Abrasive blast clean concrete surfaces on which epoxy insulation is to be applied to the extent that clean aggregate is exposed.

Apply the epoxy by brush or other means that will completely and uniformly cover the surfaces.

Remove lifting anchors as specified for their removal in a corrosive environment in section 49-2.04B(2).

52-7.03F Concrete Insulation Course

Excavate and backfill for concrete insulation course under section 19-3.

The joint between the concrete insulation course and the footing must comply with the specifications for horizontal construction joints in section 51-1.03D(4), except abrasive blast cleaning is not required.

52-7.03G Neoprene Sheet Insulation

For neoprene sheet insulation, lap each successive sheet securely to the preceding sheet by at least 6 inches.

52-7.03H Joint Sealant Insulation

Abrasive blast clean and prime concrete surfaces to receive joint sealant insulation.

52-7.03I Membrane Insulation

The exposed surfaces of membrane insulation must be of uniform height above ground without unsightly bulges, depressions, or other imperfections.

Membrane insulation must comply with the specifications for dampproofing or preformed membrane waterproofing in section 54.

52-7.03J Mortar Block Insulation

Reserved

52-7.03K Epoxy-Coated Reinforcing Steel Insulation

For a coupling nut which is epoxy coated after fabrication, apply the epoxy by brush or other means that will completely and uniformly cover the surfaces in contact with concrete.

52-7.03L Plastic End Cover Insulators

Use enough epoxy to ensure that no voids exist between the plastic end cover insulators and the reinforcing bars.

52-7.03M Pipe Wrapping Tape Insulation

For pipe wrapping tape insulation, apply 1 layer of tape half lapped.

52-7.03N Epoxy for Insulation of Embedded Metal Materials

For embedded metals insulated with epoxy:

1. Prepare galvanized surfaces under section 59-3.03.
2. Apply the epoxy by brush or other means to completely and uniformly cover the surfaces in contact with concrete.

52-7.04 PAYMENT

Not Used

53 SHOTCRETE

53-1 GENERAL

53-1.01 GENERAL

53-1.01A Summary

Section 53-1 includes general specifications for placing shotcrete.

Reinforcement must comply with section 52.

53-1.01B Definitions

dry-mix process: Deliver mixed aggregate and cementitious material pneumatically or mechanically to the nozzle body and add water and mix the materials in the nozzle body.

wet-mix process: Deliver mixed aggregate, cementitious material, and water pneumatically to the nozzle and add any admixture at the nozzle.

rebound: Shotcrete material that ricochets off the receiving surface, is recovered, and is clean and free of foreign material.

53-1.01C Submittals

Reserved

53-1.01D Quality Assurance

Reserved

53-1.02 MATERIALS

Shotcrete must consist of cementitious material, fine aggregate, and water. Cementitious material, fine aggregate, and water must comply with section 90-1.

For the dry-mix process:

1. Thoroughly mix 1 part cementitious material to not more than 4.5 parts fine aggregate in a dry state before charging into the machine. Measurement must be either by volume or weight.
2. Fine aggregate must contain not more than 6 percent moisture by weight.

For the wet-mix process:

1. Shotcrete must contain at least 675 pounds of cementitious material per cubic yard.
2. You may substitute a maximum of 30 percent coarse aggregate for the fine aggregate. Coarse aggregate must comply with section 90-1, except section 90-1.02C(4)(d) does not apply. The gradation for the coarse aggregate must comply with the gradation specified in section 90-1.02C(4)(b) for the 1/2 inch x No. 4 or the 3/8 inch x No. 8 primary aggregate nominal size.
3. You may add admixtures complying with section 90-1.02E.

If colored shotcrete is described, color shotcrete by mixing a fine ground, synthetic mineral oxide into the shotcrete. The synthetic mineral oxide must be specifically manufactured for coloring concrete. The coloring agent must be uniformly and homogeneously mixed with the shotcrete.

53-1.03 CONSTRUCTION

53-1.03A General

Reserved

53-1.03B Preparing Foundations

Evenly grade foundations before applying shotcrete. No point on the graded slope may be above the slope plane shown.

Thoroughly compact foundations. Foundations must contain enough moisture to provide a firm foundation and to prevent absorption of water from the shotcrete. Foundations must be free of surface water.

Use ground or gauging wires if necessary to establish thickness, surface planes, and finish lines.

53-1.03C Placing Shotcrete

Apply shotcrete by either the dry-mix or wet-mix process.

Direct the nozzle in a way that minimizes rebound of the shotcrete.

Maintain a uniform velocity of the material as it leaves the nozzle and at a rate determined for the job site conditions.

For dry-mix shotcrete:

1. Maintain a constant pressure of at least 45 psi in the placing machine if the hose length is 100 feet or less. Increase the pressure at least 5 psi for each additional 50 feet of hose or fraction thereof.
2. Maintain uniform water pressure at the nozzle of at least 15 psi greater than the air pressure at the machine.
3. Do not use aggregate and cementitious materials that have been mixed for more than 45 minutes.

For wet-mix shotcrete:

1. Transport shotcrete under section 90-1.02G(3)
2. Limit placing to 8-foot lifts measured along the slope
3. Place gauging wires at approximately 7-foot centers
4. Do not use materials that have been mixed for more than 90 minutes

You may reuse rebound as fine aggregate in quantities not to exceed 20 percent of the total fine aggregate requirements.

53-1.03D Finishing Shotcrete

Place shotcrete to the depth shown and check the surface with a straightedge. Bring to grade any low spots or depressions by placing additional shotcrete. The finished surface must be smooth and uniform for the type of work involved.

Remove and replace loose areas of shotcrete.

Cure shotcrete for at least 72 hours by spraying with water, by a moist earth blanket, or by any of the methods specified in section 90-1.03B.

If you add a coloring agent to the shotcrete and you use the curing compound method for curing the shotcrete, use curing compound no. 6.

Protect shotcrete under section 90-1.03C.

53-1.04 PAYMENT

Shotcrete is measured along the slope of areas placed and the thickness shown.

The Department does not pay for shotcrete placed outside the dimensions shown or to fill low areas of foundations.

53-2 STRUCTURAL SHOTCRETE

53-2.01 GENERAL

53-2.01A Summary

Section 53-2 includes specifications for placing structural shotcrete.

53-2.01B Definitions

Reserved

53-2.01C Submittals

Submit:

1. QC plan that includes:
   1.1. Number and qualifications of nozzlemen available to place shotcrete, number of nozzlemen on the job site at any time during shotcrete placement, description of their work schedule, and procedures for avoiding fatigue of any nozzleman

1.2. Proposed method of placing shotcrete, including application rates, details of proposed construction joints and their locations, and methods for achieving the required thickness and surface finish
1.3. Procedures for curing shotcrete surfaces
1.4. Description of any required debris containment system
2. Preconstruction test panels and test results
3. Production test cores and test results

53-2.01D Quality Assurance

53-2.01D(1) General

Reserved

53-2.01D(2) Qualifications

Each nozzleman must have at least 3,000 hours of experience as a nozzleman on projects with a similar application.

53-2.01D(3) Preconstruction Test Panels

Obtain authorization of the QC plan before constructing test panels.

Construct 1 unreinforced test panel and 1 reinforced test panel for each proposed mix design. Use nozzlemen, application crew, equipment, materials, mix designs, and procedures proposed for the work.

Cure the test panels under conditions similar to those in the work.

For the unreinforced test panel:

1. Determine the size of the test panel
2. Obtain 3-inch-diameter cores from the test panel
3. Discard cores that show evidence of improper coring
4. Identify each core that is to be tested
5. Test cores for compressive strength
6. Label and submit the test panel and a copy of the test results within 5 days of testing
7. Include the mix design and ambient temperature in the submittal

For the reinforced test panel:

1. Construct a square test panel that has the same (1) thickness, (2) bar size and quantity of bar reinforcement or other obstructions, and (3) positioning of bar reinforcement or obstructions as the most heavily reinforced section of shotcrete to be placed
2. Minimum length of each side must equal 3 times the thickness of the most heavily reinforced section of shotcrete to be placed but not less than 30 inches
3. Break the test panel in the presence of the Engineer after a minimum 7-day cure into pieces no larger than 10 inches in the greatest dimension
4. Surfaces of the broken pieces must be dense and free of laminations and sand pockets and must show that the bar reinforcement or other obstructions are completely encased

Obtain and test cores for compressive strength under section 53-2.01D(4)(a).

Instead of constructing a separate unreinforced test panel, you may obtain cores from the reinforced test panel to determine the compressive strength. If you choose this option, do not break the test panel until it has cured for at least 14 days.

Dispose of test panels.

53-2.01D(4) Quality Control

53-2.01D(4)(a) General

Obtain cores for compressive strength testing under ASTM C1604/C1604M. Discard cores that contain bar reinforcement or other obstructions or show evidence of improper coring. Test cores for compressive strength at 28 days under ASTM C1604/C1604M at an authorized laboratory. The compressive strength is the average strength of at least 3 cores that are free from bar reinforcement or other obstructions.

Notify the Engineer at least 24 hours before performing any coring or testing.

53-2.01D(4)(b) Field Quality Control

Obtain at least four 3-inch-diameter test cores from each 50 cu yd, or portion thereof, of shotcrete placed each day. Three cores must be free from reinforcement or obstructions. One core must include reinforcement. The Engineer determines each core location.

Cores must be both visually inspected and tested for compressive strength. The Engineer performs the visual inspection and you must perform compressive strength testing.

Identify each core, including a description of the core location and mix design, and submit the cores immediately after coring.

The Engineer will perform the visual inspection and return the cores to you for compressive strength testing within 48 hours.

53-2.01D(5) Department Acceptance

53-2.01D(5)(a) General

The Department accepts shotcrete based on test cores for visual inspection and compressive strength.

53-2.01D(5)(b) Visual Inspection

Each test core must be dense and be free of laminations and sand pockets. Any core with reinforcement must show reinforcement or other obstructions are completely encased.

Shotcrete represented by an unacceptable core will be rejected unless you submit evidence that the quality of the shotcrete placed in the work is acceptable.

53-2.01D(5)(c) Compressive Strength

If the compressive strength of the shotcrete is below the specified compressive strength:

1. Make corrections to the mix design or fabrication procedures and obtain authorization before you place additional shotcrete.
2. Shotcrete represented by the cores is subject to one of the following:
   - 2.1 If the compressive strength is at least 95 percent of the specified strength, $10/cu yd is deducted from the payment for structural shotcrete.
   - 2.2 If the compressive strength is below 95 percent of the specified strength but is at least 85 percent of the specified strength, $15/cu yd is deducted from the payment for structural shotcrete.
   - 2.3 If the compressive strength is below 85 percent of the specified strength, the shotcrete must be removed.

If the compressive strength is below the specified strength but is at least 85 percent of the specified strength, the deductions specified above apply unless you obtain and submit evidence that the strength of the concrete placed in the work is greater than or equal to the specified strength and this evidence is accepted by the Engineer.

If the compressive strength is below 85 percent of the specified compressive strength, the noncompliant concrete represented by the test must be removed unless you obtain and submit evidence that the strength of the concrete placed in the work is at least 85 percent of the specified compressive strength and this evidence is accepted by the Engineer.

If the evidence consists of tests made on cores taken from the work, obtain and test the cores under ASTM C1604/C1604M.

53-2.02 MATERIALS

Shotcrete must have a minimum compressive strength of 3,600 psi, unless otherwise described. The shotcrete must attain the minimum compressive strength at 28 days, except 42 days are allowed for shotcrete with a described minimum compressive strength greater than 3,600 psi.

Mortar must comply with section 51-1.02F.

53-2.03 CONSTRUCTION

For ground anchor and soil nail walls, backfill voids due to the removal of cobbles, boulders, portions of boulders, debris, or other obstructions with shotcrete.

Forms must comply with section 51-1.03C(2).

Splicing of reinforcing bars no. 7 or larger must be made using a service butt splice.

Apply shotcrete by the wet-mix process. Shotcrete must completely encase reinforcement and other obstructions. Rebound must not be used in structural shotcrete.

Taper construction joints. Construction joints must comply with section 51-1.03D(4).

Before final set, use air blowpipes to remove rebound, overspray, and other debris from the areas to receive shotcrete.

If a finish coat is used, remove loose material, uneven or excess material, and glaze. Scarify the remaining surface. Remove surface deposits that take a final set by abrasive blasting. Before placing the finish coat, wash receiving surface with an air-water blast.

You may apply finish coats by the dry-mix process if authorized.

Remove shotcrete that extends into the space shown for CIP concrete.

Cure shotcrete under section 51-1.03H. The surface finish of the shotcrete must comply with section 51-1.03F.

Shotcrete must be maintained at a temperature of at least 45 degrees F for 72 hours after placing and at least 40 degrees F for an additional 4 days.

After removing field QC test cores, fill the holes with mortar under section 51-1.03E(2).

53-2.04 PAYMENT

Payment for bar reinforcing steel is not included in the payment for structural shotcrete.

53-3 SCULPTED SHOTCRETE

Reserved

53-4–53-9 RESERVED

54 WATERPROOFING

54-1 GENERAL

54-1.01 GENERAL

Section 54 includes general specifications for waterproofing.

54-1.02 MATERIALS

Not Used

54-1.03 CONSTRUCTION

Not Used

54-1.04 PAYMENT

Not Used

54-2 ASPHALT MEMBRANE WATERPROOFING AND DAMPPROOFING

54-2.01 GENERAL

Section 54-2 includes specifications for applying asphalt membrane waterproofing and dampproofing.

Asphalt membrane waterproofing consists of a coating of primer and a firmly bonded membrane composed of 2 layers of saturated glass fabric and 3 moppings of waterproofing asphalt.

Dampproofing consists of a coating of primer and 2 moppings of waterproofing asphalt.

54-2.02 MATERIALS

Waterproofing asphalt must comply with ASTM D449, Type I for below ground and Type II for above ground.

The primer must comply with ASTM D41/D41M.

Treated glass fabric must comply with ASTM D1668, Type I.

54-2.03 CONSTRUCTION

54-2.03A General

The surface to be waterproofed must be smooth and free from holes and projections that could puncture or damage the membrane.

The surface to be waterproofed or dampproofed must be dry and thoroughly cleaned of dust and loose materials.

Do not apply the primer or asphalt in wet weather or at ambient temperatures below 65 degrees F.

Apply the primer to the surface and allow it to dry before applying the 1st coat of asphalt.

Apply the waterproofing asphalt at a temperature of 300-350 degrees F.

For waterproofing on steel column casings, apply the asphalt membrane waterproofing to the painted undercoat of the casings.

For a backfilled surface, you may use preformed membrane waterproofing as an alternative to asphalt membrane waterproofing.

54-2.03B Waterproofing

After priming the surface, apply the waterproofing as follows:

1. Starting at the lowest point, mop the waterproofing asphalt thoroughly onto the primed surface.
2. Roll a strip of fabric 1/2 the width of the fabric roll onto the hot asphalt immediately and press into place, eliminating all air bubbles and obtaining close conformity with the surface.
3. Mop hot asphalt onto this strip and an adjacent section of the surface of a width equal to slightly greater than 1/2 the width of the fabric being used. Roll a full width of the fabric into this hot asphalt, completely covering the first strip. Press into place in the same way as for the 1st strip.

4. Mop the 2nd strip and an adjacent section of the surface with hot asphalt. Shingle a 3rd strip of fabric on such that it laps the 1st strip by at least 2 inches.
5. Continue this process until the entire surface is covered, with each strip of fabric lapping at least 2 inches over the second to last strip.
6. Mop the entire surface with hot asphalt. Ensure a thorough seal and firm bond at all fabric laps.

Regulate the work such that at the end of the work day, the final mopping of asphalt has been applied to all the fabric in place.

The exposed surfaces of the membrane waterproofing applied to steel column casings must be of uniform height above ground, without unsightly bulges, depressions, or other imperfections.

Do not apply the asphalt membrane waterproofing to a surface until you are prepared to place the backfill within a short enough time such that the waterproofing is not damaged as a result of exposure. Remove and replace waterproofing membrane that loses bond with the surface.

54-2.03C Dampproofing

Apply dampproofing using the following procedure:

1. Prime the surface to be dampproofed.
2. Thoroughly mop the surface with waterproofing asphalt.
3. After the 1st mopping of asphalt has set sufficiently, mop the entire surface with a 2nd coat of hot asphalt.
4. Ensure that there are no skips in the coatings and that all surfaces are thoroughly covered.

54-2.04 PAYMENT

Reserved

54-3 PREFORMED MEMBRANE WATERPROOFING

54-3.01 GENERAL

54-3.01A Summary

Section 54-3 includes specifications for applying preformed membrane waterproofing to surfaces that are to be backfilled.

54-3.01B Definitions

Not Used

54-3.01C Submittals

Submit a certificate of compliance for the preformed membrane sheet. Include the following:

1. Type of preformed membrane sheet
2. Conditioner or primer application rates

54-3.01D Quality Assurance

Reserved

54-3.02 MATERIALS

Preformed membrane waterproofing must consist of:

1. Adhesive
2. Conditioner or primer applied to a prepared surface
3. Preformed membrane sheet of rubberized asphalt or polymer-modified bitumen
4. Mastic or tape for sealing the edges of the sheet
5. Protective covering over the sheet held by an adhesive

The preformed membrane sheet must be permanently applied to a polyethylene film or reinforced with one of the following:

1. Polypropylene mesh fabric
2. Polyester/polypropylene fabric

3. Fiberglass mesh fabric

The total thickness of the membrane sheet and polyethylene film or fabric reinforcement must be at least 60 mils.

The membrane sheet must comply with the requirements shown in the following table:

Membrane Sheet Quality Characteristic Requirements

Quality characteristic	Test method	Requirement	
		Polyethylene film	Fabric reinforced
Breaking strength[a] (min, lb/in)	ASTM D882[b]	20[c]	20[c]
Percent elongation at break,[d] (min)	ASTM D882[b]	150[c]	25[c]
Pliability	ASTM D146/D146M[e]	No cracks	No cracks
Rubberized asphalt softening point (° F, min)	AASHTO T 53	165	165
Polymer-modified bitumen softening point (° F, min)	AASHTO T 53	210	210

[a]Breaking factor in machine direction
[b]Method A, average 5 samples
[c]At 73.4 ± 3.6 degrees F
[d]Machine direction
[e]180-degree bend over a 1-inch mandrel at 10 degrees F

Adhesive, conditioner, primer, mastic, and sealing tape must be manufactured for use with the membrane sheet material used.

The protective covering must be hardboard at least 1/8 inch thick or another material that furnishes equivalent protection.

54-3.03 CONSTRUCTION

Apply adhesive, conditioner, primer, mastic, and sealing tape under the manufacturer's instructions.

Backfill material and equipment must not cut, scratch, depress, or cause any other damage to the preformed membrane.

Thoroughly clean dirt, dust, loose or unsound concrete, and other extraneous material from the surface to receive the waterproofing. The surface must be free from fins, sharp edges, and protrusions that could puncture or damage the membrane. Round outside corners and chamfer inside corners to be covered.

The surface must be dry when applying components of the waterproofing.

Do not apply the preformed membrane waterproofing to a surface until you are prepared to place the protective covering and backfill within a short enough time such that the membrane is not damaged by workers, equipment, exposure to weathering, or any other cause. Repair or replace damaged membrane or protective covering.

Flash all projections, such as pipes, conduits, and sleeves, passing through the preformed membrane waterproofing with prefabricated or field-fabricated boots, fitted coverings, or other devices as necessary to provide watertight construction.

Thoroughly mix and continuously agitate the conditioner or primer during application. Allow the conditioner, primer, or adhesive to dry to a tack-free condition before placing membrane sheets.

Recoat the surface if the membrane sheet is not placed over the primer, conditioner, or adhesive within the time recommended by the manufacturer.

Do not apply preformed membrane sheets in wet or foggy weather or when the ambient temperature is below 40 degrees F.

Place the preformed membrane material starting at the bottom and lap by a minimum of 6 inches at splices and at repairs to holes or tears.

After placing the membrane, apply a trowelled bead of manufacturer-recommended mastic or sealing tape to the exposed edges of the membrane sheets.

The surface of the preformed membrane must be free from dirt and other extraneous material before placing the protective covering.

Place the protective covering on a coating of adhesive. Apply the adhesive at a rate sufficient to hold the protective covering in position until backfilled.

54-3.04 PAYMENT

Not Used

54-4 WATERPROOFING AND COVER

54-4.01 GENERAL

Section 54-4 includes specifications for applying membrane waterproofing and protective cover to deck surfaces of railroad underpasses.

Furnish and apply the waterproofing and cover under the *AREMA Manual for Railway Engineering*.

54-4.02 MATERIALS

54-4.02A General

Reserved

54-4.02B Membrane

The waterproofing membrane must consist of butyl rubber secured with an authorized adhesive.

You may substitute ethylene propylene diene monomer (EPDM) for the butyl rubber if it complies with the specifications for butyl rubber.

Comply with the *AREMA Manual for Railway Engineering,* chapter 8, part 29, for:

1. Butyl rubber membrane
2. Adhesive
3. Splicing cement
4. Butyl gum splicing tape
5. Antibonding paper
6. Fibered aluminum roof coating

The butyl rubber membrane must be at least 0.060 inch thick.

54-4.02C Protective Cover

The protective cover must comply with the *AREMA Manual for Railway Engineering*, chapter 8, part 29, and must consist of 2 layers of asphaltic panels applied with adhesive and sealing compound to a total thickness of at least 3/4 inch.

Sealing compound for joints and edges must be compatible with:

1. Membrane
2. Adhesive used to fasten the membrane to the deck
3. Splicing cement
4. Protective cover panels

The individual panels must be at least 3/8 inch thick.

The installed panels must be at least 4 by 8 feet except as cut for closures.

Ship and store the panels on smooth, flat surfaces.

If the panels are shipped with an inert material between the sheets to prevent sticking, remove the inert material before installation.

54-4.03 CONSTRUCTION

54-4.03A General

Do not apply the membrane waterproofing until you are prepared to place the protective cover within a short enough time such that the membrane is not damaged by workers, equipment, exposure to weathering, or any other cause. Repair or replace damaged membrane.

Sweep or air blow the concrete surfaces to receive the seal to clean them of dirt, dust, gravel, loose concrete particles, and other extraneous materials. Remove projections and fill depressions that could damage the membrane.

The horizontal surfaces of the finished waterproofing must be free from depressions and pockets. The membrane must be carefully turned into drainage fittings. Take special care to make the waterproofing effective at the following locations:

1. Along the sides and ends of girders
2. At stiffeners, gussets, expansion joints, offsets in ballast retainers, and other discontinuities

For retainer-buffers and headers, use no. 1 structural grade Douglas fir timbers pressure treated under AWPA U1, Use Category UC4B, Commodity Specification A, except do not use chromated copper arsenate. For the anchor bolt assemblies associated with retainer-buffers and headers, use commercial-quality, hot-dip galvanized steel bolts, plates, and sheet metal.

54-4.03B Butyl Membrane Waterproofing

The surface to be waterproofed must be dry when the membrane is applied.

Do not apply the membrane when the atmospheric temperature is below 34 degrees F.

Apply the membrane using the following procedure:

1. Position and draw the membrane sheets tight without stretching.
2. Roll 1/2 of the membrane uniformly in a direction away from the starting edge or subsequent splice.
3. Apply the adhesive to the exposed deck area with a squeegee at a rate of at least 1 gallon per 100 square feet of deck surface.
4. Allow the adhesive to dry to a tack-free condition.
5. Unroll and press the membrane firmly and uniformly in place, avoiding trapping of air.
6. Repeat the same procedure for the remaining 1/2 of the membrane sheet, avoiding wrinkles and buckles. Position each succeeding sheet to fit the previously installed sheet and splice the sheets.

Membrane splices must be tongue-and-groove type as shown in figure 8-29-3, no. 3, of the *AREMA Manual for Railway Engineering*, chapter 8, part 29.

Splice the membrane sheets using the following procedure:

1. Clean all seam, lap, and splice areas with heptane, hexane, toluene, trichloroethylene, or white gasoline using a clean cloth, mop, or similar synthetic cleaning device.
2. Spread splicing cement continuously on the seam, lap, and splice areas at a uniform rate of at least 1 gallon per 75 square feet based on both mating surfaces.
3. After the cement has dried to a tack-free condition, apply the butyl gum splicing tape to the cemented area of the membrane, extending the tape to at least 1/8 inch beyond the edges of the splice and lap areas.
4. Roll or press the tape firmly into place to obtain full contact, avoiding bridging and wrinkles.
5. Reinforce corner splices with 2 continuous layers of rubber membrane over 1 layer of butyl tape.

Flash all projections, such as pipes, conduits, and sleeves, passing through the membrane waterproofing with prefabricated or field-fabricated boots, fitted coverings, or other devices as necessary to provide watertight construction. Use butyl gum tape between layers of rubber membrane.

Patch holes in the membrane sheeting under the manufacturer's instructions with a minimum overlap of 4 inches.

Before laying the membrane across a transverse expansion joint in the bridge deck, lay and center on the joint a 12-inch-wide, galvanized, 22-gage steel sheet covered by an 18-inch-wide strip of antibond paper.

54-4.03C Asphaltic Protective Cover

Before placing the protective cover:

1. Thoroughly clean the surface of the applied membrane of dirt, dust, loose or unsound concrete, and other extraneous material
2. At transverse expansion joints in the bridge deck, lay and center on the joint above the membrane a 12-inch-wide, galvanized, 22-gage steel sheet covered by an 18-inch-wide strip of antibond paper

Lay the panels with 2 superimposed layers. Offset the joints in the 2nd layer from the joints in the 1st layer by approximately 1/2 the width of the panel.

Lay the panels in an adhesive coating using the following procedure:

1. Apply the adhesive with a squeegee at a rate of at least 1 gallon per 100 square feet of deck surface.
2. As you lay successive panels, thoroughly coat the edges and ends of adjacent panels already laid with a sealing compound.
3. Lay the panels tightly against those previously laid such that the sealing compound completely fills the joints and squeezes out at the top.
4. After all of the panels have been laid, fill any voids between the panels with sealing compound.

Where an edge or protrusion of asphaltic panels is exposed to prolonged sunlight, coat the area with fibered aluminum roof coating.

54-4.04 PAYMENT

The payment quantity for waterproofing and cover is the area determined from the dimensions shown, along the slope, including the area of timber retainers and headers.

54-5 DECK SEAL

54-5.01 GENERAL

54-5.01A Summary

Section 54-5 includes specifications for applying a deck seal.

The deck seal must consist of a preformed membrane seal system.

54-5.01B Definitions

Reserved

54-5.01C Submittals

Submit a certificate of compliance for the preformed membrane sheet. Include the type of sheet and the conditioner or primer application rates.

54-5.01D Quality Assurance

Reserved

54-5.02 MATERIALS

The preformed membrane seal system must consist of:

1. Primer or conditioner applied to a prepared concrete surface
2. Preformed membrane sheet of rubberized asphalt or polymer-modified bitumen
3. Mastic for binding and sealing the edges of the sheet to the barrier or curb face

The preformed membrane sheet must be reinforced with one of the following:

1. Polypropylene mesh
2. Polyester/polypropylene fabric
3. Fiberglass mesh

The total thickness of the membrane sheet and polyethylene film or fabric reinforcement must be at least 65 mils.

The membrane sheet must comply with the values shown in the following table:

Deck Seal Membrane Sheet Quality Characteristic Requirements

Quality characteristic	Test method	Requirement
Breaking strength[a] (min, lb/in)	ASTM D882[b]	50[c]
Percent elongation at break[d] (min)	ASTM D882[b]	15[c]
Pliability	ASTM D146/D146M[e]	No cracks
Rubberized asphalt softening point (min, °F)	AASHTO T 53	165
Polymer-modified bitumen softening point (min, °F)	AASHTO T 53	210

[a]Breaking factor in machine direction
[b]Method A, average 5 samples
[c]At 73.4 ± 3.6 degrees F
[d]Machine direction
[e]180-degree bend over a 1-inch mandrel at 10 degrees F

Primer, conditioner, and mastic must be manufactured for use with the preformed membrane sheet material used.

54-5.03 CONSTRUCTION

Before applying the deck seal:

1. Where a slurry leveling course is shown, apply the slurry leveling course.
2. Sweep or air blow the concrete surfaces to receive the seal to clean them of dirt, dust, gravel, loose concrete particles, and other extraneous materials. You may leave concrete curing compound on the surface.
3. Remove sharp protrusions from the surface that could puncture the membrane.
4. Round or chamfer sharp corners to be covered. Use portland cement concrete or mortar to make chamfers or to fill the void beneath railing bumper rails.

Before applying the primer or conditioner, tape or adhere oil-resistant construction paper mask to deck areas that are to be covered by expansion dams. Place the membrane seal continuously across the paper masks, except cut the mask and the preformed sheet at or near the expansion joint if requested.

The surfaces must be dry and the temperature of the deck and of the materials must be at least 50 degrees F when the membrane seal is applied, except the rubberized asphalt material may be applied when the temperature is at least 25 degrees F.

Apply primer, conditioner, and mastic under the manufacturer's instructions.

Apply the primer or conditioner to the entire area to be sealed, except where a slurry leveling course has been applied. Where a slurry leveling course has been applied, apply a prime coat consisting of an RS1 grade asphaltic emulsion spread at a rate of 1 gallon per 100 sq yd of surface covered.

Thoroughly mix and continuously agitate the primer and conditioner during application.

Allow the primer to dry to a tack-free condition before placing membrane sheets.

Recoat the surface if the membrane sheet is not placed over the primer or conditioner within the time recommended by the manufacturer.

Apply the preformed membrane sheet to the primed or conditioned surface either by hand methods or by mechanical applicators.

Place the membrane sheets using the following procedure to achieve a shingling effect in the direction that water will drain:

1. Place a minimum 12-inch-wide membrane strip along the juncture of the deck and the base of the barrier curb face at the low side of the deck with the sheet extending up the face 3 inches.
2. Starting at the gutter line, lay sheets longitudinally, side lapped with adjacent sheets by at least 3 inches and end lapped by at least 6 inches.
3. If the deck has a reversing superelevation, place a minimum 12-inch-wide strip at the juncture of the deck and the base of the barrier or curb at the high side of the deck extending up the face 3 inches.

4. Roll the membrane sheets with hand rollers or other apparatus as necessary to develop a firm and uniform bond with the primed or conditioned concrete surface, minimizing wrinkles and air bubbles.
5. Patch tears, cuts, or narrow overlaps using an adhesive as follows:
   5.1. Place sections of a membrane sheet over the defective area such that the patch extends at least 6 inches beyond the defect.
   5.2. For modified bitumen sheets with a permanent polyester film, use a propane torch to melt the polyester film on the section to be patched. Place the patch over the heated surface and roll or press it firmly onto the surface.

At open joints and deck bleeder pipes, cut and turn the membrane sheet into the joint or bleeder while laying the membrane sheet.

If the membrane sheet is manufactured with a release film, remove the film from the contact area of the lap joint or splice before making the joint or splice. Do not remove the film from the remainder of the membrane sheet until immediately before placing the HMA.

Apply a bead of mastic at the following locations:

1. Along the exposed edge of the membrane sheet that extends up the barrier or curb face
2. If the deck has a reversing superelevation, along the edge in the high side gutter after installing the sheets

Do not allow traffic on the seal until HMA is placed over it.

54-5.04 PAYMENT

The payment quantity for deck seal is the area covered, determined from the dimensions shown, with no deduction for masked areas.

54-6 SLURRY LEVELING COURSE

54-6.01 GENERAL

Section 54-6 includes specifications for applying a slurry leveling course on rough-surfaced, deteriorated bridge decks.

54-6.02 MATERIALS

The slurry leveling course must consist of a mixture of 2 parts of undiluted asphaltic emulsion mixed with 3 parts by volume of aggregate.

The asphaltic emulsion must be commercial-quality Grade QS1h or CQS1h.

The aggregate must be a commercial-quality sand that passes a no. 30 sieve.

54-6.03 CONSTRUCTION

Mix the slurry seal in a continuous pugmill mixer. The mixer must produce a uniform and homogeneous mixture.

You may blend additional water into the slurry to improve mixing and spreading properties if the added water plus the surface moisture on the aggregate does not exceed 20 percent by volume of the undiluted emulsion.

Protect surfaces of the bridge and other improvements that are not to receive slurry leveling course from spatter and stains.

Spread the slurry on water-dampened but puddle-free concrete surfaces with a squeegee or broom of suitable stiffness. Apply the slurry at a rate sufficient to fill local depressions in the deck without filling over high deck areas. Mask or cover open joints, drains, access openings, and sliding surfaces during the application of slurry.

54-6.04 PAYMENT

The payment quantity for slurry leveling course is the volume of undiluted asphaltic emulsion used to produce the slurry, not including any additional water blended into the slurry.

54-7 SILANE WATERPROOFING TREATMENT

Reserved

54-8–54-10 RESERVED

55 STEEL STRUCTURES

55-1 GENERAL

55-1.01 GENERAL

55-1.01A Summary

Section 55-1 includes general specifications for furnishing and erecting structural steel or metalwork.

Structural steel (bridge) includes furnishing and erecting structural steel.

Furnish structural steel (bridge) includes fabricating and delivering structural steel to the job site ready to incorporate into the work.

Erect structural steel (bridge) includes erecting structural steel at the job site into final position in the work.

55-1.01B Definitions

thread stickout: The threaded end of a bolt projecting past the outer nut face.

unidentified stock material: Material that cannot be identified with certified mill test reports.

55-1.01C Submittals

55-1.01C(1) General

Submit copies of mill orders when orders are placed.

Submit certified mill test reports before fabrication. Include CVN impact test results if impact testing is specified. Include grain size if fine grain steel is specified.

Except for unidentified stock material, submit certificates of compliance for materials used in the work.

Submit a calibration certificate for each bolt tension measuring device and calibrated wrench before use.

Submit reports from testing performed on fastener components and assemblies before shipment to the job site. Test reports must include the rotational capacity lot numbers and the reports listed in the "Test Reports," "Report," "Number of Tests and Retests," and "Certification and Test Report" sections of the referenced ASTM standards. For ASTM F1554 anchor bolts, include chemical composition and carbon equivalence for each heat of steel.

For HS connections, submit a record of which lots are used in each joint as an informational submittal.

55-1.01C(2) Shop Drawings

Submit shop drawings for steel structures to OSD, Documents Unit. Notify the Engineer of the submittal. Include the submittal date and contents in the notification. Allow 45 days for the Department's review for highway bridges and 60 days for railway bridges. Submit 6 copies for highway bridges and 10 copies for railway bridges. Submit 6 to 12 copies, as requested by the Engineer, to OSD, Documents Unit after review for final authorization.

The shop drawings must include:

1. Sequence of shop and field assembly and erection. For continuous members, include proposed steel erection procedures with calculations that show girder capacity and geometry will be correct.
2. Welding sequences and procedures.
3. Layout drawing of the entire structure with locations of butt welded splices.
4. Locations of temporary supports and welds.
5. Vertical alignment of girders at each stage of erection.
6. Match-marking diagrams.
7. Details for connections not shown or dimensioned on the plans.
8. Details of allowed options incorporated into the work.
9. Direction of rolling of plates where orientation is specified.
10. Distortion control plan.
11. Dimensional tolerances. Include measures for controlling accumulated error to meet overall tolerances.
12. Material specification and grade listed on the bill of materials.
13. Identification of tension members and fracture critical members.

14. Proposed deviations from plans, specifications, or previously submitted shop drawings.
15. Contract plan sheet references for details.

Submit camber calculations with the shop drawings.

55-1.01C(3) Check Testing

Submit test samples for check testing to METS. Submit test samples for each heat of maximum thickness of:

1. Tension flanges and webs of fracture critical members
2. Tension flanges and webs of horizontally curved girders
3. Hanger plates

Furnish plates, shapes, or bars with extra length to provide for removal of check samples.

Take samples from any location within the plate. Mark donor plates with the same identifying numbers as the test samples.

Remove material for test samples in the Engineer's presence. Test samples for plates over 24 inches wide must be 10 by 12 inches with the long dimension transverse to the direction of rolling. Test samples for other products must be 12 inches long taken in the direction of rolling with a width equal to the product width.

Submit test samples before fabricating into components. Mark samples with the direction of rolling, heat numbers, and plate numbers using paint or indelible marking material. You may steel stamp samples in one corner of the plate instead of marking.

55-1.01D Quality Assurance

55-1.01D(1) General

Reserved

55-1.01D(2) Qualifications

Welder qualification must comply with AWS D1.5.

Each manual torque wrench must have a dial gauge or digital read out. Any electric, pneumatic, or hydraulic calibrated wrench used to tension fasteners must have an adjustable control unit to shut off the wrench at the desired torque.

Bolt tension measuring devices and calibrated wrenches must be calibrated not more than 1 year before use and at least yearly during the project. The calibration must be performed by an authorized repair and calibration center approved by the tool manufacturer. Certification equipment and calibration standards must be traceable to NIST.

Calibrate bolt tension measuring devices to be accurate to within 1 percent of actual tension. Calibration must consist of at least 4 evenly spaced verification readings performed over a range of 20 to 80 percent of full scale.

Calibrate calibrated wrenches to be accurate to within 2 percent of actual torque. Calibration must consist of at least 4 evenly spaced verification readings performed over a range of 20 to 100 percent of full scale. If a torque multiplier is used, calibrate the torque multiplier and calibrated wrench as a unit. Include sockets and extensions of the same length to be used in the work during calibration. Adjust the manufacturer's torque multiplier during calibration so that the product of the torque multiplier and the input calibrated wrench reading is within 2 percent of actual torque value. Use this system only as calibrated.

55-1.01D(3) Quality Control

55-1.01D(3)(a) General

Welding inspection must comply with AWS D1.5.

The Engineer determines the location of all NDT testing for welding.

In addition to NDT requirements in AWS D1.5, ultrasonically test 25 percent of all main member CJP groove welds in butt joints subject to calculated tension in material over 1/2 inch thick.

Perform NDT on 100 percent of each pin as follows:

1. MT under ASTM A788, S 18, with no linear indication allowed exceeding 3 mm
2. UT under ASTM A788, S 20, level S and level DA in two perpendicular directions

For bolts installed as snug tight, rotational capacity testing and installation tension testing are not required.

55-1.01D(3)(b) Source Quality Control

55-1.01D(3)(b)(i) General

Reserved

55-1.01D(3)(b)(ii) Charpy V-notch Requirements

Determine CVN values under ASTM E23. Sampling procedures must comply with ASTM A673. Use the Frequency H (Heat) testing for steels complying with ASTM A709/A709M, Grades 36, 50, 50W, and HPS 50W. Use the Frequency P (Piece) testing for steels complying with ASTM A709/A709M, Grades HPS 70W, 100, and 100W.

55-1.01D(3)(b)(iii) Rotational Capacity Testing

55-1.01D(3)(b)(iii)(1) General

Perform rotational capacity testing on HS fastener assemblies before shipment to the job site.

Test each combination of bolt production lot, nut lot, and washer lot as an assembly. Assign a rotational capacity lot number to each combination of lots tested. Mark each shipping unit of fastener assemblies with the rotational capacity lot number.

Test 2 fastener assemblies from each lot. Both fastener assemblies tested from a rotational capacity lot must pass for the lot to be acceptable.

Use 1 hardened washer under the nut for testing.

Test zinc-coated assemblies after lubrication.

You do not need to test cap screws or bolts used for slip base plates.

55-1.01D(3)(b)(iii)(2) Long Bolt Test

Use the following equipment:

1. Calibrated bolt tension measuring device.
2. Hand wrench or suitable tool for turning bolt.
3. Calibrated dial or digital torque wrench with socket.
4. Spacer washers or bushings. Spacer washers or bushings must have the same inside diameter and an equal or larger outside diameter as the appropriate hardened washers complying with ASTM F436.
5. Steel beam or member to which the tension measuring device will be attached. The member must be accessible from the ground.

Use the following procedure:

1. Measure and record the bolt length from the bolt washer face to the end of the shank.
2. Install the nut on the bolt such that the first 3- to 5-full threads closest to the bolt head are between the nut face and bolt head.
3. Measure and record the length of bolt thread protruding beyond the outer nut face. If the nut cannot be fully threaded onto the bolt, test the assembly under section 55-1.01D(3)(b)(iii)(3).
4. Insert the bolt into the tension measuring device. Install the hardened washer and any required spacers under the nut to produce the thread length recorded in step 3 above.
5. Tighten the nut using a hand wrench to the minimum snug tension shown in the following table:

Table 1 Grade A325 Snug-Tight Tension Values

Bolt diameter (inches)	Minimum snug tension[a] (kips)
1/2	1
5/8	2
3/4	3
7/8	4
1	5
1-1/8	6
1-1/4	7
1-3/8	9
1-1/2	10

[a]The tension may exceed the table 1 value by at most 2 kips.

6. Match-mark the assembly as follows:
   6.1. Place a mark on 1 corner of the nut.
   6.2. Place a heavy reference line on the face plate of the tension measuring device that aligns with the mark on the nut.
   6.3. Place a line that aligns with the mark on the nut across the flat end of the bolt shank or on the exposed portions of the threads of tension control bolts.
   6.4. Place a mark on the outside of the turning socket. The mark must be aligned with the mark on the nut corner and be visible when the nut is being turned.
   6.5. Make an additional mark on the face plate at the required rotation shown in the following table clockwise from the heavy reference line:

Table 2 Required Nut Rotation for Rotational Capacity Tests [a,b]

Bolt length[c]	Required rotation (turn)
4 bolt diameters or less	2/3
More than 4 and at most 8 bolt diameters	1
More than 8 and at most 12 bolt diameters[d]	1-1/3

[a]Nut rotation is relative to bolt, regardless of the element being turned. For bolts installed by 1/2 turn or less, the tolerance is ±30 degrees; for bolts installed by 2/3 turn or more, the tolerance is ±45 degrees.
[b]Applicable only to connections in which all material within the grip of the bolt is steel.
[c]As measured in step 1 above.
[d]If the bolt length exceeds 12 diameters, the required rotation must be determined by actual tests in a suitable tension device simulating site conditions.

7. Turn the nut to attain the minimum tension for the applicable bolt diameter shown the following table:

Table 3: Grade A325 Minimum Tension Values

Bolt diameter (inches)	Minimum tension (kips)
1/2	12
5/8	19
3/4	28
7/8	39
1	51
1-1/8	64
1-1/4	81
1-3/8	97
1-1/2	118

8. After attaining the tension shown in table 3, record in ft-lb the moving torque required to turn the nut and the corresponding bolt tension. Measure the torque with the nut in motion. Use this corresponding bolt tension to determine *T* using the following formula:

   $T = b \times d/48$

   where:
   b = corresponding bolt tension in pounds
   d = bolt diameter in inches

9. Turn the nut until the rotation shown in table 2 is attained. Measure the rotation from the heavy reference line on the face plate. Record the bolt tension.
10. Remove the nut and examine the threads on the nut and bolt.

Acceptance criteria are as follows:

1. Moving torque recorded in step 8 must be less than or equal to the calculated value *T.*
2. Bolt tension recorded in step 9 must be at least the turn-test tension value shown in table 4.
3. Nut is removed from the bolt with no signs of thread stripping or galling on the bolt or nut.
4. Bolt must not shear or fail during the test.
5. Assembly must not seize before the final rotation in step 9 is attained.

Table 4: Grade A325 Turn Test Tension Values

Bolt diameter (inches)	Turn test tension (kips)
1/2	14
5/8	22
3/4	32
7/8	45
1	59
1-1/8	74
1-1/4	94
1-3/8	112
1-1/2	136

55-1.01D(3)(b)(iii)(3) Short Bolt Test

Use the following equipment:

1. Calibrated dial or digital torque wrench with socket.
2. Hand wrench.
3. Spacer washers or bushings. Spacer washers or bushings must have the same inside diameter and an equal or larger outside diameter as the appropriate hardened washers complying with ASTM F436.
4. Steel plate or girder. This member must have a thickness that provides the required number of threads within the bolt grip as specified in procedure step 2 of section 55-1.01D(3)(b)(iii)(2).

Use the following procedure:

1. Measure and record the bolt length from the bolt washer face to the end of the shank.
2. Install the nut on the bolt. The first 3- to 5-full threads must be located between the nut washer face and the bolt washer face. Measure and record the length of bolt thread protruding beyond the outer nut face.
3. Install the bolt into the hole in the plate or girder. The hole must be 1/16 inch larger than the nominal bolt diameter. Install the hardened washer and any required spacers to produce the thread length recorded in step 2.
4. Tighten the nut snug tight using a hand wrench. Do not exceed 20 percent of the maximum allowable torque value shown in the following table.

Table 5 Grade A325 Maximum Allowable Torque

Bolt diameter (inches)	Torque (ft-lb)
1/2	150
5/8	290
3/4	500
7/8	820
1	1230
1-1/8	1730
1-1/4	2450
1-3/8	3210
1-1/2	4250

5. Match-mark the assembly as follows:
   5.1. Place a mark on 1 corner of the nut.
   5.2. Place a heavy reference line on the steel plate or girder that aligns with the mark on the nut.
   5.3. Place a line that aligns with the mark on the nut across the flat end of the bolt shank or on the exposed portions of the threads of tension control bolts.
   5.4. Place a mark on the outside of the turning socket that aligns with the mark on the nut. This mark must be visible when the nut is being turned.
   5.5. Make 2 additional small marks on the steel plate or girder, one at 1/3 of a turn and one at 2/3 of a turn clockwise from the heavy reference line on the steel plate or girder.

6. Tighten the nut to the rotation value shown in table 6. Measure the rotation from the heavy reference line on the steel girder or plate. Do not allow the bolt head to turn during tightening.

Table 6 Nut Rotation Required for Turn-of-Nut Installation [a,b]

Bolt length[c]	Required rotation (turn)
4 bolt diameters or less	1/3

[a]Nut rotation is relative to bolt regardless of the element being turned. For bolts installed by 1/2 turn or less the tolerance is ±30 degrees.
[b]Applicable only to connections in which all material within the grip of the bolt is steel.
[c]Measured in step 1.

7. Record in ft-lb the moving torque required to turn the nut when the rotation value shown in table 6 is attained.
8. Tighten the nut further to the rotation value shown in table 7. Measure the rotation from the heavy reference line on the steel girder or plate. The line on the end of the bolt shank or on the exposed threads of tension control bolts must remain in alignment with the start line.

Table 7 Required Nut Rotation for Rotational Capacity Test

Bolt length[a]	Required rotation (turn)
4 bolt diameters or less	2/3

[a]Measured in step 1.

9. Remove the nut and examine the threads on the nut and bolt.

Acceptance criteria are as follows:

1. Moving torque recorded from step 7 must be less than or equal to the maximum allowable torque shown in table 5.
2. Nut is removed from the bolt with no signs of thread stripping or galling on the bolt or nut after the rotation in step 8 has been attained.
3. Bolt must not shear or fail during the test.

4. Assembly must not seize before the final rotation in step 8 is attained.

55-1.01D(3)(c) Field Quality Control

55-1.01D(3)(c)(i) General

Perform job site HS fastener testing in the Engineer's presence.

If the bolt head is the turned element during installation, perform installation tension testing and verification tension testing, including determining inspection torque, by turning the bolt head.

The Engineer rejects uninstalled fasteners in the same rotational capacity lot as fasteners that fail a job site installation tension test or rotational capacity test.

Perform additional rotational capacity tests, installation tension tests, and tests to determine new inspection torques on rotational capacity lots if any of the following occur:

1. Any fastener is not used within 3 months after arrival on the job site.
2. Fasteners are improperly handled, stored, or subjected to inclement weather before final tightening.
3. Changes are noted in the original surface condition of threads, washers, or nut lubricant.
4. Required inspections are not performed within 48 hours after all fasteners in a joint have been tensioned.

55-1.01D(3)(c)(ii) Rotational Capacity Testing

Perform rotational capacity testing on each rotational capacity lot under section 55-1.01D(3)(b)(iii) at the job site before installation.

55-1.01D(3)(c)(iii) Installation Tension Testing

Perform installation tension testing on each rotational capacity lot before installation.

Test 3 representative HS fastener assemblies under section 8 of *Specification for Structural Joints Using High-Strength Bolts* of the RCSC. For short bolts, test 3 representative HS fastener assemblies under "Pre-Installation Verification Procedures" of *Structural Bolting Handbook* of the Steel Structures Technology Center.

If using direct tension indicators, perform installation verification tests under appendix X1 of ASTM F959 except that bolts must be initially tensioned to a value 5 percent greater than the minimum required bolt tension.

55-1.01D(3)(c)(iv) Verification Tension Testing

Perform fastener tension testing to verify minimum tension in HS bolted connections no later than 48 hours after all fasteners in a connection have been tensioned.

The Engineer selects fasteners to be tested. Perform testing such that the Engineer can read the torque wrench or access direct tension indicator gaps during testing.

Test 10 percent of each type of fastener assembly in each HS bolted connection for minimum tension using the procedure described in section 10 of *Specification for Structural Joints Using High-Strength Bolts* of the RCSC. Check at least 2 assemblies per connection. For short bolts, determine the inspection torque using steps 1 through 7 of "Arbitration of Disputes, Torque Method-Short Bolts" in *Structural Bolting Handbook* of the Steel Structures Technology Center.

Determine and use a separate inspecting torque for each different rotational capacity lot of fasteners.

55-1.01D(4) Department Acceptance

The Department inspects structural steel at the fabrication site. Notify the Engineer when materials are delivered to the fabrication site. Allow at least 10 days between giving notice and starting fabrication.

Results of check testing are delivered to you within 20 days of receipt of samples at METS. For multiple samples submitted on the same day, an additional day is added for every 2 samples submitted and the test report is made for the group of samples.

55-1.02 MATERIALS

55-1.02A General

Reserved

55-1.02B Delivery, Storage, and Handling

Mark the weight of any member weighing over 6,000 lb on the member.

Do not bend, scrape, or overstress members during handling and shipping. The Engineer rejects bent or damaged members.

Keep structural material clean during loading, transporting, and unloading.

Store structural material above ground on supports. Keep material clean, drained, and protected from corrosion. Store girders upright and shored. Support long members on skids placed to prevent deflection.

55-1.02C Design Requirements

Connection details for highway bridges must comply with *AASHTO LRFD Bridge Design Specifications with California Amendments.*

Design details, fabrication, and workmanship for railway bridges must comply with chapter 15 of *AREMA Manual for Railway Engineering*.

55-1.02D Materials

55-1.02D(1) General

Materials must comply with the requirements shown in the following tables:

Structural Steel

Material	Specification
Carbon steel	ASTM A709/A709M, Grade 36 or {ASTM A36/A36M}[a]
HS low alloy columbium vanadium steel	ASTM A709/A709M, Grade 50 or { ASTM A992/A992M or ASTM A572/A572M, Grade 50}[a]
HS low alloy structural steel	ASTM A709/A709M, Grade 50W or Grade HPS 50W, or {ASTM A588/A588M}[a]
HS low alloy structural steel plate	ASTM A709/A709M, Grade HPS 70W
High-yield strength quenched and tempered alloy steel plate suitable for welding	ASTM A709/A709M, Grade 100, Grade 100W, or Grade HPS 100W, or {ASTM A514/A514M}[a]

[a]Grades you may substitute for the equivalent ASTM A709 steel subject to the modifications and additions specified and to the requirements of ASTM A709.

Fasteners

Material	Specification
Steel fastener components for general applications:	
Bolts and studs	ASTM A307
Anchor bolts	ASTM F1554 [a]
HS bolts and studs	ASTM A449, Type 1 [a]
HS threaded rods	ASTM A449, Type 1 [a]
HS nonheaded anchor bolts	ASTM F1554, Grade 105, Class 2A [a]
Nuts	ASTM A563, including appendix X1 [b]
Washers	ASTM F844
Hardened washers	ASTM F436, Type 1, including S1 supplementary requirements
Components of HS steel fastener assemblies for use in structural steel joints:	
Bolts	ASTM F3125, Grade A325, Type 1
Tension control bolts	ASTM F3125, Grade F1852, Type 1
Nuts	ASTM A563, including appendix X1 [b]
Hardened washers	ASTM F436, Type 1, Circular, including S1 supplementary requirements
Direct tension indicators	ASTM F959, Type 325, zinc-coated

[a]Use hardened washers.
[b]Zinc-coated nuts tightened beyond snug or wrench tight must be furnished with a dry lubricant complying with supplementary requirement S2 in ASTM A563.

Other Materials

Material	Specification
Carbon steel for forgings, pins, and rollers	ASTM A668/A668M, Class D
Alloy steel for forgings	ASTM A668/A668M, Class G
Pin nuts	ASTM A709/A709M or ASTM A563, including appendix X1 [a]
Carbon-steel castings	ASTM A27/A27M, Grade 65-35, Class 1
Malleable iron castings	ASTM A47/A47M, Grade 32510
Gray iron castings	ASTM A48, Class 30B
Carbon steel structural tubing	ASTM A500/A500M, Grade B, ASTM A501, ASTM A847/A847M, or ASTM A1085
Steel pipe [b]	ASTM A53, Type E or S, Grade B; ASTM A106, Grade B; or ASTM A139, Grade B
Stud connectors	ASTM A108

[a]Zinc-coated nuts tightened beyond snug or wrench tight must be furnished with a dry lubricant complying with supplementary requirement S2 in ASTM A563.
[b]Hydrostatic testing will not apply.

55-1.02D(2) Charpy V-notch Requirements

Structural steel plate used for the following components must comply with longitudinal CVN impact values shown in the following table:

1. Tension members, tension flanges, eyebars, and hanger plates
2. Splice plates of tension members, tension flanges, and eyebars

Material complying with ASTM A709/A709M	CVN impact value (ft-lb at temperature)
Grade 36	15 at 40 ºF
Grade 50[a] (Thickness up to 2 inches)	15 at 40 ºF
Grade 50W[a] (Thickness up to 2 inches)	15 at 40 ºF
Grade 50[a] (Thickness over 2 inches up to 4 inches)	20 at 40 ºF
Grade 50W[a] (Thickness over 2 inches up to 4 inches)	20 at 40 ºF
Grade HPS 50W[a] (Thickness up to 4 inches)	20 at 10 ºF
Grade HPS 70W (Thickness up to 4 inches)	25 at -10 ºF
Grade 100 (Thickness of 2-1/2 inches or less)	25 at 0 ºF
Grade 100W (Thickness over 2-1/2 inches up to 4 inches)	35 at 0 ºF
Grade HPS 100W (Thickness of 2-1/2 inches or less)	25 at -30 ºF
Grade HPS 100W (Thickness over 2-1/2 inches up to 4 inches)	35 at -30 ºF

[a]If the material yield strength is more than 65,000 psi, reduce the temperature for the CVN impact value 15 °F for each increment of 10,000 psi above 65,000 psi.

For fracture critical members, minimum CVN impact values are specified in the special provisions.

55-1.02D(3) Structural Steel

Unless otherwise described, structural steel plates, shapes, and bars must comply with ASTM A709/A709M, Grade 50. You may increase girder flange plate thickness and length if the change does not decrease any portion of the plates in detailed thickness. For continuous girders, increases in the length of girder flange plates that change locations of butt welds between different thicknesses of flange plates must be authorized before fabrication.

Stud-type shear connectors longer than 8 inches may consist of multiple shorter studs connected with complete joint penetration welds.

All structural steel that is precut before arrival at the fabrication site must be cut so that the primary direction of rolling is parallel to the direction of the main tensile or compressive stress in the member.

Do not use coiled steel plate for:

1. Flanges or eyebars
2. Hanger plates
3. Splice plates for flanges or eyebars

You may substitute rolled shapes for the welded sections and welded sections for the rolled shapes shown if the substituted members comply with the following:

1. Depth, width, and average thicknesses are at least equal to the replaced shape or section.
2. For welded sections, the flanges are welded to the web with continuous fillet welds on each side of the web.
3. Strength classification of the material is not reduced.

55-1.02D(4) Bearing Pads

Elastomeric bearing pads must comply with section 51-3.02.

55-1.02D(5) Castings

Steel, gray iron, and malleable iron castings must have continuous fillets cast in place in reentrant angles. The radius of curvature of the exposed surface of a fillet will define the fillet size. The size of fillets must be at least one-half the thickness of the thinnest adjoined member but not less than 1/2 inch.

Finished casting dimensions must be at least equal to the dimensions shown. Castings must not be more than 7.5 percent overweight.

55-1.02D(6) Unidentified Stock Material

You may use unidentified stock material on non-fracture critical members if:

1. No more than 30,000 pounds is used
2. Unidentified stock material is segregated from all other materials used in the work
3. Material is authorized before fabrication

The Engineer may select samples for testing from each piece of unidentified stock material proposed for use. Testing of samples must be performed by an authorized laboratory under the applicable ASTM.

55-1.02D(7) Miscellaneous Materials

Caulking must be polysulfide or polyurethane caulking complying with ASTM C920, Type S, Grade NS.

55-1.02E Fabrication

55-1.02E(1) General

Section 55-1.02E(1) applies to work performed at the source and at the job site.

Cut and fabricate steel plates for flanges, eyebars, hanger plates, and splice plates for flanges and eyebars such that the primary direction of rolling is parallel to the direction of the main tensile or compressive stress in the member.

Mechanically cut edges must be clean cut without torn or ragged edges.

Ends of girder stiffeners shown as tight-fit must bear on the girder flange with at least point bearing. Local clearances between the end of the stiffener and the girder flange must be at most 1/16 inch.

Fabricate floor beams, stringers, and girders having end connection angles to exact length back to back of connection angles. If end connections are faced, the finished angle thickness must be at least that shown on the shop drawings.

Finished members must be true to line and free from twists, bends, and open joints.

Matchmark connecting parts that are preassembled for setting up for welding or for drilling or reaming holes for field connections. Use low-stress stamps for fracture critical members and tension members.

Where galvanizing is described, galvanize structural steel under section 75-1.02B.

Neatly finish exposed parts of the work. Slightly round edges and sharp corners, including edges marred, cut, or roughened during handling or erection.

Clean and paint iron and steel surfaces under section 59.

55-1.02E(2) Flatness of Faying and Bearing Surfaces

Surfaces of bearing and base plates and other metal surfaces that contact each other or ground concrete surfaces must be flat to within 1/32 inch in 12 inches and 1/16 inch overall.

Surfaces of bearing and base plates and other metal bearing surfaces that contact mortar, preformed fabric pads, or elastomeric bearing pads must be flat to within 1/8 inch in 12 inches and 3/16 inch overall.

Instead of machining, you may heat straighten steel slabs not in contact with other metal bearing surfaces if the above tolerances are met.

55-1.02E(3) Bent Plates

Cold-bent load-carrying rolled steel plates must comply with the following:

1. Direction of bending must be at right angles to the direction of rolling.
2. Radius of bend measured to the concave face must comply with *Manual of Steel Construction* of the AISC.
3. Before bending, the corners of the plate must be rounded to a 1/16-inch radius throughout that portion of the plate where bending is to occur.

Plates to be bent to a smaller radius than specified in *Manual of Steel Construction* of the AISC must be bent hot. Hot bent plates must have the direction of bending at right angles to the direction of rolling.

55-1.02E(4) Fastener Threads

Fastener threads for general applications must comply with the following:

1. External threads must comply with the Unified Coarse Thread Series requirements in ANSI B1.1 with Class 2A tolerances before coating with zinc
2. Internal threads must comply with ASTM A563

Threads for pin ends and pin nuts 1-1/2 inches or more in diameter must comply with the following:

1. External threads must be Unified Inch Screw Threads, UN Series with 6 threads per inch, complying with ANSI B1.1 with Class 2A tolerances
2. Internal threads must be Unified Inch Screw Threads, UN Series with 6 threads per inch, complying with ANSI B1.1 with Class 2B tolerances

55-1.02E(5) Pin Connections

Pins must:

1. Be turned to the dimensions shown
2. Be straight, smooth, and free from flaws
3. Have the final surface produced by a finishing cut

In pins more than 9 inches in diameter, bore a full length hole at least 1-7/8 inches in diameter along the pin axis after cooling and before annealing.

Holes for pins must be:

1. True to the diameter specified.
2. At right angles to the member axis.
3. Parallel with each other except for pins where nonparallel holes are required.
4. Smooth and straight with the final surface produced by a finishing cut.

Coat machined surfaces of pins and holes with an easily removed rust inhibitor.

The distance between holes for pins must not vary by more than 1/32 inch from that shown when measured outside-to-outside for tension members and inside-to-inside for compression members.

The diameter of holes for pins must not exceed the pin diameter by more than 1/50 inch for pins 5 inches or less in diameter or 1/32 inch for larger pins.

Bore holes for pins in built-up members after assembly. If authorized, you may bore holes before assembly if the same degree of accuracy is achieved as boring after assembly.

Bore pin-connected hanger plates in pairs or in stacks bolted or clamped together such that each pair of hanger plates is matched.

Use pilot and driving nuts for driving pins. Drive pins such that the members will bear fully on them. For field assembly use a positive locking device to tighten and secure pin nuts.

55-1.02E(6) Bolted Connections

55-1.02E(6)(a) General

Bolted connections in structural steel joints must be made with HS steel fastener assemblies consisting of one of the following:

1. HS steel bolt, nut, and hardened washer. You may use a direct tension indicator with the bolt, nut, and hardened washer.
2. Tension control bolt, nut, and hardened washer.

Each length and diameter of fastener assembly used in any single joint of a HS bolted connection must be from the same rotational capacity lot. Keep a record of which lots are used in each joint.

55-1.02E(6)(b) Bolt Holes

55-1.02E(6)(b)(i) General

Bolt holes must be one of the following:

1. Punched full size
2. Drilled full size
3. Subpunched and reamed
4. Subdrilled and reamed

Finished holes for bolts must be:

1. Cylindrical and perpendicular to the plane of the connection
2. At most 1/16 inch larger than the nominal bolt diameter
3. Clean cut without torn or ragged edges
4. Without irregularities that prevent solid seating

Holes punched full size, subpunched, or subdrilled must pass a pin 1/8 inch smaller than the nominal hole size without drifting in at least 75 percent of the holes for each connection after assembling and before any reaming.

All holes must pass a pin 3/16 inch smaller in diameter than the nominal hole size.

Do not correct mispunched or misdrilled holes by welding unless authorized.

55-1.02E(6)(b)(ii) Punching

Do not punch or subpunch ASTM A36/A36M structural steel thicker than 7/8 inch. Do not punch or subpunch HS structural steel thicker than 3/4 inch.

The diameter of the punching die must not exceed the punch diameter by more than 3/32 inch.

Subpunch holes to be reamed to a diameter 1/4 inch smaller than the finished hole.

55-1.02E(6)(b)(iii) Drilling

Drill full-sized holes with the parts assembled or to a steel template with hardened bushings. If authorized, you may drill full-sized holes with gang drill equipment.

The Engineer may request a proof assembly to check the fit of major field connections.

Subdrill holes to be reamed to a diameter 1/4 inch smaller than the finished hole.

Drill through templates after the templates have been firmly clamped or bolted.

If members are drilled while assembled, hold the parts together securely during drilling.

You may stack drill plates using gang drills if:

1. Parts are firmly clamped during drilling
2. Drill bits remain perpendicular to the work during drilling

55-1.02E(6)(b)(iv) Reaming

Perform reaming after built-up members are assembled and firmly bolted together or after templates are securely located over the member. Remove shavings after reaming. Mark pieces reamed together so that they may be reassembled in the same position. Do not interchange reamed parts.

Reaming templates must:

1. Have hardened steel bushings
2. Have accurately dimensioned holes
3. Have reference lines for locating templates on members
4. Be firmly clamped or bolted in position

Templates used for reaming of matching members or the opposite faces of one member must be exact duplicates.

For reaming holes in assembled material, do not mix full-sized holes with subpunched or subdrilled holes.

55-1.02E(6)(c) Installation

Bolted connections using HS fastener assemblies must comply with *Specification for Structural Joints Using High-Strength Bolts* of the RCSC.

Tension HS bolted connections as slip critical.

Use the same bolt head orientation within a single HS bolted connection.

Install the hardened washer under the element turned in tightening. Locate nuts on the side of the member not visible from the traveled way. Locate nuts for bolts partially embedded in concrete on the side of the member to be encased in concrete.

If surface moisture is present at a HS bolted connection:

1. Do not install HS fastener assemblies having components furnished with water soluble lubricants.
2. The Engineer may require you to perform additional fastener testing if fastener assemblies are furnished with lubricants not soluble in water.

Seal the sheared ends of tension control bolts with caulking. Caulking must be gray and at least 50 mils thick. Apply caulk to a clean surface the same day the splined end is sheared off.

For all bolts, thread stickout after tensioning must be at least flush with the outer nut face. At least 3 full threads must be located within the grip of the connection.

You may use 1 additional hardened washer under the nonturning element to correct excessive thread stickout.

Thread stickout of studs, rods, and anchor bolts must be at least flush with the outer nut face and at most 1 inch.

You may use bolts with diameters up to 1/4 inch larger than the specified bolt diameter if:

1. Authorized
2. You comply with the spacing and edge distance requirements for the larger bolt
3. Net section is adequate

If using direct tension indicators:

1. Install 1 indicator under each bolt head. The protrusions must contact the bolt head.
2. Hold the bolt head stationary and turn the nut.
3. Follow the manufacturer's installation procedures.
4. Tension bolts in not less than 2 stages until at least 50 percent of the gaps on each indicator are between 0.000 and 0.005 inch. Indicators with all protrusions completely crushed are rejected.

Do not torque the splined end of tension control bolts before final tensioning.

55-1.02E(7) Welding

55-1.02E(7)(a) General

Welding must comply with AWS D1.5.

Replace Table 2.2 of AWS D1.5 with the following table:

Base metal thickness of the thicker part joined (inches)	Minimum effective partial joint penetration groove weld size[a] (inches)
Over 1/4 to 1/2 inclusive	3/16
Over 1/2 to 3/4 inclusive	1/4
Over 3/4 to 1-1/2 inclusive	5/16
Over 1-1/2 to 2-1/4 inclusive	3/8
Over 2-1/4 to 6 inclusive	1/2
Over 6	5/8

[a]Weld size need not exceed the thickness of the thinner part joined.

Dimensional details and workmanship for welded joints in tubular and pipe connections must comply with part A, "Common Requirements for Design of Welded Connections" and part D, "Specific Requirements for Design of Tubular Connections," in section 2 of AWS D1.1.

The flat side of butt-welded joints must not deviate from flatness by more than 0.20 inch in a 2-foot length centered over the weld.

Do not weld or tack brackets, clips, shipping devices, or other material not described to any part of the girders unless shown on the shop drawings.

Grind weld surfaces smooth and flush when NDT is required.

For welds indicated to be subject to tensile forces that are to receive RT, grind smooth and flush on both sides of welds before testing.

For groove weld surface profiles that interfere with NDT procedures, grind welds smooth and blend with the adjacent material.

For fillet weld surface profiles that interfere with NDT procedures, grind welds and blend the toes smoothly with the adjacent base metal.

55-1.02E(7)(b) Backing for Welds

Reserved

55-1.02E(7)(c) Steel Pedestrian Bridges

Reserved

55-1.02E(8) Curved Girders

Reserved

55-1.02E(9) Shop Assembly

Prepare and paint contact surfaces of HS bolted connections before assembly. Thoroughly clean all other surfaces of metal in contact to bare metal before assembly. Remove all rust, mill scale, and foreign material.

Preassemble completed subassemblies for structures or units of structures before erection to verify geometry and to verify or prepare field connections.

Bolted trusses, skew portals, skew connections, rigid frames, bents, and towers must be completely preassembled, adjusted to line and camber, and prepared for welding or checked for bolt fit before erection.

Preassemble truss work in lengths of at least 3 abutting panels and adjust members for line and camber. Prepare joints for welding or drill or ream holes for field connections during preassembly. For holes previously drilled full size, check holes for bolt fit.

Preassemble bolted splice joints for plate girders in lengths of at least 3 abutting sections and adjust abutting sections for line and camber. Drill or ream holes for field connections during preassembly.

Preassemble prepared splice joints for welded girders with abutting members and adjust for line and camber.

Preassembly methods must be compatible with the erection methods used.

Preassemble all machinery completely. Fit bearings to the clearances and alignments specified. Gear reductions and line gears must have gear center distances set and the gears matchmarked.

55-1.03 CONSTRUCTION

55-1.03A General

Field welding must comply with section 55-1.02E(7).

Assemble parts into final positions without damage. Follow all matchmarks. Do not damage or distort members when hammering.

Drifting done during assembly must not enlarge bolt holes or distort the metal.

55-1.03B Falsework

Falsework must comply with section 48-2 except that dead loads consist of the weight of the structural steel and portions of the structure supported by the falsework.

Construct falsework and concrete forms on steel structures such that loads applied to girder webs (1) are applied within 6 inches of a flange or stiffener and (2) do not produce local distortion of the web. Provide temporary struts and ties to (1) resist lateral loads applied to girder flanges and (2) prevent appreciable vertical movement between the edge of deck form and the adjacent steel girder.

55-1.03C Erection

55-1.03C(1) General

Reserved

55-1.03C(2) Continuous Members

Unless otherwise shown, structural steel girders are designed for continuity in supporting girder dead load. If erection procedures provide girder continuity for dead load, preassemble members with field joints in a no-load condition in a horizontal or an upright condition.

You may erect structural steel girders such that dead-load girder continuity is not provided. If erection procedures do not provide girder continuity for dead load:

1. You may increase cross-sectional areas or change grades of steel to provide the specified capacity if authorized.
2. The erected structure must have a load-carrying capacity at least equal to the structure shown.

55-1.03C(3) Bearings and Anchorages

Set bearing assemblies level. The Engineer provides adjustments to horizontal positions of bearing assemblies due to temperature. Attain full bearing on the concrete under bearing assemblies.

Immediately before setting bearing assemblies or masonry plates on ground concrete surfaces, thoroughly clean and apply caulking to all contact surfaces.

During welding, protect bearings and bearing surfaces using authorized methods.

The embedded end of each anchor bolt must terminate with a head or a nut and washer. Anchor bolts must allow true positioning of bearing assemblies.

Mortar placed (1) under masonry plates or bearing assemblies or (2) in anchor bolt sleeves or canisters must comply with section 51-1.02F except the cement to sand ratio must be 1 to 3. Mortaring and constructing mortar pads under masonry plates must be done after girder erection and before placing deck concrete.

If anchor bolts are installed in pipe sleeves or metal canisters, fill the pipes or canisters completely with mortar.

55-1.03C(4)–55-1.03C(10) Reserved

55-1.04 PAYMENT

The payment quantity for structural steel is the weight determined from the dimensions shown using the following rules and assumptions:

1. Density of structural and cast steel is 0.2833 lb/cu in. The density of cast iron is 0.26 lb/cu in.
2. Weight of rolled shapes and structural plate is computed using nominal weight and dimensions with no deduction for copes, cuts, and holes.
3. Weight of fillet welds is as shown in the following table:

Size of fillet weld (inches)	Weight (lb/lf)
3/16	0.08
1/4	0.14
5/16	0.22
3/8	0.30
1/2	0.55
5/8	0.80
3/4	1.10
7/8	1.50
1	2.00

4. Weight of galvanizing is added to the calculated base metal weight using the table of weights of zinc coatings in ASTM A153/A153M.
5. Weight of bolts, nuts, and washers is added to obtain the weight of completed members. The weight of oversize bolts and nuts is not included.
6. Weight of nuts, bolts, washers, cap screws, anchor bolts, and anchor pipe sleeves in the finished structure is based on nominal weight and dimensions.
7. Weight of paint is not included.

55-2–55-10 RESERVED

56 OVERHEAD SIGN STRUCTURES, STANDARDS, AND POLES

56-1 GENERAL

56-1.01 GENERAL

56-1.01A Summary

Section 56-1 includes general specifications for constructing overhead sign structures, standards, and poles.

56-1.01B Definitions

Reserved

56-1.01C Submittals

Reserved

56-1.01D Quality Assurance

56-1.01D(1) General

Reserved

56-1.01D(2) Quality Control

56-1.01D(2)(a) General

Reserved

56-1.01D(2)(b) Nondestructive Testing

56-1.01D(2)(b)(i) General

Perform NDT of steel members under AWS D1.1 and the requirements shown in the following table:

Nondestructive Testing for Steel Standards and Poles

Weld location	Weld type	Minimum required NDT
Circumferential splices around the perimeter of tubular sections, poles, and arms	CJP groove weld with backing ring	100% UT or RT
Longitudinal seam	CJP or PJP groove weld	Random 25% MT
Longitudinal seam within 6 inches of a circumferential splice	CJP groove weld	100% UT or RT
Welds attaching base plates, flange plates, pole plates, or mast arm plates to poles or arm tubes	CJP groove weld with backing ring and reinforcing fillet	t≥ 5/16 inch: 100% UT and 100% MT t< 5/16 inch: 100% MT after root weld pass and final weld pass
	External (top) fillet weld for socket-type connections	100% MT
Hand holes and other appurtenances	Fillet and PJP welds	MT full length on random 25% of all standards and poles

NOTE: t = pole or arm thickness

Nondestructive Testing for Overhead Sign Structures

Weld location	Weld type	Minimum required NDT
Base plate to post	CJP groove weld with backing ring and reinforcing fillet	100% UT and 100% MT
Base plate to gusset plate	CJP groove weld	100% UT
Circumferential splices of pipe or tubular sections	CJP groove weld with backing ring	100% UT or RT
Split post filler plate welds	CJP groove weld with backing bar	100% UT or RT
Longitudinal seam weld for pipe posts	CJP groove weld	t < 1/4 inch: 100% MT t ≥ 1/4 inch: 100% UT or RT
	PJP groove weld	Random 25% RT
Chord angle splice weld	CJP groove weld with backing bar	100% UT or RT
Truss vertical, diagonal, and wind angles to chord angles	Fillet weld	Random 25% MT
Upper junction plate to chord (cantilever type truss)	Fillet weld	Random 25% MT
Bolted field splice plates (tubular frame type)	CJP groove weld	100% UT and 100% MT
Cross beam connection plates (lightweight extinguishable message sign)	Fillet weld	Random 25% MT
Arm connection angles (lightweight extinguishable message sign)	Fillet weld	100% MT
Mast arm to arm plate (lightweight extinguishable message sign)	CJP groove weld with backing ring	t ≥ 5/16 inch: 100% UT and 100% MT t < 5/16 inch: 100% MT after root weld pass and final weld pass
Post angle to post (lightweight extinguishable message sign)	Fillet weld	100% MT
Hand holes and other appurtenances	Fillet and PJP welds	MT full length on random 25% of all sign structures

NOTE: t = pole or arm thickness

56-1.01D(2)(b)(ii) Ultrasonic Testing

For UT of welded joints with any members less than 5/16 inch thick or tubular sections less than 13 inches in diameter, the acceptance and repair criteria must comply with Clause 9.27.1 of AWS D1.1.

For UT of other welded joints, the acceptance and repair criteria must comply with Table 6.3 of AWS D1.1 for cyclically loaded nontubular connections.

After galvanization, perform additional inspection for toe cracks along the full length of all CJP groove welds at tube-to-transverse plate connections using UT.

When performing UT, use an authorized procedure under AWS D1.1, Annex S.

56-1.01D(2)(b)(iii) Radiographic Testing

The acceptance criteria for radiographic or real time image testing must comply with AWS D1.1 for tensile stress welds.

56-1.01D(2)(b)(iv) Longitudinal Seam Welds

The Engineer selects the random locations for NDT.

Grind the cover pass smooth at the locations to be tested.

If repairs are required in a portion of a tested weld, perform NDT on the repaired portion and on 25 percent of the untested portions of the weld. If more repairs are required, perform NDT on the entire weld.

56-1.01D(3) Department Acceptance

Reserved

56-1.02 MATERIALS

Reserved

56-1.03 CONSTRUCTION

Welding of steel members must comply with AWS D1.1.

Dispose of surplus excavated material.

Backfill under section 19-3.

56-1.04 PAYMENT

Not Used

56-2 OVERHEAD SIGN STRUCTURES

56-2.01 GENERAL

56-2.01A Summary

Section 56-2 includes specifications for constructing overhead sign structures.

Furnishing sign structures includes furnishing anchor bolt assemblies, removable sign panel frames, sign structure hardware, and fabricated sign structures at the job site, ready for installation, including welding and painting or galvanizing as required.

Installing sign structures includes installing anchor bolt assemblies, removable sign panel frames, and sign panels, and performing any welding and painting or galvanizing required during installation.

Types of overhead sign structures include:

1. Truss
2. Bridge mounted
3. Tubular

56-2.01B Definitions

Reserved

56-2.01C Submittals

56-2.01C(1) General

Allow 30 days for the Department's review.

56-2.01C(2) Shop Drawings

Submit 2 copies of shop drawings for sign structures. Include:

1. Sign panel dimensions
2. Span lengths
3. Post heights
4. Anchorage layouts
5. Proposed splice locations
6. Snugging and tensioning pattern for anchor bolts and HS bolted connections
7. Details for permanent steel anchor bolt templates
8. Details of clips, eyes, or removable devices for preventing damage to the finished galvanized or painted surfaces used for:
   - 8.1 Securing the sign during shipping
   - 8.2 Lifting and moving during erection

56-2.01C(3) Quality Control Program

Submit a QC program for sign structures. Include methods, equipment, and personnel to be used during fabrication and installation.

Submit the QC program with the shop drawing submittal.

56-2.01D Quality Assurance

56-2.01D(1) General

Reserved

56-2.01D(2) Quality Control

56-2.01D(2)(a) General

Reserved

56-2.01D(2)(b) Nondestructive Testing

Reserved

56-2.01D(2)(c) Walkway Safety Railing

The assembled and raised walkway safety railing must have less than 1 inch of wobble when a 50-lb horizontal load is applied alternating each way at the top center of each railing section.

56-2.01D(3) Department Acceptance

The Department inspects structural materials for sign structures at the fabrication site. You must:

1. Notify the Engineer when the materials are delivered to the fabrication site
2. Allow at least 10 days after delivery of the material for inspection before starting fabrication

56-2.02 MATERIALS

56-2.02A General

Materials must comply with section 55.

Do not use weathering steel.

56-2.02B Bars, Plates, Shapes, and Structural Tubing

56-2.02B(1) General

Bars and plates must be structural steel complying with one or more of the following:

1. ASTM A36/A36M
2. ASTM A709/A709M, Grade 36 or 50
3. ASTM A572/A572M, Grade 50

Other open shapes must be structural steel complying with one or more of the following:

1. ASTM A36/A36M
2. ASTM A709/A709M, Grade 36 or 50
3. ASTM A992/A992M

Light fixture mounting channel must be continuous slot channel made from one of the following:

1. Steel complying with ASTM A1011/A1011M, Designation SS, Grade 33
2. Extruded aluminum of alloy 6063-T6 complying with ASTM B221 or B221M

Structural tubing and hollow structural sections must be structural steel complying with ASTM A500/A500M, Grade B or ASTM A1085.

Surface flatness after galvanizing must comply with ASTM A6/A6M for the following:

1. Base plates that are to come in contact with concrete, grout, or washers and leveling nuts
2. Plates in high-strength bolted connections

56-2.02B(2) Charpy V-notch Impact

Reserved

56-2.02C Sheets

Sheets must be carbon steel complying with ASTM A1011/A1011M, Designation SS, Grade 33.

56-2.02D Bolted Connections

Bolts, nuts, and washers must comply with section 55-1.02D(1).

Components of HS bolts must comply with section 55 for high strength steel fastener assemblies unless the bolts are shown to be snug tight. Bolts, nuts, and washers for HS bolts shown to be snug tight must comply only with section 55-1.02D(1).

Anchor bolts must comply with ASTM F1554, Grade 55, weldable steel.

Use a permanent steel template to maintain the proper anchor bolt spacing.

Provide 1 top nut, 1 leveling nut, and 2 washers for the upper threaded portion of each anchor bolt.

56-2.02E Anchorages

Anchorages for bridge mounted sign structures must comply with the specifications for concrete anchorage devices in section 75-3.

56-2.02F Pipe Posts

Pipe posts must be welded or seamless steel pipes. Manufactured pipe posts must comply with one of the following:

1. ASTM A53/A53M, Grade B
2. ASTM A106/A106M, Grade B
3. API Specification 5L PSL2 Grade B, Grade X42R or Grade X42M using nominal pipe sizes for threaded end pipe
4. ASTM A1085, Grade A

You may fabricate pipe posts from structural steel complying with ASTM A36/A36M, ASTM A709/A709M, Grade 36, or ASTM A572/A572M, Grades 42 or 50.

Spiral seam welds are not allowed.

56-2.02G Steel Walkway Gratings

Steel walkway gratings must comply with the following:

1. Gratings must be the standard product of an established grating manufacturer
2. Material for gratings must be structural steel complying with ASTM A1011/A1011M as specified for Designation CS, Type B or Designation SS, Grade 36, Type 1
3. For welded type gratings, each joint must be full resistance welded under pressure to provide a sound, completely beaded joint
4. For mechanically locked gratings:
   4.1. Method of fabrication and interlocking of the members must be authorized
   4.2. Fabricated grating must be equal in strength to the welded type
5. Gratings must be accurately fabricated and free from warps, twists, or defects affecting their appearance or serviceability including:
   5.1. Ends of all rectangular panels must be square
   5.2. Tops of the bearing bars and cross members must be in the same plane
   5.3. Gratings distorted by the galvanizing process must be straightened

56-2.02H Elastomeric Bearing Pads

Elastomeric bearing pads must comply with section 51-3.02.

56-2.02I Safety Chain at Walkways

Safety chain at walkways must comply with ASTM A413/A413M, Grade 43. The nominal chain size must be 1/4 inch. Use the minimum length that allows lock-up of safety railing.

56-2.02J Safety Cable at Walkways

Safety cable at walkways must:

1. Be constructed of Type 302 or 304 stainless steel 7 by 19 wire strand core cable
2. Have a cable breaking strength of at least 10,000 lb
3. Not be prestretched

56-2.02K Fabrication

56-2.02K(1) General

Sign structures must be:

1. Free from kinks, twists, or bends
2. Uniform in appearance

Fabricate sign structures into the largest practical sections before galvanizing.

Assemble the completed sections in the shop. Check sections for straightness, alignment, and dimension. Correct any variation.

Affix clips, eyes, and removable brackets to all signs and all posts for securing the sign during shipping, lifting, moving, and erection. Secure the sign as necessary to prevent damage to the finished galvanized or painted surfaces.

Do not make any holes in members unless the holes are shown or authorized.

Form the posts for tubular sign structures to the radii shown by heat treatment or by fabrication methods that will not:

1. Crimp or buckle the interior radius of the pipe bend
2. Change the physical characteristics of the material

56-2.02K(2) Welding

PJP longitudinal seam welds for tapered tubular members must have at least the minimum penetration shown but not less than 60 percent penetration. Within 6 inches of circumferential welds, longitudinal seam welds must be CJP groove welds.

Except for welds at posts shown as PJP welds, longitudinal seam welds of fabricated pipe posts must be CJP groove welds.

Without authorization, you may make 1 repair to circumferential welds and to base plate-to-post welds. Obtain authorization before making any additional repairs.

56-2.02K(3) Bolted Connections

Except for HS bolts shown to be snug-tight, HS bolted connections must be HS assemblies complying with section 55-1.02E(6) except assemblies must consist of:

1. HS steel bolts
2. Nuts
3. Hardened washers
4. Direct tension indicators

HS fastener assemblies and any other bolts, nuts, and washers attached to sign structures must be zinc-coated by the mechanical deposition process.

Nuts for HS bolts at joints designated as snug-tight must not be lubricated.

Use an alternating snugging and tensioning pattern for anchor bolts and HS bolted splices. Once tensioned, do not reuse HS fastener components.

For bolt diameters less than 3/8 inch, the diameter of the bolt hole must be not more than 1/32 inch larger than the nominal bolt diameter.

For bolt diameters greater than or equal to 3/8 inch, the diameter of the bolt hole must be not more than 1/16 inch larger than the nominal bolt diameter.

56-2.02K(4) Walkway

Safety cable at walkways must be continuous between lugs. Before tightening cable clips at the end anchorage, remove the slack in the cable.

Safety cable at walkways must not be kinked, knotted, deformed, frayed, or spliced.

Install clips at safety cables under the manufacturer's instructions.

56-2.02K(5) Handholes

The edges of handholes and other large post and arm openings must be ground smooth. The roughness of edges must be less than 0.001 inch.

56-2.02K(6) Identification Plate

Permanently attach an aluminum identification plate near the base using either stainless steel rivets or stainless steel screws. Attach the plate adjacent to the traffic side on 1 of the vertical posts.

The information on the plate must include:

1. Name of the manufacturer
2. Date of manufacture
3. Contract number

56-2.02L Surface Finish

56-2.02L(1) General

Galvanize all ferrous metal parts of the following sign structure types:

1. Truss
2. Bridge mounted
3. Tubular

Except for tubular type sign structures, do not paint sign structures.

Clean and paint all ferrous metal parts of tubular sign structures after galvanizing, including the areas to be covered by sign panels.

Do not treat galvanized surfaces with chemicals before cleaning and painting.

Galvanize and do not paint walkway gratings, walkway brackets, gutters, safety railings, steel mountings for light fixtures, and all nuts, bolts, and washers for sign structures after fabrication.

56-2.02L(2) Galvanizing

Galvanizing must comply with section 75-1.02B except surfaces may be coated with zinc by the thermal spray coating process if authorized.

If authorized to use thermal spray coating, apply the coating under section 59-5. The thickness of the sprayed zinc coat must be at least 5 mils.

Do not use zinc solders or zinc alloys that contain tin to repair a damaged galvanized surface.

56-2.02L(3) Cleaning and Painting

Where specified, clean and paint sign structures under section 59-4.

56-2.03 CONSTRUCTION

56-2.03A General

Do not fasten any bridge-mounted sign to concrete elements of bridges or railings before the concrete attains a compressive strength of 2,500 psi.

After erection, remove the brackets used to secure tubular sign structures during shipping and lifting.

Install sign panels as shown. Install laminated and formed sign panels on sign structures using fastening hardware of the type and sizes shown.

Complete the CIDH concrete pile foundation at least 7 days before erecting the sign structure.

56-2.03B Existing Sign Structures

56-2.03B(1) General

Work involving existing sign structures must comply with section 15.

56-2.03B(2) Remove Sign Structure

Reserved

56-2.03B(3) Reconstruct Sign Structure

Reserved

56-2.03B(4) Modify Sign Structure

Reserved

56-2.03B(5) Relocate Sign Structure

Reserved

56-2.03B(6) Salvage Sign Structure

Reserved

56-2.04 PAYMENT

The payment quantity for install sign structure does not include the weight of sign panels.

For determining the payment quantity for furnish sign structure and install sign structure, the weight of extruded aluminum used for steel slot channel for the light fixture mounting channel is the computed weight of the steel channel.

56-3 STANDARDS, POLES, PEDESTALS, AND POSTS

56-3.01 GENERAL

56-3.01A General

Section 56-3 includes general specifications for fabricating and installing standards, poles, pedestals, and posts.

56-3.01B Materials

56-3.01B(1) General

Reserved

56-3.01B(2) Fabrication

56-3.01B(2)(a) General

Configure each mast arm as a smooth curving arm.

You may change the mast arm configuration if the mounting height and stability are maintained.

56-3.01B(2)(b) Bonding Jumper

Standards with handholes must comply with the following:

1. Include a UL-listed lug and 3/16-inch or larger brass or bronze bolt for attaching the bonding jumper for non-slip-base standards.
2. Attach a UL-listed lug to the bottom slip base plate with a 3/16-inch or larger brass or bronze bolt for attaching the bonding jumper for slip-base standards.

56-3.01C Construction

56-3.01C(1) General

Holes left in the shaft of an existing standard due to the removal of equipment or mast arm must be sealed by fastening a galvanized steel disk to cover the hole. Fasten using a single central galvanized

steel fastener. Seal edges of the disk and hole with a polysulfide or polyurethane sealing compound complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

If an existing standard is ordered to be relocated or reused, remove large dents, straighten shafts, and replace parts that are in poor condition. Furnish anchor bolts or bars and nuts required for relocating or reusing standard. Repair and replacement work is change order work.

If a standard or mast arm is relocated or the Department furnishes a used standard or mast arm, furnish:

1. New bolts, nuts, cap screws, and washers
2. New keeper plate, if the standard has a slip base

56-3.01C(2) Foundations

56-3.01C(2)(a) General

Except for concrete for CIDH concrete pile foundations, concrete must comply with the specifications for minor concrete.

Construct concrete foundations on firm ground.

After each standard, pole, pedestal, and post is properly positioned, place mortar under the base plate. Finish the exposed portion to present a neat appearance. Mortar must comply with the specifications for mortar in section 51-1, except mortar must have:

1. 1 part by volume of cement
2. 3 parts by volume of clean sand

Form exposed portions of the foundation to present a neat appearance and true to line and grade. The top of the foundation at curbs or sidewalks must be finished to curb or sidewalk grade. Forms must be rigid and braced securely in place. Conduit ends and anchor bolts must be placed at the proper height and position. Anchor bolts must be installed a maximum of 1:40 from vertical and held in place by rigid top and bottom templates. Use a steel bottom template at least 1/2 inch thick that provides proper spacing and alignment of anchor bolts near the embedded bottom end. Install the bottom template before placing footing concrete.

For relocated standards, construct new foundations and furnish anchor bolts of the proper type and size.

Galvanize steel parts under section 75-1.02B.

Provide 2 nuts and washers for the upper threaded part of each anchor bolt. Provide 3 nuts and washers for each anchor bar or stud.

Do not weld HS steel used for anchor bolts, anchor bars, or studs.

Before placing concrete, moisten the forms and ground. Keep the forms in place until the concrete sets for at least 24 hours and is strong enough to prevent damage to the surface.

Except when located on a structure, construct foundations monolithically.

Apply ordinary surface finish under section 51-1.03F(2).

If a foundation must be extended for additional depth, the extension work is change order work.

Do not erect standards, poles, pedestals, or posts until the concrete foundation has cured for at least 7 days.

The Engineer selects either the plumbing or raking technique for standards, poles, pedestals, and posts. Plumb or rake by adjusting the leveling nuts before tightening nuts. Do not use shims or similar devices. After final adjustments of both top nuts and leveling nuts on anchorage assemblies have been made and each standard, pole, pedestal, and post on the structure is properly positioned, tighten nuts as follows:

1. Tighten leveling nuts and top nuts, following a crisscross pattern, until bearing surfaces of all nuts, washers, and base plates are in firm contact.
2. Use an indelible marker to mark the top nuts and base plate with lines showing relative alignment of the nut to the base plate.

3. Tighten top nuts following a crisscross pattern:
   3.1. Additional 1/6 turn for anchor bolts greater than 1-1/2 inches in diameter.
   3.2. Additional 1/3 turn for other anchor bolts.
   3.3. Tightening tolerance for all top nuts is ± 1/8 turn.

In unpaved areas, construct a raised concrete pad in front of each controller cabinet pedestal.

If a foundation is shown to be abandoned, remove the top of the foundation, anchor bolts, and conduits to a minimum depth of 0.5 foot below the sidewalk surface or original ground. Backfill the resulting hole with material equivalent to the surrounding material.

A foundation must be completely removed if not shown to be reused or abandoned.

Dispose of foundations that are removed.

56-3.01C(2)(b) Cast-In-Drilled-Hole Concrete Pile Foundations

Reinforced CIDH concrete pile foundation must comply with section 49-3 except:

1. Dispose of material resulting from drilling holes
2. Concrete for CIDH concrete piles will not be considered as designated by compressive strength

Concrete must contain not less than 590 pounds of cementitious material per cubic yard.

For standards and poles located in sidewalk areas, the pile foundation must be placed to final sidewalk grade before the sidewalk is placed. The top 4 inches must be square shaped.

If shown, use sleeve nuts on Type 1 standards. The bottom of the base plate must be flush with the finished grade.

Spiral reinforcement must be continuous above the bottom of the anchor bolts. The top termination must be either:

1. 1'-6" lap beyond the end of pitch with a 90-degree hook extending to the opposite side of the cage, or
2. 1'-6" lap beyond the end of pitch with 2 evenly spaced authorized mechanical couplers

56-3.01C(3) Identification Tags

Except for Type 1 standards and wood poles, attach rectangular corrosion-resistant metal identification tags on all standards and poles using stainless steel rivets as follows:

1. For standards and poles, attach a tag above the handhole near the base of the standard or pole.
2. For signal standards, attach 1 tag above the handhole near the base of the pole and 1 tag on the underside of the signal mast arm near the arm plate.

The lettering on each identification tag must be:

1. Either depressed or raised
2. 1/4 inch tall
3. Legible
4. Readable after the support structure is coated and installed

Include the following information on the tag:

1. Name of the manufacturer
2. Date of manufacture
3. Identification number
4. Contract number
5. Unique identification code:
   5.1. Assigned by the manufacturer
   5.2. Traceable to a particular Contract and the welds on that component

56-3.01D Payment

Not Used

56-3.02 STEEL STANDARDS, POLES, PEDESTALS, AND POSTS

56-3.02A General

56-3.02A(1) General

Section 56-3.02 includes specifications for fabricating and installing steel standards, poles, pedestals, and posts.

56-3.02A(2) Definitions

Reserved

56-3.02A(3) Submittals

56-3.02A(3)(a) General

The Engineer selects random samples of fastener components from each production lot. The Engineer determines sample sizes for each fastener component. Submit selected sample fasteners to METS for QA testing. Include test reports specified in ASTM with the test sample submittal.

56-3.02A(3)(b) Test Reports

For standards and poles with shaft lengths of 15 feet or more, submit certified test reports verifying compliance with minimum yield strength requirements. Test reports may be the mill test report for the as-received steel. If the as-received steel has a lower yield strength than required, provide test data assuring that your method of cold forming will consistently increase the steel tensile properties to meet the specified minimum yield strength. Test data must include tensile properties of the steel after cold forming for specific heats and thicknesses.

56-3.02A(4) Quality Assurance

56-3.02A(4)(a) General

Reserved

56-3.02A(4)(b) Quality Control

For cast slip bases for standards and poles with shaft lengths of 15 feet or more, perform RT on 1 casting from each lot of a maximum of 50 castings under ASTM E94. Castings must comply with the acceptance criteria for severity level 3 or better for the types and categories of discontinuities specified in ASTM E186 and E446. If the casting fails testing, 2 additional castings must be radiographed. If the 2 additional castings fail the inspection, the lot is rejected.

56-3.02A(4)(c) Department Acceptance

Reserved

56-3.02B Materials

56-3.02B(1) General

Type 1 standards and steel pedestals for controller cabinets must be manufactured of one of the following:

1. At least 0.120-inch-thick galvanized steel
2. 4-inch standard weight galvanized steel pipe complying with ASTM A53/A53M
3. 4-inch Type 1 conduit with the top designed for post-top slip fitter

Material for push button posts, pedestrian barricades, and guard posts must comply with ASTM A53/A53M or ASTM A500/A500M.

Handhole reinforcement rings must be continuous around the handholes.

Galvanize standards, poles, pedestals, posts, fasteners, and other ferrous materials under section 75-1.02B.

Steel pipe standards and mast arms must be hot dip galvanized after manufacturing. Remove spikes from galvanized surfaces.

56-3.02B(2) Bolted Connections

Anchor bolts must comply with ASTM F1554, Grade 55 for weldable steel.

HS anchor bolts, nuts, and washers must comply with section 55-1.02D(1) and the following:

1. Bolt threads must be rolled
2. Hardness of HS anchor bolts must not exceed 34 HRC when tested under ASTM F606
3. Galvanization must be by mechanical deposition
4. Nuts must be heavy-hex type
5. Each lot of nuts must be proof load tested

Bolts, nuts, and washers for general applications must comply with section 55-1.02D(1).

HS bolts shown to be snug tight must comply with section 55-1.02D(1) for general applications.

HS bolts, nuts, and flat washers used to connect slip base plates must comply with the requirements for HS fastener assemblies for use in structural steel joints in section 55-1.02D(1) except rotational capacity testing and tension testing are not required.

Zinc-coated nuts used on fastener assemblies having a specified preload obtained by specifying a prescribed tension, torque value, or degree of turn must be provided with a colored lubricant that is clean and dry to the touch. The lubricant color must contrast the zinc coating color on the nut such that the presence of the lubricant is visually obvious. The lubricant must be insoluble in water or the fastener components must be shipped to the job site in a sealed container.

Plate washers must be manufactured by saw cutting and drilling steel plate. Steel plate must comply with AISI 1018. Before galvanizing, remove burrs and sharp edges and chamfer both sides of holes to allow the bolt head to make full contact with the washer without tension.

HS cap screws for attaching arms to standards must comply with ASTM F3125 Grade A325 or ASTM A449, and the mechanical requirements in Grade A325 after galvanizing. Coat threads of cap screws with a colored lubricant that is clean and dry to the touch. The lubricant color must contrast the zinc coating color on the cap screw such that the presence of the lubricant is visually obvious. The lubricant must be insoluble in water or the fastener components must be shipped to the job site in a sealed container.

Before manufacturing, details must be adjusted to ensure that cap screw heads can be turned using conventional installation tools. During manufacturing, properly locate the position of the luminaire arm on the arm plate to avoid interference with the cap screw heads.

56-3.02B(3) Standards and Poles

56-3.02B(3)(a) General

Standards and poles with shaft lengths of 15 feet or more must comply with sections 55-1.02 and 56-3.02B(3).

Tapered tubes must be manufactured from sheet steel of a weldable grade having a minimum yield strength of 55,000 psi after manufacturing.

Steel having a nominal thickness greater than 2 inches that is used for tube-to-transverse plate connections must have a minimum CVN impact value of 20 ft-lb at 20 degrees F when tested under ASTM E23.

56-3.02B(3)(b) Fabrication

When a single-ply 5/16-inch-thick pole is specified, a 2-ply pole with equivalent section modulus may be substituted.

Standards may be manufactured of full-length sheets or shorter sections. Each section must be manufactured from 1 or 2 pieces of sheet steel. If 2 pieces are used, the longitudinal welded seams must be directly opposite from one another. If the sections are butt-welded together, the longitudinal welded seams of adjacent sections must be placed to form continuous straight seams from the base to the top of the standard.

Standards with an outside diameter of 12 inches or less must be round. Standards with an outside diameter greater than 12 inches may be round or multi-sided. Multi-sided standards must:

1. Be convex

2. Have a minimum of 12 sides
3. Have a minimum bend radius of 4 inches

Manufacture mast arms from material specified for the standard.

Standards and poles must be straight with a maximum variation of:

1. 1 inch measured at the midpoint of a 30- to 35-foot standard
2. 3/4 inch measured at the midpoint of a 17- to 20-foot standard

Exposed edges of the plates that make up the base assembly must be finished smooth. Exposed corners of the plates must be broken. Provide shafts with slip-fitter shaft caps.

Surface flatness requirements specified in ASTM A6/A6M apply to plates meeting one or more of the following:

1. In contact with concrete, grout, or washers and leveling nuts
2. In HS bolted connections
3. In joints where cap screws are used to secure luminaire and signal arms
4. Used for breakaway slip base assemblies

Do not make additional holes in structural members.

Manufacture the cast steel option for slip bases from material of Grade 70-40 complying with ASTM A27/A27M. You may use other comparable material if authorized. Casting tolerances must comply with the Steel Founders' Society of America's recommendations for green sand molding.

56-3.02B(3)(c) Welding

Butt-welded circumferential joints of tubular sections requiring CJP groove welds must be made using a metal sleeve backing ring inside each joint. The sleeve must have at least a 1/8-inch nominal thickness and be manufactured from steel having the same chemical composition as the steel in the tubular sections to be joined. If the sections to be joined have different specified minimum yield strengths, the sleeve must have the same chemical composition as the tubular section having the higher minimum yield strength. The width of the metal sleeve must be consistent with the type of NDT selected and must be a minimum width of 1 inch. At fitting time, the sleeve must be centered at the joint and in contact with the tubular section at the point of the weld.

Welds must be continuous.

Weld metal at the transverse joints must extend to the sleeve, making the sleeve an integral part of the joint.

During manufacturing, longitudinal seams on vertical tubular members of cantilevered support structures must be within 90 degrees circumferentially of the center of the longest mast arm connection. Longitudinal seams on horizontal tubular members, including signal and luminaire arms, must be within 45 degrees of the bottom of the arm.

Longitudinal seam welds in steel tubular sections may be made by the electric resistance welding process.

Longitudinal seam welds must have a 60 percent minimum penetration except:

1. Within 6 inches of a circumferential weld, the longitudinal seam weld must be a CJP groove weld.
2. Longitudinal seam welds on lighting support structures having a telescopic pole segment splice must be CJP groove welds on the female end for a length on each end equal to the designated slip-fit splice length plus 6 inches.

Except for fillet and fatigue-resistant welds, exposed circumferential welds must be ground flush with the base metal before galvanizing or painting. Ground flush is specified as -0, +0.08-inch.

Circumferential welds and base plate-to-pole welds may be repaired only 1 time.

The length of telescopic slip-fit splices must be at least 1.5 times the inside diameter of the exposed end of the female section.

For welds connecting reinforced handholes or box-type pole plate connections to a tubular member, the start and stop points must be at points located on a longitudinal axis of symmetry of the tube coinciding with the axis of symmetry of the hand hole or pole plate.

56-3.02C Construction

Assemble and tighten the slip base when the pole is on the ground. Threads of heavy hex nuts for each slip base bolt must be coated with additional lubricant that is clean and dry to the touch. Tighten HS slip base bolts to within ±10 ft-lb of torque shown in the following table:

Slip Base Bolt Tightening Requirements

Standard type	Torque (ft-lb)
15-SB	150
15-SBF	150
30	150
31	200

Bolted connections attaching signal or luminaire arms to standards, poles, and posts are considered slip critical. Galvanized faying surfaces of plates on luminaire arms, signal arms, and poles must (1) be roughened by hand using a wire brush before assembly and (2) comply with requirements for Class C surface conditions for slip-critical connections in *Specification for Structural Joints Using High-Strength Bolts* of the RCSC. Coatings for faying surfaces must comply with the RCSC specification for Class B coatings.

56-3.02D Payment

Not Used

56-3.03–56-3.04 RESERVED

56-3.05 HIGH MAST LIGHTING ASSEMBLY POLES

Reserved

56-3.06 WOOD POLES

56-3.06A General

Section 56-3.06 includes specifications for fabricating and installing wood poles.

56-3.06B Materials

Each wood pole must:

1. Be class 5 or larger as specified in ANSI O 5.1
2. Have not more than 180-degree twist in grain over the full length
3. Have a sweep of not more than 4 inches
4. Have a beveled top
5. Be placed in the ground at least 6 feet
6. Unless otherwise specified, have a length of:
   6.1. 25 feet for a service pole
   6.2. 35 feet for other poles

After fabrication, pressure-treat poles under section 57-2.01B(3) and AWPA U1, Use Category UC4B, Commodity Specification D. If poles are specified to be painted, use a waterborne wood preservative.

Manufacture the mast arm from standard pipe, free from burrs. Each mast arm must have an insulated wire inlet and wood pole mounting brackets for the mast arm and tie-rod cross arm. Manufacture tie rod from structural steel and pipe.

56-3.06C Construction

After each pole is set in ground, backfill the space around the pole with selected earth or sand, free of rocks and other deleterious material, placed in 4-inch-thick layers. Moisten each layer and thoroughly compact.

Mount the mast arm for luminaires to provide a 34-foot mounting height for a 165 W LED luminaire and a 40-foot mounting height for a 235 W LED luminaire. Traffic signals and flashing beacons on the mast arm must provide a minimum vertical clearance of 17 feet from bottom of equipment to pavement.

56-3.06D Payment

Not Used

56-4–56-10 RESERVED

57 WOOD AND PLASTIC LUMBER STRUCTURES

57-1 GENERAL

57-1.01 GENERAL

57-1.01A Summary

Section 57-1 includes general specifications for constructing wood and plastic lumber structures.

57-1.01B Definitions

hardware: Bolts with necessary nuts and washers, timber connectors, drift pins, dowels, nails, screws, spikes, wire rope for wrapping, lag screws, and other metal fastenings.

structural metal: Structural shapes, eyebars, castings, rods with necessary nuts and washers, metal shoes, and plates, but not including hardware.

57-1.01C Submittals

Reserved

57-1.01D Quality Assurance

Reserved

57-1.02 MATERIALS

57-1.02A General

Deliver, store, and handle timber and lumber as follows:

1. Store in piles at the job site unless it is to be placed in the structure immediately
2. Stack neatly on dunnage above ground so that it can be readily inspected
3. Store and handle such that injury and breakage are avoided
4. Protect from the sun to prevent warping

57-1.02B Structural Metal

Structural metal must comply with section 75-3.

Hot-dip galvanize structural metal under section 75-1.02B.

57-1.02C Hardware

Hardware must comply with section 75.

Except for malleable iron washers, hot-dip galvanize hardware under section 75-1.02B.

Bolts and nuts must comply with ASTM A307.

Machine bolt heads and nuts must be regular square series and threads must be coarse thread series, Class 2 tolerance, all complying with ANSI Standard.

Washers must be cast iron ogee, malleable iron, plate, or cut washers.

Nails must be common wire nails.

Wire rope must be commercial-quality galvanized steel wire rope. Splices and end connections of wire rope must be made with metal clips.

57-1.03 CONSTRUCTION

Not Used

57-1.04 PAYMENT

For a bid item with a MFBM measurement unit, the payment quantity is the volume determined from (1) nominal widths and thicknesses and (2) lengths shown.

57-2 WOOD STRUCTURES

57-2.01 GENERAL

57-2.01A General

57-2.01A(1) Summary

Section 57-2 includes specifications for constructing wood structures.

57-2.01A(2) Definitions

Reserved

57-2.01A(3) Submittals

Submit a certificate of compliance for timber and lumber stating the species of the material to be shipped and including a certified grading report. If timber is treated, include a certified treating report.

Submit a certificate of compliance for glued laminated timbers and glued laminated decking.

57-2.01A(4) Quality Assurance

Treated and untreated timber and lumber must comply with the grading specifications when delivered to the job site.

57-2.01B Materials

57-2.01B(1) General

Grease used to fill bolt holes must be recommended by the manufacturer for corrosion protection and must not melt or run at a temperature of 150 degrees F.

57-2.01B(2) Structural Timber and Lumber

Structural timber and lumber must be one of the species shown in the following table:

Type	Species
Douglas fir	*Pseudotsuga menziesii*
Hem-Fir	*Abies magnifica, Abies grandis, Abies procera, Abies amabillis, Abies concolor, Tsuga heterophylla*
Redwood	*Sequoia sempervirens*
Southern yellow pine	One of the species recognized by the Southern Pine Inspection Bureau

Structural timber and lumber must be inspected and grade marked under the rules and specifications shown in the following table:

Timber and Lumber Grading

Type	Rules/specifications and publisher
Douglas fir and Hem-Fir	*Standard No. 17 Grading Rules for West Coast Lumber* published by West Coast Lumber Inspection Bureau, or *Western Lumber Grading Rules* published by Western Wood Products Association
Redwood	*Standard Specifications for Grades of California Redwood Lumber* published by Redwood Inspection Service
Southern yellow pine	*Standard Grading Rules for Southern Pine Lumber* published by Southern Pine Inspection Bureau

Stress-graded lumber must comply with the following:

1. Wood must be sound and free from decay.
2. Green timber must be protected from uneven seasoning during transit.
3. Douglas fir must be end coated with a protective coating during manufacturing to retard checking.

For all stress grades, the sizes described for timber and lumber are nominal sizes under *American Softwood Lumber Standard*, PS 20, published by NIST.

Plywood must be 3/4-inch-thick Grade BC Douglas fir plywood manufactured with adhesives for wet use and must be preservative treated.

Each glued laminated timber or decking unit must bear the American Institute of Timber Construction quality mark.

Glued laminated timbers must be architectural grade with glue for wet use and saw-textured exposed surfaces.

Glued laminated timbers must comply with ANSI/AITC A190.1 and AITC 117, published by the American Institute of Timber Construction.

Glued laminated decking units must be:

1. Douglas fir, white pine, or Hem-Fir
2. Kiln-dried solid stock lumber
3. Factory laminated using adhesive for wet use
4. At least 3 plies thick, with tongue and groove edges
5. At least 5.5 inches in width and thickness

The surface of glued laminated decking units at exposed faces must be saw textured.

57-2.01B(3) Preservative Treatment

Where preservative treatment is specified, treat timber, lumber, and piling after millwork is completed.

Preservatives, treatment, and treatment results must comply with AWPA Standards U1 and T1 and the specified AWPA Use Category. If a Use Category is not specified, the preservative treatment must comply with AWPA U1, Use Category UC4B.

The treating plant must imprint legible symbols in the ends of all treated timber and lumber. The symbols must indicate the name of the treating company and the type and year of treatment under AWPA Standards M1 and M6.

Where timber is specified to be kiln dried before treatment, the moisture content after drying and immediately before treating must not exceed 25 percent. Measure the moisture content under ASTM D4444 at the midpoint of the piece in the outer 1 inch. Use an authorized type of moisture meter.

Timber and lumber treated with waterborne preservatives must be dried after treatment and have a moisture content of no more than 25 percent when shipped to the job site.

For treated wood that is to be painted, use a waterborne wood preservative.

Manually applied wood preservative must be creosote or copper naphthenate complying with AWPA Standard M4.

57-2.01C Construction

57-2.01C(1) General

Reserved

57-2.01C(2) Framing

Timber and lumber must be accurately cut and framed to a close fit and must have even bearing over the entire contact surface. Do not use shimming in making joints.

Bore fastener holes as shown in the following table:

Fastener Bore Holes

Fastener type	Member type	Boring requirement
Drift pin or dowel	Untreated timber	Hole diameter a minimum of 1/16 inch less than the pin or dowel diameter
	Treated timber	Hole diameter the same as the pin or dowel diameter
Bolt	All cases	Hole diameter a maximum of 1/16 inch larger than the bolt diameter
Lag screw	All cases	Bit diameter a maximum of the root diameter of the lag screw thread
Boat or wire spike	Small member, if necessary to prevent splitting	Bit diameter the same as the spike diameter or the smallest dimension of the spike

Fit each bolt 5/8 inch or less in diameter with a cut washer. Fit each bolt or lag screw over 5/8 inch in diameter with a cast or malleable iron washer.

Framed bents must comply with the following:

1. Mud sills must be firmly and evenly bedded in solid material.
2. Sills must have full, even bearing on the pedestals, mud sills, or piles.
3. Posts must be framed true and must have full bearing on pedestals, sills, and caps.

Align bents before placing bracing. Provide a minimum of 8 inches between the outside bolt and the end of the brace.

For bridge deck stringers, place the better edge down. After placing stringers, the tops of the stringers must not vary from a plane more than will allow bearing of the floor on all the stringers.

Wheel guards and railings must be accurately framed and aligned.

57-2.01C(3) Treated Timber

57-2.01C(3)(a) General

Section 57-2.01C(3) applies to treated timber.

Preservative-treated timber must be Douglas fir or Hem-Fir.

Chromated copper arsenate must not be used for preservative treatment.

Do not remove bolts and hardware using flame-type or air-arc cutting equipment.

Predrill for bridge spikes within 1 foot of the ends of existing timbers and new planking. Predrill elsewhere if necessary to avoid splitting the timber or bending the spikes.

If authorized, you may relocate holes for new bolts and drift pins to avoid conflicts with existing hardware embedded in existing wood.

For lumber treated with ammoniacal copper arsenate, ammoniacal copper zinc arsenate, ammoniacal copper quat, or copper azole:

1. Fill bolt holes with grease before inserting bolts
2. Use nylon spacers, polyethylene tape, or other authorized corrosion-resistant barrier on surfaces of hardware that will be in contact with treated wood

57-2.01C(3)(b) Manual Treatment

Do not manually apply preservative to unprotected wood in wet or damp weather or to wood with a moisture content exceeding 25 percent or with free surface moisture.

If manually applying preservative, use suitable brushes for exposed surfaces, use swabs for holes, or use other means that result in adequate coverage.

If treated timber is framed, cut, or bored after treatment, thoroughly swab each cut, dap, or hole with 2 applications of the same preservative specified for the timber treatment or of copper naphthenate.

Manually treat the following items with 2 applications of wood preservative:

1. Portions of rail posts to be embedded in earth or concrete
2. Faces of timber bulkheads to be in contact with earth except those of treated Douglas fir

57-2.01C(3)(c) Handling

Handle and care for pressure-treated wood materials under AWPA Standard M4.

Handle treated timber with rope slings. Do not use cant hooks, peaveys, or other sharp instruments to handle treated timber.

57-2.01C(4) Painting

For painted timber and lumber, comply with section 78-4.02.

Paint the following items with 1 application of latex-base wood primer and 2 applications of white exterior latex-based paint:

1. Rails
2. Portions of rail posts not embedded in earth or concrete
3. Wheel guards or timber curbs except the bottom faces over an earth surface
4. Exposed faces of posts

57-2.01D Payment

Not Used

57-2.02 TIMBER LAGGING

57-2.02A General

Section 57-2.02 includes specifications for installing timber lagging.

57-2.02B Materials

Timber members must be (1) preservative-treated Douglas fir and (2) full sawn to the dimensions shown.

Chromated copper arsenate must not be used for preservative treatment.

57-2.02C Construction

If no concrete facing is shown:

1. Install lagging members 4 inches thick or less with a 3/8-inch gap between members
2. Install lagging members greater than 4 inches thick with a 1/2-inch gap between members

If a concrete facing is shown, install lagging members with mortar-tight joints.

57-2.02D Payment

Not Used

57-2.03 TIMBER CATWALK

57-2.03A General

Section 57-2.03 includes specifications for constructing timber catwalks.

A timber catwalk consists of a walkway of two 3- by 12-inch planks bolted to steel supports and a cable handrail, if shown.

57-2.03B Materials

57-2.03B(1) General

Reserved

57-2.03B(2) Timber Planks

The timber planks must be untreated Douglas fir Dense no. 1, rough sawn on top, optional surfaced on bottom.

57-2.03B(3) Cable Handrail

The cable for the cable handrail must be wire rope with a minimum diameter of 1/2 inch and a minimum breaking strength of 7,500 lb. The wire rope must be furnished with Class A weight zinc-coated wire under ASTM A603.

The turnbuckles, U-bolts, and thimbles must be commercial quality. The turnbuckles must be steel pipe type or drop forged steel and must have jaw or eye ends. The turnbuckles and U-bolts must have a minimum breaking strength of 7,500 lb.

The cable clamps and other required fittings must be commercial-quality steel, malleable iron, or wrought iron.

Galvanize hardware, turnbuckles, U-bolts, cable clamps, and other fittings under section 75-1.02B.

57-2.03C Construction

Tension the handrail cables to provide taut railings between supports.

Steel surfaces to be covered by timber must be painted the full number of applications specified before placing timber. Painting of timber planks is not required.

57-2.03D Payment

Not Used

57-2.04 ABUTMENT LUMBER BLOCKING

Reserved

57-2.05 TIMBER RETAINING WALLS

Reserved

57-2.06–57-2.10 RESERVED

57-3 PLASTIC LUMBER STRUCTURES

57-3.01 GENERAL

57-3.01A Summary

Section 57-3 includes specifications for constructing plastic lumber structures.

57-3.01B Definitions

postconsumer waste: Finished material, not including manufacturing waste, that has completed its life cycle as a consumer item and would have been disposed of as a solid waste.

production lot of plastic lumber: Quantity of 100 cu yd or less that is ready for shipment to the job site and is of the same type, manufactured by the same method, and made of the same material.

recycled product: Material, good, or supply, of which at least 50 percent of its total mass consists of secondary waste and at least 10 percent of its total mass consists of postconsumer waste.

secondary waste: Finished products or fragments of finished products of a manufacturing process, including postconsumer waste but not including excess virgin resources of the manufacturing process.

57-3.01C Submittals

57-3.01C(1) General

Submit the following product data:

1. Manufacturer's material test reports
2. Manufacturer's performance data
3. SDSs

4. 2 copies of the printed literature for the product

Submit a certificate of compliance for each shipment of plastic lumber. The certificate must be accompanied by a laboratory test report.

Submit test samples for void testing.

Submit results of stiffness tests.

57-3.01C(2) Shop Drawings

Submit 5 copies of shop drawings for the plastic lumber for initial review. After review, submit from 6 to 12 copies, as requested, for authorization and use during construction.

Shop drawings must show:

1. Details for component layout and connections
2. Sequence of shop and field assembly
3. Installation procedures

57-3.01D Quality Assurance

57-3.01D(1) General

Reserved

57-3.01D(2) Quality Control

57-3.01D(2)(a) General

Start a new production lot if any production parameter changes before the maximum production lot size is reached.

57-3.01D(2)(b) Stiffness Test

Before shipment to the job site, perform stiffness tests for the plastic lumber in the presence of the Engineer at an authorized laboratory. Notify the Engineer at least 15 days before conducting the tests.

The Engineer randomly selects 2 test samples from each production lot for stiffness testing.

Determine the stiffness and the yield stress in bending under ASTM D790, except the test samples must have a minimum length of 13 feet and tests must be performed on a 12-foot span length at a crosshead motion of 0.25 inch per minute. Calculate the stiffness using the secant modulus at the flexural strain of 0.010 inch per inch.

If the stiffness or the yield stress in bending of either of the 2 test samples does not comply with section 57-3.02A, perform a retest on 2 additional test samples selected by the Engineer. If the stiffness or the yield stress in bending of either of the 2 additional test samples does not comply with section 57-3.02A in the retest, the entire production lot of plastic lumber represented by the test samples is rejected.

57-3.01D(3) Department Acceptance

57-3.01D(3)(a) General

The Engineer selects 2 test samples of each size from each production lot of plastic lumber delivered to the job site for void testing.

57-3.01D(3)(b) Void Testing

57-3.01D(3)(b)(i) General

Before use in the work, the plastic lumber must be tested for both exterior and interior voids.

Allow 15 days for void testing.

57-3.01D(3)(b)(ii) Exterior Void Test

The Engineer examines the test samples for exterior voids.

If the exterior voids of either of the 2 test samples do not comply with section 57-3.02A, the Engineer selects 2 additional test samples and performs a retest. If the exterior voids of either of the 2 additional

test samples do not comply with section 57-3.02A in the retest, the entire production lot of plastic lumber represented by the test samples is rejected.

57-3.01D(3)(b)(iii) Interior Void Test

After acceptance under the exterior void test, cut the test samples into 1-foot-long segments. The Engineer examines the cut sections for interior voids.

If the interior voids of a cut section of either of the 2 test samples do not comply with section 57-3.02A, the Engineer selects 2 additional test samples and performs a retest. If the interior voids of a cut section of either of the 2 additional test samples do not comply with section 57-3.02A in the retest, the entire production lot of plastic lumber represented by the test samples is rejected.

57-3.02 MATERIALS

57-3.02A General

Plastic lumber must:

1. Be produced continuously and homogeneously without joints
2. Be straight and true and free from twist, curvature, bulging, or other deformations
3. Have a smooth outer layer with no visible voids
4. Not vary from the dimensions shown by more than 1/2 inch for cross-sectional dimensions or 1 inch for the length
5. Have total resistance to marine borers and dry rot
6. Not swell, shrink, or crack
7. Comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Density (kg/m^3, min)	ASTM D792, Test Method A	Skin: 880 Core: 680
Water absorption (weight increase, percent, max)	ASTM D570	1.0 at 2 hours; 3.0 at 24 hours
Brittleness, (at -40 °C)	ASTM D746	Skin: No break
Hardness	ASTM D2240, Type D	Skin: 45–75
UV deterioration (hardness change, percent after 500 hours of exposure, max)	ASTM D4587[a] ASTM D2240, Type D	Skin: 10
Abrasion	ASTM D4060: Cycles: 10,000 Wheel: CS17 Load: 1 kg	Skin: Weight loss: < 500 mg Wear index: 2.5–3.0
Chemical resistance (weight increase, percent)	ASTM D543: Practice A, Procedure 1	Sea water: < 1.5 Gasoline: < 7.5 No. 2 diesel: < 6.0
Coefficient of thermal expansion (per degree C, max)	ASTM D696	0.00009
Ignition temperature (°C)	ASTM D1929	> 340

[a]ASTM D4329 using UVA 340 bulbs operating at a UV intensity of 0.77 W/m^2/nm measured at 340 nm. The exposure cycle must be 4 hours of ultraviolet (UV) exposure at 60 °C and 4 hours of condensate (CON) exposure at 40 °C.

Stiffness and yield stress in bending of plastic lumber must have at least the values shown in the following table:

Cross section size (inches)	Stiffness EI (kip-sq ft)	Yield stress in bending (psi)
8 x 10	932	4,650
8 x 12	883	3,775
10 x 10	1,764	3,900
10 x 12	1,830	3,625
12 x 12	2,892	3,050

NOTE: These values are for the weak axis of rectangular sections.

For the exterior voids at each exposed end of plastic lumber:

1. Maximum dimension of any void must not exceed 1 inch.
2. Total number of voids with a maximum dimension greater than 1/4 inch must not exceed 4.

For the interior voids in the cut sections of each segment of plastic lumber:

1. Maximum dimension of any void in a cut section must not exceed 1/2 inch.
2. Total area of voids in a cut section must not exceed 5 percent of the total cross-sectional area.

Permanently mark each piece of plastic lumber with the manufacturer's name.

Ship and store plastic lumber in a way that minimizes scratching or damage to the outer surfaces.

57-3.02B Reinforced Recycled Plastic Lumber

Reinforced RPL must consist of recycled plastic reinforced with fiberglass reinforcing bar elements, fiberglass filaments, or a combination of both.

Reinforced RPL must be a recycled product.

Fabricate reinforced RPL from one or more of the following thermoplastics:

1. High-density polyethylene
2. Medium-density polyethylene
3. Low-density polyethylene
4. High-density polypropylene

Reinforced RPL must have a dense outer skin at least 3/16 inch thick surrounding a less dense core. The plastic for the outer skin must be mixed with colorants to match color no. 37030 or 30097 of FED-STD-595 and must contain a UV inhibitor and antioxidants.

Fiberglass reinforcing bar elements must comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Flexural strength (psi, min)	ASTM D790	70,000
Compression modulus (psi, min)	ASTM D695	40,000
Tensile strength (psi, min)	ASTM D638	70,000

Fiberglass filaments must comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Density (kg/m^3)	ASTM D792	2,560–2,592
Mechanical, single filament tensile strength (MPa)	ASTM D3822	3,450–3,790
Tensile modulus of elasticity (MPa)	ASTM D3822	69–72

All reinforced RPL must contain the same type of reinforcement.

57-3.02C Composite Plastic Lumber

CPL may be substituted for reinforced RPL.

Fabricate the shell for CPL from polyester or epoxy resin reinforced with E-glass and mixed with colorants, UV inhibitors, and antioxidants. The CPL coating must match color no. 37030 or 30097 of FED-STD-595.

The core material for CPL must be lightweight aggregate polymer concrete.

CPL must comply with the physical quality characteristics specified for reinforced RPL and the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Density of concrete core (kg/m^3, min)	ASTM D792	1,762
28-day compressive strength of concrete core (psi, min)	ASTM C579	5,000
Structural strength of shell: Tensile strength, tensile modulus (percent loss) Flexural strength, flexural modulus (percent loss)	 ASTM D638 ASTM D790	 Less than 10 after UV deterioration test specified for plastic lumber
Dry film thickness of coating (mils, min)	--	15
Color change of coating	ASTM D4587, Test Cycle 2	No visible color change when tested for 800 hours
Initial adhesion of coating (psi, min)	ASTM D4541	150
Decrease in initial adhesion of coating, decrease (percent)	ASTM D4541 ASTM D1183, Test Condition D[a]	No more than 10 following 2 exposure cycles

[a]Use a low temperature phase at 4 ± 5 °F and high temperature phase at 140 ± 5 °F.

Seal the cut ends of CPL with a cap securely held in place with an adhesive recommended by the manufacturer. The adhesive must show no more than a 10 percent decrease in strength when tested under ASTM D3164 following 2 cycles of exposure under ASTM D1183, Test Condition D, with a low temperature phase of -16 ± 3 degrees C and a high temperature phase of 60 ± 3 degrees C.

57-3.02D Unreinforced Recycled Plastic Lumber

Unreinforced RPL may be substituted for reinforced RPL for chocks, filler blocks, and other nonstructural members shown. Unreinforced RPL must comply with the specifications for reinforced RPL, except fiberglass reinforcement is not required and stiffness tests do not apply.

57-3.03 CONSTRUCTION

Install plastic lumber under the manufacturer's instructions.

Cut, bevel, drill, counterbore, and otherwise fabricate plastic lumber under the manufacturer's instructions. Fabricate lumber in the manufacturer's plant to the greatest extent possible.

Holes for bolts in plastic lumber must be bored 1/8 inch larger in diameter than the bolt to be placed. Holes for lag screws must be bored to a diameter under the manufacturer's instructions. Recess bolts and lag screw heads 1/2 inch from the surface of the face of plastic lumber fenders.

Coat holes drilled through CPL members with a concrete sealant approved by the CPL manufacturer.

Plastic lumber elements that are split, broken, warped, or otherwise damaged are rejected.

57-3.04 PAYMENT

Not Used

57-3.05–57-3.10 RESERVED

58 SOUND WALLS

58-1 GENERAL

58-1.01 GENERAL

Section 58-1 includes general specifications for constructing sound walls.

Reinforcement must comply with section 52.

58-1.02 MATERIALS

Not Used

58-1.03 CONSTRUCTION

Not Used

58-1.04 PAYMENT

Sound walls are measured by the area of wall projected on a vertical plane between the elevation lines and wall length.

58-2 MASONRY BLOCK

58-2.01 GENERAL

58-2.01A Summary

Section 58-2 includes specifications for constructing masonry block sound walls.

58-2.01B Definitions

Reserved

58-2.01C Submittals

58-2.01C(1) General

Reserved

58-2.01C(2) Test Data

Submit test data for:

1. Prepackaged mortar materials
2. Compressive strength of masonry for preconstruction testing and field QC testing
3. Grout compressive strength

58-2.01C(3) Product Data

Submit manufacturer's descriptive data for each type of CMU, accessory, and manufactured material as an informational submittal.

58-2.01C(4) Mix Design

Submit a mix design for each grout mix proposed for use. Admixtures are not allowed unless authorized.

Submit a mix design for the mortar cap.

58-2.01C(5) Samples

Submit samples of the CMUs for each color and texture as specified in ASTM C90.

58-2.01C(6) Qualification Data

Submit qualification data for the authorized laboratory as an informational submittal.

58-2.01C(7) Certificates of Compliance

Submit a certificate of compliance for CMUs, aggregate for grout, and grout.

58-2.01C(8) Daily Field Report and Final Report

Submit a copy of the daily field report on the business day following the preparation of the report.

Upon completion of the work requiring special inspection, submit a copy of the final report.

58-2.01D Quality Assurance

58-2.01D(1) General

Reserved

58-2.01D(2) Quality Control

58-2.01D(2)(a) General

Reserved

58-2.01D(2)(b) Preconstruction Testing

Perform masonry preconstruction testing at an authorized laboratory. The authorized laboratory must comply with ASTM E329.

Determine the compressive strength of masonry for each grout mix to be used under one of the following 2010 CBC test methods:

1. Unit strength method in section 2105.2.2.1 except grout must comply with item 3.3.2 in the 1st paragraph of section 2105.2.2.1.2
2. Prism test method in section 2105.2.2.2

If the prism test method is used to determine the compressive strength, you must also test the grout compressive strength under ASTM C1019.

If prepackaged mortar materials are used, perform the following preconstruction tests at an authorized laboratory:

1. California Test 551. Test data must be from samples having a moist cure, except that the samples must not be immersed in lime water. The average 28-day compressive strength of mortar must be not less than 1,800 psi.
2. California Test 422 or 417. Mortar must not contain more than 0.05 percent soluble chlorides when tested under California Test 422 or more than 0.25 percent soluble sulfates as SO_4 when tested under California Test 417.

58-2.01D(2)(c) Field Quality Control

58-2.01D(2)(c)(i) General

You must employ a special inspector and an authorized laboratory to perform Level 1 inspections and structural tests of masonry to verify the masonry construction complies with section 1705 and section 2105 of the 2016 CBC.

Masonry special inspection personnel used in the work must not be employed or compensated by any subcontractor, or by other persons or entities hired by subcontractors, who will provide other services or materials for the project.

58-2.01D(2)(c)(ii) Special Inspector

The special inspector must be an ICC certified Structural Masonry Special Inspector. The special inspector must perform the inspections required in section 1705.4 of the 2016 CBC.

The special inspector must prepare a daily field report providing information regarding the specific activities witnessed, including placing of CMUs and bar reinforcing, grouting, fabrication of test specimens, and other observations of importance to the work.

A daily field report is required for each day that the special inspector is on the job site. The special inspector must prepare a signed final report stating whether the work requiring special inspection was, to the best of the inspector's knowledge, in compliance with the plans, specifications, and the applicable workmanship requirements of these specifications and the 2016 CBC.

58-2.01D(2)(c)(iii) Masonry Compressive Strength Testing

Test the compressive strength of masonry for each 10,000 sq ft of sound wall area, or portion thereof. Determine the compressive strength as specified for masonry preconstruction testing in section 58-2.01D(2)(b).

58-2.01D(3) Department Acceptance

Reserved

58-2.02 MATERIALS

58-2.02A General

Reserved

58-2.02B Concrete Masonry Units

Obtain CMUs of a uniform color and texture from a single source and from a single manufacturer.

CMUs must comply with ASTM C90 for hollow, load bearing, lightweight or medium weight class units. You may use standard or open-end units. If you use open-ended units, do not reduce the spacing of the bar reinforcement shown.

The weight of a CMU for a sound wall on a bridge must not exceed 38 lb.

Identify each HS CMU with a groove in an interior corner. The groove must extend from a mortar surface for a length of about 2 inches and must have a depth of about 3/16 inch.

58-2.02C Mortar

Mortar must comply with ASTM C270 except the cement must comply with section 90-1.02B(2).

Aggregate must comply with ASTM C144.

Hydrated lime must comply with ASTM C207, Type S.

Obtain mortar ingredients of a uniform quality, including color, from a single manufacturer for cement and lime and from a single source or producer for each aggregate.

Mortar for laying CMUs must consist by volume of 1 part cement, 0.25 to 0.5 part hydrated lime, and 2.25 to 3 parts mortar sand. Add enough water to make a workable mortar. Accurately measure and thoroughly mix each batch of mortar. Do not retemper mortar more than 1 hour after mixing.

Mortar color must match the CMU. Color pigments must be iron oxides complying with ASTM C979. The dosage must not exceed 10 percent by weight of cement in the mortar.

If authorized, you may use prepackaged mortar materials and mortar containing admixtures complying with ASTM C270.

Packages of mortar materials must bear the manufacturer's name, brand, contents, weight, and color identification.

58-2.02D Grout

The minimum compressive strength of the grout at 28 days must be 85 percent of the greater of (1) the masonry compressive strength shown or (2) 2,000 psi.

Cementitious material must comply with section 90-1.02B.

Grout must contain at least 550 pounds of cementitious material per cubic yard. Grout for HS CMUs must contain at least 675 pounds of cementitious material per cubic yard.

Aggregate must comply with section 90-1.02C except section 90-1.02C(4) does not apply.

Aggregate for grout must be a mixture of fine and coarse aggregate. At least 20 percent of the aggregate must be coarse aggregate. One hundred percent of the combined grading must pass the 1/2-inch sieve.

Mix the grout with enough water to produce a mix consistency suitable for pumping without segregation. The grout must have a slump from 8 to 11 inches.

58-2.02E Lightweight Aggregate

Reserved

58-2.02F Reinforcement

Ladder type joint reinforcement must comply with ASTM A951, hot-dip galvanized.

58-2.02G Expansion Joint Filler

Expansion joint filler must comply with ASTM D1751 or ASTM D2000 M2AA805.

58-2.02H Access Gates

Timber members must be tongue and groove Douglas fir subflooring free of knotholes.

Timber members, steel frames, channels, anchorage devices, mounting hardware, gate rollers, corrugated steel pipe, nylon washers, and neoprene tubing must be commercial quality.

The ladder rungs must be no. 8 deformed bar reinforcing steel with a nonskid surface.

Gate rollers must be rigid casters with self-lubricating bearings and hard rubber wheels.

Metal parts and hardware must be hot-dip galvanized under section 75-1.02B.

Primer and stain must be top grade primer and stain from a manufacturer who has manufactured industrial paints and stains complying with custom specifications for at least 10 years.

If the back side of the masonry wall is constructed of split-faced or rough-surface blocks, the bond beam above the gate opening where the upper gate guide is to be mounted must have smooth-sided blocks.

Aggregate filling the inside of corrugated steel pipe landings must be a coarse concrete aggregate of commercial quality. Compaction of the aggregate is not required.

58-2.03 CONSTRUCTION

58-2.03A General

Construct sound wall with hand laid CMUs.

Vertical lines and surfaces must not vary from plumb by more than 1/4 inch in 10 feet.

Provide bond beam units or recesses for horizontal reinforcement.

Construct walls in 4-foot-maximum-height lifts. Complete grouting of each lift before starting construction of the next lift. The top course of each lift must be a bond beam.

Bond beams must be continuous. Cover the top of unfilled cells under horizontal bond beams with metal or plastic lath.

Roughen, clean, and lightly wet contact surfaces where fresh masonry joins masonry that is partially or totally set. The roughened surface must be at least as rough as a wood troweled surface. Remove laitance, curing compounds, debris, dirt, and any substance that decreases bond to the fresh masonry.

Roughen and clean concrete surfaces on which masonry walls are to be constructed, exposing the aggregate. Immediately before laying the CMUs, flush the surface with water and allow to dry to a surface dry condition.

Use a masonry saw to cut CMUs to neat and true lines.

Protect masonry as specified for protecting concrete in section 51-1.03I.

During erection in inclement weather, keep cells dry by covering partially completed walls. The covering must be waterproof fabric, plastic or paper sheeting, or other authorized material. Do not use wooden boards or planks as covering materials. Extend the covering down each side of masonry walls approximately 2 feet.

Remove splashes, stains, and spots from exposed faces of the wall.

58-2.03B Mortar Bedding and Jointing

Mortar joints must be approximately 3/8 inch thick.

Walls and cross webs forming cells to be filled with grout must be full bedded in mortar to prevent leakage of grout. All head and bed joints must be solidly filled with mortar for a distance in from the face of the wall or unit not less than the thickness of the longitudinal face shells. Shove head joints tight.

58-2.03C Reinforcement

Before placing grout, securely hold the reinforcement in position at the top and bottom and at intervals not exceeding 192 bar diameters with wire ties or spacing devices. Wire must be 16 gauge or heavier. Wooden, aluminum, or plastic spacing devices must not be used.

Splice vertical reinforcement only at the locations shown.

58-2.03D Grouting

Preserve the unobstructed vertical continuity of the grout during mortar placement in joints. Any overhanging mortar projecting more than 1/2 inch, or other obstruction or debris, must be removed from the inside of cells.

Only fill cells containing reinforcement with grout.

Consolidate grout in the cells by vibrating and reconsolidating after excess moisture has been absorbed and before plasticity is lost. Do not slice grout with a trowel.

If placing of grout in grout filled cells is stopped for more than 1 hour, a construction joint must be made. The construction joint must be approximately 1-1/2 inches below the top of the last course filled with grout.

58-2.03E Access Gates

Construct access gates with the tongue in the up position. Remove the tongue of the top board and the groove of the bottom board. Stagger knot locations of adjoining boards.

Prime and stain timber surfaces of access gates with 2 coats of stain to match the adjacent sound wall.

For backfill outside of pipe landings, you may use material from excavation.

58-2.04 PAYMENT

Not Used

58-3 PRECAST CONCRETE PANELS

Reserved

58-4 ALTERNATIVE SOUND WALL SYSTEMS

58-4.01 GENERAL

58-4.01A Summary

Section 58-4 includes specifications for constructing alternative sound wall systems.

You may only use an alternative sound wall system where specified in the special provisions.

58-4.01B Definitions

Reserved

58-4.01C Submittals

58-4.01C(1) General

Reserved

58-4.01C(2) Shop Drawings

Submit project specific shop drawings to the OSD, Documents Unit. Notify the Engineer of your submittal. For initial review, submit 4 copies of shop drawings. Allow 25 days for the Department's review. After review and correction, submit from 6 to 12 copies, as requested, to the OSD, Documents Unit, for authorization and use during construction.

The shop drawings must include:

1. Design firm's name, address, and telephone and fax numbers
2. Information required for the proper construction of the system at each location
3. Design parameters, material notes, and wall construction procedures
4. Calculations for each installation of the system

Submit as-built drawings at the completion of each sound wall.

58-4.01D Quality Assurance

Reserved

58-4.02 MATERIALS

Not Used

58-4.03 CONSTRUCTION

Construct the alternative sound wall system to the lines and grades shown, except that the alternative sound wall system may have a height greater than that shown. The construction must comply with the details shown on the authorized shop drawings and proprietary system details.

58-4.04 PAYMENT

Not Used

58-5–58-6 RESERVED

59 STRUCTURAL STEEL COATINGS

59-1 GENERAL

59-1.01 GENERAL

59-1.01A Summary

Section 59-1 includes general specifications for coating structural steel.

59-1.01B Definitions

Reserved

59-1.01C Submittals

Submit a certificate of compliance and SDS for each shipment of blast cleaning material.

59-1.01D Quality Assurance

Measure coating dry film thickness with a calibrated Type 2 magnetic film thickness gauge under SSPC-PA 2 except there is no limit to the number or location of spot measurements that may be requested by the Engineer to verify coating thickness.

Measure coating adhesion strength with a self-aligning adhesion tester under ASTM D4541.

Measure levels of soluble salts on surfaces using a retrieval method specified in SSPC-Guide 15.

59-1.02 MATERIALS

59-1.02A General

Water for pressure rinsing and pressure washing must be fresh potable water with a chloride content of not more than 75 ppm and a sulfate content of not more than 200 ppm. Continuous recycling of rinse water is not allowed. You may collect rinse water in a tank for reuse if test samples meet specified requirements and no water is added to the tank after sampling.

Sealing compound must be a polysulfide or polyurethane type complying with ASTM C920, Type M or Type S, Grade NS, Class 25, Use M.

59-1.02B Abrasives

Abrasives for blast cleaning must be of a grading suitable to produce satisfactory results.

Unless other abrasives are authorized, use only:

1. Clean dry sand. Do not use unwashed beach sand containing salt or excessive silt.
2. Mineral grit.
3. Steel shot.
4. Steel grit.
5. Manufactured abrasives.

Mineral, manufactured, and slag abrasives must comply with the requirements for Class A, Grade 2 to 3 abrasives in SSPC-AB 1 and must not contain hazardous material.

Steel abrasive must comply with SSPC-AB 3. Recycled steel abrasive must comply with SSPC-AB 2.

59-1.02C Coatings

Coatings must comply with section 91.

Coatings selected for use must comply with the volatile organic compound concentration limits specified for the air quality district where the project is located.

59-1.03 CONSTRUCTION

59-1.03A General

Notify the Engineer at least 5 business days before starting work.

Provide protective devices to prevent damage to the work, property, or persons.

59-1.03B Weather Conditions

Apply paint only to thoroughly dry surfaces during periods of favorable weather.

Do not perform blast cleaning or apply solvent-borne paint if any of the following atmospheric conditions exist:

1. Atmospheric or surface temperature is below 36 degrees F
2. Atmospheric or surface temperature is above 100 degrees F
3. Relative humidity is more than 85 percent

Do not apply water-borne paint if any of the following atmospheric conditions exist:

1. Atmospheric or surface temperature is below 51 degrees F
2. Atmospheric or surface temperature is above 100 degrees F
3. Relative humidity is more than 75 percent

Except for work within enclosures, do not apply paint if any of the following applies:

1. Freshly painted surfaces may become damaged by rain, fog, or condensation
2. Atmospheric temperature or relative humidity will not remain within the specified application conditions during the drying period
3. Steel surface temperature is less than 5 degrees F above the dew point

Repair or replace uncured paint damaged by weather.

If authorized, you may use enclosures to allow painting during inclement weather. Enclosures must provide atmospheric conditions within the specified limits.

59-1.03C Cleaning

59-1.03C(1) General

Prepare and clean surfaces before painting.

59-1.03C(2) Pressure Rinsing

Pressure rinsing includes cleaning surfaces using a pressure wash system with a minimum nozzle pressure of 1,160 psi. Keep the nozzle tip from 12 to 18 inches from the surface. The nozzle must have a maximum fan tip angle of 45 degrees.

59-1.03C(3) Pressure Washing

Pressure washing includes cleaning surfaces using a pressure wash system with a nozzle pressure from 2,500 to 5,000 psi and a maximum fan tip angle of 45 degrees.

59-1.03C(4) Steam Cleaning

Steam cleaning includes cleaning dirt, grease, loose chalky paint, and other foreign material from surfaces using steam. Steam temperature at the nozzle must be from 265 to 375 degrees F.

Use a biodegradable detergent during steam cleaning. After steam cleaning, pressure rinse cleaned surfaces with water.

Do not perform steam cleaning more than 2 weeks before painting or other phases of cleaning.

Do not paint steam-cleaned surfaces until they are thoroughly dry and at least 24 hours have elapsed.

59-1.03C(5) Blast Cleaning

Blast cleaning includes abrasive blasting surfaces to be painted.

Surfaces to be blast cleaned must be dry.

Prime or treat blast-cleaned surfaces on the same day blast cleaning is performed unless otherwise authorized.

59-1.03D Painting

Each spray pot must have an authorized water trap installed.

Do not thin paint unless authorized.

Before applying, mix paint using mechanical mixers to thoroughly blend pigment and vehicle together.

Apply paint to clean dry surfaces in a neat and workmanlike manner. Apply by brush, spray, or roller in any combination. Gun extensions and aerosol cans are not allowed.

Brushes must have sufficient bristle body and length to spread paint in a uniform film. Paint must be evenly spread and thoroughly brushed out.

Rollers must not leave a stippled texture in the paint film.

Apply paint to areas not accessible by regular means using daubers, bottle brushes, or other authorized methods.

Thoroughly cure each application of paint and correct skips, holidays, thin areas, or other deficiencies before the next application. Painted surfaces being covered must be free from moisture, dust, grease, and deleterious material that would prevent bonding of succeeding coats. In spot painting, remove old paint that lifts after the first paint application by scraping and repaint the area before the next application.

Pressure rinse painted surfaces before applying additional paint if 7 days or more elapse between paint applications unless otherwise authorized.

The Engineer may require you to blast clean and reapply paint to areas with runs, sags, thin and excessively thick areas in the paint film, skips, holidays, or areas of non-uniform appearance.

Repair painted surfaces damaged during work activities with materials and to a condition equal to that of the specified coating.

Remove paint or paint stains on surfaces not designated to be painted.

Thoroughly clean painted surfaces after completing painting activities and other work that would deposit foreign material on the painted surfaces.

Stencil the month and year of painting on structures at 2 locations selected by the Engineer. Use block letters 2-1/2 inches high. The paint used must contrast with the background.

59-1.04 PAYMENT

Not Used

59-2 PAINTING STRUCTURAL STEEL

59-2.01 GENERAL

59-2.01A General

59-2.01A(1) Summary

Section 59-2.01 includes specifications for preparing and painting structural steel, except galvanized or thermal spray coated surfaces.

59-2.01A(2) Definitions

Reserved

59-2.01A(3) Submittals

59-2.01A(3)(a) General

Submit certification showing the maximum allowable dry film thickness for inorganic zinc-rich coatings to be used on faying surfaces of HS bolted connections as determined under appendix A of *Specification for Structural Joints Using High-Strength Bolts* of the RCSC.

59-2.01A(3)(b) Mandatory SSPC-QP Certifications

Reserved

59-2.01A(3)(c) Painting Quality Work Plan

Submit 3 copies of a painting quality work plan for each work item requiring structural steel painting or paint removal. Allow 20 days for the Department's review.

Submit the work plan after attending the prepainting meeting and include:

1. Names of the painting contractor and any subcontractors to be used.
2. 1 copy of each applicable ASTM and SSPC specification and qualification procedure.
3. Coating manufacturer's guidelines and instructions for surface preparation, painting, drying, curing, handling, shipping, and storage of painted structural steel. Include testing methods and maximum allowable levels for soluble salts.
4. Materials, methods, and equipment to be used.
5. Proof of required SSPC-QP certifications. For work requiring SSPC-QP 1 or SSPC-QP 2 certification, include:
   5.1. List of all personnel who will perform blast cleaning or spray painting work.
   5.2. Proof of CAS certifications, as required under (1) SSPC-QP 1, Mandatory Annex A and (2) the SSPC CAS Implementation Schedule in effect at the time of contract advertisement.
6. Methods to control environmental conditions.
7. Methods to protect the coating during curing, shipping, handling, and storage.
8. Rinse-water collection plan.
9. Detailed paint repair plan for damaged areas.
10. Procedures for containing blast media and water.
11. Examples of proposed daily reports for testing to be performed, including type of testing, location, lot size, time, weather conditions, test personnel, and results.

59-2.01A(4) Quality Assurance

59-2.01A(4)(a) General

Reserved

59-2.01A(4)(b) Certifications

You must hold SSPC certifications in good standing throughout the Contract to perform painting activities as shown in the following table:

SSPC Certifications

Painting activity	SSPC certification
Cleaning and painting structural steel in the field	SSPC-QP 1
Removing hazardous coatings from structural steel	SSPC-QP 2
Cleaning and painting structural steel in a permanent painting facility	AISC-420-10/SSPC-QP 3, enclosed shop

59-2.01A(4)(c) Prepainting Meeting

Before starting painting activities, conduct a prepainting meeting to discuss painting quality work plan requirements. Meeting attendees must include the Engineer and all painting subcontractors.

59-2.01A(4)(d) Quality Control

59-2.01A(4)(d)(i) General

You must determine the sequence of testing. The Engineer selects test locations.

If repairs are required, retest rejected areas after completing repairs.

Test blast-cleaned steel for soluble salts using a Class A or B retrieval method before applying the undercoat. Levels of soluble salts must not exceed the lesser of the coating manufacturer's recommendations or 10 µg/sq cm. Perform 3 tests for the first 1,000 sq ft prepared per shift and 1 test for each additional 1,000 sq ft or portion thereof. Perform at least 2 tests when less than 1,000 sq ft is prepared in a shift. Clean and retest areas represented by soluble salt tests exceeding specified limits.

59-2.01A(4)(d)(ii) Inorganic Zinc Coatings

Test the inorganic zinc undercoat before applying final or finish coats. Perform adhesion and hardness testing at least 72 hours after application.

Test the inorganic zinc undercoat as follows:

1. Perform 3 adhesion tests per girder or 1,000 sq ft of painted surface, whichever is less. If less than 1,000 sq ft is painted in a work shift, perform 3 tests. The coating must have an adhesion to steel of at least 600 psi. If 2 or more locations fail adhesion requirements, the area represented by the tests is rejected. If 1 of the locations fails adhesion requirements, test 3 additional locations. If any of the additional locations fail, the area represented by the tests is rejected. Repair rejected areas by blast cleaning and repainting. Repair test locations meeting adhesion requirements by applying organic zinc-rich primer to the specified dry film thickness.
2. Test surfaces where finish coats are to be applied for soluble salts. Soluble salt levels must not exceed the lesser of the coating manufacturer's recommendations or 10 µg/sq cm. Perform 3 tests for the first 1,000 sq ft prepared per day and 1 test for each additional 1,000 sq ft or portion thereof. Perform at least 2 tests when less than 1,000 sq ft is prepared in a shift. Clean and retest areas represented by soluble salt tests exceeding specified limits.
3. The inorganic zinc coating must exhibit a solid, hard, and polished metal surface when firmly scraped with the knurled edge of a quarter before final or finish coats are applied. Repair areas that are powdery, soft, or do not exhibit a polished metal surface by blast cleaning and repainting.

Perform the following additional testing for AASHTO M 300 Type II inorganic zinc primers:

1. Determine the dry-to-solvent insolubility under ASTM D4752 except use water as the solvent. The resistance rating must be at least 4. The test rate is 1 test per 500 sq ft or portion thereof. Repair inorganic zinc coating represented by tested areas that fail to meet solvent insolubility requirements by blast cleaning and repainting.
2. Before applying finish coats, test the surface pH. Wet the surface with deionized water for 15 to 30 minutes. Apply pH paper with measuring increments of 0.5 pH units. Take at least 2 pH readings for every 500 sq ft or portion thereof. If less than 500 sq ft is coated in a single shift, take at least 2 pH readings. Do not apply finish coats until the surface pH is 7 or less.

Perform the following additional testing for AASHTO M 300 Type I inorganic zinc primers:

1. Determine the dry-to-solvent insolubility under ASTM D4752. The resistance rating must be at least 4. The test rate is 1 test per 500 sq ft or portion thereof. Repair inorganic zinc coating represented by tested areas that fail to meet solvent insolubility requirements by blast cleaning and repainting.
2. Determine surface hardness under ASTM D3363. Hardness must be 2H or harder. The test rate is 1 test per 500 sq ft or portion thereof. Repair inorganic zinc coating represented by tests that fail to meet surface hardness requirements by blast cleaning and repainting.

59-2.01B Materials

59-2.01B(1) General

Inorganic zinc-rich primer used on faying surfaces must comply with the slip coefficient specifications for Class B coatings on blast-cleaned steel in appendix A of *Specification for Structural Joints Using High-Strength Bolts* of the RCSC.

59-2.01B(2) Design Criteria

59-2.01B(2)(a) General

Reserved

59-2.01B(2)(b) Ventilated Containment Systems

Ventilated containment systems must comply with the specifications for scaffolding in section 7-1.02K(6)(e).

The minimum total design load for the ventilated containment system must consist of the sum of the dead and live vertical loads.

Dead and live loads are as follows:

1. Dead load must consist of the actual load of the ventilated containment system
2. Live loads for bridges with only spot blast cleaning work must consist of:
   2.1. Uniform load of at least 25 psf applied over the supported area
   2.2. Moving concentrated load of 1000 lb to produce maximum stress in the main supporting elements of the ventilated containment system

3. Live loads for bridges with 100 percent blast cleaning to bare metal must consist of:
   3.1. Uniform load of at least 45 psf, which includes 20 psf of sand load, applied over the supported area
   3.2. Moving concentrated load of 1000 lb to produce maximum stress in the main supporting elements of the ventilated containment system

Assumed horizontal loads do not need to be included in the design of the ventilated containment system.

Maximum allowable stresses must comply with section 48-2.02B(3).

59-2.01C Construction

59-2.01C(1) General

Clean and paint all exposed structural steel and other metal surfaces.

You must provide enclosures for cleaning and painting structural steel. Maintain atmospheric conditions inside enclosures within specified limits.

Cleaning and painting of new structural steel must be performed in an enclosed shop as defined in AISC-420-10/SSPC-QP 3.

59-2.01C(2) Containment Systems

59-2.01C(2)(a) General

Construct containment systems when disturbing existing paint systems during bridge rehabilitation.

The containment system must be one of the following:

1. Ventilated containment system
2. Vacuum-shrouded surface preparation equipment and drapes and ground covers
3. Equivalent containment system if authorized

The containment system must contain all water, resulting debris, and visible dust produced when the existing paint system is disturbed.

Properly maintain the containment system while work is in progress and do not change the containment system unless authorized.

Containment systems over railroad property must provide the minimum clearances for the passage of railroad traffic specified in the *Information Handout* in the document titled "Railroad Relations and Insurance Requirements."

59-2.01C(2)(b) Ventilated Containment Systems

59-2.01C(2)(b)(i) General

If flexible framing is used, support and fasten it to (1) prevent the escape of abrasive and blast materials due to whipping from traffic or wind and (2) maintain clearances.

If the wind speed reaches 50 mph or greater, relieve the wind pressure on the containment system using an authorized method.

Scaffolding or supports for the ventilated containment system must not extend below the vertical clearance level nor to the ground line at locations within the roadbed.

For truss-type bridges, all connections of the ventilated containment system to the existing structure must be made through the deck, girder, stringer, or floor beam system. No connections are allowed that will cause bending stresses in a truss member.

59-2.01C(2)(b)(ii) Ventilation

The ventilation system in the ventilated containment system must be of the forced input airflow type with fans or blowers.

Negative air pressure must be employed within the ventilated containment system and will be verified by visual methods by observing the concave nature of the ventilated containment system while taking into

account wind effects or by using smoke or other visible means to observe airflow. The input airflow must be properly balanced with the exhaust capacity throughout the range of operations.

The exhaust airflow of the ventilation system in the ventilated containment system must be forced into wet or dry dust collectors or bag houses.

59-2.01C(3) Surface Preparation

59-2.01C(3)(a) General

Corners must be chamfered and without sharp edges.

Condition thermal-cut edges before blast cleaning by shallow grinding or other authorized method to remove the thin, hardened layer resulting from resolidification during cooling.

Remove visually-evident base metal surface irregularities and defects under ASTM A6 before blast cleaning new structural steel.

After removing material defects exposed by blast cleaning, restore the blast profile by blast cleaning or using mechanical tools under SSPC-SP 11.

59-2.01C(3)(b) Cleaning

59-2.01C(3)(b)(i) General

Clean previously painted surfaces by pressure washing or steam cleaning before performing other cleaning or painting activities. Remove gloss from existing paint without removing sound paint. Lightly roughen remaining areas of gloss using 100- to 200-grit sandpaper. Paint that becomes loose, curled, lifted, or that loses its bond after cleaning must be removed to sound paint or metal.

After pressure washing or steam cleaning, spot blast clean painted surfaces having rust or foreign material remaining that would hinder bonding of new paint. If there is no bid item for spot blast cleaning, this is change order work. Spot blast clean surfaces under SSPC-SP 6/NACE no. 3. For small areas, the Engineer may allow cleaning under SSPC-SP 11.

Remove dirt, loose rust, mill scale, or paint not firmly bonded to surfaces under SSPC-SP 2. Feather edges of remaining paint. Do not use pneumatic chipping hammers unless authorized.

59-2.01C(3)(b)(ii) Blast Cleaning

Blast clean steel surfaces to be coated with inorganic zinc under SSPC-SP 10/NACE no. 2. After blast cleaning, surfaces must have a dense, uniform, angular anchor pattern of 1.5 to 3.5 mils when measured under ASTM D4417.

Where shown, spot blast clean existing painted steel surfaces under SSPC-SP 6/NACE no. 3. After blast cleaning, surfaces must have a dense, uniform, angular anchor pattern of at least 1.5 mils when measured under ASTM D4417.

Seal journals, bearings, motors, and moving parts before blast cleaning near machinery.

Reblast cleaned surfaces that rust or become contaminated before paint is applied.

Do not expose blast-cleaned steel to relative humidity exceeding 85 percent before painting.

59-2.01C(4) Painting

59-2.01C(4)(a) General

Paint new structural steel as follows:

1. Apply the total thickness of undercoats before erection. Apply finish and final coats after erection. If a concrete deck is placed on steel members, apply finish and final coats after deck placement.
2. After erection and deck placement, clean and spot paint areas of damaged or deteriorated coating and exposed unpainted surfaces with undercoats to the specified thickness before applying subsequent coatings.
3. Clean and paint surfaces exposed to the atmosphere and inaccessible for painting after erection with the full number of coats before erection.

Paint existing structural steel as follows:

1. Apply a stripe coat of undercoat paint on all edges, corners, seams, crevices, interior angles, junctions of joining members, weld lines, and similar surface irregularities. The stripe coat must completely hide the surface being covered. If spot blast cleaning portions of the bridge, apply the stripe coat of undercoat paint before each undercoat and follow with the undercoat as soon as practical. If removing all existing paint from the bridge, apply the undercoat first as soon as practical and follow with the stripe coat of undercoat paint for each undercoat.
2. Apply the finish coats after the total dry film thickness of undercoat has been applied.
3. Apply all undercoats and the 1st finish coat within 30 days of initial cleaning activities.

Caulk contact surfaces of stiffeners, railings, built-up members, or open seams more than 6 mils wide with sealing compound or other authorized material. Apply the sealing compound at least 72 hours after the last application of undercoat unless otherwise authorized. Cure the sealing compound under the manufacturer's instructions before performing subsequent painting activities. If no finish coats are applied, the sealing compound color must be gray.

Limit the thickness of each paint application to allow uniform drying throughout the paint film.

Paint ungalvanized anchor bolt assemblies with 2 applications of organic zinc-rich primer before installation. You do not need to paint other metal surfaces to be embedded in concrete.

Prepare and paint (1) the bottom surfaces of masonry plates and (2) structural steel surfaces contacting elastomeric bearing pads or preformed fabric pads with the full number of applications before erection.

Except for (1) abutting chord and column splices and (2) column and truss shoe bases, coat machine-finished surfaces with an easily removed rust inhibitor. Paint machine-finished surfaces of iron and steel castings with 1 coat of shop paint.

Where bridge deck drains are located over steel girders, paint the top and edges of top flanges beneath drains and for 2 inches on each side of drains before installing the drains.

Paint surfaces of machinery exposed to air with 2 coats of organic zinc-rich primer before installation. Paint exposed surfaces after installation with 2 finish coats of commercial-quality gray gloss enamel.

59-2.01C(4)(b) Zinc Coating System

59-2.01C(4)(b)(i) General

Coatings for new structural steel and connections between new and existing structural steel must comply with the requirements shown in the following table:

Zinc Coating System Requirements

Description	Coating	Dry film thickness (mils)
All new surfaces:		
Undercoat	Inorganic zinc primer, AASHTO M 300 Type I or II	4–8
Finish coat[a]	Exterior grade latex[b], 2 coats	2 minimum each coat, 4–8 total
Total thickness, all coats		8–14
Connections to existing structural steel:[c]		
Undercoat	Inorganic zinc primer, AASHTO M 300 Type I or II	4–8
Finish coat[a]	Exterior grade latex[b], 2 coats	2 minimum each coat, 4–8 total
Total thickness, all coats		8–14

[a]If no finish coats are described:

1. A final coat of inorganic zinc primer is required
2. Total thickness of undercoats and final coat must be from 5 to 9 mils

[b]Exterior grade latex must comply with section 91-2.02B unless otherwise specified.

[c]Includes the following locations:

1. New and existing contact surfaces
2. Existing member surfaces under new HS bolt heads, nuts, or washers
3. Bare surfaces of existing steel after trimming, cutting, drilling, or reaming
4. Areas within a 4-inch radius from the point of application of heat for welding or flame cutting

Strain inorganic zinc primer after mixing through a 30- to 60-mesh screen immediately before or when pouring into the spray pot.

Use an agitating spray pot. The agitator or stirring rod must reach to within 2 inches of the bottom of the spray pot and be moving at all times during painting. The agitator must keep the coating well mixed.

Apply inorganic zinc primer by spray. On areas inaccessible to spray application, you may make limited applications if authorized by brush, dauber, or roller.

Zinc coatings must be free from dust, dirt, salt, and other deleterious deposits and thoroughly cured before applying subsequent coats.

59-2.01C(4)(b)(ii) Undercoat

Use inorganic zinc primer within 12 hours of initial mixing of components.

Apply the undercoat in 2 or more applications within 8 hours of starting blast cleaning.

Blast clean and repaint areas where mudcracking of the undercoat occurs.

Protect surfaces coated with Type II inorganic zinc from conditions that may cause the coating film to dissolve. Blast clean and repaint areas of dissolved coating.

Remove dry spray by screening or other methods that minimize surface polishing before applying additional coats or final acceptance. Dry film thickness after dry spray removal must comply with the specified thickness.

If damaged areas of the undercoat is:

1. More than 2 percent of the total undercoated surface, blast clean and repaint damaged areas with inorganic zinc
2. 2 percent or less of the total undercoated surface, you may wire brush the damaged surfaces to remove loose or cracked coating and apply 2 coats of organic zinc-rich primer

At faying surfaces, the total undercoat dry film thickness must be from 1 mil to the maximum allowable for Class B coatings as determined by certified testing under appendix A of *Specification for Structural Joints Using High-Strength Bolts* of the RCSC.

Complete the field testing of the undercoat and correct deficiencies before applying subsequent coats.

59-2.01C(4)(b)(iii) Final Coat

Apply a final coat of inorganic zinc primer to undercoated surfaces that do not receive finish coats. Use the same coating as used for the undercoat.

Lightly roughen areas to receive a final coat by abrasive blasting. Use an abrasive no larger than 30 mesh. Protect undersurfaces of girder flanges from abrasive blasting.

Apply the final coat in 1 application within 24 hours of roughening. The final coat dry film thickness must be from 1 to 3 mils.

59-2.01C(4)(b)(iv) Finish Coats

Pressure rinse undercoated surfaces to receive finish coats. Perform pressure rinsing at least 72 hours after the final application of the undercoat.

Apply the 1st finish coat within 48 hours of pressure rinsing.

Apply the 1st finish coat in 2 applications. The 1st application consists of a spray-applied mist application. Apply the 2nd application after the mist application has dried to a set-to-touch condition as determined using the procedure in section 7 of ASTM D1640.

Apply the 2nd finish coat after the 1st finish coat has dried 12 hours unless authorized. You may apply the 2nd finish coat in a single application.

The 1st finish coat color must match color no. 34272 of FED-STD-595. The 2nd finish coat color must match color no. 14090 of FED-STD-595.

59-2.01C(4)(c) State Specification Paint Waterborne Coating System

The State Specification paint waterborne coating system for existing structural steel must comply with the requirements shown in the following table:

State Specification Paint Waterborne Coating System Requirements

Surface	Description	State specification PWB coating	Dry film thickness (mils)
Surfaces cleaned to bare metal[a]:	1st undercoat	145	2–3
	2nd undercoat	146	2–3
	1st finish coat	171	1.5–3
	2nd finish coat	172	1.5–3
	Total thickness, all coats	--	7–12
Existing painted surfaces to be topcoated:	Undercoat	146	2–3
	1st finish coat	171	1.5–3
	2nd finish coat	172	1.5–3
	Total thickness, new coats	--	5–9

[a]Includes locations of spot blast cleaning

Allow at least 12 hours of drying time before applying the subsequent undercoat or finish coats unless otherwise authorized.

59-2.01C(4)(d) Moisture-Cured Polyurethane Coating System

Reserved

59-2.01D Payment

Not Used

59-2.02 PAINTING STEEL SOLDIER PILES

59-2.02A General

Section 59-2.02 includes specifications for preparing and painting steel soldier piles.

Where shown, prepare and paint steel soldier piles under the specifications for painting new structural steel in section 59-2.01.

59-2.02B Materials

Not Used

59-2.02C Construction

Repair damaged areas of the undercoat before installing piles.

Protect the exposed exterior flange and flange edges of undercoated piles from lean concrete backfill to minimize undercoating repairs.

After removing lean concrete backfill, repair damaged or deteriorated undercoat by blast cleaning and repainting with the same inorganic zinc coating as used for the undercoat.

Apply final or finish coats after installation and excavation are complete.

Caulk open joints between concrete and steel soldier piles with sealing compound or other authorized material.

59-2.02D Payment

Not Used

59-2.03–59-2.05 RESERVED

59-3 PAINTING GALVANIZED SURFACES

59-3.01 GENERAL

Section 59-3 includes specifications for preparing and painting galvanized metal surfaces.

59-3.02 MATERIALS

Coatings must comply with either State Specification PWB-174A or with section 91-2.02.

59-3.03 CONSTRUCTION

Clean galvanized surfaces by pressure washing or steam cleaning.

Roughen galvanized areas after cleaning by abrasive blasting. Use an abrasive no larger than 30 mesh. Do not remove galvanizing.

Apply 2 finish coats in at least 2 applications. Apply the 1st finish coat the same day abrasive blasting is performed unless otherwise authorized. Apply the 2nd finish coat after the 1st finish coat has dried at least 12 hours unless otherwise authorized. The dry film thickness of each finish coat must be at least 2 mils. The dry film thickness of all coats must be from 4 to 8 mils.

The 2nd finish coat color must match color no. 14090 of FED-STD-595.

59-3.04 PAYMENT

Not Used

59-4 PAINTING SIGN STRUCTURES

59-4.01 GENERAL

Section 59-4 includes specifications for preparing and painting sign structures.

Preparing and painting of sign structures must comply with sections 59-2 and 59-3.

59-4.02 MATERIALS

Not Used

59-4.03 CONSTRUCTION

59-4.03A General

You may prepare and paint sign structures before or after erection. After erection, repair any damaged paint.

The total dry film thickness of finish coats on contact surfaces of galvanized HS bolted connections (1) must be from 1 to 4 mils and (2) may be applied in 1 application.

59-4.03B Undercoating of Ungalvanized Surfaces

Blast-cleaned surfaces must receive a single undercoat consisting of an inorganic zinc coating as specified in AASHTO M 300, Type I or Type II, except:

1. The first 2 sentences of section 5.6 do not apply.
2. Section 5.6.1 does not apply.

If you propose to use a coating that is not on the Authorized Material List for inorganic zinc-rich primer, submit the required documentation specified in section 5.6 of AASHTO M 300. Allow 30 days for the Engineer's review.

59-4.03C Testing of Inorganic Zinc Coating

Perform adhesion and hardness testing at least 72 hours after application of the single undercoat of inorganic zinc coating.

59-4.03D Finish Coats

The exposed area of inorganic zinc coating must receive at least 2 finish coats of exterior grade latex paint.

The 1st finish coat color must match no. 24558 of FED-STD-595. The 2nd finish coat color must match no. 24491 of FED-STD-595.

59-4.04 PAYMENT

Not Used

59-5 THERMAL SPRAY COAT STRUCTURAL STEEL

59-5.01 GENERAL

59-5.01A Summary

Section 59-5 includes specifications for coating steel surfaces with a thermal spray coating.

59-5.01B Definitions

Reserved

59-5.01C Submittals

59-5.01C(1) General

Submit a certificate of compliance for each shipment of wire feedstock.

59-5.01C(2) Coating Quality Work Plan

Submit 3 copies of a coating quality work plan for thermal spray coating activities. Allow 20 days for the Department's review.

Submit the work plan after attending the precoating meeting and include:

1. Names of the coating contractor and any subcontractors to be used
2. 1 copy each of applicable ASTM and SSPC specifications or qualification procedures
3. Materials, methods, and equipment to be used
4. Proof of certification for each thermal spray coating operator
5. Methods to control environmental conditions
6. Methods to protect the coating during shipping, handling, and storage
7. Procedures for containing blast media
8. Examples of proposed daily reports for testing to be performed, including type of testing, location, time, weather conditions, test personnel, and results

59-5.01D Quality Assurance

59-5.01D(1) General

Each thermal spray coating operator must be certified under AWS C2.16/C2.16M.

59-5.01D(2) Precoating Meeting

Before starting coating activities, conduct a precoating meeting to discuss coating quality work plan requirements. Meeting attendees must include the Engineer and all coating subcontractors.

59-5.01D(3) Test Coupons

Thermal spray coating operators must prepare 3 test coupons for bend testing before each work shift. Test coupons must:

1. Be 2 by 6 inches by 1/16-inch thick
2. Be of the same material as the surface to be coated
3. Pass bend test requirements before the operator starts production work

Bend test coupons under section 6.5 of SSPC-CS 23.00/AWS C 2.23M/NACE no. 12. Coupons must exhibit no cracking with lifting from substrate.

59-5.01D(4) Quality Control

The Engineer selects the test locations.

If repairs are required, retest rejected areas after completing repairs.

Test the surface profile of blast-cleaned steel under ASTM D4417, Method C. Perform 3 tests for the first 200 sq ft of blast-cleaned steel and 1 test for every 200 sq ft thereafter.

Test blast-cleaned steel for soluble salts before coating. Levels of soluble salts must not exceed 10 µg/sq cm. Perform 3 tests for the first 200 sq ft placed during a shift and 1 test for every 200 sq ft thereafter.

Inspect surfaces for visual cleanliness under SSPC-SP 10/NACE no. 2 before applying coating.

Test coating thickness under section 6.3 of SSPC-CS 23.00/AWS C 2.23M/NACE no. 12. Perform 1 test for every 150 sq ft of coating and 1 test for each faying surface.

Perform cut testing under SSPC-CS 23.00/AWS C 2.23M/NACE no. 12. Perform 3 tests of 3 cuts for every 1,000 sq ft of coating. Surfaces must exhibit no peeling or delamination.

Test coating adhesion to steel before applying seal coating. Thermal spray coating must have an adhesion to substrate of at least 850 psi. Perform 3 tests for every 200 sq ft of coating.

Repair areas represented by tests failing adhesion or cut testing by removing and reapplying coating.

59-5.02 MATERIALS

Abrasives must be (1) slag or mineral abrasive or (2) steel or recycled steel.

Wire feedstock must be 85/15 Zn/Al complying with ASTM B833.

Seal coat paint must be authorized before use.

59-5.03 CONSTRUCTION

Do not apply coating when the steel surface temperature is less than 32 degrees F.

Prepare the surfaces under section 59-2.01C(3)(a).

Blast clean surfaces under SSPC-SP 10/NACE no. 2. Surfaces must have a sharp, angular anchor pattern of from 2.5 to 4.0 mils. Reblast surfaces that rust or become contaminated before coating is applied.

Apply coating using arc-spray equipment within 6 hours of starting blast cleaning. Coating thickness must be 10 ± 2 mils. Coating thickness on faying surfaces must be not more than 10 mils.

Apply a seal coating to thermal spray-coated surfaces. Apply the seal coat within 6 hours of applying the thermal spray coating. Dry film thickness must be from 1.5 to 2.0 mils. Do not apply the seal coating to faying surfaces.

You may field weld thermal spray-coated surfaces if authorized in advance. Remove thermal spray coating from weld locations by blast cleaning under SSPC-SP 10/NACE no. 2 or with power tools under SSPC-SP 11 immediately before welding. Recoat welded connections after fabrication.

Repair test areas of thermal spray coating that meet adhesion and cut test requirements with 2 coats of organic zinc-rich primer.

59-5.04 PAYMENT

Not Used

59-6–59-15 RESERVED

60 EXISTING STRUCTURES

60-1 GENERAL

60-1.01 GENERAL

Section 60 includes specifications for performing work on existing structures.

Work performed on existing structures must comply with section 15.

60-1.02 MATERIALS

Not Used

60-1.03 CONSTRUCTION

Not Used

60-1.04 PAYMENT

Not Used

60-2 STRUCTURE REMOVAL

60-2.01 GENERAL

60-2.01A General

Section 60-2 includes specifications for removing structures or portions of structures.

Design and construct temporary support shoring, temporary bracing, and protective covers under section 48.

60-2.01B Materials

Not Used

60-2.01C Construction

Before removing portions of monolithic concrete elements, make a 1-inch-deep saw cut to a true line along the limits of removal on faces of the element that will be visible in the completed work.

Remove piling, piers, abutments, footings, and pedestals to 1 foot below the ground line or 3 feet below finished grade, whichever is lower.

Protect existing reinforcement to be incorporated into the new work from damage. Thoroughly remove all material adhering to the existing reinforcement before embedding the existing reinforcement in new concrete.

Do not use explosives.

Do not use the following for breaking or removing concrete attached to or supported by bridges:

1. Tools with a manufacturer's-rated striking energy of more than 1,200 ft-lb per blow
2. Freely falling mass
3. Falling mass attached to a cable, rope, or chain

Do not use a freely falling mass or a falling mass attached to a cable, rope, or chain above any public space. Do not use falling masses within 30 feet horizontally of any public space without protective covers.

Design and construct protective covers, shoring, and falsework with sufficient strength and rigidity to support all imposed loads. Covers must be at least equal to 2-inch Douglas-fir planking on posts spaced at 5-foot centers

The Engineer may require you to remove existing footing concrete that is below ground and outside of the footing limits. This work is change order work.

60-2.01D Payment

Not Used

60-2.02 BRIDGE REMOVAL

60-2.02A General

60-2.02A(1) Summary

Section 60-2.02 includes specifications for removing bridges or portions of bridges.

60-2.02A(2) Definitions

Reserved

60-2.02A(3) Submittals

If a daily inspection report is required, submit the daily inspection report as an informational submittal.

Submit a bridge removal work plan for each bridge. Include details for the following:

1. Removal sequence, including staging of removal activities and equipment locations
2. Temporary support shoring or bracing
3. Locations where work is performed over traffic, utilities, or railroad property
4. Locations and types of protective covers
5. Protection of people, property, utilities, and improvements
6. Methods for preventing material, equipment, and debris from falling onto traffic or railroad property

If protective covers are required or superstructure removal work is performed, bridge removal work plans must be (1) accompanied by substantiating calculations and (2) signed by an engineer who is registered as a civil engineer in the State.

Calculations for bridge removal work plans must demonstrate the stability of the structure during each stage of removal and must include dead and live loads used in the design of the protective covers. A stage is removal of (1) the deck, soffit, or girders in any span; or (2) walls, bent caps, or columns at support locations.

If an unplanned event occurs or the removal activities deviate from the authorized work plan, immediately submit procedures proposed to correct or remedy this occurrence. The procedures must be signed by an engineer who is registered as a civil engineer in the State.

Allow 20 days for review of the bridge removal work plan.

60-2.02A(4) Quality Assurance

60-2.02A(4)(a) General

Reserved

60-2.02A(4)(b) Quality Control

For bridge removal work plans signed by a registered engineer, the engineer signing the work plan must:

1. Be present at all times during bridge removal activities.
2. Prepare a daily inspection report for removal activities. The daily inspection report must describe work activities for each day and the condition of the remaining structure. A copy of the report must be available at the job site at all times.

60-2.02B Materials

60-2.02B(1) General

Reserved

60-2.02B(2) Design Criteria for Temporary Support Shoring and Temporary Bracing

The horizontal load to be resisted in any direction for temporary support shoring and temporary bracing must be (1) the sum of actual horizontal loads due to equipment, construction sequence, or other causes plus an allowance for wind and (2) not less than 5 percent of the total dead load of the structure being removed.

60-2.02C Construction

60-2.02C(1) General

The Engineer may require you to perform additional exploratory work of bridge members for unforeseen damage. This work is change order work.

You may use flame and saw cutting for removing, widening, or modifying bridges.

If complete bridges are removed, do not start removal activities until traffic is no longer carried on the bridge.

For bridge removal activities over or adjacent to roadways that are only closed to traffic when removal work is being performed:

1. Have all necessary personnel, materials, and equipment to complete the work onsite before closing the roadway. Perform activities without interruption until the roadway is reopened.
2. Perform bridge removal activities only when the roadway is closed to traffic except as specified for preliminary work.
3. During roadway closures, debris from bridge removal activities may fall directly onto the roadway if protection is furnished for highway facilities. Minimum protection for paved areas is a 2-foot-thick earthen pad or a 1-inch-thick steel plate placed over the impact area. Before reopening the roadway, all debris, protective pads, and devices must be removed and the roadway swept clean with wet power sweepers or equivalent methods.
4. For girder bridges, completely remove each girder within a span before starting removal of the adjacent girder.
5. For slab bridges, perform removal activities within a span along a front parallel with the primary reinforcing steel.

Temporary support shoring, temporary bracing, and protective covers must not encroach within 8 feet horizontally or 15 feet vertically of traffic lanes or shoulders open to traffic.

Temporary support shoring, temporary bracing, and protective covers over railroad property must (1) conform to guidelines of the railroad company involved and (2) provide the minimum clearances specified for railroad traffic.

60-2.02C(2) Protective Covers

Provide protective covers for removal work over traffic or railroad property. Protective covers must:

1. Be constructed before starting removal activities.
2. Prevent any materials, equipment, or debris from falling onto traffic or railroad property.
3. Be supported using shoring, falsework, or the existing structure.
4. Provide the openings specified in section 12-4. If no openings are specified for removal work, provide a vertical opening of 15 feet and a horizontal opening of 32 feet for traffic.
5. Be cleaned of debris and fines before being removed.

At locations where only bridge railing is removed, protective covers must extend from the face of the exterior girder or at least 2 feet inside of the railing to be removed to at least 4 feet beyond the outside face of the railing.

At locations where entire girders are removed, protective covers must extend at least 10 feet beyond the outside face of the bridge railing.

A separate protective cover is not required during removal of bridge segments if portions of the bridge satisfy the requirements for protective covers.

60-2.02C(3) Preliminary Work

Preliminary work is limited to activities that (1) will not reduce the structural strength or stability of the bridge or bridge elements to a hazardous level as determined by the Engineer or (2) do not cause debris or any other material to fall onto the roadway.

You may perform preliminary work if you use protective covers. Protective covers must:

1. Support all loads

2. Prevent dust and fine material from falling onto the traveled way
3. Extend at least 4 feet beyond the limit of the work being performed.

Bottom slabs of box girders may be considered as protective covers for preliminary work performed on top slabs inside the limits of the exterior girders.

Use temporary support shoring and bracing during preliminary work if needed to ensure the stability of the bridge.

60-2.02D Payment

Not Used

60-2.03–60-2.10 RESERVED

60-3 STRUCTURE REHABILITATION

60-3.01 GENERAL

60-3.01A General

Section 60-3 includes specifications for rehabilitating structures.

60-3.01B Materials

Not Used

60-3.01C Construction

Not Used

60-3.01D Payment

Not Used

60-3.02 BRIDGE DECK REPAIR AND PREPARATION

60-3.02A(1) Summary

Section 60-3.02 includes specifications for (1) repairing concrete deck surfaces and (2) preparing concrete deck surfaces to receive an overlay or a deck treatment.

60-3.02A(2) Definitions

Reserved

60-3.02A(3) Submittals

Submit a work plan for chip seal removal. Include:

1. Description of equipment for chip seal removal
2. Procedure for residual chip seal removal from the deck after grinding or micro milling operations
3. Procedure for chip seal removal next to bridge rails, undulations, or drains

60-3.02A(4) Quality Assurance

Reserved

60-3.02B Materials

60-3.02B(1) General

Reserved

60-3.02B(2) Rapid Setting Concrete

Rapid setting concrete must comply with the specifications for bonding materials in section 51-1.02C.

You may extend rapid setting concrete using a clean, uniform, and rounded aggregate filler with a moisture content of no more than 0.5 percent. Aggregate gradation must comply with the requirements shown in the following table:

Sieve size	Percentage passing
1/2"	100
No. 16	0–5

The amount of aggregate filler must comply with the manufacturer's instructions. Concrete strengths for extended concrete must be at least as specified for magnesium phosphate concrete.

Combine components of dual-component magnesium phosphate by mixing only complete units supplied by the manufacturer. Do not add water to dual-component magnesium phosphate.

60-3.02C Construction

60-3.02C(1) General

Before starting deck rehabilitation activities, complete the removal of any traffic stripes, pavement markings, and pavement markers.

Coarse aggregate remaining above the removal depth must be firmly embedded.

High-pressure water jet equipment must (1) have rotating or oscillating jets and (2) be rated at 30,000 psi minimum.

Dust must not be blown into the air while blowing the deck.

Cold milling equipment must:

1. Have a minimum concrete removal depth of 1/4 inch
2. Provide a surface relief of at most 1/4 inch
3. Provide a 5/32-inch grade tolerance

Cold milling equipment must have:

1. 3 or 4 riding tracks
2. Automatic grade control system with electronic averaging with 3 sensors on each side
3. Conveyer system that leaves no debris on the bridge
4. Drum that operates in an up-milling direction
5. Bullet tooth tools with tungsten carbide steel cutting tips
6. Maximum tool spacing of 1/4 inch
7. Maximum operating weight of 66,000 lb
8. Maximum track unit weight of 6,000 lb/ft
9. New tooth tools at the start of the work

Micro milling equipment must:

1. Have a minimum concrete removal depth of 0.04 inch
2. Provide a surface relief of at most 0.045 inch
3. Provide a 5/32-inch grade tolerance
4. Produce consistent depth of texture in the finished surface

Micro milling equipment must have:

1. 3 or 4 riding tracks
2. Automatic grade control system with electronic averaging and 3 sensors on each side
3. Conveyer system that leaves no debris on the bridge
4. Drum that operates in an up-milling direction
5. Bullet tooth tools with polycrystalline diamond enhanced cutting tips
6. Maximum tool spacing of 0.20 inch
7. Maximum operating weight of 66,000 lb
8. Maximum track unit weight of 6,000 lb/ft
9. New tooth tools at the start of the work

Produce the finished surface using 2 passes of the micro milling equipment.

Provide personnel on each side of the milling drum to monitor milling activities. Maintain constant radio communication with the operator during milling activities.

60-3.02C(2) Removing Concrete Deck Surface

Remove the concrete deck surface to the depth described.

Before removing concrete, clean the deck surface by vacuuming, then blow the deck clean with high-pressure air.

Remove the deck surface by micro milling or high-pressure water jetting.

60-3.02C(3) Removing Asphalt Concrete Surfacing

Where shown, remove asphalt concrete surfacing and reinforced concrete expansion dams from concrete bridges and approaches.

Before removing asphalt concrete surfacing, verify the depth of the surfacing at the supports and midspans of each structure (1) in each shoulder, (2) in the traveled way, and (3) at the roadway crown, if a crown is present.

Remove asphalt concrete surfacing by cold milling. At least 1/2 inch of asphalt concrete surfacing must remain after milling activities.

Remove the remaining asphalt surfacing using other authorized means. Do not damage the concrete slab.

60-3.02C(4) Removing Seals

Where shown, remove bituminous chip seals, bituminous slurry seals, and polymer chip seals entirely from bridge decks by grinding or micro milling. Remove no more than 1/4 inch of concrete deck surface.

Grinding must comply with section 42-3.

Any residual chip seals and other foreign materials remaining in the bridge deck after the grinding or micro milling operation must be removed by other authorized means.

60-3.02C(5) Removing Unsound Concrete

Where shown, remove unsound portions of bridge decks, curbs, and railings.

Unsound concrete is concrete that emits a dead or hollow sound when chained or tapped with a metal tool. The Engineer determines the soundness of concrete.

Equipment and tools that in the Engineer's opinion remove excess quantities of sound concrete are not allowed.

For bridges over railroads, stop removal activities when trains pass under the bridge.

Reinforcing steel exposed after removing unsound concrete must be restored to position and blocked and tied under section 52.

Replace or repair reinforcing steel damaged and rendered useless during removal.

60-3.02C(6) Rapid Setting Concrete Patch

Before placing rapid setting concrete patches, abrasive blast clean the contact surfaces of existing concrete and reinforcing steel. Remove at least 1/8 inch of concrete and all foreign material. Immediately before placing new concrete, clean surfaces by vacuuming and (1) pressure jetting or (2) other authorized means to remove debris.

The surface temperature of the existing concrete must be at least 40 degrees F during placement of the rapid setting concrete. Contact surfaces to receive magnesium phosphate concrete must be dry. Contact surfaces to receive modified high-alumina concrete or portland-cement-based concrete may be damp but not saturated.

Magnesium phosphate concrete must not be mixed in containers or worked with tools containing zinc, cadmium, aluminum, or copper. Modified high-alumina based concrete must not be mixed in containers or

worked with tools containing aluminum. Do not retemper concrete. Finishing tools cleaned with water must be thoroughly dried before working concrete.

The Engineer may require that you use a flow-controlled modified concrete on slopes greater than 5 percent.

Cure modified-high-alumina-based concrete and portland-cement based concrete using the curing compound method. Do not cure magnesium phosphate concrete.

60-3.02C(7) Prepare Concrete Deck Surface

Prepare concrete bridge decks (1) after the removal of any unsound concrete and placement of any rapid setting concrete patches and (2) before applying deck treatments or placing deck overlays.

Perform the following activities in the order listed:

1. Abrasive blast the deck surface with steel shot. Steel shot must comply with SSPC-AB 3. Recycled steel shot must comply with SSPC-AB 2.
2. Clean the deck surface by vacuuming.
3. Blow the deck surface clean using high-pressure oil-free air.

The deck surface must be dry when abrasive blasting is performed. Remove all laitance, surface contaminants, and foreign material from the deck surface.

If the deck surface becomes contaminated or you allow traffic on the clean deck before placing the deck treatment or overlay, abrasive blast clean the contaminated area, clean the deck by vacuuming, and blow the deck surface clean using high-pressure oil-free air.

60-3.02C(8)–60-3.02C(15) Reserved

60-3.02D Payment

The payment quantity for rapid setting concrete (patch) is the volume determined from scale weights divided by a plastic density of 135 lb/cu ft.

If rapid setting concrete is used to fill voids from the removal of unsound concrete, the payment quantity for remove unsound concrete is the same as the payment quantity for rapid setting concrete (patch). No deduction is made for concrete used to fill spalls that existed before the work began.

60-3.03 BRIDGE DECK TREATMENT

60-3.03A General

60-3.03A(1) General

Section 60-3.03 includes specifications for treating bridge decks.

60-3.03A(2) Materials

Not Used

60-3.03A(3) Construction

Not Used

60-3.03A(4) Payment

Not Used

60-3.03B Methacrylate Resin Bridge Deck Treatment

60-3.03B(1) General

60-3.03B(1)(a) Summary

Section 60-3.03B includes specifications for treating bridge decks with a high-molecular-weight methacrylate resin.

60-3.03B(1)(b) Definitions

Reserved

60-3.03B(1)(c) Submittals

Submit a work plan for applying the methacrylate resin treatment. Include in the plan:

1. Schedule of work for the test area and for each bridge
2. Procedure for storing and handling resin components and absorbent material
3. Description of equipment for applying resin
4. Range of gel time and final cure time for resin
5. Description of absorbent material to be used
6. Description of equipment for applying and removing excess sand and absorbent material
7. Procedure for removing resin from the deck and equipment to be used
8. Procedure for avoiding spills or discharges of methacrylate, including materials and equipment
9. Procedure for cleaning up spills or discharges of methacrylate, including materials and equipment
10. Procedure for preventing resin from dripping from the structures
11. Procedure for disposing of excess resin and containers

Submit an SDS for each resin component and diatomaceous earth shipment before use.

Submit test samples of methacrylate resin components at least 15 days before use.

60-3.03B(1)(d) Quality Assurance

Complete a test area before starting deck treatment activities. Notify the Engineer at least 15 days before treating the test area.

The test area must be:

1. At least 500 sq ft
2. Located within the project limits outside the traveled way at an authorized location
3. Constructed (1) using the same materials, equipment, and construction methods to be used in the work and (2) under conditions similar to those anticipated when the work will be performed.

The completed test area must demonstrate (1) compliance with these specifications and (2) work will be completed within the time allowed.

The Engineer performs friction testing of the treated test area under California Test 342. After completion of the test area, allow 10 days for the Engineer to perform the testing.

Do not perform deck treatment activities until the test area is authorized. The authorized test area is the standard of comparison in determining the acceptability of treated deck surfaces.

The Engineer may perform testing under California Test 342 to verify the coefficient of friction of the treated deck surfaces. The coefficient of friction of the treated surface must be at least 0.35 when tested under California Test 342.

60-3.03B(2) Materials

High-molecular-weight methacrylate resin consists of resin, promoter, and initiator.

High-molecular-weight methacrylate resin must be low odor and comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Volatile content[a] (max, %)	ASTM D2369	30
Viscosity[a] (max, cP, Brookfield RV with UL adaptor , 50 RPM, at 25 °C)	ASTM D2196	25
Specific gravity[a] (min, at 25 °C)	ASTM D1475	0.90
Flash point[a] (min, °C)	ASTM D3278	82
Vapor pressure[a] (max, mm Hg, at 25 °C)	ASTM D323	1.0
Tack-free time (max, minutes) except Sample 50 ± 5g Test 2 ± 0.05g in 55 ± 5 mm diameter disposable aluminum weighing dish	ASTM C679	400
PCC-saturated surface-dry bond strength (min, psi, at 24 hours and 70 ± 2 °F)	California Test 551	500

[a]Perform test before adding the initiator.

Sand for the abrasive sand finish must be a commercial-quality, dry-blast sand. The size of the sand must be such that not less than 95 percent passes the no. 8 sieve and not less than 95 percent is retained on the no. 20 sieve when tested under California Test 205.

Absorbent material must be diatomaceous earth, abrasive blast dust, or an authorized substitute recommended by the resin supplier.

60-3.03B(3) Construction

Notify the Engineer at least 15 days before delivery of methacrylate resin components in containers larger than 55 gallons to the job site.

The Engineer determines the exact methacrylate resin application rate at time of placement.

High-molecular-weight methacrylate resin applied by machine must be (1) combined in volumetric streams of promoted resin to initiated resin by static in-line mixers and (2) applied without atomization.

You may apply resin manually. Mix at most 5 gallons of resin at a time.

The deck must be dry before applying resin. The concrete surface must be from 50 to 100 degrees F. Relative humidity must be not more than 85 percent during the work shift.

Thoroughly mix all resin components. Apply resin to the deck within 5 minutes of mixing at an approximate application rate of 90 sq ft/gal. Resin that thickens during application is rejected.

Uniformly spread the resin. Completely cover surfaces to be treated and fill all cracks. Redistribute excess resin using squeegees or brooms within 10 minutes of application. For textured or grooved deck surfaces, remove excess resin from the texture indentations.

Apply the abrasive sand finish no sooner than 20 minutes after applying the resin. The sand application rate must be at least 2 lb/sq yd or until saturation as determined by the Engineer. Apply absorbent material before opening the lane to traffic. Remove excess sand and absorbent material by vacuuming or power sweeping.

Traffic or equipment is not allowed on the treated surface until you have verified that the following requirements have been met and the opening of the treated surface to traffic and equipment is authorized:

1. Treated deck surface is tack free and not oily
2. Sand cover adheres and resists brushing by hand
3. Excess sand and absorbent material has been removed
4. No material will be tracked beyond the limits of treatment by traffic

Remove resin from the deck surface if the Engineer determines (1) the conditions listed above have not been met and (2) the allowable lane closure time will be exceeded.

60-3.03B(4) Payment

The payment quantity for furnish bridge deck treatment material is the volume of mixed high-molecular-weight methacrylate resin placed.

60-3.03C–60-3.03J Reserved

60-3.04 DECK OVERLAYS

60-3.04A General

60-3.04A(1) General

Section 60-3.04 includes specifications for overlaying concrete bridge decks.

60-3.04A(2) Materials

Not Used

60-3.04A(3) Construction

Not Used

60-3.04A(4) Payment

Not Used

60-3.04B Polyester Concrete Overlays

60-3.04B(1) General

60-3.04B(1)(a) Summary

Section 60-3.04B includes specifications for placing polyester concrete overlays on concrete bridge decks.

Placing polyester concrete overlay includes placing a prime coat of methacrylate resin to the bridge deck before placing the polyester concrete overlay.

Furnishing polyester concrete includes furnishing and placing the trial overlay and concrete base for the trial overlay.

60-3.04B(1)(b) Definitions

Reserved

60-3.04B(1)(c) Submittals

Submit a work plan for the placement of the deck overlay. Include the following in the work plan:

1. Schedule of overlay work for each bridge and a schedule of work for any trial overlays
2. Method for storage and handling of methacrylate resin and polyester concrete components
3. Description of equipment for applying methacrylate resin
4. Description of equipment for measuring, mixing, placing, and finishing the polyester concrete overlay
5. Method for isolating expansion joints and drainage
6. Cure time for polyester concrete
7. Description of equipment for applying sand
8. Method for avoiding spills or discharges of methacrylate and polyester concrete, including materials and equipment
9. Method for cleaning up spills or discharge of methacrylate and polyester concrete, including materials and equipment
10. Procedure for preventing resin from dripping from the structures
11. Method for disposal of excess methacrylate resin, polyester concrete, and containers

For each shipment of methacrylate and polyester concrete, submit an SDS for each component.

Submit test samples of methacrylate resins, polyester resins, and aggregates with a certificate of compliance and manufacturer's test results at least 15 days before use.

Submit aggregate and resin volumes recorded from the volumetric mixer at the end of each work shift.

60-3.04B(1)(d) Quality Assurance

Complete a trial polyester concrete overlay before starting overlay activities. Notify the Engineer at least 15 days before constructing the trial overlay.

The trial overlay must be:

1. At least 12 by 12 feet and the same thickness as the overlay shown
2. Constructed on a prepared concrete base within the project limits at an authorized location
3. Constructed (1) using the same materials, equipment, and construction methods to be used in the work and (2) under conditions similar to those anticipated when the work will be performed

Use the trial overlay to determine the initial polyester-concrete set time.

The Engineer performs friction testing of the trial overlay under California Test 342. After completion of the trial overlay, allow 10 days for the Engineer to perform the testing.

The completed trial overlay must demonstrate (1) compliance with these specifications and (2) that the work will be completed within the time allowed.

Do not perform overlay activities until the trial overlay is authorized. The authorized trial overlay is the standard of comparison in determining the acceptability of the overlay.

The Engineer may perform testing under California Test 342 to verify the coefficient of friction of the overlay surfaces.

Dispose of the trial overlay and concrete base after acceptance of all polyester concrete overlay surfaces.

Place polyester concrete overlay on:

1. Portland cement concrete no sooner than 28 days after concrete placement
2. Portland cement based RSC no sooner than 14 days after concrete placement and your test results for prequalification of RSC show that the concrete attained at least 3,500 psi compressive strength
3. RSC using hydraulic cement other than portland cement no sooner than 3 days after concrete placement and your test results for prequalification of RSC show that the concrete attained at least 3,500 psi compressive strength
4. Magnesium phosphate based rapid setting concrete patch material no sooner than 3 days after final set
5. Modified high alumina based rapid setting concrete patch material no sooner than 30 minutes after final set

60-3.04B(2) Materials

Polyester concrete consists of polyester resin binder and aggregate.

Polyester resin binder must:

1. Be an unsaturated isophthalic polyester-styrene copolymer
2. Contain not less than 1 percent by weight gamma-methacryloxypropyltrimethoxysilane, an organosilane ester silane coupler
3. Be used with a promoter compatible with suitable methyl ethyl ketone peroxide and cumene hydroperoxide initiators
4. Comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Viscosity[a] (cP, RV, no. 1 spindle, 20 RPM, at 25 °C)	ASTM D2196	75–200
Specific gravity[a] (at 25 °C)	ASTM D1475	1.05–1.10
Elongation (min, %) Type I specimen, 0.25 ± 0.03 inch thick Rate = 0.45 in/min Sample Conditioning: 18/25/50+5/70	ASTM D638 ASTM D618	35
Tensile strength (min, psi) Type I specimen, 0.25 ± 0.03 inch thick Rate = 0.45 in/min Sample conditioning: 18/25/50+5/70	ASTM D638 ASTM D618	2,500
Styrene content[a] (%, by weight)	ASTM D2369	40–50
PCC saturated surface-dry bond strength (min, psi, at 24 hours and 70 ± 2 °F)	California Test 551	500
Static volatile emission[a] (max, gram/sq m loss)	SCAQMD Method 309-91	60

[a]Test must be performed before adding initiator.

Aggregate for polyester concrete must:

1. Comply with sections 90-1.02C(1), 90-1.02C(2), and 90-1.02C(3), except fine aggregate must consist of natural sand
2. Have not more than 45 percent crushed particles retained on the no. 8 sieve when tested under California Test 205
3. Have a weighted-average aggregate absorption of not more than 1 percent when tested under California Tests 206 and 207
4. At the time of mixing with resin, have a moisture content of not more than one half of the weighted-average aggregate absorption when tested under California Test 226
5. Comply with the percentage passing limits for one of the aggregate gradations shown in the following table:

Aggregate Gradation

Sieve size	Percentage passing	
	3/8 inch maximum	No. 4 maximum
1/2"	100	100
3/8"	83–100	100
No. 4	65–82	62–85
No. 8	45–64	45–67
No. 16	27–48	29–50
No. 30	12–30	16–36
No. 50	6–17	5–20
No. 100	0–7	0–7
No. 200	0–3	0–3

High-molecular-weight methacrylate for the resin prime coat must comply with section 60-3.03B except:

1. Methacrylate resin must be free of wax
2. Tack-free time requirements do not apply
3. Friction testing is not required for the resin prime coat

Sand for abrasive sand finish must:

1. Be commercial-quality blast sand

2. Be graded such that not less than 95 percent passes the no. 8 sieve and not less than 95 percent is retained on the no. 20 sieve when tested under California Test 205
3. Have an average absorption of not more than 1 percent when tested under California Test 207

60-3.04B(3) Construction

60-3.04B(3)(a) General

Notify the Engineer at least 15 days before delivery of methacrylate resin components in containers larger than 55 gallons to the job site.

The Engineer provides the final grade and cross slope before the start of overlay work.

The Engineer tests existing deck surface smoothness under section 51-1.01D(3)(b)(ii) and may require you to modify the existing deck smoothness under section 42-3. Modifying the existing deck smoothness is change order work.

Complete the construction of approach slabs before placing polyester overlay.

New concrete deck surfaces must comply with section 51-1.03F(5) before starting overlay work.

60-3.04B(3)(b) Placing Methacrylate Resin

The Engineer determines the exact percentage of polyester resin binder at the time of placing.

The deck must be dry before placing the methacrylate prime coat. The concrete surface must be from 50 to 100 degrees F and the relative humidity must be not more than 85 percent.

Clean the deck by vacuuming, then blow the deck clean with high-pressure oil-free air. Dust must not be blown into the air while blowing the deck.

Thoroughly mix all components of the methacrylate resin. Apply the resin to the deck surface within 5 minutes of mixing. Apply the resin uniformly and spread to completely cover surfaces to be overlaid.

Apply methacrylate resin at an approximate rate of 55 sq ft/gal.

60-3.04B(3)(c) Placing Polyester Concrete

Use a continuous mixer to mix polyester concrete. The continuous mixer must:

1. Employ an auger screw device with a discharge chute
2. Be equipped with an automatic metering device that measures and records aggregate and resin volumes
3. Have a visible readout gage that displays volumes of aggregate and resin being recorded
4. Be certified under California Test 109 before use
5. Produce a satisfactory mix consistently during a demonstration

Record polyester concrete volumes at least every 5 minutes, including time and date.

Finishing equipment for polyester concrete must:

1. Have grade control capabilities resulting in a roadway surface that meets the smoothness requirements of section 51-1.01D(3)(b)(ii) and is capable of adjusting for a variable thickness overlay along and across the existing deck surface. The use of fixed height skid-supported strike off equipment is not allowed.
2. Be used to consolidate the polyester concrete.
3. Have a 12-foot minimum paving width.
4. Be self-propelled and equipped with automatic screed controls and sensing devices that control the thickness, longitudinal grade, and transverse screed slope. Advancing the finishing equipment with winches or a pulling device is not allowed.

Place polyester concrete:

1. Immediately after applying the methacrylate prime coat
2. Before gelling occurs
3. Within 15 minutes of adding the initiator

The weight of resin binder must be approximately 12 percent of the weight of the aggregate. Polyester concrete must have an initial set time from 30 to 120 minutes when tested using an initial-setting-time Gillmore needle under ASTM C266.

Consolidate and finish the overlay to the required grade and cross section using finishing equipment. Polyester concrete must be consolidated to a relative compaction of not less than 97 percent when tested under California Test 552.

Texture the polyester concrete surface before gelling occurs by longitudinal tining under 51-1.03F(5)(b)(iii), except do not perform initial texturing.

Apply a sand finish of not less than 0.8 lb/sq yd before gelling occurs.

Protect the overlay from moisture for at least 4 hours after finishing. Do not allow traffic or equipment on the overlay for at least 4 hours after final finishing.

Completed polyester concrete deck surfaces must have a uniform surface texture with a coefficient of friction of at least 0.35 when tested under California Test 342 and a surface smoothness complying with section 51-1.01D(3)(b)(ii).

Taper the polyester concrete overlay edges if the overlay (1) is not completed within the allowable lane closure time and (2) is more than 1/2 inch higher in elevation than the adjacent pavement. Taper the edges that are longitudinal to the direction of traffic at a 4:1 (horizontal:vertical) slope.

Tapers may remain and be overlaid with polyester concrete overlay.

60-3.04B(4) Payment

The payment quantity for furnish polyester concrete overlay is the volume determined using:

1. Quantity of resin binder used
2. Percentage by weight of resin binder in the polyester concrete
3. Unit weight of 135 lb/cu ft

60-3.04C Polyester Concrete Expansion Dams

60-3.04C(1) General

60-3.04C(1)(a) Summary

Section 60-3.04C includes specifications for constructing polyester concrete expansion dams.

Polyester concrete expansion dams must comply with the specifications for polyester concrete overlays in section 60-3.04B, except a trial overlay is not required.

Reinforcement must comply with section 52.

60-3.04C(1)(b) Definitions

Reserved

60-3.04C(1)(c) Submittals

Reserved

60-3.04C(1)(d) Quality Assurance

Reserved

60-3.04C(2) Materials

Not Used

60-3.04C(3) Construction

For new asphalt concrete overlays, place the asphalt concrete overlay before starting polyester concrete activities. Saw cut and remove asphalt concrete at expansion dam locations.

For existing asphalt concrete overlays, remove expansion dams and asphalt concrete to the limits shown. Removing expansion dams must comply with section 60-2.02, except a bridge removal work plan is not required.

Where a portion of the asphalt concrete overlay is to remain, saw cut a 2-inch-deep true line along the edge to remain in place before removing the asphalt concrete. Do not damage the existing surfacing to remain in place.

Prepare the deck surface under section 60-3.02C(7).

You may use a mechanical mixer to mix the polyester concrete for expansion dams. The mixer capacity must not exceed 9 cu ft unless authorized. Initiate the resin and thoroughly blend it immediately before mixing it with the aggregate. Mix the polyester concrete for at least 2 minutes before placing.

The application rate of methacrylate resin must be approximately 100 sq ft/gal.

You may place and finish expansion dams using hand methods.

Protect expansion dams from moisture, traffic, and equipment for at least 4 hours after finishing.

For expansion dams over 6 feet long, install 1/4-inch-wide joint material at 6-foot intervals across the width of the expansion dam. Joint material must be either expanded polyurethane or expanded polyethylene.

60-3.04C(4) Payment

The payment quantity for polyester concrete expansion dam is the volume determined from the dimensions shown.

60-3.04D Concrete Overlays

60-3.04D(1) General

Section 60-3.04D includes specifications for overlaying bridge decks with concrete.

Constructing concrete overlays must comply with section 51.

60-3.04D(2) Materials

Not Used

60-3.04D(3) Construction

Not Used

60-3.04D(4) Payment

Not Used

60-3.04E Multilayer Polymer Overlays

Reserved

60-3.04F–60-3.04M Reserved

60-3.05 REPAIRING STRUCTURES

60-3.05A General

60-3.05A(1) General

Section 60-3.05 includes specifications for repairing structures.

60-3.05A(2) Materials

Not Used

60-3.05A(3) Construction

Not Used

60-3.05A(4) Payment

Not Used

60-3.05B Repairing Spalled Surface Areas

60-3.05B(1) General

60-3.05B(1)(a) Summary

Section 60-3.05B includes specifications for repairing spalled concrete surfaces except on bridge decks.

60-3.05B(1)(b) Definitions

Reserved

60-3.05B(1)(c) Submittals

For alternative filler material, submit a test sample of at least 1 complete unit of all materials for repairing the concrete surfaces. Allow 45 days for testing.

For a contract with less than 60 original working days, submit certificates of compliance for the filler material and bonding agents.

60-3.05B(1)(d) Quality Assurance

Reserved

60-3.05B(2) Materials

Mortar must comply with section 51-1.02F.

Shotcrete must comply with section 53.

Alternative filler materials and bonding agents must comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Abrasion resistance (max, grams, at 28 days)	California Test 550	25
Modulus of elasticity (psi, at 28 days)	California Test 551	1.5×10^6 to 3.5×10^6
Water soluble chlorides (max, mg/kg)	California Test 422	500
Water soluble sulfates (max, mg/kg)	California Test 417	2,500

For a contract with less than 60 original working days, alternative materials must be authorized before use.

60-3.05B(3) Construction

Remove unsound concrete under section 60-3.02C(5).

Clean concrete surfaces and existing reinforcing steel by abrasive blasting before placing filler material. Place reinforcing steel where shown.

Fill spalled surface areas under section 51-1.03F(2) or you may use an authorized alternative filler material and bonding agent.

If using an alternative filler material, apply a bonding epoxy before placing the filler material. Place the filler material under the manufacturer's instructions.

If using shotcrete, you may apply the shotcrete using a dry-mix process with a hydration liquid applied immediately after placing the shotcrete.

The final surface finish of the patched concrete surface must comply with section 51-1.03F.

Patched concrete must emit a ringing sound similar to adjacent sound concrete when struck with a metal tool 14 days after placement.

Removing and patching spalled concrete more than 4 inches deep is change order work.

60-3.05B(4) Payment

The payment quantity for repair spalled surface area is the area measured of the completed repaired surface. Measured areas are recorded daily by the Engineer and agreed upon by you.

60-3.05C Epoxy Crack Injection

60-3.05C(1) General

60-3.05C(1)(a) Summary

Section 60-3.05C includes specifications for filling cracks in concrete structures with pressure-injected epoxy.

60-3.05C(1)(b) Definitions

Reserved

60-3.05C(1)(c) Submittals

Reserved

60-3.05C(1)(d) Quality Assurance

Before starting injection activities and at hourly intervals when requested, take a 3-ounce sample of mixed epoxy from the injection gun. If samples show improper proportioning or mixing, stop injection activities and correct deficiencies.

60-3.05C(2) Materials

Epoxy must comply with the specifications for epoxy resin adhesive for injection grouting of concrete pavement. Multiple formulations may be required for cracks of varying widths.

60-3.05C(3) Construction

The Engineer selects cracks having widths from 8 to 250 mils for injection and filling.

Clean cracks of material that would impair bonding of epoxy using oil-free compressed air. Remove any remaining material by flushing with water under pressure. After flushing, blow cracks clean with oil-free compressed air.

Insert injection ports into cracks. Space the ports not more than a distance equal to the thickness of the concrete being injected. Spacing at ends of cracks must be equal to half the concrete thickness. Adjust port spacing to ensure epoxy substantially fills the cracks.

Seal the crack surfaces between ports with tape or other temporary sealant capable of retaining epoxy in cracks during pressure injection and until epoxy has hardened.

Concrete temperature must be from 50 to 90 degrees F during injection activities.

Pressure inject epoxy adhesive into cracks through injection ports. Use the lowest practical pumping pressure. Injection equipment must maintain epoxy proportion and mix consistency. Fill cracks completely. Do not allow epoxy to run down the face of the concrete from the head of the injection gun.

Start injection at the 1st port at the end of a crack. Pump epoxy into the port until epoxy runs substantially from the adjacent port. Seal the 1st port and start injection from the next port. Continue in this manner until the crack is filled. For slanting or vertical cracks, start injecting at the lower end of the crack. Where vertical and horizontal cracks intersect, inject the vertical crack below the intersection first.

Seal ports by removing the fitting, filling the void with epoxy, and covering the void with tape or surface sealant. Leave the sealing tape and temporary surface sealant in place until the epoxy has hardened.

Clean excess epoxy from concrete surfaces exposed to public view after removing sealant.

60-3.05C(4) Payment

For cracks extending around corners of members, the payment quantity for inject crack epoxy is the crack length measured on both faces, including the crack length shown to be filled on the opposite side of a member that is completely filled after injection from only 1 side.

60-3.05D Heat-Straighten Steel Girders

Reserved

60-3.05E–60-3.05J Reserved

60-3.06–60-3.10 RESERVED

60-4 MODIFYING STRUCTURES

60-4.01 GENERAL

60-4.01A General

Section 60-4 includes specifications for modifying structures.

60-4.01B Materials

Not Used

60-4.01C Construction

Not Used

60-4.01D Payment

Not Used

60-4.02 REFINISHING BRIDGE DECKS

60-4.02A General

Section 60-4.02 includes specifications for refinishing bridge decks.

The Engineer determines the exact area to be refinished.

60-4.02B Materials

Concrete for refinishing bridge decks must be either portland cement concrete or rapid setting concrete.

Portland cement concrete must comply with section 90-1 and the following:

1. Concrete must contain at least 675 pounds of cementitious material per cubic yard.
2. Free water must not exceed 280 lb/cu yd.
3. Aggregate must contain from 50 to 55 percent fine aggregate. The remaining portion must be pea gravel. Grade pea gravel such that 100 percent passes the 1/2-inch sieve and at most 5 percent passes the no. 16 sieve.
4. Engineer may request that admixtures be used.

Rapid setting concrete must comply with section 60-3.02.

Epoxy adhesive must comply with the specifications for epoxy adhesive for bonding freshly mixed concrete to hardened concrete.

60-4.02C Construction

60-4.02C(1) General

For removal work performed within 10 feet of a traffic lane or over a traffic lane, remove the dust and residue using an authorized vacuum, a water spray, or a shield method.

Make a 3/4-inch-deep saw cut around the perimeter of the deck to be refinished. Remove concrete in areas to be refinished to a depth of approximately 3/4 inch. Do not damage concrete to remain in place.

Prepare existing deck areas more than 3/4 inch below adjoining deck surfaces by removing at least 1/4 inch of surface material to expose sound aggregate. Remove concrete by abrasive blast cutting, abrasive sawing, impact tool cutting, machine rotary abrading, or other methods. Removal methods must be authorized.

Clean prepared areas of dust and loose and deleterious materials by vacuuming, abrasive blast cleaning, and using high-pressure oil-free air. Re-blast contaminated areas before starting concrete placement activities. Dust must not be blown into the air while blowing the deck.

Protect existing reinforcement exposed during concrete removal.

Cut off dowels 1 inch below the existing deck surface or at the bottom of concrete removal, whichever is lower.

Where refinishing is not required, cut dowels off 1 inch below the finished surface. Patch holes with rapid setting concrete complying with section 60-3.02.

You may refinish isolated high areas by cutting the concrete down flush with adjoining deck surfaces. Use abrasive sawing, grinding, impact tool cutting, or other authorized methods.

Fill prepared areas flush with the plane of the adjoining deck using concrete.

Transversely score fresh concrete surfaces. Use a stiff-bristled broom or other suitable device.

Completed surfaces must have a uniform texture with a coefficient of friction of at least 0.35 when tested under California Test 342.

Grind or groove surfaces having a coefficient of friction less than 0.35 under section 42.

Refinished surfaces must (1) be flush with the adjoining surface and (2) not vary more than 0.02 foot from the lower edge of a 12-foot straightedge placed in the longitudinal direction.

60-4.02C(2) Placing Portland Cement Concrete

Abrasive-blast clean concrete surfaces to be refinished. Clean blast-cleaned surfaces by vacuuming, then blow them clean using high-pressure oil-free air. Dust must not be blown into the air while blowing the deck.

Apply an epoxy adhesive to cleaned surfaces immediately after cleaning. Surfaces must be dry and have a temperature of at least 40 degrees F when applying the adhesive. The Engineer determines the application rate.

Place concrete on fresh epoxy adhesive. Consolidate concrete immediately after placement until voids are filled and free mortar appears on the surface. Strike off concrete to the required grade.

Cure concrete under section 51-1.03H.

Do not apply loads of any type to the concrete until at least 7 days after placement.

60-4.02C(3) Placing Rapid Setting Concrete

Blow surfaces to be refinished with high-pressure oil-free air immediately before placing rapid setting concrete. Abrasive-blast clean concrete surfaces that are contaminated before the concrete is placed.

Allow traffic on new concrete under the manufacturer’s instructions and when authorized.

60-4.02D Payment

The payment quantity for refinish bridge deck is the sum of (1) the area measured along the surface and (2) 0.2 square foot for patching around each dowel.

The Department does not adjust the unit price for an increase or decrease in the refinish bridge deck quantity.

60-4.03 ACCESS OPENINGS

60-4.03A General

Section 60-4.03 includes specifications for constructing access openings and closing access openings when access is no longer required.

Reinforcement must comply with section 52.

Steel plates, hardware, and thread-locking compound must comply with section 75-3.

60-4.03B Materials

Rapid-setting concrete must comply with section 60-3.02B(2).

60-4.03C Construction

60-4.03C(1) General

Removing portions of bridges must comply with section 60-2. Limits of removal shown are approximate. The Engineer must authorize removal limits before you start removal activities.

Paint exposed ends of the remaining reinforcement with 2 coats of organic zinc-rich coating as specified for exposed ends of prestressing steel in section 50-1.03B(3)(a).

Within cells where work activities are performed, remove existing formwork and concrete that interfere with the work. In cells that adjoin hinges, bent caps, or abutments, remove existing forms and sharp projections in the cell between the adjoined element and 5 feet past the access opening.

60-4.03C(2) Deck Access Openings

Remove portions of existing bridge decks, including bar reinforcing steel, at the locations shown.

60-4.03C(3) Soffit Access Openings

Remove portions of the existing soffit, including the bar reinforcing steel, at the locations shown.

Seal the access openings with access doors when cell access is no longer required.

60-4.03C(4) Soffit Access Opening Extensions

For bridge soffit access opening extensions, remove and replace concrete to the limits shown. You may reduce removal limits if authorized.

Reconstruct and seal soffit access openings to the original dimensions when cell access is no longer required.

Use concrete or rapid-setting concrete to reconstruct the access openings. Placing concrete must comply with section 51. Placing rapid-setting concrete must comply with section 60-3.02C(6).

60-4.03C(5) Close Deck Access Openings

Close deck access openings using rapid-setting concrete. Placing rapid-setting concrete must comply with section 60-3.02C(6).

Use water to flush dust from areas to be filled with concrete. Remove all water by air blasting before placing concrete.

Allow traffic on new concrete under the manufacturer’s instructions and when authorized.

If the close deck access opening work has not been completed, use temporary deck cover plates to temporarily close the deck access openings before opening the lane to traffic.

Temporary deck cover plates must remain in place until the deck access opening is permanently closed.

60-4.03D Payment

Not Used

60-4.04 CORING CONCRETE

60-4.04A General

60-4.04A(1) Summary

Section 60-4.04 includes specifications for coring holes through concrete structures.

60-4.04A(2) Definitions

Reserved

60-4.04A(3) Submittals

If cored holes are greater than 10 feet in length, submit:

1. Work plan for the coring activities, including methods and equipment to be used
2. Labeled cores

If reinforcement shown not to be cut is cut during coring operations, submit a work plan for (1) repairing the cut reinforcement and (2) preventing cutting of additional reinforcement. Allow 3 business days for review.

60-4.04A(4) Quality Assurance

Reserved

60-4.04B Materials

Water for coring activities must either (1) be from the local water supply or (2) contain:

1. Not more than 1,000 ppm chlorides as Cl
2. Not more than 1,300 ppm of sulfates as SO_4
3. No impurities that discolor the concrete or etch the surface

60-4.04C Construction

Use coring methods that do not shatter or damage the concrete adjacent to the holes.

Stop coring operations if reinforcement shown not to be cut is cut during coring operations. Do not resume coring operations until your work plan is authorized.

If cored holes are greater than 10 feet in length:

1. Alignment of the cored hole must not deviate from that shown by more than 1/2 inch per 10 feet of length with a total maximum deviation of 3 inches.
2. Label each core with the core location immediately after coring.

Do not allow water from coring activities to fall onto traffic, flow across shoulders or lanes occupied by traffic, or flow into gutters or other drainage facilities.

60-4.04D Payment

The payment quantity for core concrete is the length measured along the centerline of the hole. The payment quantity includes the length of any expansion joints.

60-4.05 CORING AND PRESSURE GROUTING DOWELS

60-4.05A General

Section 60-4.05 includes specifications for coring holes through concrete and grouting dowels into the cored holes.

Coring must comply with section 60-4.04.

60-4.05B Materials

Grout must comply with ASTM C1107 or ASTM C845, Type K, with a compressive strength of 5,000 psi at 28 days when tested under California Test 551.

Dowels must comply with the specifications for bar reinforcing steel in section 52.

Water for grout must comply with the specifications for water in section 90-1.02D.

Admixtures must not contain more than 500 ppm of chlorides as Cl when tested under California Test 422 and not more than 2,500 ppm of sulfates as SO_4 when tested under California Test 417.

60-4.05C Construction

Clean loose and foreign material from concrete and steel surfaces that will be in contact with the grout. Flush holes with water and let them dry to a surface-dry condition immediately before grouting.

Seal the ends of holes after placing the dowels. Place a vent tube at one end of the hole and an injection feed tube at the other end of the hole. For holes with only a single end, place vent and injection feed tubes in the same end. Place tubes such that the air will vent and the hole will be completely filled with grout.

Mix grout under the manufacturer's instructions.

Pump grout into holes. Use sufficient pressure so that the hole is free of voids. Continually waste grout until air and water eject from the vent tubes and there are no visible slugs.

60-4.05D Payment

Payment for furnishing dowels is not included in the payment for core and pressure grout dowel.

60-4.06 STEEL COLUMN CASINGS

60-4.06A General

60-4.06A(1) Summary

Section 60-4.06 includes specifications for fabricating, installing, and cleaning and painting steel column casings.

Column casings must comply with the specifications for structural steel in section 55.

Cleaning and painting column casings must comply with the specifications for cleaning and painting new structural steel in section 59-2.

60-4.06A(2) Definitions

Reserved

60-4.06A(3) Submittals

Reserved

60-4.06A(4) Quality Assurance

For field welding of column casings:

1. Only visual inspection is required
2. 2nd sentence of clause 3.13.2(2) and the 1st sentence of clause 3.13.3 of AWS D1.5 do not apply.

60-4.06B Materials

60-4.06B(1) General

Steel for casings must comply with ASTM A36/A36M or ASTM A709/A709M, Grade 36.

Mortar must comply with section 51-1.02F.

Polyethylene must have a compressive strength of at least 10 psi at no more than 15 percent deflection when tested under ASTM D3575, Suffix D.

Drain extension pipe must comply with the specifications for drainage piping in section 75-3.

60-4.06B(2) Grout

Grout must consist of cement and water, and may contain an admixture if authorized. Do not exceed 5 gallons of water per 94 lb of cement.

Cement must comply with section 90-1.02B(2).

Water must comply with section 90-1.02D.

Admixtures must comply with section 90, except admixtures must not contain chloride ions in excess of 0.25 percent by weight.

For noncircular columns with a maximum gap greater than 4 inches, extend the grout as follows:

1. Aggregate must consist of at least 70 percent fine aggregate and approximately 30 percent pea gravel, by weight.
2. Fine aggregate must comply with section 90-1.02C(3).
3. Size of pea gravel must be such that 100 percent passes the 1/2-inch sieve, at least 90 percent passes the 3/8-inch sieve, and not more than 5 percent passes the no. 8 sieve.
4. Minimum cement content of the grout must not be less than 845 lb/cu yd.

Mix the grout as follows:

1. Add water to the mixer followed by cement and any aggregates or admixtures.
2. Mix the grout with mechanical mixing equipment that produces a uniform and thoroughly mixed grout.
3. Agitate the grout continuously until the grout is pumped.
4. Do not add water after initial mixing.

60-4.06C Construction

60-4.06C(1) General

Remove and dispose of all material from the space to be occupied by column casing materials.

Bond polyethylene to column surfaces where shown. Use an authorized waterproof adhesive. Apply adhesive to the entire contact surface.

Use spacers to center casings around columns during placement. You may weld spacers to the inside of casings. Do not use spacers in areas where polyethylene is used.

Paint the information that is on existing columns onto casings under section 51-1.03E(1).

60-4.06C(2) Painting

Apply the undercoat before shipment to the job site. Do not paint surfaces that are to be thermal spray coated or covered with polyethylene.

Apply final coats after installing the casing.

60-4.06C(3) Grouting

Grout the space between casing and column faces.

Grouting equipment must comply with section 50-1.03B(2)(d)(ii).

If hot weather conditions will contribute to quick stiffening of the grout, cool the grout by authorized methods as necessary to prevent blockages during pumping activities.

If freezing weather conditions are anticipated during and following the placement of grout, provide adequate means to protect the grout in the casings from damage by freezing.

Do not:

1. Allow the grout temperature to rise above 90 degrees F during mixing and pumping
2. Grout when the ambient or grout temperature is less than 50 degrees F

Limit the height of each grout lift to minimize casing undulations and displacements. Undulations in the casing surface must not exceed 1/4 inch in 12 inches. Total casing displacement from the position shown must not exceed 2 inches at any point.

You may use bracing or other means to restrain casing. Except where shown, restraints may not pass through columns.

Allow grout to harden before placing the next lift of grout unless a bracing system is used.

The maximum height of grout lifts for portions of casings with polyethylene is 10 feet.

Install external injection valves for grouting casings. Begin filling casing from the bottom. Space valves so that grout fills the void between the casing and the column.

Seal casings at the bottom. Pump grout such that a uniform grout head around the column is maintained and no visible water or air is ejected from the top of the grout. Cover grout at the casing top with mortar. Slope mortar to drain.

Remove accessories from casings no sooner than 24 hours after placing grout. Voids must be filled with mortar and finished flush with the exterior casing surface.

60-4.06D Payment

Not Used

60-4.07 COMPOSITE COLUMNS CASINGS

Reserved

60-4.08 PRESTRESSING STEEL GIRDERS

Reserved

60-4.09 BRIDGE JOINT RESTRAINERS

60-4.09A General

60-4.09A(1) Summary

Section 60-4.09 includes specifications for fabricating and installing bridge joint restrainers.

Bridge joint restrainers must comply with the specifications for miscellaneous bridge metal in section 75-3.

60-4.09A(2) Definitions

Reserved

60-4.09A(3) Submittals

60-4.09A(3)(a) General

Reserved

60-4.09A(3)(b) Cable-Type Restrainers

Submit 2 certified copies of mill test reports for each manufactured length of cable.

Submit 2 certified copies of the mill test and heat treating reports for each heat of bars used for cable yield indicators.

Submit at the manufacturer's plant:

1. 1 cable-type restrainer test sample for each 200 restrainers or fraction thereof produced. The sample restrainer must:
   1.1 Consist of a cable fitted with a swaged fitting and right hand thread stud at both ends
   1.2 Be 3 feet in total length
2. 1 turnbuckle fitted with an 8-inch stud at each end for each 200 turnbuckles or fraction thereof.
3. Greater of 1 percent or 8 of the cable yield indicators produced from each mill heat.
4. 2 disc springs of each size produced from each mill heat.

Items to be submitted at the manufacturer's plant must be submitted with all manufacturer's plant-applied coatings.

60-4.09A(3)(c) Pipe-Type Restrainers

Submit shop drawings showing the method of grouting pipe-type restrainers.

60-4.09A(4) Quality Assurance

Bridge joint restrainer materials are inspected at the fabrication site.

Notify the Engineer:

1. When materials have been delivered to the fabrication site
2. At least 10 days before starting fabrication

60-4.09B Materials

60-4.09B(1) General

Reserved

60-4.09B(2) Cable Type Restrainers

60-4.09B(2)(a) General

Cable-type restrainers consist of cables, swaged fittings, studs, nuts, cable yield indicators, disc springs, and, if shown, turnbuckles.

Cables must be galvanized, 3/4-inch preformed, 6 by 19, wire strand core or independent wire rope core, complying with Federal Specification RR-W-410, right regular lay, manufactured of improved plow steel with a minimum breaking strength of 23 tons.

Each swaged fitting must:

1. Be machined from hot-rolled steel bars complying with AISI C-1035
2. Be annealed, suitable for cold swaging
3. Have a hole drilled through the head to accommodate the locking pin
4. Have the manufacturer's identifying mark stamped on the body

The locking pin must be a 1/4-inch-diameter, zinc-plated steel spring pin. The pin must keep the stud in proper position.

Before galvanizing, mill a 3/8-inch slot for the locking pin in the stud end. Each stud must comply with ASTM A449 after galvanizing.

Nuts must comply with ASTM A563, including appendix X1, except lubrication is not required.

Each cable yield indicator must:

1. Be machined from hot-rolled steel bars complying with AISI C-1035
2. Be annealed, suitable for cold swaging
3. Have the heat number and manufacturer's identifying mark stamped on the end surface

Disc springs must be made from steel complying with ASTM A684/A684M, Grade 1075.

Turnbuckles must be steel pipe type. Pulls for turnbuckles must consist of a swaged fitting and stud assembly.

Steel parts must comply with ASTM A36/A36M or A576, Grade 1030 (AISI 1030) and must not be rimmed or capped steel.

Pipe sleeves must be commercial-quality welded steel pipe.

Concrete for filling cable drum units must either (1) comply with the specifications for minor concrete or (2) be a concrete mix with a 3/8-inch maximum combined aggregate grading and at least 675 pounds of cementitious material per cubic yard.

Elastomeric bearing pads must comply with section 51-3.02 except pads may consist of only elastomer and laminated reinforcement is not required.

PVC must be commercial quality.

Bond breaker on PVC pipe must be a mortar-tight wrapping of plastic or rubber sheet at least 0.010 inch thick.

Expanded polystyrene and hardboard must comply with section 51-2.01B(1).

Neoprene sheets must comply with the specifications for neoprene in section 51-2.04. The sheets must be smooth, free from pinholes and surface blemishes, and show no evidence of delamination.

Closed-cell expanded neoprene material must be commercial quality and comply with the stiffness requirements in ASTM D1056 for Class SC, Grade SCE43 material or firmer.

60-4.09B(2)(b) Corrosion Protection

Reserved

60-4.09B(2)(c) Fabrication

60-4.09B(2)(c)(i) General

You are responsible for determining the required lengths of cable-type restrainers.

Each swaged fitting, turnbuckle, stud, and nut assembly must develop the specified breaking strength of the cable.

Machine the wall of the reduced section of the cable yield indicator such that the indicator yields at a load of from 36,000 to 38,000 pounds when tested in compression along the major axis at a test speed of at most 1/2 inch/minute.

Clean and paint disc springs the described color using a paint recommended by the manufacturer of the disc springs. Disc springs do not need to be galvanized.

The minimum size of fillet welds must comply with AWS D1.1 except as follows:

Minimum Fillet Weld Sizes

Base metal thickness of thicker part joined (T) (inches)	Minimum size of fillet weld (inches)
3/4 < T ≤ 1-1/2	5/16
1-1/2 < T ≤ 2-1/4	3/8
2-1/4 < T ≤ 6	1/2
6 < T	5/8

You may drill holes in steel parts after galvanizing if you repair the holes as specified for repairing damaged galvanized surfaces in section 75-1.02B.

The finish coat must match color no. 26373 of FED-STD-595.

Securely wrap each free end of restrainer-unit cables to prevent separation.

Ship cable-type restrainers as complete units.

60-4.09B(2)(c)(ii) Applying Corrosion Protection

Reserved

60-4.09B(3) Bar Type Restrainers

Bar-type restrainers consist of HS bars, bearing plates, couplers, anchorage devices, and incidentals.

You must determine the required length of each bar-type restrainer.

Bar-type restrainers must comply with the specifications for bar prestressing steel in section 50.

Each anchorage device and coupler must develop the specified minimum ultimate tensile strength of the steel bar and include locking devices to prevent turning or loosening.

Bearing plates must comply with ASTM A36/A36M.

Elastomeric bearing pads must comply with section 51-3.02 and must be bonded to bearing plates with adhesive complying with Federal Specification MMM-A-121.

Ship each bar-type restrainer as a complete unit, including anchorage device and coupler.

60-4.09B(4) Pipe Type Restrainers

Pipe-type restrainers consist of double extra-strong steel pipe and associated hardware.

Double extra-strong pipe for pipe-type restrainers must comply with ASTM A53/A53M, Grade B.

Grout for bonding the pipe to the existing concrete must comply with section 60-4.06B(2).

60-4.09C Construction

60-4.09C(1) General

Place new concrete adjacent to restrainers before installing them.

Where removing and replacing restrainers, remove at most 50 percent of the restrainers at any joint and replace them with an equal proportion of new restrainers before subsequent removal activities. Perform all removal and replacement symmetrically about the centerline of the existing bridge.

If paint removal or welding at connections to existing steel is not described at restrainer locations, wash loose dirt and dust from existing contact surfaces of HS bolted connections without disturbing the existing

paint. Clean and paint existing contact surfaces of HS bolted connections that contain rust, loose paint, or other foreign substances other than dirt and dust. Cleaning and painting existing contact surfaces is change order work.

Repair painted areas of existing structural steel damaged (1) by your operations or (2) from drilling holes through existing steel members. Repairing painted areas must comply with the specifications for repairing damaged galvanized surfaces in section 75-1.02B.

60-4.09C(2) Cable Type Restrainers

Notify the Engineer at least 2 days before tightening and setting cable-type restrainer units.

60-4.09C(3) Bar Type Restrainers

Clean and paint new metal surfaces of bar-type restrainer units after fabrication as specified for new structural steel in section 59-2, except:

1. SSPC-QP 1, SSPC-QP 2, and AISC-420-10/SSPC-QP3 certifications are not required
2. Blast-cleaned surfaces require only a single undercoat of inorganic zinc primer

60-4.09C(4) Pipe Type Restrainers

Bond pipe-type restrainers to existing concrete by completely filling the void between the pipe and the cored hole with grout within the limits shown. Provide filler material and seals along the sides of the pipe to prevent grout from entering the bridge hinge joints. The filler material and seals must not restrict joint movement.

60-4.09D Payment

The payment quantity for miscellaneous metal (restrainer) does not include the weight of nonmetallic materials used in constructing the restrainers.

60-4.10–60-4.15 RESERVED

60-5 ABANDONING STRUCTURES

60-5.01 GENERAL

60-5.01A General

Section 60-5 includes specifications for abandoning structures.

60-5.01B Materials

Not Used

60-5.01C Construction

Not Used

60-5.01D Payment

Not Used

60-5.02 ABANDONING PEDESTRIAN UNDERCROSSINGS

Reserved

60-5.03–60-5.10 RESERVED

60-6–60-10 RESERVED

DIVISION VII DRAINAGE FACILITIES

61 GENERAL

61-1 GENERAL

61-1.01 GENERAL

Section 61 includes general specifications for constructing drainage facilities.

61-1.02 MATERIALS

Not Used

61-1.03 CONSTRUCTION

Not Used

61-1.04 PAYMENT

Not Used

61-2 CULVERT AND DRAINAGE PIPE JOINTS

61-2.01 GENERAL

61-2.01A Summary

Section 61-2 includes specifications for constructing joint systems and couplers for culverts and drainage pipes.

Joint systems and couplers for culverts and drainage pipes are classified as standard, positive, or downdrain.

61-2.01B Definitions

shear strength: Required joint shear strength expressed as a percentage of the calculated pipe shear strength at a transverse section remote from the joint.

moment strength: Moment strength required of the joint expressed as a percentage of the calculated moment capacity of the pipe on a transverse section remote from the joint.

tensile strength: Resistance to the longitudinal force that tends to separate adjacent pipe sections.

integral joint overlap: Projection of 1 pipe barrel into another pipe barrel.

sleeve joint overlap: Minimum sleeve width required to engage abutted pipe barrels.

watertightness: Ability of a joint to hold water under pressure without leaking.

joint: Connection point for 2 or more pipe sections.

61-2.01C Submittals

For watertight joints, submit your analysis or test results performed on representative joints proposed for installation.

Submit a certificate of compliance for each classification of joint systems and couplers.

Where field leakage testing is shown for pipe systems, submit:

1. Proposed field leakage test procedure for each portion of each pipe system at least 15 days before you start testing. The submittal for each proposed field leakage test procedure must include:
   1.1. Type of test: exfiltration, low-pressure air, negative air pressure, or other authorized method
   1.2. Specific joints or pipe sections to be tested
   1.3. Maximum and minimum pressures or hydrostatic head to be applied
   1.4. Duration of tests from location to location
   1.5. Date and time of each test
   1.6. List of test equipment to be used
   1.7. Date of last calibration if applicable
2. Leakage calculations for the exfiltration and infiltration tests
3. Repair procedure for joints or pipe sections that fail the field leakage test

61-2.01D Quality Assurance

61-2.01D(1) General

Reserved

61-2.01D(2) Quality Control

61-2.01D(2)(a) Watertightness Test

Perform watertightness tests of the assembled joints. The assembled joints must pass the tests without joint leakage.

The watertightness test must consist of testing the hydrostatic pressure on a joint by connecting 2 pipe sections under the manufacturer's instructions. Provide suitable bulkheads within the pipe adjacent to and on either side of the joint or at the outer ends of the joined pipe sections. Do not place mortar or concrete coating, filling, or packing in addition to that normally required for the joint before conducting the watertightness test. After the pipe sections are fitted together with the gasket or gaskets in place, subject the assembly to a 10-foot water pressure head above the pipe crown for 10 minutes. Moisture or beads of water appearing on the surface of the joint are not considered leakage. Perform the test on individual joints at the manufacturer's plant.

Test joint watertightness on pipe sections in straight alignment and on pipe sections deflected from straight alignment. When you test joints on pipe sections not in straight alignment, position the pipe sections to create a gap on one side of the outside pipe perimeter that is 1/2 inch wider than the gap for the pipe sections in straight alignment. If you use coupling bands to test the pipe sections not in straight alignment and the maximum gap on one side of the outside pipe perimeter is less than 1/2 inch wider than that for the pipe sections in straight alignment, position the coupling band and the pipe sections to provide the maximum gap.

61-2.01D(2)(b) Performance Specifications

For joint systems and couplers under section 61-2.01D(2)(b), determine the values for joint properties by mathematical analysis or an authorized test. Joint components subject to bending forces must not be stressed beyond the minimum specified yield strength of the material as determined by using the plastic section modulus.

Joint systems or couplers must:

1. Perform their intended function
2. Possess durability equivalent to that of the pipe
3. Comply with the quality characteristics shown in the following table:

Joint Classification Requirements

Quality characteristic	Requirement		
	Standard	Positive[a]	Downdrain[b]
Shear strength (min, %)	2	5	5
Moment strength (min, %)	0	15	15
Tensile strength			
6"–42" dia[c,] (min, lb)	0	0	5,000
45"–84" dia[c] (min, lb)	0	0	10,000
Joint overlap[d]			
Integral			
12" and smaller dia[e] (min, in)	1/4	1/2	--
15"–33" dia[e] (min, in)	1/2	3/4	--
36" and larger dia[e] (min, in)	3/4	1	--
Sleeve width (min, in)	10-1/2	10-1/2	10-1/2
Watertightness	Where described	Where described	Required

[a]Positive joints must comply with either (1) shear strength, moment strength, and joint overlap-sleeve properties, or (2) shear strength and joint overlap-integral characteristics.
[b]Joints for downdrains have at least the specified values when tested with joints sealed to comply with the watertightness requirement.
[c]Limits for corrugated metal pipe arch depend upon the equivalent diameter of circular pipe under AASHTO M 36 for corrugated steel pipe and AASHTO M 196 for corrugated aluminum pipe.
[d]Joints designed to comply with required values by means other than joint overlap as shown in the table may be used if authorized.
[e]Inside diameter of circular pipes or inside horizontal dimension of oval or arch pipes.

61-2.01D(3) Field Leakage Testing

61-2.01D(3)(a) General

Perform field leakage testing on culverts and drainage structures wherever field leakage testing is shown.

Field leakage testing includes:

1. Cleaning and presoaking pipes
2. Installing and removing bulkheads or plugs necessary to perform tests
3. Removing and disposing of waste materials
4. Retesting
5. Repairing
6. Changing the drainage system to comply with specifications for field leakage testing

For pipe systems less than 1,500 feet in length, test all joints for leakage.

For pipe systems 1,500 feet or greater in length, test each pipe system for leakage at locations selected by the Engineer at a rate of:

1. 50 joints per 100 pipe joints for pipe systems less than 1 mile in length
2. 30 joints per 100 pipe joints for pipe systems from 1 mile to 3 miles in length
3. 20 joints per 100 pipe joints for pipe systems more than 3 miles in length

For every selected joint or section that fails leakage requirements, the Engineer may select up to 4 more joint locations or sections between joints for testing.

Clean the pipe and remove debris and sediment before you start testing.

Clean and test each pipe system and appurtenances by using the exfiltration, infiltration, low-pressure air, or negative air pressure method, except the Engineer must approve the use of the infiltration test if the groundwater table is low. You may test installed pipe joints using air or water under low pressure. Field leakage testing is conducted after backfilling.

Do not use your test equipment until it is authorized. The Engineer may require a calibration test of gauges or other instrumentation.

Use only 1 leak test method on a contiguous pipe system unless the pipe type or diameter changes in the same run.

Complete the cleaning and testing of each pipe system between inlets or ends within 20 days after backfilling for storm drain lines and structures.

Perform each test in the presence of the Engineer.

Prevent joints from separating during a test. Repair any damage resulting from the field leakage test.

Take corrective action and retest the line if the leakage exceeds the allowable quantity. Determine the leak source and repair or replace the defective pipe whenever an installed pipe system fails to comply with the requirements under the test method used.

The Engineer does not accept a pipe installation if it fails to pass the field leakage test.

Stop all obvious leaks even if the leakage is below the allowable quantity.

61-2.01D(3)(b) Exfiltration and Infiltration Testing

Exfiltration and infiltration tests must comply with ASTM C969 except:

1. You may fill the pipe with clear water to allow normal absorption into the pipe wall before performing the exfiltration leakage test. Start the leakage test within 72 hours after filling the pipe and complete the field leakage test within 24 hours thereafter. The test period must be at least 1 hour in duration. For plastic and metal pipe, the absorption period is not required.
2. Leakage must not be more than 1,000 gallons per inch of nominal pipe diameter per mile of pipe per day with a minimum test pressure of 6 feet of water column above the pipe crown at the upper end of the pipe or above the active groundwater table, whichever is higher. Limit the length of pipe you test such that the pressure on the invert of the lower end of the section does not exceed 20 feet of water column. Increase the allowable leakage by 8 percent for each increase in pressure of 1.5 feet above the basic 6-foot water column measured above the crown or at the lower end of the section.
3. Whenever a suitable head of groundwater exists above the pipe crown and if the pipe is large enough to work inside, the Engineer may accept the installed pipe on the basis of visible leakage repair during the infiltration leakage test.
4. Take into account all lateral or side storm drains included in the test section in computing the allowable leakage. Make an allowance of 0.2 gallons per hour per foot of head above the invert for each junction structure or drainage inlet included in the test section.

Storm drains, side storm drains, and fittings must be open, clean, and free draining upon final completion of the work.

61-2.01D(3)(c) Low-Pressure Air Test

You may use the low-pressure air test instead of the exfiltration test or the infiltration test for pipes 30 inches in nominal diameter or less. You may prewet the pipes. Test pipes from inlet to inlet or shorter lengths. Do not use the low-pressure air test for drainage pipes over 30 inches in nominal diameter regardless of the material type. If you use a low-pressure air test, perform the test immediately following pipe cleaning.

Brace plugs and bulkheads to prevent release during the low-pressure air test. Locate gauges, air piping manifolds, and valves above the ground. Do not allow anyone to enter a manhole or inlet of a plugged pipe when it is under pressure. Equip the air testing apparatus with a pressure release device, such as a rupture disk or a pressure relief valve, designed to relieve pressure in the pipe at 6 psi when under test.

Start the test after the pressure is stabilized at or above an internal pressure of 3.5 psi greater than the average back pressure of the groundwater that could submerge the pipe. Start recording the time when the internal pressure drops to 3.5 psi. The tested portion of the pipe passes the field leakage test when the pressure drop is less than 1 psi for the time period calculated for the size and length of the pipe to be tested as shown in the following table:

Minimum Test Time for Pressure Drop

Nominal pipe diameter (inches)	Time for pressure drop (minutes/100 feet)
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8

61-2.01D(3)(d) Other Allowable Tests

If authorized, you may test:

1. Pipes over 27 inches in nominal diameter 1 joint at a time under ASTM C1103 instead of the exfiltration test specified in section 61-2.01D(3)(b).
2. Plastic pipe 30 inches or less in nominal diameter with the low-pressure air test specified in ASTM F1417.
3. Pipes 36 inches or less in nominal diameter with the negative 3.5 psi vacuum air pressure test specified in ASTM C1214 instead of the exfiltration test or low-pressure air test specified in section 61-2.01D(3)(b) and 61-2.01D(3)(c). The minimum test times for pressure drop for pipes:
   - 3.1. 30 inches in nominal diameter and smaller must be the same as the low-pressure air test specified in section 61-2.01D(3)(c)
   - 3.2. 33 inches in nominal diameter must be 5.4 minutes per 100 feet
   - 3.3. 36 inches in nominal diameter must be 6.0 minutes per 100 feet

61-2.01D(3)(e) Joints or Pipe Section Not Passing Leakage Testing

Identify joints or pipe sections that exceed the maximum allowable leakage after you complete field leakage testing. Repair and retest the failed joints or pipe sections until they comply with the test requirements.

Repair and retest the failed joints or pipe sections as specified in the repair procedures submitted under section 61-2.01C. If the same joint fails the leakage test a second time, remove and replace the pipe sections on either side of the joint with new pipes. Replace any pipe section that fails. Retest the replaced pipe section for leaks.

61-2.01D(3)(f) Reserved

61-2.02 MATERIALS

Resilient joint material must be a neoprene expanded rubber or sheet rubber gasket, "O" ring rubber gasket, butyl rubber base joint sealant, or other authorized resilient material.

All joints, including any connection, must be capable of transferring the required shear across the joint.

Watertightness must be attained by use of an authorized durable, high-quality, resilient joint material designed to perform the intended function.

61-2.03 CONSTRUCTION

Not Used

61-2.04 PAYMENT

The payment quantity for field leakage testing:

1. Is the length of the pipe that has passed field leakage tests
2. Is measured:
   2.1. Along the invert of the pipe
   2.2. To the inside face of drainage inlets or similar structures that are within the length of the tested pipe
3. Includes the length through elbows, tees, and other fittings that have passed field leakage tests

61-3 ALTERNATIVE CULVERTS

61-3.01 GENERAL

Section 61-3 includes specifications for constructing alternative culverts.

Choose from the types of alternative culverts shown.

Reinforced concrete pipe must comply with section 65.

Corrugated steel pipe and pipe arches must comply with section 66.

Corrugated aluminum pipe and pipe arches must comply with section 66.

HDPE pipe must comply with section 64.

PVC pipe must comply with section 64.

Structural steel plate pipe, arches, and pipe arches must comply with section 67.

Structural aluminum plate pipe, arches, and pipe arches must comply with section 67.

Reinforced concrete box culverts must comply with section 51.

Alternative culverts include concrete collars and concrete tees and reinforcement for connecting new pipe to existing or new facilities.

61-3.02 MATERIALS

Concrete for the collars and tees must be minor concrete.

Reinforcement for the concrete collars or tee connections must comply with section 52.

61-3.03 CONSTRUCTION

Not Used

61-3.04 PAYMENT

Not Used

61-4 ALTERNATIVE SLOTTED PIPE

61-4.01 GENERAL

Section 61-4 includes specifications for installing alternative slotted pipe.

Choose from the types of alternative slotted pipe shown. Do not mix different types of slotted pipe in the same installation.

Slotted plastic pipe must comply with section 64-3.

Slotted corrugated steel pipe must comply with the specifications for slotted corrugated steel pipe in section 66-2.

61-4.02 MATERIALS

Not Used

61-4.03 CONSTRUCTION

Not Used

61-4.04 PAYMENT

Not Used

61-5 CONCRETE BACKFILL FOR PIPE TRENCHES

61-5.01 GENERAL

61-5.01A Summary

Section 61-5 includes specifications for placing concrete backfill in pipe trenches.

61-5.01B Definitions

Reserved

61-5.01C Submittals

If RSC is used for concrete backfill, submit the concrete mix design and test data from an authorized laboratory at least 10 days before excavating the pipe trench. The laboratory must specify the cure time required for the concrete mix to attain a 500 psi compressive strength when tested under California Test 521.

61-5.01D Quality Assurance

Reserved

61-5.02 MATERIALS

Concrete backfill must comply with the specifications for minor concrete, except the concrete must contain at least 380 pounds of cementitious material per cubic yard.

You may use RSC for concrete backfill except:

1. Section 90-1 does not apply
2. RSC must comply with minor concrete sections 90-2.01C, 90-2.01D, 90-2.02B, 90-2.02C 90-2.02D and 90-2.02E

61-5.03 CONSTRUCTION

For installation of plastic pipe where saturated clay, peat, or other unsuitable material is encountered immediately adjacent to the pipe trench, the material must be removed to a distance at least equal to 1/4 of the pipe diameter, but not less than 6 inches, on each side of the pipe.

Place concrete backfill in the trench against undisturbed material at the sides and bottom of the trench in a way that prevents (1) floating or shifting of the pipe and (2) voids or segregation of the concrete. Immediately remove foreign material that falls into the trench before or during placement of the concrete. Construct and compact earth plugs at the ends of the planned concrete backfill to contain the concrete within the trench where necessary.

Wherever minor concrete is used, do not place materials on top of the concrete backfill within 8 hours of placing the concrete backfill.

Wherever RSC is used, do not place materials on top of the concrete backfill before the required cure time to attain 500 psi has elapsed.

Consolidate concrete backfill using high-frequency internal vibrators.

If HMA is to be placed directly on the concrete backfill, broom the surface with a heavy broom to produce a uniform rough surface.

61-5.04 PAYMENT

The payment quantity for concrete backfill (pipe trench) is the volume determined from the dimensions shown and the length of pipe if the limits of concrete backfill are shown.

If the limits of concrete backfill are not shown, the payment quantity for concrete backfill (pipe trench) is the volume determined as follows:

1. Horizontal limits are determined from vertical planes 6 inches outside of each side of the pipe for a diameter or span of less than 42 inches and 12 inches outside of each side of the pipe for a diameter or span of 42 inches or greater.
2. Upper limit is determined from a horizontal plane 12 inches above the top of the pipe.
3. Lower limit is determined from a horizontal plane at the bottom of the pipe.
4. If alternative pipe is shown, the payment quantity for concrete backfill (pipe trench) is determined from the required trench width for the alternative pipe with the smallest outside diameter and the length of the pipe.
5. Volume occupied by the pipe is not included in the payment quantity. Concrete backfill placed outside of these limits is not included in the payment.

61-6 TEMPORARY CULVERTS

61-6.01 GENERAL

Section 61-6 includes specifications for constructing temporary culverts.

Temporary culverts include pipe bends, wyes, tees, and other branches.

Excavation, backfill, and shaped bedding must comply with section 19-3.

61-6.02 MATERIALS

You may install a removed, undamaged, temporary culvert in the permanent work if it complies with the specifications for the permanent culvert and it is new when installed as a temporary culvert on the project.

61-6.03 CONSTRUCTION

Install a size and type of temporary culvert capable of sustaining the intended load and discharging a quantity of water equivalent to the type and size of culvert shown. Obtain authorization for the strength and capacity of the culvert before its installation.

Excavate and backfill the trench for a temporary culvert in a way that provides a firm, nonsettling foundation for the roadbed to be constructed over the culvert.

61-6.04 PAYMENT

The payment quantity for temporary culvert:

1. Is the length measured along the centerline of the pipe and parallel with the slope line.
2. Includes the length of pipe reducers, bends, wyes, tees, and other branches to the point of intersection. The length of pipe reducer is included in the length of the larger diameter pipe connected to the reducer.
3. Is the length of pipe necessary to be placed before cutting, measured in 2-foot increments, if the pipe is cut to fit a structure of slope.

61-7 TEMPORARY SLOTTED PIPE

Reserved

61-8–61-15 RESERVED

62–63 RESERVED

64 PLASTIC PIPE

64-1 GENERAL

64-1.01 GENERAL

64-1.01A Summary

Section 64-1 includes general specifications for fabricating and installing plastic pipe.

64-1.01B Definitions

Reserved

64-1.01C Submittals

Submit a certificate of compliance for plastic pipe, including the average pipe stiffness, resin material cell classification and date of manufacture.

64-1.01D Quality Assurance

Reserved

64-1.02 MATERIALS

Not Used

64-1.03 CONSTRUCTION

Not Used

64-1.04 PAYMENT

Not Used

64-2 PLASTIC PIPE

64-2.01 GENERAL

64-2.01A Summary

Section 64-2 includes specifications for fabricating and installing plastic pipe.

Installing plastic pipe includes excavation, backfill, connection of new pipe to new or existing facilities, reinforcement, concrete collars or tees, and other connecting devices.

64-2.01B Definitions

Reserved

64-2.01C Submittals

For corrugated polyethylene pipe, submit the manufacturer's copy of plant audits and test results from the National Transportation Product Evaluation Program for the current cycle of testing for each pipe diameter furnished.

64-2.01D Quality Assurance

Reserved

64-2.02 MATERIALS

64-2.02A General

Plastic pipe must be Type C or Type S corrugated polyethylene pipe or corrugated PVC pipe with smooth interior.

The residue from the ignition of HDPE and PVC compounds must not exceed 30 percent as determined under ASTM D2584 except the muffle furnace temperature must be 840 ± 45 degrees F.

Pipes and fittings must be homogenous throughout and uniform in color, opacity, density, and other properties. The inside and outside surfaces must be semimatte or glossy in appearance and free of chalky, sticky, or tacky material. The pipe walls must be free of cracks, holes, blisters, voids, foreign inclusions, or other defects affecting the pipe wall integrity or visible to the naked eye. Do not use pipes or fittings with abrasions or scratches deeper than 10 percent of the wall thickness. The joint surfaces where

the gaskets bear must be smooth and free of imperfections, ridges, fractures, or cracks that could adversely affect the joint seal.

Store pipes in unit packages and protect the bell end of the pipes from damage. Support unit packages with racks or dunnage to prevent damage and bending. If unit packages are stacked, do not allow the weight of the upper units to cause deformation to the pipes in the lower units. Do not store pipes adjacent to heat sources. Do not allow pipes to overhang vehicles or storage areas unsupported by more than 3 feet.

Cover pipes to provide temporary sun block protection. Provide adequate air circulation around the covered pipes to reduce excessive heat accumulation. Protect gaskets from exposure to weather, heat, ozone, oil, grease, and sunlight for any time period exceeding 48 hours. Do not store gaskets near electrical or exhaust heat sources.

The Department rejects pipes with cracked or split gaskets.

Protect pipes and fittings from damage when handling and installing.

64-2.02B Backfill

Structure backfill material for plastic pipe must comply with section 19-3 except the gradation of structure backfill must comply with the following table:

Gradation of Structure Backfill for Plastic Pipe

Sieve size	Percentage passing
1-1/2"	100
No. 4	25–70
No. 50	5–20
No. 200	0–5

Controlled low-strength material and slurry cement backfill must comply with section 19-3.

64-2.02C Corrugated Polyethylene Pipe

Corrugated polyethylene pipe must be 60 inches or less in nominal diameter.

Type C and Type S corrugated polyethylene pipe must be manufactured from HDPE virgin compounds and comply with AASHTO M 294.

HDPE compounds used in the manufacture of corrugated polyethylene pipe and fittings must comply with AASHTO M 294 except the mix must contain from 2 to 4 percent well-dispersed carbon black.

The corrugated polyethylene pipe manufacturer must:

1. Participate in the National Transportation Product Evaluation Program for each plant supplying corrugated polyethylene pipe and fittings for the project
2. Conduct and maintain a quality control program under National Transportation Product Evaluation Program

64-2.02D Corrugated PVC Pipe with Smooth Interior

Corrugated PVC pipe must have smooth interior and be manufactured as a single extrusion. The corrugated exterior profile must be annular and seamless. The pipe dimensions, wall thickness, socket sizes, and fitting tolerances must comply with ASTM F949.

The minimum stiffness of corrugated PVC pipe must be 46 psi when tested under ASTM D2412.

Corrugated PVC pipe and fittings must be manufactured from PVC virgin compounds, except clean, reworked, recycled PVC materials generated from the manufacturer's pipe or fitting fabrication may be reused.

Corrugated PVC pipe must comply with ASTM F949 for cell classification 12454 under ASTM D1784. Fillers that lower the tensile strength of the compound or change the minimum cell classification are not

allowed. PVC compounds must contain at least 0.5 percent by weight rutile titanium dioxide or the quantity recommended by the pipe manufacturer.

The chemical resistance of corrugated PVC pipe and fittings must comply with ASTM D5260 for cell classification S47552.

The manufacturer's code must include the day, month, year, shift, and plant of manufacture.

Do not expose pipes to direct sunlight for more than 30 days.

64-2.02E Joints

Plastic pipe joints must comply with section 61-2.01D(2)(b) for standard or positive joints. Where sleeve joint connections are used, the sleeve width must be at least 7-3/4 inches and engage at least 2 corrugations of each pipe being joined.

Joints for pipes shown as watertight must be watertight under pressure and all conditions of expansion, contraction, and settlement, and must comply with section 61-2.01D(2)(a) for watertightness.

For corrugated polyethylene pipe:

1. If watertight joints are shown, use Type S corrugated polyethylene pipe with gaskets. If watertight joints are not shown, use gasketed joints when specified. Gaskets for Type C corrugated polyethylene pipe must be installed on each side of the joint. Gaskets must comply with ASTM F477 and be factory-installed.
2. Corrugated polyethylene pipe joints manufactured to comply with section 61-2.01D(2)(b) for integral joints must be laid to line and grade with sections closely jointed. Corrugated polyethylene pipe to be joined by sleeve joints must be laid to line and grade with the separate sections not more than 1-1/2 inches apart and then firmly joined together with at least 2 corrugations from each pipe section engaged in the coupler.

For corrugated PVC pipe with smooth interior:

1. Elastomeric gaskets must comply with ASTM F477 for low-head applications. Use extruded or molded gaskets cured in a way so that any cross section will be dense, homogeneous, and free of pores, blisters, pitting or other imperfections. Double gaskets must be single-piece gaskets that fit into the first 2 full corrugation valleys on the spigot end. Ship gaskets in containers that will prevent damage from UV exposure and handling.
2. Wyes, tees, reducers, elbows, couplings, laterals, and other fittings must be molded or fabricated under ASTM F949 for cell classification 12454 or 13343 as specified in ASTM D1784.
3. Lubricant must comply with the pipe manufacturer's instructions. The lubricant must not have a detrimental effect on gaskets or pipes.
4. Joints must comply with section 61-2.01D(2)(b) for integral joints except the joint overlap requirements are as shown. Pipe joints must be bell and spigot type with gaskets ready for field assembly. Install joints so that the elastomeric gasket will be compressed radially between the pipe bell and spigot to form a tight seal when assembled.

64-2.02F–64-2.02H Reserved

64-2.03 CONSTRUCTION

64-2.03A General

Install Type C corrugated polyethylene pipe wherever corrugated interior wall type is shown.

Install Type S corrugated polyethylene pipe or corrugated PVC pipe wherever smooth interior wall type is shown.

You may install corrugated or smooth interior wall pipe if the type of plastic pipe is not shown.

For PVC pipe, whenever the atmospheric temperature is forecast to be 40 degrees F or less, demonstrate to the Engineer that the bar and block method or any other mechanical assistance method for assembling the pipes will not damage the pipes before proceeding with pipe assembly.

64-2.03B Earthwork

Excavation, backfill, and shaped bedding must comply with section 19-3 except:

1. Where saturated clay, peat, or other unsuitable material is encountered immediately adjacent to the pipe trench, remove the material to a distance at least equal to the pipe diameter on each side of the pipe if compacted backfill is to be placed or a distance at least equal to 1/4 the pipe diameter, but not less than 6 inches, on each side of the pipe if slurry cement or controlled low-strength material is to be placed.
2. Backfill corrugated polyethylene pipe greater than 48 inches in nominal diameter with either controlled low-strength material under section 19-3.02G or with slurry cement backfill under section 19-3.02E.
3. Place controlled low-strength material or slurry cement backfill used for structure backfill to a level at least 12 inches above the pipe crown.

Lay plastic pipe in a trench excavated to the established lines and grades. Grade and prepare the bottom of the trench as shown throughout the entire length of the pipe.

Removing unsuitable material and replacing it with suitable material is change order work.

64-2.03C Pipe Placement

Provide the necessary facilities for lowering and properly placing pipe sections in the trench.

Lay plastic pipe to line and grade with sections closely jointed.

Do not let the pipe trench flood before backfilling.

Construct concrete collars or tee connections with minor concrete whenever concrete collars or tee connections are required to connect new plastic pipe to existing or new pipe. Reinforcement for concrete collars and tees must comply with section 52.

For corrugated PVC pipe with smooth interior:

1. Install gaskets on pipe spigots after the pipe is placed into the trench and ready for joint connection. Place the gasket on the spigot end under the pipe manufacturer's installation instructions. The leading edge of the gasket must point toward the spigot end whenever a double gasket is used. Both the spigot and bell ends must be free of debris before connection. Apply the pipe manufacturer's recommended lubricant to the inside of the bell and over the gasket. Insert the spigot end of the pipe into the bell end until the factory provided insertion line on the spigot end lines up with the bell edge.
2. Whenever the spigot end of a pipe is shortened, cut the end square and bevel it to the same angle as provided on the factory-finished spigot end so that burrs are not visible. Re-mark the shortened pipe with a new insertion line on the spigot using a factory-marked spigot insertion line as a guide.
3. Cover the ends of installed corrugated PVC pipe that were not backfilled after installation at the end of each day.
4. Pipes must not exhibit deflection in excess of 5 percent of the original inside diameter at any location after being backfilled to at least 5 feet above the top of the pipe or to the completed grade, whichever is less.

64-2.04 PAYMENT

The payment quantity for plastic pipe:

1. Is the length designated by the Engineer
2. Is measured along the centerline of the pipe and parallel with the slope line
2. Includes the length of pipe elbows, wyes, tees, and other branches to the point of intersection
3. Is the length of pipe necessary to be placed before cutting, measured in 2-foot increments, if the pipe is cut to fit a structure or slope

64-3 SLOTTED PLASTIC PIPE

64-3.01 GENERAL

64-3.01A Summary

Section 64-3 includes specifications for constructing slotted plastic pipe.

Slotted plastic pipe includes structure excavation, concrete backfill, connecting new pipe to new or existing facilities, concrete collars, reinforcement, and other connecting devices.

64-3.01B Definitions

Reserved

64-3.01C Submittals

If an *or* equal slotted plastic pipe is being considered, it must be submitted 30 days before installation for approval.

If RSC is used for concrete backfill for slotted plastic pipe, submit the concrete mix design and test data from an authorized laboratory 10 days before excavating the pipe trench. The laboratory must specify the cure time required for the concrete mix to attain 2,000 psi compressive strength when tested under California Test 521.

Heel-resistant grates if specified must be submitted 30 days before installation for approval. Anchorage details must be included in the submittal.

64-3.01D Quality Assurance

Reserved

64-3.02 MATERIALS

64-3.02A General

Not Used

64-3.02B Slotted Plastic Pipes

Slotted plastic pipe must be one of the following or equal:

Slotted Plastic Pipe

12" diameter	18" diameter
Zurn Z888-12	Zurn Z888-18
ACO Qmax 350	ACO Qmax 365
ADS Duraslot-12	ADS Duraslot-18

64-3.02C Concrete Backfill

Concrete for concrete backfill for slotted plastic pipe must comply with the specifications for minor concrete. You may use RSC instead of minor concrete for concrete backfill.

If RSC is used for concrete backfill, the RSC must:

1. Contain at least 590 pounds of cementitious material per cubic yard
2. Comply with section 90-3.02A, except section 90-1 does not apply
3. Comply with section 90-2

64-3.02D Heel-Resistant Grates

Heel-resistant grate must:

1. Be designed to carry traffic loadings
2. Comply with ADA requirements
3. Be constructed of steel or cast iron
4. Be provided by the same manufacturer of the slotted plastic pipe
5. Comply with the manufacturer's instructions

64-3.02E Bar Reinforcement

Bar reinforcement must comply with ASTM A615/A615M, Grade 60 or ASTM A706/A706M, Grade 60.

64-3.02F Miscellaneous Metal

Ductile iron, nuts, bolts, and washers must comply with section 75.

64-3.02G Grout

Grout must be non-shrink grout complying with ASTM C1107/C1107M.

64-3.02H Curing Compound

Non-pigmented curing compound must comply with ASTM C309, Type 1, Class B.

64-3.02I End Caps

End cap must:

1. Be provided by the same manufacturer of the slotted plastic pipe
2. Prevent concrete backfill from entering the pipe

64-3.03 CONSTRUCTION

64-3.03A General

Cover the grate slots with heavy-duty tape or other authorized covering during paving and concrete backfilling activities to prevent material from entering the slots.

64-3.03B Preparation

Pave adjacent traffic lanes before installing slotted plastic pipes.

Excavation must comply with section 19-3.

64-3.03C Installation

Lay and join slotted plastic pipes under the pipe manufacturer's instructions.

Lay pipes to line and grade with sections closely jointed and adequately secured to prevent separation during placement of the concrete backfill. If the pipes do not have a positive interlocking mechanism like a slot and tongue connection, secure the sections together with nuts, bolts, and washers before backfilling.

The top of slotted plastic pipes must not extend above the completed surface. Position the pipes so that the concrete backfill is flush with the surrounding grade and above the top of the grate from 1/8 to 1/4 inch.

Place channels with the male and female ends facing each other.

Place lateral support bar reinforcement on both sides of the grate slots. The support bar reinforcement must run the full length of the slots.

Anchor heel-resistant grates to the concrete backfill under the manufacturer's instructions.

64-3.03D Concrete Backfill

Wherever minor concrete is used for concrete backfill for slotted plastic pipe, do not allow traffic on top of the backfill within 7 days of placement.

Wherever RSC is used for concrete backfill for slotted plastic pipe, do not allow traffic on top of the backfill before the required cure time of 2,000 psi is achieved.

Place concrete backfill where shown.

Consolidate the concrete backfill with high-frequency internal vibrators.

Texture the concrete backfill surface with a broom or burlap drag to produce a durable skid-resistant surface.

Apply a non-pigmented curing compound to the exposed concrete backfill surface whenever the atmospheric temperature is 90 degrees F or greater after placement.

64-3.03E Transition Fittings

Use transition fittings to connect slotted plastic pipes to drainage inlets. The transition fittings must be supplied by the same pipe manufacturer.

Where welds are required in transition fittings, welds must comply with the pipe manufacturer’s instructions. The completed welds must not have visible pinholes.Fill the gaps around the pipes in the inlet structure wall with non-shrink grout where the pipes connect to an existing drainage structure. Install the grout under the pipe manufacturer's instructions.

Cut the pipes as shown after the grout used to seal the transition fitting has cured for at least 24 hours.

64-3.04 PAYMENT

Slotted plastic pipe is measured along the centerline of the pipe and parallel with the slope line. If the pipe is cut to fit a structure or slope, the payment quantity is the length of pipe necessary to be placed before cutting, measured in 2-foot increments.

64-4–64-10 RESERVED

65 CONCRETE PIPE

65-1 GENERAL

65-1.01 GENERAL

Section 65-1 includes general specifications for constructing concrete pipe.

Excavation, backfill, and culvert beddings must comply with section 19-3.

65-1.02 MATERIALS

Not Used

65-1.03 CONSTRUCTION

Where pipes are connected to inlet and outlet structures, place the ends of the pipes flush or cut them off flush with the structure face.

Lay and joint reinforced concrete pipe used for drainage purposes and dry conduits under generally accepted practices suitable for the purpose intended.

Connect new reinforced concrete pipe to new or existing drainage facilities as shown.

Furnish the necessary facilities for lowering and properly placing pipe sections in the trench.

Clean and then seal each joint with the type of sealing material necessary to make a tight joint to prevent leakage and infiltration.

Lay pipes to lines and grades with the sections closely jointed. Lay pipes upgrade.

Fill any voids occurring in the outer and inner annular sealing material with the same type of sealing material and finish the inside of the joint smooth.

Take every precaution to prevent flooding of the pipe trench before backfilling activities start.

65-1.04 PAYMENT

The payment quantity for concrete pipe is the length measured along the centerline of the pipe and parallel with the slope line. The payment quantity includes the length of bends, wyes, tees, and other branches to the point of intersection.

If pipes are cut to fit a structure or a slope, the payment quantity is the length of pipe necessary to be placed before cutting measured in 2-foot increments. If you construct CIP connection instead of cutting off the pipe to fit the structure, the payment quantity is the length measured along the centerline of the pipe to the inside face of the structure.

65-2 REINFORCED CONCRETE PIPE

65-2.01 GENERAL

65-2.01A Summary

Section 65-2 includes specifications for constructing reinforced concrete pipe.

65-2.01B Definitions

modified designs: Designs that differ from direct designs shown with respect to reinforcement only.

oval shaped pipe: Pipes having major and minor internal axial dimensions described. The minor axis length must be 60 to 65 percent of the major axis length. The 1st dimension designated represents the rise and the 2nd dimension represents the span.

special designs: Designs that differ from direct designs in any respect from those shown.

65-2.01C Submittals

If you choose to use resilient joint materials, submit them for testing and authorization.

For circular reinforced concrete pipe, direct design method, submit:

1. Shop drawings. Modified designs and special designs must comply with the Department's bridge design specifications. For modified designs, do not change the clear coverage between the surface of

the concrete and the outside of the reinforcement or the thickness of the pipe barrel wall shown. Submit 3 sets of shop drawings for initial review by the Office of Design and Technical Services. Submit 6 sets of shop drawings after the initial review for use during construction and by the Office of Design and Technical Services. Shop drawings must include:

1.1. Wall thickness
1.2. Type, size, location, and configuration of the reinforcement
1.3. List of station locations for the pipes, including the size, wall type, and maximum cover height
1.4. Method of excavation, bedding, and backfill for each location

2. Proof of adequacy for modified design and special design proposals. The Engineer will determine the adequacy of modified and special designs based upon compliance with crack requirements and structural design parameters. The Department will not be liable to you for failure to accept any modified design or special design you submit.
3. A copy of the concrete mix design before using the concrete or revising the mix proportions
4. A certificate of compliance for each pipe shipment. The certificate must:
   4.1. Be signed by the manufacturer's quality control representative
   4.2. State that all materials and workmanship comply with the specifications and authorized shop drawings

For nonreinforced concrete pipe substituted for circular reinforced concrete pipe described or chosen by class, submit proof of adequacy for proposed modifications or special designs. Proof must consist of 3-edge bearing tests either (1) certified by an authorized laboratory or (2) the pipe manufacturer's tests witnessed by the Department. The tests must demonstrate the adequacy of the proposed design. A minimum of 3 proof tests will be required for each size and class you supply.

65-2.01D Quality Assurance

65-2.01D(1) General

Before hydrostatic testing, reinforced concrete pipe must be tested under the 3-edge bearing method to a maximum D-load that is 10 percent greater than the 0.01-inch cracking D-load under AASHTO M 170 or to the actual D-load required to produce a 0.01-inch-wide crack, whichever is less.

65-2.01D(2) Field Testing of Siphon and Pressure Pipe

Perform field leakage tests on siphons and low-head conduits with internal hydrostatic heads not exceeding 50 feet.

Fill the pipe with water to a hydrostatic head of 10 feet above the highest point in the line after the pipe has been laid and backfill has been placed and compacted to a minimum of 2 feet above the pipe.

Conduct a hydrostatic test for a period of not less than 24 hours. Make accurate measurements of the water required to maintain the test pressure during that period. Any leakage developed by the test must not exceed the allowable leakage as computed by the following formula:

$E = 0.00002H^{1/2}LD$

where:
E = allowable leakage in gpm
H = difference in elevation in feet between the water surface at 10 feet above the highest point in the line and the invert elevation of the pipe at its lowest point
L = length of the culvert or drainage pipe in feet
D = internal diameter of the pipe in inches

Furnish all water, materials, and labor for the hydrostatic test. Conduct all hydrostatic tests in the presence of the Engineer. The Department does not pay for hydrostatic testing.

Stop any leakage in excess of the allowable leakage as authorized. Repeat the hydrostatic test until the total leakage does not exceed the allowable leakage. Stop all obvious leaks whether or not the leakage from the line exceeds the allowable leakage.

You may maintain the pipe line full of water for not more than 8 hours before you start hydrostatic testing.

65-2.01D(3) Circular Reinforced Concrete Pipe, Described or Chosen by Class

The basis for acceptance of reinforced concrete pipe over 24 inches in nominal diameter is determined from results of the 3-edge bearing test for the load to produce a 0.01-inch-wide crack. Testing to the ultimate load is not required except as necessary to obtain samples for the absorption test.

Pipes 24 inches in nominal diameter and smaller do not need to be tested to the load to produce a 0.01-inch-wide crack if the pipe is subjected to a load equivalent to the ultimate test load and complies with section 65-2.02. Instead of broken pipe pieces obtained as specified above, you may furnish 4-inch-diameter cores from pipe sections selected by the Engineer for performing the absorption test. Pipe sections that have been tested to the actual 0.01-inch-wide crack will not be load-tested further, and those sections that comply with or exceed the required strength and workmanship standards may be used in the work if authorized.

65-2.01D(4) Circular Reinforced Concrete Pipe, Direct Design Method

Sample and test the concrete compressive strength under AASHTO M 170 at least once every production shift, but not less than once daily.

The 3-edge bearing test does not apply to direct design method pipes.

65-2.01D(5) Oval Shaped Reinforced Concrete Pipe

The basis for acceptance of oval shaped reinforced concrete pipe larger than an equivalent 24-inch-nominal-diameter circular pipe must be determined by the results of the 3-edge bearing test for the load to produce a 0.01-inch-wide crack. Testing to the ultimate load will not be required except as necessary to obtain samples for the absorption test.

Oval shaped reinforced concrete pipe 24 inches in nominal diameter and smaller does not need to be tested to the load to produce a 0.01-inch-wide crack if the pipe is subjected to a load equivalent to the ultimate test load and complies with section 65-2.02. Instead of broken pipe pieces obtained as specified above, you may furnish 4-inch-diameter cores from pipe sections selected by the Engineer for performing the absorption test. Pipe sections that have been tested to the actual 0.01-inch-wide crack will not be load-tested further, and those sections that comply with or exceed the required strength and workmanship standards may be used in the work if authorized.

65-2.02 MATERIALS

65-2.02A General

The cementitious material and aggregate for concrete pipe must comply with section 90-1.02, except (1) gradation requirements do not apply to the aggregate and (2) the use of SCM must comply with AASHTO M 170.

The concrete for reinforced concrete pipe must contain at least 470 pounds of cementitious material per cubic yard and have a water to cementitious material ratio that does not exceed 0.40 by weight. You may use SCM. Reinforcement must have a minimum cover of 1 inch, except pipes with a nominal diameter of 18 inches or less must have a minimum cover of 3/4 inch.

Special reinforced concrete pipe having concrete cover over the steel reinforcement greater than the cover under AASHTO M 170 must comply with section 65-2.02, except the crack width produced by the D-load test under AASHTO M 170 must be determined by the following formula:

$$b = \frac{t - 3/8d}{t - 3/8d - C} \text{ x } 0.01 \text{ inch}$$

where:

b = Width of crack to be produced instead of 0.01-inch crack under AASHTO M 170
t = Wall thickness of pipe, inches
d = Effective depth of section to be tested, feet
C = Concrete cover over steel reinforcement in excess of cover under AASHTO M 170

If concrete collars or tee connections are required to connect new concrete pipe to new or existing pipes, the concrete collars or tee connections must be constructed of minor concrete. Reinforcement for the concrete collars or tee connections must comply with section 52.

65-2.02B Delivery, Storage and Handling

Rubber gaskets must be stored at 70 degrees F or less. Do not expose rubber gaskets to direct sun rays for more than 72 hours.

Sufficiently protect jointing materials from the air and sun to prevent drying or deterioration.

Keep liquid types of sealing materials in molds or runners.

65-2.02C Circular Reinforced Concrete Pipe

65-2.02C(1) General

Circular reinforced concrete pipe described by class must comply with section 65-2.02C(2) for the class of pipe described.

If the class of pipe is not described and the nominal diameter is less than 24 inches, choose the class of pipe. The pipe chosen must comply with section 65-2.02C(2).

Pipes must be marked as specified in AASHTO M 170, except circular pipe sections with elliptical reinforcing must have the location of the minor axis of the reinforcing indicated by 3-inch-wide, waterproof, painted stripes on the inside and outside of each pipe at the top and bottom, at least 12 inches long at each pipe section end, or you may provide a lift hole or lift holes at the top of each pipe along the minor axis of the reinforcement.

If the class of pipe is not described and the nominal diameter is 24 inches or greater, choose either:

1. The class of pipe. The pipe chosen must comply with section 65-2.02C(2).
2. The wall thickness and reinforcement details under section 65-2.02C(3).

If 1 lift hole is provided, the lift hole must be located at the balance point; if 2 lift holes are provided, the lift holes must be spaced equidistant on each side of the balance point. The lift holes must not interfere with the reinforcement. After placing the pipe, fill the open lift holes with cement mortar or concrete plugs before backfilling.

65-2.02C(2) Circular Reinforced Concrete Pipe, Described or Chosen by Class

Circular reinforced concrete pipe described or chosen by class must comply with AASHTO M 170.

If the class of circular reinforced concrete pipe is not described, choose the class of pipe and corresponding method of backfill for the type of installation shown.

If the class of circular reinforced concrete pipe is described, choose the method of backfill for the type of installation shown.

The D-load to produce a 0.01-inch-wide crack must be not less than the specified D-load.

For pipe classes not specified under AASHTO M 170, but within the minimum and maximum size limits under AASHTO M 170, determine the wall thickness and steel area by interpolation from data given in the tables for pipes of the next smaller size and pipes of the next larger size.

For pipe classes, except Class I, that are less than the minimum size for a particular class under AASHTO M 170, the minimum wall thickness must be not less than 1-3/4 inches and the steel area must be not less than 0.06 sq in/lf of pipe barrel.

The Department will grant the authorization required under AASHTO M 170 to extrapolate minimum wall thicknesses and steel areas beyond the limits for wall A or B in table 4 and for wall B in table 5 under AASHTO M 170 if you submit your pipe designs in advance and the pipes comply with all of the specified tests and performance requirements.

For reinforced concrete pipe sizes 36 inches in nominal diameter and smaller, you may substitute nonreinforced concrete pipe if the nonreinforced concrete pipe complies with the following requirements:

1. Minimum 3-edge bearing strength must be the D-load to produce the ultimate load for the class of equivalent reinforced concrete pipe under AASHTO M 170.
2. Pipes must comply with AASHTO M 86M/M 86, Class 1, 2 or 3 as required to comply with the specified D-load requirements. You may request authorization for modified or special designs under AASHTO M 86M/M 86.
3. Cementitious material and aggregate for nonreinforced concrete pipe must comply with specifications for cementitious material and aggregate under section 65-2.02.

65-2.02C(3) Circular Reinforced Concrete Pipe, Direct Design Method

Circular reinforced concrete pipe, direct design method must comply with AASHTO M 170.

The wall thickness and reinforcement you choose must comply with the details shown. Use the backfill method shown for the particular pipe design chosen.

The wall thickness of *Wall X* circular reinforced concrete pipe must not vary by more than 1/4 inch from the wall thickness shown.

Determine the mix proportions for the concrete to be used in direct design method pipes.

Concrete must comply with the specifications for concrete designated by compressive strength.

The circumferential reinforcement for circular reinforced concrete pipe must be smooth or deformed with a minimum yield strength of 65,000 psi. Longitudinal reinforcement must be welded to circumferential reinforcement at not more than 8-inch spacing if the reinforcement is smooth or at not more than 16-inch spacing if the reinforcement is deformed.

Splices of circumferential reinforcement must develop a strength at least equal to $A_{wr} \times F_y$.

Where:
A_{wr} = required area of reinforcement shown, sq in
F_y = specified yield strength of reinforcement, psi

Spacers or stirrups may be welded to the longitudinal reinforcement. The welding of spacers or stirrups will be allowed on not more than 10 percent of the circumferential reinforcement at not less than 24-inch spacing along the pipe length. The strength of the circumferential reinforcement across the completed welds must be at least equal to $1.1 \times A_{wr} \times F_y$ where spacers or stirrups are welded to the circumferential reinforcement in excess of the above requirements or where longitudinals are welded to the circumferential reinforcement.

If you determine that handling and installation stresses require additional reinforcement, furnish and place additional reinforcement. The Department does not pay for additional reinforcement required for handling and installation stresses.

Markings for circular reinforced concrete pipe, direct design method must comply with AASHTO M 170, except the pipe class marking is not required. The markings under AASHTO M 170 must be supplemented with the Contract number, maximum cover height, and method of backfill.

65-2.02D Oval Shaped Reinforced Concrete Pipe

Oval shaped reinforced concrete pipe must comply with AASHTO M 207M/M 207.

The Department will grant the authorization required under AASHTO M 207/M 207 to extrapolate the minimum wall thicknesses and steel areas beyond the limits in table 1 and table 2 under AASHTO M 207M/M 207 if you submit your pipe designs in advance and the pipes comply with the specified tests and performance requirements.

Special oval shaped reinforced concrete pipe having concrete cover over the steel reinforcement greater than the cover specified under AASHTO M 207M/M 207 must comply with section 65-2.02C, except the crack width produced by the D-load test under AASHTO M 207M/M 207 must be determined by the following formula:

$$b = \frac{t - 3/8d}{t - 3/8d - C} \times 0.01 \text{ inch}$$

where:

b = Width of crack to be produced instead of 0.01-inch crack under AASHTO M 207
t = Wall thickness of pipe, inches
d = Effective depth of section to be tested, feet
C = Concrete cover over steel reinforcement in excess of cover under AASHTO M 207M/M 207

65-2.02E Reserved

65-2.02F Joints

Joints for culvert and drainage pipes must be standard joints unless the classification is described.

At your choosing, concrete pipe joints must comply with the details shown or section 61-2.01D(2)(b).

Unless described otherwise, sealing materials must be one or more of the following:

1. Cement mortar composed of 1 part portland cement and 2 parts sand by volume and the following:
   1.1. Well graded sand passing a no. 8 sieve.
   1.2. Mix materials to a consistency suitable for the purpose intended. Use the mortar within 30 minutes after you add the mixing water.
   1.3. You may use admixtures of hydrated lime, fire clay, diatomaceous earth, or other authorized inert material in the mortar to facilitate workability. Obtain authorization for the quantity of admixture.
2. Rubber gasketed joints complying with ASTM C443. Rubber gasketed joints must be:
   2.1. Flexible and able to withstand expansion, contraction, and settlement.
   2.2. The type of rubber gaskets requiring lubrication. Lubricate the rubber gaskets with lubricant recommended and supplied by the pipe manufacturer.
3. Resilient joint materials consisting of polyvinyl chloride, fiberglass impregnated with epoxy resin, or other suitable resilient materials.

You may use other joint sealant materials that prevent leakage and infiltration if authorized.

Joints for siphons and pressure pipes and joints for pipes shown as watertight must be watertight under pressure and all conditions of expansion, contraction, and settlement, and must comply with section 61-2.01D(2)(a) for watertightness.

65-2.03 CONSTRUCTION

65-2.03A General

Reserved

65-2.03B Earthwork

Lay the pipe in a trench excavated to the lines and grades established by the Engineer. Grade and prepare the bottom of the trench to provide a firm and uniform bearing throughout the entire pipe length.

You may partially or completely backfill culvert pipe trenches while the joint mortar is still plastic. If the joint mortar sets before you place the backfill, do not backfill the pipe trench within 16 hours after jointing the pipe sections.

65-2.03C Laying Pipe

Reinforced concrete pipe used for siphons and low-head conduits with internal hydrostatic heads not exceeding 50 feet must have watertight joints under pressure and all conditions of expansion, contraction, and settlement.

Place circular pipe with elliptical reinforcement with the minor axis of the reinforcement in the vertical position.

Pour or pump liquid materials into the joint space in a continuous operation and agitate until the joint is completely filled.

Do not allow free water to come in contact with the pipeline until portland cement sealing materials have set at least 24 hours.

65-2.04 PAYMENT

Not Used

65-3 NONREINFORCED CONCRETE PIPE

65-3.01 GENERAL

Section 65-3 includes specifications for constructing nonreinforced concrete pipe.

Nonreinforced concrete pipe must comply with the requirements in section 65-2 for substitution of nonreinforced concrete pipe for circular reinforced concrete pipe designated or selected by class.

65-3.02 MATERIALS

Reserved

65-3.03 CONSTRUCTION

If you substitute nonreinforced concrete pipe for reinforced concrete pipe, excavation and backfill for nonreinforced concrete pipe must comply with the details shown for reinforced concrete pipe.

65-3.04 PAYMENT

Not Used

65-4–65-10 RESERVED

66 CORRUGATED METAL PIPE

66-1 GENERAL

66-1.01 GENERAL

66-1.01A Summary

Section 66-1 includes general specifications for constructing corrugated metal pipe and pipe arches.

Corrugated metal pipe arches must comply with section 66-1.02E.

Excavation, backfill, and shaped bedding must comply with section 19-3.

66-1.01B Definitions

Reserved

66-1.01C Submittals

Submit a certificate of compliance for:

1. Corrugated steel materials
2. Corrugated aluminum materials

66-1.01D Quality Assurance

66-1.01D(1) General

Reserved

66-1.01D(2)Quality Control

66-1.01D(2)a Field Testing of Corrugated Steel Pipe Siphons

Perform field leakage tests on corrugated steel pipe siphons.

Fill the pipe with water to a hydrostatic head of 10 feet above the highest point in the line after the pipe has been laid and backfill has been placed and compacted to a minimum of 2 feet above the pipe.

Conduct a hydrostatic test for a period of not less than 24 hours. Make accurate measurements of the water required to maintain the test pressure during the test period. Any leakage developed by the test must not exceed the allowable leakage as computed by the following formula:

$E = 0.00002H^{1/2}LD$
where:
E = allowable leakage in gpm
H = difference in elevation in feet between the water surface at 10 feet above the highest point in the line and the invert elevation of the pipe at its lowest point
L = length of the culvert or drainage pipe in feet
D = internal diameter of the pipe in inches

Furnish all water, materials, and labor for the hydrostatic test. Conduct all hydrostatic tests in the presence of the Engineer. The Department does not pay for hydrostatic testing.

Stop any leakage in excess of the allowable leakage as authorized. Repeat the hydrostatic test until the total leakage does not exceed the allowable leakage. Stop all obvious leaks whether or not the leakage from the line exceeds the allowable leakage.

66-1.02 MATERIALS

66-1.02A General

Corrugated metal pipe must be corrugated aluminum pipe or corrugated steel pipe as described. Do not mix aluminum and steel materials in any installation, except coupling band fastening hardware.

Ship, handle, and lay corrugated metal materials in a way that prevents bruising, scaling, or breaking of the galvanized surface, aluminized surface, or protective coating.

If concrete collars or tee connections are required, construct the collars or tee connections with minor concrete. Reinforcement must comply with section 52.

66-1.02B Dimensions and Thickness

Dimensions and thicknesses shown are nominal and must comply with AASHTO M 36 for corrugated steel pipe and AASHTO M 196 for corrugated aluminum pipe.

The nominal sheet thickness for corrugated metal pipe must be equal to or greater than the nominal thickness described.

Lapped longitudinal seams of riveted pipe arches must be placed in the top arch and must be staggered so as to alternate on each side of the center of the top arch at least 3 inches.

66-1.02C Protective Coatings, Linings, and Paving

Where coating, lining, or paving is shown, pipes must be protected with bituminous coating or bituminous lining, or have the invert paved with one or more of the following materials:

1. Bituminous coating
2. Polymeric sheet coating
3. Bituminous lining
4. Bituminous invert paving

Remove moisture, dirt, oil, unbonded or incompatible paint, grease, alkalies, or other foreign matter from the surface to be protected before application of the coating, lining, or paving material.

The bituminous coating for bituminous coated pipes must be applied to the inside and outside of pipes to a minimum thickness of 0.05 inch under AASHTO M 190, Type A.

An asphalt mastic coating may be used instead of the bituminous coating on corrugated steel pipe if linings and paving are not required. The asphalt mastic must be placed on the outside surface of the pipe. The inside of the pipe does not need to be coated.

Asphalt mastic coatings must comply with AASHTO M 243, except the asbestos fibers are not required. The asphalt mastic material must be applied uniformly to the surface with a thickness of at least 0.05 inch at any point. The asphalt mastic coating must be applied at the fabrication plant. Pinholes, blisters, cracks, or lack of bond are cause for rejection.

Polymeric sheet coatings must comply with AASHTO M 246. The polymeric sheet coating must be applied to both sides of the galvanized sheet before corrugating. The thickness of the coating must be at least 0.010 inch. Pinholes, blisters, cracks, or lack of bond are cause for rejection.

A bituminous lining must be applied to the inside of the pipe over the bituminous coating wherever bituminous lining is shown.

For bituminous lined corrugated metal pipe, the rivet heads inside the pipe must be located in the valley of the corrugation. Provisions must be made at the ends of the pipes to retain bituminous material during the fabrication process. Both the inside and outside surfaces must be bituminous coated under AASHTO M 190, Type A. In addition to this coating, the valleys on the inside periphery must be filled by the centrifugal process with the same type of bituminous material to the extent that the thickness on the crests of corrugations is at least 1/8 inch. The lining must be smooth and uniform, and its surface must be parallel to a line projected along the crests of the corrugations.

Bituminous paving must be applied to the inside bottom portion of the pipe over the bituminous coating under AASHTO M 190, Type C, where bituminous paving is shown.

If protective coatings are applied to pipes, clearly identify the thickness of the metal on each section of pipe and fittings on the inner surface with paint or by other authorized means.

Repair damaged protective coatings, linings, and invert paving. Use bituminous material under AASHTO M 190 or other authorized materials to repair damaged bituminous coatings. Use asphalt mastic material under AASHTO M 243 to repair damaged asphalt mastic coatings. Use tar base material under AASHTO M 243 to repair damaged polymeric sheet coatings.

Coupling bands and connecting hardware for coated pipes must have a protective coating. Coupling bands to be protected by coatings under AASHTO M 190 may be single-dipped with the coating thickness requirement waived.

66-1.02D Coupling Bands

Coupling bands for corrugated metal pipe must comply with either section 66-1.02D or section 61-2.01D(1)(b).

Choose one of the types of corrugated metal pipe coupling bands shown. The metal bands must be corrugated, dimpled, or otherwise formed in a way that will effectively engage the corrugations of the pipe ends.

Coupling bands for corrugated steel pipe must comply with AASHTO M 36. Coupling bands for corrugated aluminum pipe must comply with AASHTO M 196.

If channel or wing channel coupling bands are used, the interior bend radii of the pipe flange and the channel must be at least the thickness of the metal of which they are formed.

Joints for siphons must consist of connections made with coupling bands shown for positive joints. Do not use universal coupling bands.

Joints for siphons and joints for pipes shown as watertight must be watertight under pressure and all conditions of expansion, contraction, and settlement, and must comply with section 61-2.01D(1)(a) for watertightness.

66-1.02E Corrugated Steel Pipe

66-1.02E(1) General

Corrugated steel materials must comply with AASHTO M 36 and be fabricated from either zinc-coated steel sheet or aluminum-coated steel sheet as shown.

Zinc-coated steel sheet must comply with AASHTO M 218, except the coating weight is determined under ASTM A123/A123M and A153/A153M.

Aluminum-coated steel sheet must comply with AASHTO M 274.

66-1.02E(2) Fabrication

66-1.02E(2)(a) General

Corrugated steel pipe must be fabricated by one of the following methods:

1. Riveting
2. Helically corrugated steel pipe with a continuous helical lock seam
3. Continuous helical welded seam paralleling the corrugation

Pipes fabricated from 0.050-inch-thick sheets must be helically corrugated steel pipe with a continuous helical lock seam or a continuous helical welded seam.

Annular corrugated steel pipe must be fabricated from sheets having either 2-2/3-by-1/2-inch or 3-by-1-inch corrugations.

66-1.02E(2)(b) Fabrication by Riveting

Pipes fabricated by riveting must comply with AASHTO M 36.

66-1.02E(2)(c) Fabrication by Continuous Helical Seam

66-1.02E(2)(c)(i) General

Helically corrugated steel pipe must comply with AASHTO M 36.

Helically corrugated pipe must be fabricated using corrugation profiles and continuous helical seam pitches as shown in the following table:

Corrugation Profile

Diameter (Inches)	Nominal pitch[a] (inches)	Max. pitch[a] (inches)	Nominal depth (inches)	Seam pitch[a] (inches)
6–18	1-1/2	1-7/8	1/4	12
12–84	2-2/3	2-3/4	1/2	24
48–120	3	3-1/4	1	21
48–120	5	5-3/16	1	29-1/2

[a]Pitch must be measured at right angles to the direction of corrugations. A tolerance of ±1/2 inch on seam pitch is allowable.

66-1.02E(2)(c)(ii) Fabrication by Continuous Lock Seam

You may use pipes fabricated with a continuous helical lock seam extending from end to end of each length for full circle and equivalent pipe arch sizes. Fabrication must comply with AASHTO M 36.

66-1.02E(2)(c)(iii) Fabrication by Continuous Welded Seam

You may use pipes fabricated with a continuous helical welded seam parallel to the corrugations for full circle and equivalent pipe arch sizes. Control the welding process so that the combined width of the weld and adjacent spelter or aluminum coating burned by the welding does not exceed 3 times the metal thickness.

If the spelter is damaged by the welding outside the specified area, repair the weld and damaged spelter adjacent to the weld under section 75-1.02B

If the metalizing is applied immediately in a continuous operation following the resistance welding, apply a coating of aluminum to the welded area of aluminum-coated pipe using the metalizing process under AWS C2.2, except surface cleaning will not be required.

66-1.02E(3) End Finish

Helically corrugated steel pipe ends may be rerolled to form annular corrugations extending at least 2 corrugations from the pipe end or to form an upturned flange with or without reformed annular corrugations. The diameter of the reformed ends must not exceed that of the pipe barrel by more than the depth of the corrugation. All types of pipe ends, whether rerolled or not, must be matched in a joint so that the maximum difference in diameter of the abutting pipe ends is 1/2 inch.

If the ends of helically corrugated steel lock seam pipes have been rerolled, the lock seam in the rerolled end must not contain visible cracks in the base metal and the tensile strength of the lock seam must be at least 60 percent of the tensile strength required for the remainder of the pipe. This requirement does not apply to the lock seam located within a flange formed in rerolling. The rerolled ends of the pipe and flanges must exhibit good workmanship and must not have open lock seams.

If corrugated steel pipe is rerolled for coupling with a wing channel coupling or a channel coupling band, the maximum distance from any point on the end of the pipe to the plane, normal to pipe axis and passing through the outermost portion of the pipe end, must not exceed 1/2 the width of the channel minus the thickness of the pipe metal. The difference between the minimum and maximum flange diameter must not exceed 1/2 inch.

Fabricate pipes so that they can be joined effectively with the described standard coupling bands.

66-1.02E(4) Damaged Galvanizing

Repair damaged galvanized surfaces under section 75-1.02B.

If you burn the galvanized surfaces by welding, thoroughly clean all the surfaces of the welded connections by wire brushing and remove all traces of the welding flux and loose or cracked galvanizing before repair.

66-1.02E(5) Damaged Aluminum Coatings

Repair damaged aluminum coatings under section 75-1.02B.

66-1.02E(6) Corrugated Steel Pipe Siphons

The thickness of siphons must be the described thickness. If coating is required, coated pipes must comply with section 66-1.02C.

Order pipes for siphons in lengths that will keep the number of field connections to a minimum.

If soldering is required, the outside seams of pipe fabricated by riveting, or continuous helical lock seam must be soldered, the solder being sweated into the joints. If the pipe is fabricated by riveting, rivets on the circumferential seams must be spaced at approximately 2-1/2-inch centers with a maximum spacing of 3 inches. If the pipe is fabricated by a continuous helical welded seam, soldering is not required.

66-1.02F Corrugated Aluminum Pipe

66-1.02F(1) General

Corrugated aluminum materials must comply with AASHTO M 196 and AASHTO M 197.

66-1.02F(2) Fabrication

66-1.02F(2)(a) General

Corrugated aluminum pipe must be fabricated by riveting or with a continuous helical lock seam paralleling the corrugations. Annular or helically corrugated pipe must be fabricated from sheets having 2-2/3-by-1/2-inch or 3-by-1-inch corrugations.

66-1.02F(2)(b) Fabrication by Riveting

Pipes fabricated by riveting must be lap joint construction with annular corrugations. Fabrication must comply with AASHTO M 196.

66-1.02F(2)(c) Fabrication by Continuous Helical Lock Seam

For full circle and equivalent pipe arch sizes, you may install pipes fabricated with a continuous helical lock seam extending from end-to-end of each length. Fabrication must comply with AASHTO M 196.

66-1.02F(3) End Finish

Helically corrugated aluminum pipe ends may be rerolled to form annular corrugations extending at least 2 corrugations from the pipe end. The diameter of the reformed ends must not exceed the diameter of the pipe barrel by more than the corrugation depth. All types of pipe ends, whether rerolled or not, must be matched in a joint so that the maximum difference in diameter of the abutting pipe ends is 1/2 inch.

If the ends of helically corrugated aluminum lock seam pipes have been rerolled, the lock seam in the rerolled end must not contain visible cracks in the base metal and the tensile strength of the lock seam must be at least 60 percent of the tensile strength required for the remainder of the pipe. The rerolled pipe ends must exhibit good workmanship and must not have open lock seams.

Pipes must be fabricated so that they can be joined effectively with the described standard coupling bands.

66-1.03 CONSTRUCTION

Excavate a pipe trench to the lines and grades established by the Engineer. Grade and prepare the trench bottom to provide a firm and uniform bearing throughout the entire pipe length.

Lay annular corrugated pipe in a trench with:

1. Outside laps of circumferential joints upgrade
2. Longitudinal laps positioned other than in the invert
3. Separate sections spaced not more than 1-1/2 inches apart and then firmly joined together

Lay helical corrugated pipe in a trench with separate sections spaced not more than 1-1/2 inches apart and then firmly jointed together with corrugations in alignment.

Corrugations or projections on the coupler must properly engage the corrugations of the pipe section before bolts are tightened.

Connect new corrugated metal pipe to new or existing drainage facilities as shown.

Wherever pipes are connected to inlet and outlet structures, place the ends of the pipes flush or cut them off flush with the structure face.

66-1.04 PAYMENT

The payment quantity for corrugated metal pipe is the length measured along the centerline of the pipe and parallel with the slope line. The payment quantity includes the length of pipe reducers, bends, wyes, tees, and other branches to the point of intersection. Pipe reducers are paid for as pipe of the larger diameter connected to the reducer.

If pipes are cut to fit a structure or slope, the payment quantity is the length of pipe necessary to be placed before cutting, measured in 2-foot increments.

66-2 SLOTTED CORRUGATED STEEL PIPE

66-2.01 GENERAL

Section 66-2 includes specifications for constructing slotted corrugated steel pipe.

66-2.02 MATERIALS

Slotted corrugated steel pipe must be grate-slot type as shown.

Grate assemblies for slotted corrugated steel pipe must comply with section 75-1, but may be fabricated from any of the materials under section 75-1.02 for steel bars, plates and shapes. Any damage to the galvanized surface of the pipe at the toe of the grate assembly fillet weld connection to the pipe must be repaired under section 75-1.02B.

Where a heel guard is shown, the heel guard must be expanded metal and must comply with ASTM F1267, Type II, Class 2, and Grade B. Galvanizing must comply with section 75-1.02B.

Coupling bands for slotted corrugated steel pipe must be galvanized or coated as shown.

Joints must be watertight.

If you use a channel coupling band, place a 3/8-inch-thick closed-cell sponge neoprene gasket or butyl rubber joint sealant in the channel interior for its full width.

If you use a modified hugger band, place a butyl rubber joint sealant between the coupling band and the periphery of the pipe. The butyl rubber joint sealant material must:

1. Be an extruded strip or bead compounded from a nondrying, nontoxic, synthetic resin base with butyl rubber and inorganic extenders and be 100 percent solid material with no shrinkage
2. Be furnished in 5/8-by-1-inch strips or 1-inch-diameter beads on 1-inch-wide release paper and wound into rolls
3. Have enough adhesion so that the strip or bead will adhere to the galvanized steel and be soft enough to allow cold flow if compressed during connection of the pipe sections
4. Not flow or sag at temperatures up to 180 degrees F or become brittle, crack, or lose adhesion at -30 degrees F
5. Contain no migrating components that could leach out or produce a chemical reaction with the galvanized steel

You may use an alternative joint sealant or sealing method for slotted corrugated steel pipe to provide a watertight joint if authorized.

66-2.03 CONSTRUCTION

Do not start installation of slotted corrugated steel pipe until after paving of the traffic lanes adjacent to the pipe have been completed at the locations where the pipe is to be placed.

Join slotted corrugated steel pipe with coupling bands as shown.

Cover pipe slots with a heavy duty tape or other authorized covering during backfilling and paving activities to prevent material from entering the slots.

Place cement treated structure backfill for slotted corrugated steel pipe under the details shown and section 19-3.02E for soil cement beddings. Cover the completed cement treated structure backfill with a curing seal of asphaltic emulsion, Grade SS1 or CSS1.

Do not place loads on the cement treated structure backfill within 16 hours after placement.

66-2.04 PAYMENT

Not Used

66-3 SPIRAL RIB PIPE

66-3.01 GENERAL

Section 66-3 includes specifications for constructing spiral rib pipe.

The specifications for profile and fabrication in section 66-1 do not apply to spiral rib pipe.

66-3.02 MATERIALS

Steel spiral rib pipe must be fabricated by continuous helical lock seam under section 66-1.02E(2)(c)(ii).

Aluminum spiral rib pipe must be fabricated by continuous helical lock seam under section 66-1.02F(2)(c).

The fabricated rib configuration for spiral rib pipe must be one of the following:

1. Three rectangular ribs spaced midway between seams with ribs 3/4 inch wide by 3/4 inch high at a maximum rib pitch of 7-1/2 inches
2. Two rectangular ribs and 1 half-circle rib equally spaced between seams with ribs 3/4 inch wide by 1 inch high at a maximum rib pitch of 11-1/2 inches with the half-circle rib diameter spaced midway between the rectangular ribs
3. For steel spiral rib pipes, 2 rectangular ribs equally spaced between seams with ribs 3/4 inch wide by 1 inch high at a maximum rib pitch of 8-1/2 inches

The rib pitch measured at right angles to the direction of the ribs may vary by ±1/2 inch.

Coupling bands for spiral rib pipes must comply with section 66-1.02D.

You may use the coupling band shown, or an authorized coupling band under section 61-2.01D(2)(b) for use on a pipe corrugation of 2-2/3 by 1/2 inch for corrugated metal pipe on spiral rib pipe having 2-2/3-by-1/2-inch rerolled annular ends.

66-3.03 CONSTRUCTION

Not Used

66-3.04 PAYMENT

Not Used

66-4 COMPOSITE STEEL SPIRAL RIB PIPE WITH SMOOTH INTERIOR

66-4.01 GENERAL

Section 66-4 includes specifications for constructing composite steel spiral rib pipe with smooth interior.

Composite steel spiral rib pipe must have a smooth interior and must comply with the specifications for corrugated metal pipe in section 66-1 except profile and fabrication.

66-4.02 MATERIALS

The precoated exterior of composite steel spiral rib pipe with polymeric sheet coating must comply with section 66-1.02C. The pipe interior must be lined with polyethylene (polyolefin plastomer). The pipe dimensions, wall thickness, and fitting tolerances must comply with ASTM A978/A978M.

Composite steel spiral rib pipe must be fabricated by continuous helical lock seam under section 66-1.02E(2)(c)(ii). Three rectangular ribs must be spaced midway between seams with ribs 3/4 inch wide by 3/4 inch high at a maximum rib pitch of 7-1/2 inches on center. The rib pitch measured at right angles to the direction of the ribs may vary by ±1/2 inch.

Pipes formed from polymer precoated sheets must comply with ASTM A742/A742M, Grade 10, except the sheet side for the pipe interior must have additives that will enhance the bond of the sheet to the extruded polyethylene liner. Before application of protective coatings, the galvanized sheet must be cleaned with an alkaline cleaner followed by chrome pretreatment.

Steel sheets coated with zinc metallic coating must comply with ASTM A929/A929M.

The polyethylene for filling the ribs and the internal liner must be virgin resin. The virgin resin quality characteristics must comply with the values in the following table:

Quality characteristic	Test method	Requirement
Melt index (min)	ASTM D1238	I_2+ 7.5g/10 min ± 1.5
Flow rate ratio	ASTM D1238	I_{10}/I_2=7–8
Density	ASTM D792	0.902 g/cc ± 0.002
Hardness Shore D	ASTM D2240	45 ± 5
Ash content (%)	ASTM D5630	< 1.0

Joint coupling bands fabricated from the steel sheets used to manufacture pipes must comply with section 66-1.02C and section 66-1.02D, except steel sheets with polymeric coating on both sides. Coupling bands must be 12 inches wide for nominal pipe diameters less than 60 inches. Coupling bands must be 24 inches wide for nominal pipe diameters 60 inches and greater.

Galvanized nuts, bolts, and washers must comply with section 75-1.02B.

Expanded rubber gaskets must comply with ASTM D1056, Type 2, Class C, and Grade 1. Protect gaskets from excessive exposure to heat, direct sunlight, ozone, oil, or grease. Gaskets placed over spiral ribs must have a groove routed to match the rib's depth and width before installation. Do not substitute O-rings for gaskets.

The gasket adhesive must be 1 part urethane elastomeric joint sealant under ASTM C920, Type S, Grade NS, Class 25, Use NT, A, and M. Use the sealant within 9 months from the date of manufacture. Store the adhesive at an ambient temperature of 80 degrees F or below. Do not use any adhesive that has been stored at temperatures exceeding 80 degrees F.

Manufactured pipe joints must comply with section 61-2.01D(2)(b) for sleeve joints.

Each standard and random length of pipe must be marked clearly in permanent letters not less than 1/4 inch in height at intervals of 5 feet or less with at least the following:

1. Manufacturer’s code and name or trademark
2. ASTM A978/A978M
3. Nominal pipe size

Each coupling band must be marked clearly with at least the following:

1. Manufacturer’s code and name or trademark
2. ASTM A978/A978M
3. Nominal size

The manufacturer’s code must include the day, month, year, shift, and manufacturing plant.

Store pipes in unit packages with the pipe ends protected from deformation and damage. Support unit packages with racks or dunnage to prevent damage and bending. Stack unit packages to ensure that the weight of the upper units will not cause deformation to pipes in the lower units. Do not store pipes adjacent to electrical or exhaust heat sources.

Do not expose pipes to direct sunlight for periods exceeding 30 days. Cover pipes with an opaque sheeting material to provide sun protection. Arrange the opaque sheeting material so that it provides adequate air circulation around pipes to reduce excessive heat accumulation. Ship gaskets in containers

that will prevent damage from UV exposure and handling. Do not store gaskets near electrical or exhaust heat sources or where they will be exposed to the sunlight for more than 48 hours.

66-4.03 CONSTRUCTION

Lay composite steel spiral rib pipe in the same way specified for helical corrugated pipe in section 66-1.03, except the gap between pipe sections must not be more than 1/2 inch. Clean the pipe ends before applying the adhesive and installing the gaskets and the coupling bands.

Cover the ends of installed composite steel spiral rib pipe that were not backfilled after installation at the end of each day.

Repair damaged polymeric pipe coatings on pipe and pipe fittings. For polymeric coatings with damaged areas less than 36 square inches in area, repair breaks and scuffs under the manufacturer's recommended repair procedures. Do not install a pipe if the individual breaks or total area of the breaks exceeds 36 square inches in area or if the total area of the breaks exceeds 0.5 percent of the total pipe surface area.

The polymer repair material must be one of the following:

1. Denflex Coating - Dennis Chemical Company, St. Louis, MO
2. Scotch-Clad 1706 Protective Coating - 3M Company, St. Paul, MN
3. Ranbar Trispec TPC-515-7 Black Synthetic Coating - P.D. George Company, Manor, PA

Clean and dry surfaces to be coated. The repair coating must be at least 0.010 inches thick after hardening and must bond securely and permanently to the pipe. Apply 6 coats if the thickness of the repair coating is not measured. Allow 30 minutes drying time between the coats.

66-4.04 PAYMENT

Not Used

66-5–66-10 RESERVED

67 STRUCTURAL PLATE CULVERTS

67-1 GENERAL

67-1.01 GENERAL

Section 67-1 includes general specifications for constructing structural plate culverts.

Excavation, backfill, and shaped bedding must comply with section 19-3.

Section 61-2 does not apply.

67-1.02 MATERIALS

Not Used

67-1.03 CONSTRUCTION

Not Used

67-1.04 PAYMENT

Not Used

67-2 STRUCTURAL METAL PLATE PIPE

67-2.01 GENERAL

67-2.01A Summary

Section 67-2 includes specifications for constructing structural metal plate pipe, arches, and pipe arches.

67-2.01B Definitions

Reserved

67-2.01C Submittals

Submit certificates of compliance for structural metal plate pipe, arches, and pipe arches.

Submit a copy of the manufacturer's assembly instructions before assembling structural plates.

67-2.01D Quality Assurance

Reserved

67-2.02 MATERIALS

67-2.02A General

Structural metal plate pipe, arches, and pipe arches must be fabricated from structural steel plates or structural aluminum plates. The type of metal, steel or aluminum is described.

Structural plates, nuts, and bolts for structural steel plate pipe, arches, and pipe arches must comply with AASHTO M 167M/M 167.

Structural plates, nuts, and bolts for structural aluminum plate pipe, arches, and pipe arches must comply with AASHTO M 219. Bolts must be zinc-coated steel and comply with ASTM A449. Nuts must be zinc-coated steel and comply with ASTM A563, Grade C.

Do not mix aluminum and steel materials in the same installation, except steel bolts and nuts on structural aluminum plate pipe.

The thickness of galvanized coating for structural steel plate is determined under ASTM A123/A123M and ASTM A153/A153M.

If welding of steel is required, it must comply with AWS D1.1 "*Structural Welding Code*." Weld steel plates, except fittings, before galvanizing. If welding of aluminum is required, it must comply with AWS D1.2/D1.2M "*Structural Welding Code*." The Engineer may perform nondestructive testing of the welds.

Corner plates must be at least 0.138 inch thick for structural steel plate pipe arches that are 0.109 inch thick.

67-2.02B Protective Coating

Structural steel plate pipe, arches, and pipe arches must be protected with bituminous coating where coating is shown. Coating must comply with section 66-1.02C, except polymeric sheet coatings are not allowed and asphalt mastic may be field applied.

If protective coating is applied to plates for structural steel plate pipe, arches, and pipe arches, each plate must have the nominal metal thickness painted on the inner surface of each plate so that the plate thickness can be readily identified.

After installation, coat the portion of nuts and bolts used for assembly of coated structural steel plate pipe, arches, and pipe arches projecting outside the pipe. The portion of nuts and bolts projecting inside the pipe need not be coated.

If asphalt mastic is used for the protective coating, the surface at pipe joints need not be coated before assembly. Joints must be sealed thoroughly after assembly with the asphalt mastic on the outside of the sealed joint.

Repair damaged coatings under section 66-1.02C.

67-2.02C Identification

If plates of two dissimilar thicknesses are involved in one cross section of an installation, the installation is described by pipe size and by a symbol designating the number and thickness of plates required. For example, the symbol (4.109-1.168) designates an installation for one plate length composed of four 0.109-inch-thick steel plates and one 0.168-inch-thick steel plate, the thicker plates to be centered on the invert. This designation does not prevent you from using fewer plates if the minimum thickness requirements are complied with.

67-2.02D Reserved

67-2.03 CONSTRUCTION

Assemble structural plates under the manufacturer's instructions.

Repair damaged galvanized surfaces under section 75-1.02B.

You may construct pipes and pipe arches with fewer plates than the number designated if the number of plates around the circumference of structural metal plate pipes and pipe arches are described.

Before backfilling, tighten plate section bolts within the ranges shown in the following table:

Bolt diameter (inch)	Torque (ft-lb)
3/4	100–300
7/8	150–350

Place struts as shown during construction of pipes, arches, and pipe arches. Maintain the struts in place until backfill has been placed to the grading plane elevation or 5 feet over the crown, whichever is less. Remove the struts before construction of structures at the ends of pipes, arches, and pipe arches.

Wherever pipes are connected to inlet and outlet structures, place the ends of the pipes flush or cut them off flush with the structure face.

Each side of an arch must rest on a galvanized metal angle or channel bearing that is securely anchored to the footing and capable of resisting the arch thrust without damage to the angle or channel.

67-2.04 PAYMENT

The payment quantity for structural metal plate pipe is the length measured along the centerline of the pipe and parallel with the slope line. The payment quantity includes the length of bends and elbows.

If the pipe is cut to fit a structure or slope, the payment quantity is the length of pipe necessary to be placed before cutting, measured in 4-foot increments.

67-3 METAL LINER PLATE PIPE

67-3.01 GENERAL

67-3.01A Summary

Section 67-3 includes specifications for constructing metal liner plate pipe.

Metal liner plate pipe must be constructed from 2-flange or 4-flange plates.

Pipes must be circular and consist of a series of galvanized corrugated metal liner plates with a minimum width of 18 inches for 2-flange plates and 16 inches for 4-flange plates.

Furnish plates with 2-inch diameter, or larger, grouting holes with pipe plugs. When the plates are installed, grouting holes must be spaced so that one line of holes is at the pipe crown and one line of holes is on each side at approximately the midpoint as shown. The holes in each line must be not more than 6 feet apart, and holes in adjacent lines must be staggered.

67-3.01B Definitions

Reserved

67-3.01C Submittals

Submit a certificate of compliance for metal liner plate pipe.

Submit a copy of the manufacturer's instructions before you assemble pipes.

For tension test specimens, submit mill test reports as specified for plates for each heat and thickness upon notification.

67-3.01D Quality Assurance

Prepare and test specimens for tension under ASTM A283/A283M for plates and ASTM A1011/A1011M for sheets.

67-3.02 MATERIALS

67-3.02A General

The base metal for liner plates must comply with ASTM A1011/A1011M. Ungalvanized flat sheets and plates must comply with the quality requirements in the following table:

Quality characteristics	
Tensile strength (min, psi)	42,000
Yield point (min, psi)	28,000
Elongation in 2 inches (min, %)	30

Galvanize plates under AASHTO M 167M/M 167 after the plates are formed, punched, and curved.

Bolts and nuts for assembling 2-flange plates must not be less than 5/8 inch in nominal diameter. Bolts and nuts for circumferential flange seams must comply with ASTM A307 for Grade A chemical and mechanical requirements and Grade B dimensions. Bolts and nuts for longitudinal seams must have square heads with a square shoulder to engage the plate. Bolts and nuts for longitudinal plate seams from 0.075 to 0.179 inch thick must comply with ASTM A307 for Grade A chemical and mechanical requirements. Bolts for longitudinal plate seams from 0.209 to 0.239 inch or thicker must comply with the chemical and mechanical requirements under ASTM A449. Nuts for use on bolts specified in ASTM A449 must comply with ASTM A307 for Grade A chemical and mechanical requirements and Grade B dimensions.

Bolts and nuts for the assembly of 4-flange plates must not be less than 1/2 inch in nominal diameter for 0.105 to 0.179 inch thick plates and not less than 5/8 inch in nominal diameter for plates of greater thickness. Bolts and nuts must be quick-acting coarse thread complying with ASTM A307.

Galvanize bolts and nuts under ASTM A153/A153M.

The moment of inertia based on the average of 1 ring of plates, must not be less than the values shown in the following table:

Uncoated plate thickness (inch)	Moment of inertia (inches^4/inch)	
	2-flange	4-flange
0.075	0.034	--
0.105	0.049	0.042
0.135	0.064	0.055
0.164	0.079	0.070
0.179	0.087	0.075
0.209	0.103	0.087
0.239	0.118	0.120
0.250	--	0.101
0.313	--	0.123
0.375	--	0.143

Longitudinal seams must have enough bolts to develop the ultimate seam strength shown in the following table:

Uncoated plate thickness (inch)	Strength (lb/ft of length of pipe)	
	2-flange	4-flange
0.075	20,000	--
0.105	30,000	26,000
0.135	47,000	43,000
0.164	55,000	50,000
0.179	62,000	54,000
0.209	87,000	67,000
0.239	92,000	81,000
0.313	--	115,000
0.375	--	119,000

Plates must be:

1. Punched for bolting on both longitudinal and circumferential seams or joints
2. Formed to produce squarely formed flanges
3. Fabricated so that complete erection is from the inside of the pipe

Bolt holes in flanges must be spaced so that plates of the same curvature are interchangeable and to allow staggering of the longitudinal seams. Drilling, punching, or drifting to correct defects in manufacturing is not allowed. Plates with improperly punched holes will be rejected. Circumferential bolt spacing must be approximately 9-1/2 inches center-to-center for 4-flange plates and must be approximately 12-1/2 inches center-to-center for 2-flange plates.

67-3.02B Pressure Grouting

Grout for pressure grouting must consist of a suitable mixture of cementitious material, sand, and a chloride-free admixture designed to provide a pumpable mix. The grout must contain at least 463 pounds of cementitious material per cubic yard and no more water than necessary to provide a pumpable grout. Materials for grout must be commercial quality.

Grout must consist of cement and water and may contain an admixture if authorized.

Admixtures must comply with the specifications for admixtures in section 90, except admixtures must not contain chloride ions in excess of 0.25 percent by weight and may be dispensed in solid form.

Add water to the mixer followed by cement and admixture.

Mix the grout with mechanical mixing equipment that produces a uniform and thoroughly mixed grout.

Do not exceed 5 gal of water per 94 lb of cement. Retempering of grout is not allowed.

Agitate the grout continuously until the grout is pumped.

67-3.02C Reserved

67-3.03 CONSTRUCTION

Install pipes in existing embankments and natural ground by the tunnel method, except you may use open trench methods with shaped bedding near the entrance if authorized.

Excavation must not precede plate installation by more than the width of a plate. Do not leave any excavation, including the face, unsupported except during excavation activities. Voids between the liner plate and the wall of the excavation must be force-grouted within 8 hours of excavation.

Assemble liner plates under the pipe manufacturer's instructions.

Handle plates in a way that prevents bruising, scaling, or breaking of spelter coating. Replace plates damaged during handling or placing, and plates with damaged spelter coating, except you may repair small areas of spelter coating with minor damage under section 75-1.02B if authorized.

Tighten bolts specified in:

1. ASTM A307 to a torque from 25 to 60 ft-lb
2. ASTM A449 to a torque from 60 to 120 ft-lb

Metal liner plate pipe must not vary by more than 1 foot from the line established by the Engineer and by more than 0.5 foot from the grade established by the Engineer.

Grouting equipment must be:

1. Capable of grouting at a pressure of at least 100 psi
2. Equipped with a pressure gauge having a full-scale reading of not more than 300 psi

Force the grout through grouting holes in the plates in such a sequence and with enough pressure to completely fill the voids. Remove the plugs in grouting holes adjacent to the grouting hole being force-grouted to allow inspection of the grout filling.

You may use free-running aggregate forced pneumatically into the voids between the liner plate and the wall of the excavation as temporary support of the excavation. Pressure grouting of aggregate must comply with section 50-1.03B(2)(d) if the aggregate is pressure grouted within 72 hours of excavation.

67-3.04 PAYMENT

The payment quantity for metal liner plate pipe is the length measured along the centerline of the pipe and parallel with the slope line.

67-4–67-9 RESERVED

68 SUBSURFACE DRAINS

68-1 GENERAL

68-1.01 GENERAL

68-1.01A Summary

Section 68-1 includes general specifications for constructing subsurface drains.

68-1.01B Definitions

Reserved

68-1.01C Submittals

Submit a certificate of compliance for each type of subsurface drain involved.

68-1.01D Quality Assurance

Reserved

68-1.02 MATERIALS

68-1.02A General

Reserved

68-1.02B Protective Coating

If described as coated, subsurface drains must be protected with a coating under section 66-1.02C.

68-1.03 CONSTRUCTION

68-1.03A General

Repair damaged coatings under section 66-1.02C.

68-1.03B Filter Fabric

Remove loose or extraneous material and sharp objects immediately before placing filter fabric.

The subgrade and trench to receive the filter fabric must comply with the compaction and elevation tolerance specified for the material involved.

Handle and place filter fabric under the manufacturer's instructions.

Align and place filter fabric without wrinkles.

Overlap adjacent roll ends of filter fabric at least 18 inches. The preceding roll must overlap the following roll in the direction that the permeable material is being spread.

Completely replace torn or punctured sections damaged during placement or repair by placing a piece of filter fabric that is large enough to cover the damaged area and comply with the overlap specified.

Cover filter fabric with the thickness of overlying material within 72 hours of placing the fabric.

68-1.04 PAYMENT

Not Used

68-2 UNDERDRAINS

68-2.01 GENERAL

68-2.01A Summary

Section 68-2 includes specifications for constructing underdrains.

Excavation and backfill must comply with section 19-3.

68-2.01B Definitions

Reserved

68-2.01C Submittals

Submit a certificate of compliance for each type of pipe, tubing, and fitting.

68-2.01D Quality Assurance

Reserved

68-2.02 MATERIALS

68-2.02A General

For alternative pipe underdrain, do not mix types of pipe in the same installation.

68-2.02B Perforated Steel Pipe

Perforated steel pipe and coupling bands must comply with AASHTO M 36 and AASHTO M 218 with the following modifications:

1. Pipe must comply with any one of the full circle types specified in AASHTO M 36.
2. Pipe perforations must be drilled or punched.
3. Perforations must be located in the inside of crests or in the flat tangent portion of all corrugations but not in both locations in a given length of pipe.

The weight of galvanizing must comply with ASTM A123/A123M and ASTM A153/A153M.

You may substitute sleeve type couplings for the band couplers required under AASHTO M 36. The couplings must be plastic or galvanized steel, suitable for holding the pipe firmly in alignment without the use of sealing compound or gaskets. The couplings must have mechanical properties that will prevent distortion under normal conditions of use.

68-2.02C Perforated Aluminum Pipe

Aluminum underdrain pipe and fittings must comply with AASHTO M 196 and the following modifications:

1. Pipe must comply with Type III specified in AASHTO M 196.
2. Pipe perforations must be either drilled or punched.
3. Minimum thickness of sheet must be 0.060 inch.

You may substitute sleeve type couplings for band couplers required under AASHTO M 196.

The couplings must be plastic or aluminum, suitable for holding the pipe firmly in alignment without the use of sealing compound or gaskets. The couplings must have mechanical properties that will prevent distortion under normal conditions of use.

68-2.02D Perforated Plastic Pipe

Perforated plastic pipe must be smooth-wall PVC plastic pipe, corrugated PVC plastic pipe with a smooth interior surface, or corrugated polyethylene plastic tubing.

Smooth-wall PVC plastic pipe must comply with AASHTO M 278.

Corrugated PVC plastic pipe with a smooth interior surface must comply with material and structural requirements in AASHTO M 278. Pipe must have perforations located in the bottom half of the pipe; the perforations must be slots complying with the size and opening area requirements in AASHTO M 252. Inside diameter and diameter tolerances must comply with AASHTO M 252 or M 278.

Corrugated polyethylene plastic tubing must comply with AASHTO M 252 or M 294.

PVC plastic pipe must be connected with belled ends, or with sleeve-type or stop-type couplings under AASHTO M 278. Polyethylene tubing must be connected with snap-on, screw-on, or wrap-around fittings and couplings under AASHTO M 252 or AASHTO M 294.

68-2.02E Underdrain Outlets and Risers

Underdrain outlets and risers must be fabricated from the same material as the underdrain pipe or from corrugated metal pipe. Do not mix aluminum and steel in the same installation except for covers and coupling band fastening hardware. Outlet and riser pipe and fittings must not be perforated.

Welded steel covers must be galvanized under section 75-1.02B after fabrication.

Welding workmanship and technique must be equal to the best practice in modern commercial shops.

Covers must be fitted and bolted onto the riser pipe or elbow.

68-2.02F Permeable Material

68-2.02F(1) General

Permeable material for use in backfilling trenches under, around, and over underdrains must consist of hard, durable, clean sand, gravel, or crushed stone and must be free from organic material, clay balls, or other deleterious substances.

Permeable material must have a durability index of not less than 40.

Use Class 1 permeable material for underdrains unless the class or type of permeable material is specified in the special provisions.

At bridge abutments and wingwalls, use either Class 1 or Class 2 permeable material. Place filter fabric between Class 1 permeable material and backfill. No filter fabric is required with Class 2 permeable material.

68-2.02F(2) Class 1 Permeable Material

Alternative gradations within Class 1 permeable material are identified by types. Place one of the types specified for Class 1 permeable material.

The percentage composition by weight of Class 1 permeable material in place must comply with the gradation requirements shown in the following table:

Class 1 Permeable Material
Gradation Requirements

Sieve size	Percentage passing	
	Type A	Type B
2"	--	100
1-1/2"	--	95–100
3/4"	100	50–100
1/2"	95–100	--
3/8"	70–100	15–55
No. 4	0–55	0–25
No. 8	0–10	0–5
No. 200	0–3	0–3

68-2.02F(3) Class 2 Permeable Material

The percentage composition by weight of Class 2 permeable material in place must comply with the gradation requirements shown in the following table:

Class 2 Permeable Material
Gradation Requirements

Sieve size	Percentage passing
1"	100
3/4"	90–100
3/8"	40–100
No. 4	25–40
No. 8	18–33
No. 30	5–15
No. 50	0–7
No. 200	0–3

Class 2 permeable material must have a sand equivalent value of not less than 75.

68-2.02F(4) Class 3 Permeable Material

The percentage composition by weight of Class 3 permeable material in place must comply with the gradation requirements shown in the following table:

Class 3 Permeable Material
Gradation Requirements

Sieve size	Percentage passing
1-1/2"	100
1"	88–100
3/4"	52–85
3/8"	15–38
No. 4	0–16
No. 8	0–6

At least 90 percent by weight of Class 3 permeable material must be crushed particles as determined by California Test 205.

68-2.02G Filter Fabric

Filter fabric for use with underdrains must comply with section 96-1.02B.

At bridge abutments and wingwalls, filter fabric for underdrains must be Class A.

68-2.02H–68-2.02N Reserved

68-2.03 CONSTRUCTION

Excavate trenches for underdrains, place filter fabric, install pipe, and backfill trenches with permeable material as shown. Where underdrains are installed in trenches outside the subgrade area, backfill the top 6 inches of the trench with structure backfill complying with section 19-3.

Join lengths of perforated steel pipe and perforated aluminum pipe with couplers.

Lay perforated pipe with the perforations down.

Solvent cementing of joints on perforated plastic pipe is not required.

Repair damaged galvanized surfaces under section 75-1.02B.

Underdrain outlets and riser covers must seat uniformly and not be subject to rocking.

Place perforated polyethylene tubing to line and grade in a close-fitting semicircular bedding groove formed in the bottom of the trench.

At bridge abutments and wingwalls:

1. Install welded steel covers on underdrains terminating underground.
2. Place permeable material in horizontal layers. Thoroughly consolidate permeable material along with and by the same methods specified for structure backfill in section 19-3. Ponding and jetting of permeable material or structure backfill adjacent to permeable material is not allowed.
3. You may substitute permeable material for structure backfill material where the required width of backfill material adjacent to the neat lines of the permeable material as shown is approximately 1 foot or less.

68-2.04 PAYMENT

The payment quantity for pipe underdrain is the length measured parallel with the slope line. The payment quantity includes the length measured along the centerline of elbows, outlets and risers and the length of wyes, tees, and other branches to the point of intersection.

68-3 HORIZONTAL DRAINS

68-3.01 GENERAL

Section 68-3 includes specifications for constructing horizontal drains.

Section 61-2 does not apply.

68-3.02 MATERIALS

Horizontal drains must consist of nominal 1-1/2-inch, schedule 80 PVC plastic pipe complying with ASTM D1785. At your option, the type, grade, and design stress designation of the pipe must be 1120, 1220, 2110, 2112, 2116, or 2120 as specified in ASTM D1785. The plastic pipe must comply with the *National Sanitation Foundation Standard No. 14* if the plastic pipe is used to conduct water for human consumption.

Slotted pipe must have 2 rows of slots. The rows must be in the longitudinal direction of the pipe and the slots must be cut in the circumferential direction of the pipe. The rows must be centered on 2 of the 3rd points, 120 degrees apart, of the pipe circumference. Each row of slots must comply with one of the configurations shown in the following table. The Engineer determines the configuration to be used.

Number of slots (±1 per linear foot)	Width of slot (inch)	Minimum opening per linear foot (square inches)
22	0.050	1.00
23	0.020	0.46
46	0.010	0.46

Slots must be spaced uniformly along the pipe. The minimum opening is measured on the inner surface of the pipe.

Perforated pipe must have 3 rows of perforations with 1 row on each side of the pipe and the 3rd row on the top. The perforations must be 3/8 inch in diameter spaced at 3-inch centers with the top perforations staggered in relation to the holes on either side.

Fittings for the PVC plastic pipe must be schedule 80 Type II PVC solvent weld type fittings and must comply with ASTM D2467. You may use machined male and female ends instead of couplings.

Unslotted or unperforated PVC plastic pipe, approximately 3 to 30 feet in length, must be provided at the outlet of the drain. The Engineer determines the exact length of pipe.

68-3.03 CONSTRUCTION

The locations shown for horizontal drains are approximate. The Engineer determines the exact locations and placement sequence. Any ordered exploratory work is change order work.

Complete the installation of horizontal drains at a bench in an excavation slope before excavating more than 40 feet below the bench.

Furnish water required for drilling.

Drill horizontal holes to the designated lines and grades with rotary equipment capable of drilling 3 to 6-inch-diameter holes 600 feet long through soil and rock formations.

Install plastic pipe with pipe slots or perforations on top by pushing it into the hole or inserting it inside the drill rod then retracting the drill rod so that the drilled hole is cased for the full depth. Tightly plug the entrance end with a rounded or pointed extension that does not extend more than 0.5 foot beyond the end of the pipe.

During casing activity, cement plastic pipe together to form a continuous tube. Prevent telescoping and damage to plastic pipe during installation.

Identify each drain by securely attaching a permanent brass plate with a number assigned by the Engineer to the outlet end of the nonperforated pipe drain or by other permanent marking designated by the Engineer.

Tightly plug the annular space between the hole and the pipe with earth for a length of at least 2 feet at the outlet end of the drilled hole.

Connect the outlet end of the drain to the collector system by installing a pipe tee, pipe plug, street ell, and galvanized steel pipe or plastic pipe. The Engineer determines the length of the pipe.

Furnishing and installing a collector system is change order work.

During drilling activities, determine the drilled hole elevation at 100-foot intervals and the elevation at the upper end of the completed drain hole. You may take measurements by inserting tubes or pipes and measuring liquid levels or by other authorized methods.

Dispose of water used for drilling and water developed during drilling activities under section 13. Comply with the requirements of the RWQCB for nonstormwater discharges and the Department's *Construction Site Best Management Practices (BMP) Manual* for dewatering.

68-3.04 PAYMENT

The payment quantity for furnish and install drain pipe (horizontal drain) is the length measured (1) along the centerline of the pipe and (2) from the outlet end to the collector system.

The payment quantity for drill hole is the length measured along the centerline of the pipe for the length of the hole drilled, except the Department does not measure or pay for any hole drilled where the drain pipe cannot be installed for the full length of the drilled hole.

68-4 EDGE DRAINS

68-4.01 GENERAL

Section 68-4 includes specifications for constructing plastic pipe edge drains and edge drain outlets.

Edge drain outlets include:

1. Outlet pipes, vent pipes, cleanouts, and Y-fittings at cleanout pipes
2. Intermediate outlet connections between the couplings at each end of the curved section of the Y-fitting

Edge drains include cross drain interceptors at structure approaches, at end anchors or pressure relief joints, and at pavement terminals joining existing pavements.

Section 61-2 does not apply.

68-4.02 MATERIALS

68-4.02A General

Reserved

68-4.02B Pipe and Pipe Fittings

Pipe installed in trenches to be backfilled with asphalt treated permeable material must be PVC 90 degree C electric plastic conduit, EPC-40 or EPC-80, and must comply with NEMA TC 2.

All other edge drain pipe and edge drain outlets, vents, and cleanouts must be one of the following:

1. PVC 90 degree C electric plastic conduit, EPC-40 or EPC-80, and must comply with NEMA TC 2.
2. PVC plastic pipe, schedule 40 or schedule 80, and must comply with ASTM D1785. At your option, the type, grade, and design stress designation of the pipe may be 1120, 1220, 2120, 2116, 2112, or 2110 as specified in ASTM D1785.

Pipe must be straight end or bell end. Bell end sockets must comply with ASTM D2672 except for marking.

Pipe shown as slotted must have 3 rows of slots in the pipe. The rows must be in the longitudinal direction of the pipe and the slots must be cut in the circumferential direction of the pipe. The 3 rows must be spaced equally around the circumference of the pipe. Each row must have 22 ± 1 uniformly spaced slots per linear foot of pipe. The slots must be 0.045–0.065 inch wide and of a length to provide at least 2.00 square inches of slot opening per linear foot of pipe. Other suitable configurations of slots that provide drainage equal to or better than the above slot requirements may be used if authorized.

Fittings for PVC 90 degree C electric plastic conduit must comply with NEMA TC 3, and fittings for PVC plastic pipe must be socket-type fittings under ASTM D2467 for schedule 80 pipe and ASTM D2466 for schedule 40 pipe. Y-fittings must be shop fabricated from pipe as specified for the type of edge drain pipe installed. The fitting must provide an unobstructed passageway through both legs of the Y-fitting.

68-4.02C Treated Permeable Material

At your option, permeable material for edge drains must be asphalt treated permeable material or cement treated permeable material complying with section 29 for treated permeable bases.

68-4.02D Filter Fabric

Filter fabric must comply with section 96-1.02B.

68-4.02E Miscellaneous

Concrete for splash pads must be constructed of minor concrete, except the concrete must contain at least 470 pounds of cementitious material per cubic yard.

Mortar placed where edge drain outlets and vents connect to drainage pipe and existing drainage inlets must comply with section 51-1.

Expansion type pressure plugs for cleanouts must seat firmly against the pipe lip and be one of the following:

1. Expandable plugs manufactured from neoprene under section 51-2.04B with commercial quality stainless steel bolts and 2 hex nuts
2. Commercial quality expandable duct plugs consisting of reinforced polypropylene rigid threaded plug with a commercial quality thermoplastic rubber sealing ring

Aggregate base for backfilling trenches in existing paved areas must comply with the materials specifications for Class 2 aggregate base, 3/4-inch-maximum gradation, under section 26-1.02B.

Use minor HMA to backfill trenches in existing asphalt shoulders.

The 1/2-inch screen or grate must be made of commercial quality galvanized metal with nominal 1/2-inch square openings.

68-4.02F–68-4.02H Reserved

68-4.03 CONSTRUCTION

Before excavating trenches for the installation of edge drains, outlets, vents, and cleanouts in existing paved areas, cut the outline of the paved areas to be removed to a neat line to a minimum depth of 2 inches with a power-driven saw or a wheel type rock cutting excavator. Cuts along the joint between existing asphalt concrete and existing concrete pavement are not required.

Remove concrete deposits that could occur along the lower edge of the concrete pavement in Type 1 installations.

Join pipe and fittings with commercial quality solvent cement and primer specifically manufactured for use with rigid PVC plastic pipe and fittings. The solvent cement and primer must be made by the same manufacturer. The color of the primer must contrast with the color of the pipe and fittings. Apply the solvent cement and primer under the manufacturer's instructions.

Spread treated permeable material when the atmospheric temperature is above 40 degrees F.

You may spread the treated permeable material in 1 or more layers.

Where edge drains are to be installed adjacent to asphalt treated permeable base, you may spread the lower 6 inches of asphalt treated permeable material in a separate operation, then spread the upper portion of the asphalt treated permeable material with the adjacent asphalt treated permeable base.

Place asphalt treated permeable material at a temperature of not less than 180 degrees F or more than 230 degrees F, except the temperature of asphalt treated permeable material spread with asphalt treated permeable base must comply with section 29 for spreading asphalt treated permeable base.

Compact asphalt treated permeable material spread with adjacent asphalt treated permeable base with the adjacent base and in the same way specified in section 29 for compacting the base. Compact all other layers of treated permeable material with a vibrating shoe-type compactor connected to the spreading device. The vibrating shoe-type compactor must be in operation when the material is being spread in the trench and must be turned off when the material is not being spread.

Cure cement treated permeable material that is not covered with HMA within 12 hours after compacting the permeable material by sprinkling the material with a fine spray of water every 4 hours during daylight hours or by covering the material with a white polyethylene sheet not less than 6 mils thick. Start the curing requirements at 7:00 a.m. on the morning following compaction of the cement treated permeable material and continue for the next 72 hours or until the material is covered with HMA, whichever is less. Do not spray the cement treated permeable material with water during the first 12 hours after compacting. You may cover the cement treated permeable material with the polyethylene sheet during the first 12 hours or before the start of the curing period.

Backfill and compact trenches in existing embankment areas with native material.

Aggregate base backfill must be spread and compacted by methods that produce a uniform base, firmly compacted and free from pockets of coarse or fine material.

Place Type G pavement markers with retroreflective face facing away from the oncoming traffic under section 81-3.02C on paved shoulders or dikes at outlet, vent, and cleanout locations where authorized. The waiting period for placing pavement markers on new HMA surfacing does not apply.

Clean edge drain outlets, vents, and cleanout pipes during installation and remove obstructions after installation. Use a high-pressure, flexible hose with a nominal 1-inch-diameter nozzle containing flushing and propelling jets. Insert the hose into each edge drain outlet, vent, and cleanout pipe and push it through the pipe with a minimum 1,000 psig water pressure so that the entire edge drain system is penetrated by the flushing nozzle. At your expense, replace pipes found to be plugged, including replacement of treated permeable material, surfacing, and backfill materials.

Install outlet and vent covers at the end of each outlet pipe and vent pipe.

Dispose of surplus excavated material.

68-4.04 PAYMENT

The payment quantity for edge drain is the length measured along the centerline of the pipe with no deductions for gaps in edge drain pipe at outlets and vents.

The payment quantity for edge drain outlet is the length measured along the centerline of the pipe.

68-5 PERMEABLE MATERIAL BLANKET

Reserved

68-6 RESERVED

Reserved

68-7 GEOCOMPOSITE DRAIN SYSTEMS

68-7.01 GENERAL

68-7.01A Summary

Section 68-7 includes specifications for constructing geocomposite drain systems.

Geocomposite drain includes filter fabric and plastic pipe.

68-7.01B Definitions

Reserved

68-7.01C Submittals

Submit a certificate of compliance for the geocomposite drain certifying that the drain produces the specified flow rate. The certificate must be accompanied by a flow capability graph for the geocomposite

drain showing flow rates and the externally applied pressures and hydraulic gradients. Include verification by an authorized laboratory for the flow capability graph.

68-7.01D Quality Assurance

Reserved

68-7.02 MATERIALS

68-7.02A General

Filter fabric must be Class A.

68-7.02B Geocomposite Drain

Geocomposite drain must comply with the specifications for geocomposite wall drain.

68-7.02C Plastic Pipe

Plastic pipe must comply with the specifications for pipe for edge drains and edge drain outlets in section 68-4.

68-7.02D Drainage Pads

Drainage pads must be constructed of minor concrete.

68-7.02E Treated Permeable Base

Treated permeable base to be placed around slotted plastic pipe at the bottom of geocomposite drains must comply with section 29.

If asphalt treated permeable base is used, place the base material at a temperature of not less than 180 degrees F or more than 230 degrees F.

68-7.03 CONSTRUCTION

Install the geocomposite drain with the drainage void and the filter fabric facing the embankment. The fabric facing the embankment side must overlap at least 3 inches at all joints and wrap around the exterior edges at least 3 inches beyond the exterior edge. If additional fabric is needed to provide overlap at joints and wraparound at edges, the added fabric must overlap at least 6 inches and be attached to the fabric on the geocomposite drain.

Place core material manufactured from impermeable plastic sheeting having nonconnecting corrugations with the corrugations approximately perpendicular to the drainage collection system.

If the fabric on the geocomposite drain is torn or punctured, replace the damaged section completely or repair it by placing a piece of fabric that is large enough to cover the damaged area and provide at least a 6-inch overlap.

68-7.04 PAYMENT

Not Used

68-8–68-15 RESERVED

69 OVERSIDE DRAINS

69-1 GENERAL

69-1.01 GENERAL

69-1.01A Summary

Section 69 includes specifications for constructing overside drains.

Excavation and backfill must comply with section 19-3.

69-1.01B Definitions

Reserved

69-1.01C Submittals

Submit a certificate of compliance for each of the following materials:

1. Steel
2. Aluminum
3. Plastic

69-1.01D Quality Assurance

Joints for overside drains must comply with section 61-2.01D(2)(a) for watertightness.

69-1.02 MATERIALS

69-1.02A General

For alternative pipe downdrain, choose 1 of the types shown.

Fabrication of overside drain materials must comply with the details and dimensions shown. If authorized, minor variations may be used to allow the use of the manufacturer's standard jigs and templates during the fabrication. The material thickness must be not less than the thickness described.

For pipe downdrains under concrete slope paving, the end of the downdrain must consist of steel pipe or steel conduit.

Do not mix steel and aluminum pipe in the same installation. You may use the anchor assemblies shown with an aluminum installation if the anchor assemblies are electrically insulated.

Plastic pipe and fittings used for overside drains must be from 1 manufacturer for each installation.

Welding workmanship and techniques must be equal to the best practice in modern commercial shops.

69-1.02B Steel Pipe Overside Drains

Steel entrance tapers, pipe downdrains, reducers, coupling bands, and slip joints must be fabricated from galvanized steel sheets and must comply with AASHTO M 36 and section 66. The nominal thickness of the sheet must be at least 0.064 inch. The pipe must be Type I pipe under AASHTO M 36.

Steel tapered inlets and flume downdrains must be fabricated from steel sheets under section 69-1.02B.

Coupling bands for corrugated steel pipe must comply with either section 69-1.02B or section 61-2.01D(2)(b) for downdrain pipe.

The weight of galvanizing for overside drain materials must comply with ASTM A123/A123M and A153/A153M.

Galvanized surfaces on overside drain materials that are damaged must be repaired under section 75-1.02B.

69-1.02C Aluminum Pipe Overside Drains

Aluminum entrance tapers, pipe downdrains, reducers, coupling bands, and slip joints must be fabricated of aluminum sheets and comply with AASHTO M 196 and section 66. The nominal thickness of the sheet must be at least 0.060 inch. The pipe must be Type I pipe under AASHTO M 196.

Aluminum tapered inlets and flume downdrains must be fabricated of aluminum sheet complying with AASHTO M 197 with a thickness of at least 0.060 inch.

Coupling bands for corrugated aluminum pipe must comply with either section 69-1.02C or section 61-2.01D(2)(b) for downdrain pipe.

69-1.02D Plastic Pipe Overside Drains

Plastic pipe for overside drains must be Type S corrugated high-density, polyethylene pipe, and comply with section 64.

Plastic pipe joints must comply with section 61-2.01D(2)(b). If pipe joint details are shown, the tensile strength requirements do not apply. The joint overlap requirements for integral joints must comply with the requirements for positive joints.

69-1.02E Anchor Assemblies

A single anchor assembly includes:

1. 2 pipe stakes with necessary hardware
2. Bars or coupling bands
3. Hardware for fastening downdrain pipe or flume downdrain

Pipe stakes, plates, bars, clip brackets, and hardware must be hot-dip galvanized after fabrication under section 75-1.02B.

69-1.02F Cable Anchorage System

Cable anchorage systems for pipe downdrains must comply with section 69-1.02E.

Cables, welded steel eyes, steel rods, turnbuckles, thimbles, cable clamps, and anchor plates must comply with specifications for similar materials in section 83-1.02B.

Steel pipe must comply with specifications for pipe posts in section 56-2.02F.

Concrete for concrete anchors must comply with the specifications for minor concrete except the concrete must contain at least 420 pounds of cementitious material per cubic yard.

69-1.02G Protective Coatings

If described as coated, metal overside drains must be protected with coating under section 66-1.02C.

If a protective coating is applied to a metal overside drain, each section of the downdrain pipe and each accessory must have the nominal thickness of the metal clearly identified on the inner surface with paint or other authorized means.

Repair damaged coatings under section 66-1.02C.

69-1.03 CONSTRUCTION

Install entrance tapers and tapered inlets so that they function properly and efficiently, keep material in the dike, and prevent water from percolating under or around them. The seal between the taper or inlet and the surrounding material must be watertight.

Connect an entrance taper to a downdrain pipe by means of a band coupler or a slip joint.

Weld or rivet bulkheads and outlet pipes or flume pieces to the taper or inlet to form watertight connections.

Securely anchor a downdrain to the slope of the ground as shown if the downdrain is not in a trench.

Cable must not contact soil in finished position. Either adjust position or replace affected portion of cable with galvanized steel rod of equivalent diameter.

If a plastic pipe joint restrainer assembly under Alternative A is used, install it immediately below the pipe bell.

The bell end of a plastic pipe overside drain must face uphill.

69-1.04 PAYMENT

The payment quantity for pipe downdrain is measured along the centerline of the pipe and parallel with the slope line. The payment quantity includes the length of elbows, wyes, tees, and other branches to the point of intersection. If the pipe is cut to fit a structure or slope, the payment quantity is the length of pipe necessary to be placed before cutting, measured in 2-foot increments. Payment for the length of slip joints is not included in the payment for pipe downdrain.

The payment quantity for pipe downdrains under concrete slope paving is measured from the beginning of the corrugated steel pipe to the end of the downdrain.

The payment quantity for an entrance taper includes the length of the tapered section and the tail pipe.

The payment quantity for a tapered inlet includes the length of the tapered section and the flume stub.

69-2–69-10 RESERVED

70 MISCELLANEOUS DRAINAGE FACILITIES

70-1 GENERAL

70-1.01 GENERAL

Section 70-1 includes general specifications for (1) installing miscellaneous drainage facilities for water drainage and transmission and (2) constructing casings for bridges.

Miscellaneous drainage facilities include pipe components made of pipe or other materials.

Pipe risers include pipe riser connections and bar reinforcement steel riser safety cage.

Miscellaneous drainage facilities do not include steel covers, frames and grates, frames and covers, manhole frames and grates, manhole frames and covers, or other miscellaneous metal parts.

Iron and steel items used for miscellaneous drainage facilities must comply with section 75.

For a miscellaneous drainage component with *alternative* in the bid item description, choose from the types of the component shown. Do not mix different types of the same component in the same location.

70-1.02 MATERIALS

Steps and ladders must be (1) steel if they are installed in steel or concrete drainage facilities or (2) aluminum if they are installed in aluminum drainage facilities.

Hardware installed in aluminum drainage facilities must be aluminum.

Epoxy-resin adhesive for bonding a pipe slip joint to a cross drain must comply with the materials specifications for applying epoxy-resin adhesive to concrete.

Boards for redwood covers must be no. 1 heart structural grade, S4S redwood.

Minor concrete drainage appurtenances including concrete foundations, bases, and basin floors must comply with section 51-7.

70-1.03 CONSTRUCTION

Excavation and backfill for miscellaneous drainage facilities must comply with section 19.

Attach steps and ladders to miscellaneous drainage facilities where described.

If new drain inlets or manholes are placed in paved or surfaced areas, do not construct the drain to final grade until the paving or surfacing adjacent to the drain is completed.

Install drainage pipe stubs, pipe riser connections and bar reinforcement steel riser safety cages.

70-1.04 PAYMENT

The Department does not pay for pipe or casing in excess of the length shown.

The payment quantity for any type of pipe is the length measured along the centerline of the pipe to the nearest 0.1 foot of pipe.

70-2 CORRUGATED METAL PIPE DRAINAGE FACILITIES

70-2.01 GENERAL

Section 70-2 includes specifications for fabricating and installing drainage facilities with corrugated metal pipe.

Corrugated metal pipe and coatings must comply with section 66.

70-2.02 MATERIALS

Not Used

70-2.03 CONSTRUCTION

Not Used

70-2.04 PAYMENT

Not Used

70-3 WELDED STEEL PIPE DRAINAGE FACILITIES

70-3.01 GENERAL

70-3.01A Summary

Section 70-3 included specifications for fabricating and installing drainage facilities with welded steel pipe.

Drainage facilities constructed with welded steel pipe include:

1. Energy dissipators
2. Inlets
3. Risers
4. Reducers
5. Manholes

70-3.01B Definitions

Reserved

70-3.01C Submittals

Submit color options for the finish paint. The Engineer selects the color of the finish paint.

70-3.01D Quality Assurance

70-3.01D(1) General

Reserved

70-3.01D(2) Quality Control

Test the pipe under the operating head for 2 hours with no leaks. Correct any leaks or defects and retest if necessary.

70-3.02 MATERIALS

70-3.02A General

Welded steel pipe must comply with one of the following specifications:

1. AWWA C200
2. ASTM A53/A53M, Grade B
3. API Specification 5L, Grade B or Grade X42

70-3.02B Coatings

70-3.02B(1) General

If a coating is described, coat all portions of the welded steel pipe drainage facility.

Repair of internal and external wall coatings must comply with the following:

1. Breaks or scuffs in the epoxy coating that are less than 36 square inches must be repaired by the application of epoxy material similar to and compatible with the durability, adhesion and appearance of the original epoxy coating under section 4.4.4.1.2 of AWWA C213
2. Repair coating must be a minimum thickness of 0.010 inch, 10 mils, after drying
3. Department rejects a pipe section if individual breaks exceed 36 square inches or if the total area of breaks exceeds 0.5 percent of the total surface area of the pipe section

70-3.02B(2) Coal Tar Coating

A coal tar coating for welded steel pipe must be applied before shipping as follows:

1. The interior and exterior surfaces must be cleaned, primed, and coated with coal tar enamel.
2. The exterior surface must be wrapped with a bonded felt wrapper under AWWA C203 and section A1.2 of the appendix.

70-3.02B(3) Factory-Applied Fusion-Bonded Epoxy Coating

Factory-applied fusion-bonded epoxy coating must be applied to the interior and exterior surfaces of welded steel pipe under AWWA C213.

If a fusion-bonded epoxy coating will be exposed to above-grade sunlight, the exterior coated wall surfaces must be primed and painted. The primer and paint must comply with the type, standard, and coating thickness as shown in the following table:

Coatings	Type	Standard	Coating thickness[a] (mil)
Primer	Zinc rich	AASHTO M 300	2.5–3.5
Finish paint	Exterior grade latex satin or flat	Complying with State VOC requirements and as recommended by the manufacturer of inorganic zinc-rich primer	2.0–3.0

[a]Dry film thickness

70-3.02B(4) Asphalt Coating

Reserved

70-3.03 CONSTRUCTION

70-3.03A General

After the pipe has been fabricated and welded into lengths, it must be thoroughly cleaned of dirt, oil, grease, loose scale and other foreign material.

Perform field welding under AWWA C206.

Install welded steel pipe such that it is not electrically connected to or in direct physical contact with other metal pipe. If welded steel pipe is mechanically connected to public utility lines or other metal pipe, provide electrically insulated connections. Place the connections within 5 feet of the pipe's ingress or egress to any building or structure. Electrically insulated connections are not required for connections to nonmetallic pipe.

If backfill material contains rock or highly expansive clay soils, install a sand shield under AWWA C203 section A1.3 of the appendix.

Before backfilling at the welded joints, pressure test the pipe.

70-3.03B Coatings

Repair damage to coatings under section 66-1.02C.

70-3.04 PAYMENT

Not Used

70-4 PRECAST CONCRETE PIPE DRAINAGE FACILITIES

70-4.01 GENERAL

Section 70-4 includes specifications for fabricating and installing drainage facilities with precast concrete pipes.

70-4.02 MATERIALS

PC concrete pipe for drainage facilities must comply with AASHTO M 199M/M 199.

Concrete must comply with section 90-1 except for the aggregate gradation requirements.

Reinforcement must comply with section 52.

70-4.03 CONSTRUCTION

Construct mortar joints under section 65.

You may form inlets in place as an alternative to using PC concrete pipe and cutting the side openings.

70-4.04 PAYMENT

Not Used

70-5 DRAINAGE APPURTENANCES

70-5.01 GENERAL

70-5.01A General

Section 70-5.01 includes general specifications for fabricating and installing appurtenances to drainage facilities. Drainage appurtenances include:

1. Miscellaneous metal appurtenances
2. Drainage inlet markers
3. Drainage gates

Miscellaneous metal appurtenances are not included in the payment for miscellaneous drainage facilities.

70-5.01B Materials

Not Used

70-5.01C Construction

Construct concrete appurtenances under section 51.

70-5.01D Payment

Not Used

70-5.02 FLARED END SECTIONS

70-5.02A General

70-5.02A(1) Summary

Section 70-5.02 includes specifications for fabricating and installing flared end sections..

70-5.02A(2) Definitions

Reserved

70-5.02A(3) Submittals

Reserved

70-5.02A(4) Quality Assurance

The Department accepts a PC concrete flared end section based on section 5.1.2 of AASHTO M 170.

70-5.02B Materials

70-5.02B(1) General

Minor fabrication variations in flared end sections may be authorized.

70-5.02B(2) Concrete Flared End Sections

PC flared end sections must comply with the specifications for Class III reinforced concrete pipe in AASHTO M 170 and the following requirements:

1. Portland cement and aggregate must comply with section 90-1 except for the aggregate gradation requirements
2. Area of steel reinforcement per linear foot of a flared end section must be at least equal to the minimum steel requirements for circular reinforcement in a circular pipe with the same diameter as the internal diameter of the circular portion of the flared end section

Reinforcement must comply with section 52.

Cutoff walls for PC concrete flared end sections must be minor concrete except the concrete must contain at least 470 pounds of cementitious material per cubic yard.

70-5.02B(3) Metal Flared End Sections

Metal flared end sections must be prefabricated steel or aluminum sections.

Prefabricated steel flared end sections must comply with AASHTO M 36 and AASHTO M 218.

Prefabricated aluminum flared end sections must comply with AASHTO M 196 and AASHTO M 197.

Metal flared end sections may be used as an alternative to PC concrete flared end sections or plastic flared end sections. Metal flared end sections used on concrete pipe 36 inches in diameter or smaller must have toe plates.

Mortar used to connect metal flared end sections to PC concrete pipe must comply with section 51-1.

Welded wire fabric must be commercial quality.

70-5.02B(4) Plastic Flared End Sections

Plastic flared end sections must comply with ASTM D3350.

70-5.02B(5) Alternative Flared End Sections

An alternative flared end section must be the same material type as the drainage facility that it is attached. Comply with the material specifications in section 61-3.

70-5.02C Construction

Construct cutoff walls under section 51.

70-5.02D Payment

Not Used

70.5.03 DRAINAGE GATES

70-5.03A General

Section 70-5.03 includes specifications for installing drainage gates.

70-5.03B Materials

70-5.03B(1) General

Reserved

70-5.03B(2) Automatic Drainage Gates

70-5.03B(2)(a) General

An automatic drainage gate must:

1. Provide free outflow
2. Prevent backflow
3. Be attached to the pipe or anchored to a concrete wall

The gate must be assembled in the shop and its cast iron parts must be shop coated with commercial quality asphaltic paint.

70-5.03B(2)(b) Automatic Drainage Gates for Low Head Pressure

Reserved

70-5.03B(2)(c) Automatic Drainage Gates for High Head Pressure

Reserved

70-5.03B(3) Slide Headgates

Reserved

70-5.03C Construction

Not Used

70-5.03D Payment

Not Used

70-5.04 INLET DEPRESSIONS

70-5.04A General

Section 70-5.04 includes specifications for installing inlet depressions for drainage.

70-5.04B Materials

70-5.04B(1) General

Reserved

70-5.04B(2) Hot Mix Asphalt Inlet Depressions

HMA drainage inlet depressions must comply with section 39.

In shoulder areas of roadways, use the HMA type that is specified for roadway construction.

In locations outside the shoulder areas, use the HMA type that is specified for miscellaneous areas.

70-5.04B(3) Concrete Inlet Depressions

Concrete drainage inlet depressions must comply with specifications for minor concrete except the concrete must contain at least 470 pounds of cementitious material per cubic yard.

70-5.04C Construction

If necessary to match the grade of the surrounding material, place and finish HMA by hand.

Whenever concrete pavement is placed near an inlet depression, place the pavement before constructing the inlet depression.

Whenever concrete inlet depressions are constructed in shoulder areas, place the concrete on the prepared base material compacted to at least 95 percent relative compaction.

After the placement to the lines and grades shown, smooth the surface with a float and trowel. If concrete is adjacent to isolation joints, smooth the surface with an edger.

Broom finish the smoothed concrete surface. Create a surface with a coefficient of friction of at least 0.30 when tested under California Test 342.

Apply any necessary water immediately before brooming the surface.

Cure the concrete under section 40-1.03I.

70-5.04D Payment

Not Used

70-5.05 DRAINAGE INLET MARKERS

70-5.05A General

Section 70-5.05 includes specifications for installing drainage inlet markers.

70-5.05B Materials

If a specific type of drainage marker is not shown, choose one of the following:

1. Thermoplastic
2. Medal medallion
3. Plastic medallion
4. Stamped concrete

The thermoplastic drainage inlet marker must be free of lead and chromium and must comply with the requirements shown in the following table:

Thermoplastic Inlet Marker Requirements

Quality characteristic	Test method	Requirement
Thickness (in)	--	0.080–0.160
Legend color, nonreflective	--	Blue or green
Background color, nonreflective	AASHTO M 249	White
Skid resistance (min, BPN[a])	ASTM E303	60

[a]BPN means British Pendulum Number

The metal medallion drainage inlet marker must be fabricated from commercial-grade stainless steel, aluminum, brass, or bronze sheet metal or cast and must comply with the requirements shown in the following table:

Metal Medallion Inlet Marker Requirements

Quality characteristic	Test method	Requirement
Thickness of metal (in)	--	0.055–0.138
Height of marker (in)	--	0.055–0.138
Legend color, nonreflective[b]	--	Blue or green
Background color, nonreflective[b]	--	White or bare metal
Skid resistance (min, BPN[a])	ASTM E303	60

[a]BPN means British Pendulum Number
[b]Requirement if metal marker is colored

The plastic medallion drainage inlet marker must be fabricated from plastic that contains UV inhibitors and must comply with the requirements shown in the following table:

Plastic Medallion Inlet Marker Requirements

Quality characteristic	Test method	Requirement
Thickness(in)	--	0.025–0.060
Thickness with dome (in)	--	0.055–0.120
Legend color, nonreflective	--	Blue or green
Background color, nonreflective	--	White
Weathering resistance	ASTM D1435	1 year without yellowing, fogging, or pitting

70-5.05C Construction

Install prefabricated drainage inlet markers by:

1. Mechanically cleaning and preparing the surface
2. Attaching the prefabricated drainage inlet markers to the surface with adhesives, fasteners, or heat as recommended by the manufacturer

Install stamped concrete drainage inlet markers by:

1. Imprinting uncured concrete with an authorized concrete stamp for drainage inlet markers
2. Producing stamped concrete surfaces that are free from blemishes

70-5.05D Payment

Not Used

70-5.06–70-5.15 RESERVED

70-6 GRATED LINE DRAINS

70-6.01 GENERAL

70-6.01A Summary

Section 70-6 includes specifications for installing grated line drains.

Use only 1 type of grated line drain.

70-6.01B Definitions

Reserved

70-6.01C Submittals

Submit the following:

1. Certificate of compliance for the grated line drains from the manufacturer
2. Documentation of the channel discharge capacity
3. Inspection report of the completed grated line drain

70-6.01D Quality Assurance

Reserved

70-6.02 MATERIALS

70-6.02A General

Grated line drain must be on the Authorized Material List for grated line drains and must have (1) a channel discharge capacity equal to or greater than the capacity shown and (2) the minimum slope shown.

Line drain sections must be either non-sloped uniform depth sections from 4-7/16 to 12 inches or pre-sloped sections with a minimum continuous 0.6 percent slope with graduated depths from 4-7/16 to 12 inches.

Concrete backfill must comply with the specifications for minor concrete.

In freeze-thaw areas, add an air entraining admixture at a rate to achieve an air content of 4 ± 1.5 percent in the freshly mixed concrete.

Reinforcing bars must be Grade 60 and comply with section 52. Mechanical splice couplers must be commercial-quality double-sleeve type with friction locking screws for use with Grade 60 steel.

70-6.02B Line Drain Channel

Line drain channel may be monolithic polymer concrete, fiberglass, high density polyethylene, or cast-in-place using expanded polystyrene form. End caps must be provided by the line drain manufacturer.

Drain channel sections must not have side extensions. The interior surface of the line drain channel must be smooth below the level of the frame, grate, and associated connections.

70-6.02C Line Drain Frames and Grates

Grated line drain frames and grates must comply with section 75-2 except grates must be ductile iron. Frames and grates include bolts, nuts, frame anchors, connector cover and other connecting hardware. Steel frame must be galvanized under section 75-1.

Frames and grates must comply with AASHTO M306 and be classified heavy duty traffic rated with a transverse proof-load strength of 25,000 pounds.

Frames and grates must be anchored into the body of the line drain or concrete backfill. Grates must be non-removable.

Steel anchoring rods and shear studs, if used, must comply with ASTM A1044.

Steel cover plate must comply with ASTM A36 and be galvanized under section 75-1.02B. Except for grates installed within designated pedestrian paths of travel, grate design must accept inflow of runoff

through openings consisting of a minimum of 60 percent of the total top surface area of the grate. Individual openings or slots must have a dimension not greater than 2 inches measured in the direction of the grated line drain flow line.

Grates installed within designated pedestrian paths of travel must be certified as conforming to the provisions of the ADA.

70-6.03 CONSTRUCTION

Excavation and backfill must comply with section 19-3.

Grated line drains must be installed in trenches excavated to the lines and grades established by the Engineer. Grade and prepare the bottom of the trench to provide a firm and uniform bearing throughout the entire length of the grated line drain.

Installation of grated line drains and joints must comply with the manufacturer's instructions.

Install grated line drains with sections closely jointed and secured such that no separation of the line drains occur during backfilling.

The frame or grate must not extend above the level of the surrounding concrete backfill.

Connect grated line drains to new or existing drainage facilities as shown. Drill and bond dowels must comply with section 51-1.03E(5).

Place concrete backfill in the trench as shown. Place against undisturbed material at the sides and bottom of the trench in a manner that prevents (1) floating or shifting of the grated line drain and (2) voids or segregation in the concrete.

Immediately remove foreign material that falls into the trench before or during concrete placement. Prevent material from entering the grated line drain during construction.

Where necessary, construct and compact earth plugs at the ends of the concrete backfill to contain the concrete within the trench.

Place a 1/2-inch isolation joint where grated line drain is placed in PCC pavement. Isolation joint must comply with section 40-1.

Contraction and expansion joints must comply with section 73-2.

Secure frame and grate or line drain wall to the surrounding concrete backfill with steel anchoring rods as shown. Alternative securing methods must provide a minimum pullout resistance of 685 lb/ft of length of grated line drain frame.

Concrete backfill must be finished flush with the adjacent surfacing.

The surface of the concrete must be textured with a broom or burlap drag to produce a durable skid-resistant surface.

Remove all forming material from the cast-in-place drain channel without gouging or marring the surface. Patch spalls, holes or rock pockets with mortar with a cement to sand ratio of 1 to 3 by volume.

Do not allow traffic or equipment on the concrete backfill until 7 days after placement or before the concrete has attained a strength of 2,000 psi, whichever is sooner.

70-6.04 PAYMENT

Not Used

70-7 CASINGS FOR BRIDGES

70-7.01 GENERAL

70-7.01A Summary

Section 70-7 includes specifications for fabricating and installing welded steel pipe casings through bridges and under approach slabs.

70-7.01B Definitions

Reserved

70-7.01C Submittals

Submit shop drawings for the temporary support of casings at the abutments.

70-7.01D Quality Assurance

Reserved

70-7.02 MATERIALS

70-7.02A General

Reserved

70-7.02B Casing

Casings for bridges must be welded steel pipe complying with section 70-3.02.

Before shipping, the exterior surfaces of the casing must be cleaned, primed, and coated to comply with ANSI/AWWA C213 or ANSI/AWWA C214.

Wrapping tape for repairing damaged coating and wrapping field joints and fittings must be a pressure-sensitive PVC or polyethylene tape with a minimum thickness of 50 mils, 2 inches wide.

70-7.02C Casing Hanger Assemblies

Casing hanger assemblies include a concrete clevis plate, adjustable steel yoke, cast iron pipe roller, steel roller rod, and hex nuts. Steel components must be galvanized.

You may use embedded steel welded linked eye rods instead of a clevis plate.

The casing hanger assembly must be rated for the water supply line and casing.

Clevis plate, yoke, roller, rod, expansion anchors, pipe clamps, nuts and bolts, and other fittings must be adequate for the type and size of the water supply line and casing being supported.

Clevis plate, expansion anchors, yoke, rod, pipe clamps, nuts and bolts, and other fittings must be steel and comply with section 75-1.03.

70-7.02D Concrete Casing Supports

Concrete casing supports must consist of either a PC or CIP minor concrete pipe cradle, galvanized steel pipe clamp, and 2 anchor bolts.

Wire mesh and reinforcement must be commercial quality.

Moist cure the PC concrete casing support for at least 3 days.

Epoxy for anchoring the concrete casing supports must be one of the following types:

1. Epoxy binder
2. Rapid set epoxy adhesive for pavement markers
3. Standard set epoxy adhesive for pavement markers

70-7.03 CONSTRUCTION

Install casings at each abutment and extend the casing to the greater of:

1. 5 feet beyond the approach slab
2. 5 feet beyond the end of the adjacent wingwall
3. 20 feet beyond the abutment

Where the casing passes through an abutment wall, the casing must be additionally wrapped with 2 layers of 15-lb asphalt-felt building paper, securely taped or wired in place.

Anchor PC concrete casing supports with epoxy.

If a blockout is shown in the bridge abutment wall for the casing, the space between the casing and bridge abutment wall must be filled with mortar complying with section 51-1.

Openings for casings through the bridge superstructure concrete must either be formed or consist of pipe sleeves that are two pipe sizes larger than the casing.

Repair damaged coating on the casing and wrap field joints and fittings with wrapping tape as follows:

1. Before wrapping, thoroughly clean and prime the pipe casing, joints, and fittings under the tape manufacturer's instructions.
2. Wrap the tape tightly with 1/2 uniform lap, free from wrinkles and voids to provide not less than a 100-mil thickness.
3. Wrapping at joints must extend at least 6 inches over adjacent pipe casing coverings. Apply tension such that the tape will conform closely to contours of the joint.

70-7.04 PAYMENT

The payment quantity for welded steel pipe casing is the length measured along the centerline of the casing.

70-8–70-15 RESERVED

71 EXISTING DRAINAGE FACILITIES

71-1 GENERAL

71-1.01 GENERAL

Section 71-1 includes general specifications for performing work on existing drainage facilities.

Drainage facilities include culverts, inlets, headwalls, endwalls, aprons, drains, pipes, gutters, gutter depressions, junction structures, spillways, and check dams.

71-1.02 MATERIALS

Temporary pipe plug must be one of the following:

1. Wall of minor concrete not less than 6 inches thick
2. Tight brick wall not less than 8 inches thick with cement mortar joints
3. Commercially-manufactured plug if its use is required for less than 6 months

71-1.03 CONSTRUCTION

Trenches, holes, depressions, and pits caused by removing, salvaging, reconstructing, abandoning, destroying, modifying, resetting, relocating, adjusting, relaying, remodeling, and rehabilitating highway facilities must be backfilled with embankment material under section 19. If the trenches, holes, depressions, and pits are in surfaced areas that remain undisturbed, backfill with material that is equal or better in quality and to the thickness of the surrounding materials.

Where partial removal of reinforced concrete is required, remove a sufficient volume of concrete to expose the reinforcement for splicing. Splicing must comply with section 52. Clean off material adhering to the reinforcement before placing new concrete.

71-1.04 PAYMENT

Not Used

71-2 REMOVE DRAINAGE FACILITIES

71-2.01 GENERAL

Section 71-2 includes work for removing drainage facilities.

71-2.02 MATERIALS

Not Used

71-2.03 CONSTRUCTION

Box culverts, inlets, headwalls, and endwalls must be completely removed if any portion of these structures is (1) within 3 feet of the grading plane in excavation areas, (2) within 1 foot of original ground in embankment areas, or (3) shown to be removed.

Except for concrete pipe, removing PCC components of drainage facilities must comply with section 15-1.03B.

Reuse frames, grates, and covers at the locations shown.

71-2.04 PAYMENT

Payment for removing and reusing frames, grates, and covers is included in the payment for the various items of work that include the reused frames, grates, and covers.

71-3 REHABILITATE DRAINAGE STRUCTURES

71-3.01 GENERAL

71-3.01A General

71-3.01A(1) Summary

Section 71-3 includes specifications for cleaning and preparing, inspecting and evaluating, repairing, rehabilitating, and reinspecting culverts.

Storm drains, pipes, conduit, risers, downdrains, median drainage inlets, and underdrains are included in the work under section 71-3 if they are attached to the culvert.

Repair as described. Repairing includes:

1. Filling voids below and around the exterior of the culverts
2. Restoring culvert openings
3. Smoothing protrusions inside culverts

Rehabilitate as described. Rehabilitating includes:

1. Filling voids below and around culverts
2. Paving culvert inverts
3. Installing pipeliners inside culverts

For a miscellaneous drainage component with *alternative* in the bid item description, choose from the types of the component shown. Do not mix different types of the same component in the same location.

71-3.01A(2) Definitions

alternative pipeliner: Bid items used where more than one type of pipeliner is shown for a given culvert.

annular space: Space or void between the outside wall of the pipeliner and the inside wall of a culvert.

lateral pipe opening: Opening in a culvert for a connecting pipe or drain of any kind.

service opening: Opening in a culvert for maintenance, repair, inspection, or cleaning.

wastewater: Water and contaminants generated by culvert rehabilitation.

waterway: Existing drainage system, including surface water, tributaries, and groundwater.

71-3.01A(3) Submittals

Reserved

71-3.01A(4) Quality Assurance

71-3.01A(4)(a) General

Use an authorized laboratory with staff experienced and capable of conducting the specified testing.

Your staff that performs inspections must be trained and experienced in locating defects, breaks, and obstacles.

71-3.01A(4)(b) Preconstruction Meetings

71-3.01A(4)(b)(i) Prerehabilitation Meeting

Before starting cleaning and preparation work, you must schedule and attend a prerehabilitation meeting with the Engineer. Include any subcontractors, manufacturers and other parties involved in the culvert work. Provide a meeting facility that is within 5 miles of the job site or at another location accepted by the Engineer.

71-3.01A(4)(b)(ii) Pregrouting Meeting

Before starting grouting work, you must schedule and conduct a grouting meeting with the Engineer and your personnel involved in the grouting work, including your:

1. Project superintendent
2. Supervisory personnel
3. Grouting foreman
4. Grouting subcontractors

Provide a meeting facility that is within 5 miles of the job site or at another location accepted by the Engineer.

71-3.01A(4)(c) Quality Control

71-3.01A(4)(c)(i) Annular Space Grouting

The grout cast density at the point of placement must be from 53 to 68 lb/cu ft and the minimum compressive strength must be 300 psi at 28 days.

Test the grout for compressive strength under ASTM C495 except that specimens must be moist cured before the 28-day compressive strength test and not be oven dried. If the grouting plan shows multiple stages, the grouting plan must include test results that verify that the grout stiffness is adequate for placement of multiple lifts.

For each batch of grout, perform density and viscosity tests under ASTM C138 and ASTM C939 in the presence of the Engineer. Grout density must be within 3 lb/cu ft of the density in the authorized grout plan with mix design. The time of efflux (outflow) must not exceed 20 seconds as specified in ASTM C939 unless otherwise authorized.

For pipeliners with a stiffness of less than 29 psi, the grout pump's pressure measured at the point of injection must not exceed either of the following:

1. 5 psi
2. Manufacturer's instruction

For pipeliners with a stiffness of at least 29 psi, the grout pump's pressure measured at the point of injection must not exceed 7.25 psi.

The pipeliner must be able to withstand a static head of grout that is 6 inches above the highest crown elevation. The maximum grout pressure for a static grout head must not exceed the grout pump's maximum allowable pressure.

Install a grout pressure gauge and recorder immediately adjacent to each injection port. Continuously record on paper with ink the actual grouting pressure versus time. Record grout pressure to an accuracy of ±0.5 psi. Attach a gauge to a saddle-type diaphragm seal to prevent clogging with grout.

71-3.01A(4)(c)(ii) CCTV Recording

CCTV recordings must be made and submitted in high quality electronic media such as CD or DVD.

The CCTV equipment must include:

1. CCTV camera with articulating head
2. Transporter adapted for conditions of the culvert
3. Television monitor
4. Lighting
5. Cables and power sources

CCTV equipment must:

1. Be specifically designed and constructed for pipe inspection
2. Have camera lighting for minimizing reflective glare
3. Have an adjustable focal-distance range from 6 inches to infinity
4. Produce a minimum resolution of 356 lines per inch for both the camera and monitor
5. Have a remote-reading meter counter accurate to 1 percent over the length of the particular section being inspected

Verify accuracy of the distance meter in the CCTV with a walking meter, roll-a-tape, or other authorized device.

Where human entry is possible for the entire length of the culvert, you may use a handheld video camera with lighting as an alternative to CCTV. Video and audio content must comply with the requirements for CCTV. Inspect at a rate that is not more than 30 feet per minute.

71-3.01A(4)(c)(iii) Photographs

Use a digital camera and lighting. Lighting and photo quality must be suitable to provide clear and focused photographs of the entire culvert surface under all conditions.

71-3.01A(4)(c)(iv) Monitoring of Annular Space Grouting

Wherever a pipeliner with annular space grouting is described, monitor the grouting and record pressures throughout the grouting process. Verify compliance with the manufacturer's instructions for each phase of

the grouting process. Gauges must comply with ANSI B40, Grade 2A. The pressure gauges, recorder, and field equipment must be calibrated by an independent testing agency.

71-3.01A(4)(c)(v) Pipeliners

Pipeliners must be continuous over the entire length of the culvert and must have no visual defect such as foreign inclusions, concentrated ridges, discoloration, pitting, pin holes, cracking or other deformities. The pipeliner must not be over-deflected. There must not be segregation or voids in the grout.

71-3.01A(4)(c)(vi) Deflection Testing of Pipeliners

If a pipeliner with annular space grouting is described, test the pipeliner for deflection. Test after grouting and in the presence of the Engineer.

For pipeliners with a nominal inside diameter of 36 inches or less, either pull a mandrel through the pipeliner by hand or use another authorized method. The mandrel must be:

1. Rigid and nonadjustable
2. Comprised of at least 9 legs and have an odd number of total legs
3. Longer than it is wide
4. Made of steel
5. Fitted with pulling rings at each end
6. Stamped or engraved on some segment other than a runner indicating pipeliner material specification, nominal size, and mandrel outside diameter (e.g., HDPE F 714-SDR 26- 36" – 31.569")
7. Furnished in a suitable carrying case labeled with the same data as stamped on the mandrel
8. Authorized before use

For pipeliners with a nominal inside diameter greater than 36 inches, determine the deflection using a 1-inch diameter, rigid, nonadjustable metal bar; a minimum-radius rigid template; or other authorized method.

The pipeliner must not be over-deflected. For pipeliners 36 inches or less in nominal diameter, the mandrel must pass through the entire pipeliner. For pipeliners greater than 36 inches in nominal diameter, the deflection must be the lesser of either of the following:

1. 5 percent greater than the actual dimension of the pipeliner in place. This actual dimension includes the pipe joint system.
2. 6-1/2 percent of the nominal pipeliner dimension.

If more than 8 percent of the nominal pipeliner dimension is over-deflected, the pipeliner is rejected. If 8 percent or less of the nominal pipeliner dimension is over-deflected, the pipeliner may remain in place and the Department deducts 20 percent of the bid amount for that pipeliner.

71-3.01B Materials

71-3.01B(1) General

Slurry cement backfill for culverts must comply with section 19-3.02E.

71-3.01B(2) Contact Grout

Grout for contact grouting must comply with section 41-2 and contain:

1. Not more than 2 percent bentonite by weight of cement and water
2. Not less than 590 lb of cement per cubic yard

If sand is used in the grout mix, the sand must comply with section 90-1.02C(3) and the gradation requirements in the following table:

Sieve size	Percent passing
No. 8	100
No. 16	95–100
No. 30	60–85
No. 50	20–50
No. 100	10–30
No. 200	0–20

71-3.01B(3) Annular Space Grout

Grout for annular space grouting must be low-density foam concrete that consists of water, cementitious materials, foaming agent, and optional chemical admixtures.

Cementitious materials must comply with section 90-1 except:

1. Use of SCM is not mandatory
2. You may only use SCM if you submit a statement from the foaming agent's manufacturer verifying that the foaming agent is compatible with the SCM

Foaming agent must comply with ASTM C869.

71-3.01C Construction

71-3.01C(1) General

Comply with the following work sequence and notify the Engineer before you start each of the following steps:

1. Clean and prepare
2. Inspect and evaluate
3. Repair culvert
4. Rehabilitate culvert
5. Restore openings
6. Perform post-rehabilitation inspection

Before starting the inspection, the culvert must be clean and free of water and debris. During all culvert work, keep the culvert clean and free of water and debris.

Wherever culvert struts are described in the grouting plan, install struts before starting any grouting.

Wherever structural concrete repairs to the culvert are shown or ordered, the structural concrete repair must be complete and the concrete must have a compressive strength of at least 2,500 psi before starting any grouting.

Wherever concrete invert paving is shown or ordered, the invert paving must be complete and the concrete paving must have a compressive strength of at least 2,500 psi before starting any grouting.

71-3.01C(2) Cleaning and Preparation

Remove all debris, sediment, and other accumulated material from the culvert invert and restore the flow area to the original flow area or to the diameter shown.

Where shown, disconnect down drains towards the downstream end of the culvert.

Clean the culvert with high-velocity cleaning equipment and air mover or mechanically powered equipment. If human entry is possible, you may use nonmechanically powered cleaning equipment.

71-3.01C(3) Inspection and Evaluation

After cleaning and preparation is complete, inspect the entire length of the culvert and submit the inspection and evaluation report. Inspect by either CCTV or human entry.

If sediment, debris, or other accumulated material is found during inspection, stop the inspection and reclean the culvert. Cleaning must comply with the manufacturer's instructions for the type of pipeliners

shown. Cleaning must be complete to allow accurate CCTV and photography of the entire culvert. No payment is made for recleaning.

Make a 360-degree inspection, video, and photographic record of each joint and lateral joint.

If the CCTV camera does not pass from one end of the culvert through the entire length of the culvert, reset the equipment and inspect from both ends until the entire length is documented.

If the inspection video is low quality and does not adequately depict the condition of the culvert, correct the deficiencies and reinspect the culvert. Low quality may result from:

1. Poor camera head position
2. Poor focus
3. Low lighting
4. Rapid rate of progression
5. Missing documentation of time and location
6. Inadequate cleaning of the culvert

No payment is made for reinspection due to low quality and recleaning.

71-3.01C(4) Repairing

After obtaining authorization of the inspection and evaluation report, repair the existing culvert as described or ordered.

Complete repairs before starting rehabilitation work.

71-3.01C(5) Rehabilitation

71-3.01C(5)(a) General

Place slurry cement backfill around the culvert and below the culvert invert as shown.

71-3.01C(5)(b) Annular Space Grouting

Before starting grouting activities, install the bulkheads and place grout injection tubes and breather tubes with removable plugs around the pipeliner and through bulkheads as shown in the authorized grouting plan.

Grout the entire annular space between the pipeliner and culvert without voids or grout segregation. If you determine, before starting grouting, that the entire annular space is not accessible for grouting, submit a work plan for correcting the annular space to allow for grouting. No payment is made for correction of the annular space to allow for grouting.

Mix the water, cementitious materials, and chemical admixtures before adding the foaming agent to the grout. Add the foaming agent at the job site.

Grout must be placed in a continuous manner and injected in lifts. The height of the lifts must (1) not exceed the height in the authorized grout plan or (2) be less if needed to avoid floating, shifting, or deforming the pipeliner. Monitor the injection pressure, including the pressure for the last lift at the crown. If the pipeliner cannot withstand grouting pressures or static head, either reduce the maximum pressure at the point of grout injection, or employ staged grouting.

71-3.01C(5)(c) Restoring Openings

Within 72 hours of installing a pipeliner, restore the lateral pipe and service openings, risers, downdrains, median drainage inlets, and underdrains. Restore these openings before starting pipeliner installation at another culvert location. The openings must conform and match the invert of connecting pipes.

Do not excavate unless authorized.

Restore openings from the interior of the pipe. Use either a CCTV and remote-control cutting device or human entry.

The area of the restored opening must be at least 95 percent of the original area. Openings must have an edge that is crack-free, smooth, and free of burrs and projections.

Where human entry is possible, grout the restored opening so that the seal is watertight. Grout must be one of the following:

1. Quick-set epoxy mortar
2. High-viscosity epoxy
3. Hydrophilic vulcanized expansive rubber strip
4. Manufacturer's recommended mix

71-3.01C(5)(d) Postrehabilitation Inspection

Postrehabilitation inspection must comply with section 71-3.01C(3).

71-3.01D Payment

Payment for the following work is included in the payment for cleaning, inspecting, and preparing the culvert:

1. Cleaning and preparation
2. Quality control and assurance
3. Keeping the culvert free of water and debris
4. Inspection and evaluation
5. Performing postrehabilitation inspection

Unless a separate pay item is described for diverting the culvert flow, payment for diverting the flow of water away from the culvert is included in the payment for cleaning, inspecting, and preparing the culvert.

Repairs, additional cleaning, disconnecting downdrains, and reconnecting down drains are paid as change order work unless such work is described in the Contract.

Record the quantity of slurry cement backfill that is installed in the culvert and submit this quantity. The Department does not pay for slurry cement backfill material that is wasted, disposed of, or remaining on hand after the completion of the work.

Record the quantity of grout that is installed and submit this quantity. The Department does not pay for grout that leaks through to the inside of the culvert. The Department does not pay for grout material that is wasted, disposed of, or remaining on hand after the completion of the work.

Pipeliners are measured along the flow line of the existing culvert. No payment is made for pipeliner length in excess of the measured length.

71-3.02 FILL CULVERT VOIDS

Reserved

71-3.03 CONTACT GROUTING

Reserved

71-3.04 INVERT PAVING

Reserved

71-3.05 EPDM RUBBER PIPE JOINT SEAL

Reserved

71-3.06 WELDED STEEL PIPELINERS

Reserved

71-3.07 PLASTIC PIPELINERS

Reserved

71-3.08 CURED-IN-PLACE PIPELINERS

Reserved

71-3.09 MACHINE SPIRAL WOUND PVC PIPELINERS

71-3.09A General

71-3.09A(1) General

71-3.09A(1)(a) Summary

Section 71-3.09 includes specifications for installing machine spiral wound PVC pipeliners directly into the culvert..

71-3.09A(1)(b) Definitions

Reserved

71-3.09A(1)(c) Submittals

Submit a certificate of compliance for each reel of PVC strip and include:

1. Name of the manufacturer
2. Plant location
3. Date of manufacture and shift
4. Cell classification
5. Unit mass
6. Average pipeliner stiffness and profile type

71-3.09A(1)(d) Quality Assurance

Reserved

71-3.09A(2) Materials

Each reel and continuous PVC strip must be distinctively marked on the inside surface, at intervals not exceeding 5 feet, and with a coded number. The coded number must include:

1. Name of the manufacturer
2. Plant location
3. Date of manufacture and shift
4. Minimum strip thickness
5. Cell classification and profile type
6. Size

The marking must be visible from inside the completed pipeliner.

71-3.09A(3) Construction

Restore openings.

71-3.09A(4) Payment

Not Used

71-3.09B Machine Spiral Wound PVC Pipeliners, Grouted

71-3.09B(1) General

71-3.09B(1)(a) Summary

Section 71-3.09B includes specifications for installing a continuous spiral wound PVC pipeliner into the interior of an existing culvert and filling the annular space with grout.

The pipeliner must be wound directly into the culvert using equipment that is either self running or static. Where human entry is feasible, the pipeliner may be wound by hand inside the culvert.

71-3.09B(1)(b) Definitions

Reserved

71-3.09B(1)(c) Submittals

If you use pressure for installing the pipeliner, the annular space grouting plan must include:

1. Manufacturer's instructions for the maximum internal pressure
2. Maximum differential pipeliner pressures

71-3.09B(1)(d) Quality Assurance

The nominal dimensions for the pipeliner must comply with dimensions shown.

71-3.09B(2) Materials

PVC profile strips must comply with ASTM F1697 or ASTM F1735.

You may use alternative profile types and corresponding minimum properties if authorized.

71-3.09B(3) Construction

Pipeliner installation must comply with ASTM F1741 or ASTM F1698. The profile strip may be nonreinforced or reinforced with a continuous-profiled steel strip with interlocking edges. Sealants and gaskets necessary for effectively interlocking the edges of the profile strip must be pre-applied at the time of manufacture. Lock edges together as the strip is wound into the culvert. If the profile strip is reinforced, mechanically lock the profiled steel band onto the outside of the PVC pipeliner.

For circular culverts, wind the profile strip at a fixed diameter. For noncircular culverts, wind the profile strip at a fixed dimension. Leave an annular space between the pipeliner and culvert wall. The ends of the pipeliner must be flush with the culvert unless a beveled end is shown.

After grouting and beveling where shown, seal the ends of the culvert between the pipeliner and culvert with cement mortar under section 65-2.02F.

71-3.09B(4) Payment

Not Used

71-3.09C Machine Spiral Wound PVC Pipeliners, Expandable Diameter

71-3.09C(1) General

Section 71-3.09C(1) includes specifications for installing a continuous spiral wound pipeliner into the interior of an existing culvert and expanding the pipeliner radially against the culvert.

71-3.09C(2) Materials

PVC profile strips must comply with ASTM F1697.

71-3.09C(3) Construction

Pipeliner installation must comply with ASTM F1741. The pipeliner must be continuous over the entire length of the insertion.

Install PVC strips directly into the culvert from an insertion point and expand the strips radially against the culvert after insertion.

Sealants and gaskets necessary for effectively interlocking the edges of the profile strip must be pre-applied at the time of manufacture. Lock edges together as the strip is wound into the culvert.

Seal the ends of the culvert between the pipeliner and culvert with cement mortar under section 65-2.02F.

71-3.09C(4) Payment

Not Used

71-3.10 CEMENTITIOUS PIPELINERS

Reserved

71-3.11–71-3.15 RESERVED

71-4 MODIFY DRAINAGE STRUCTURES

71-4.01 GENERAL

71-4.01A General

Section 71-4 includes specifications for partially removing, adjusting, and adding to drainage facilities.

71-4.01B Materials

Not Used

71-4.01C Construction

Not Used

71-4.01D Payment

Not Used

71-4.02 PIPES

71-4.02A General

Modifying pipes includes extending pipes. Extending pipes must comply with the specifications for new pipe installation.

71-4.02B Materials

Not Used

71-4.02C Construction

Existing headwalls or end walls must be removed or moved to a new location.

If headwalls or end walls are to be moved, cut the pipe so that it has smooth edges at a point approximately 1 foot behind the headwall or end walls and perpendicular to the centerline of the pipe. Move the headwall or end wall to the reconstructed location and connect the pipes.

71-4.02D Payment

Not Used

71-4.03 INLETS, MANHOLES, AND RISERS

71-4.03A General

Not Used

71-4.03B Materials

Not Used

71-4.03C Construction

Modify inlet, manhole, and riser structures by capping.

Excavate and remove structures to a depth of at least 1 foot below the grading plane.

Cap inlet structures with minor concrete. Where shown, round the bottom of structures with minor concrete. Minor concrete must contain at least 590 pounds of cementitious material per cubic yard.

Backfill to match the grading plane

71-4.03D Payment

Not Used

71-4.04 SLOTTED PIPE GRATE

Reserved

71-5 ADJUST DRAINAGE STRUCTURES

71-5.01 GENERAL

Section 71-5 includes specifications for partially removing and either lowering or raising facilities.

Adjust to grade with new materials that are similar in character to the existing materials.

71-5.02 MATERIALS

Not Used

71-5.03 CONSTRUCTION

71-5.03A General

Not Used

71-5.03B Frames, Covers, Grates, and Manholes

Adjust frames, covers, grates and manholes by lowering before cold planing and raising after paving or surfacing. Before opening the lane to traffic, either (1) complete permanent paving or surfacing or (2) temporarily fill any depressions with HMA.

Where paving or surfacing work is shown, do not adjust to final grade until the adjacent pavement or surfacing is complete.

For a structure that is to be raised, remove the cover or frame and trim the top of the structure to provide a suitable foundation for the new material.

Instead of using new materials similar in character to those in the existing structure, you may use raising devices to adjust a manhole to grade. Before starting paving work, measure and fabricate raising devices. Raising devices must:

1. Comply with the specifications for section 75 except that galvanizing is not required
2 Have a shape and size that matches the existing frame
3. Be match marked by painting identification numbers on the device and corresponding structure
4. Result in an installation that is equal to or better than the existing one in stability, support, and nonrocking characteristics
5. Be fastened securely to the existing frame without projections above the surface of the road or into the clear opening

Where manholes are to be lowered, remove the facility to 3.5 feet below finished grade or to an authorized depth. Adjust the manhole using the taper needed to match the finished grade.

If a manhole cover is unstable or noisy under traffic, place a coil of asphalt-saturated rope, a plastic washer, or asphaltic compound on the cover seat. Before placement, obtain authorization for use of the material.

71-5.03C Inlet

Adjust inlets as shown.

Use minor concrete with at least 590 pounds of cementitous material per cubic yard.

Where inlets are adjusted before placing the uppermost layer of pavement or surfacing, limit the work area so that adjusting the inlet and final paving or surfacing is completed within the same work day. The top of the inlet grate or cover must be protected during paving operations by heavy plywood covers, steel plate covers, or other authorized methods. Excess paving material must be removed before rolling.

Where inlets are adjusted after placing the uppermost layer of pavement or surfacing, do not adjust the inlet to final grade until the paving or surfacing has been completed immediately adjacent to the inlet.

71-5.04 PAYMENT

If adjust inlet is paid by the linear foot, adjusting the inlet is measured as the difference in the length between the top of the existing inlet and the top of the adjusted inlet.

If no item is shown for adjust inlet, payment for adjusting the inlet is included in the payment for the type of pavement or surfacing shown in the Bid Item List.

If (1) no item is shown for adjust inlet and (2) pavement or surfacing is not involved, payment for adjusting the inlet is included in the payment for the type of excavation shown in the Bid Item List.

If no item is described for adjust (1) frames, (2) covers, (3) grates, or (4) manholes, payment for adjusting these materials is included in the payment for the type of pavement or type of surfacing in the Bid Item List.

If no item is shown for adjust (1) frames, (2) covers, (3) grates, or (4) manholes, and if pavement or surfacing is not involved, payment for adjusting these materials is included in the payment for the type of excavation shown in the Bid Item List.

71-6 ABANDON DRAINAGE STRUCTURES

71-6.01 GENERAL

71-6.01A General

Section 71-6 includes specifications for partially removing and rendering facilities unserviceable in place.

Wherever manholes or drainage facilities are abandoned, pipes entering the manhole or drainage facility must be securely closed by a tight-fitting plug that is either of the following:

1. Wall of minor concrete not less than 6 inches thick
2. Tight brick wall not less than 8 inches thick with cement mortar joints

The bases of manholes or drainage facilities must be broken so that water is prevented from being entrapped. Demolish the manhole or drainage facility to an elevation that is 3.5 feet below finished grade. Backfill must comply with section 19-3.03E.

71-6.01B Materials

Not Used

71-6.01C Construction

Not Used

71-6.01D Payment

Not Used

71-6.02 MANHOLES

Reserved

71-6.03 CULVERTS AND PIPELINES

Reserved

71-6.04 INLETS

Reserved

71-6.05–71-6.15 RESERVED

71-7 SALVAGE DRAINAGE FACILITIES

71-7.01A GENERAL

Section 71-7 includes specifications for salvaging drainage facilities.

Salvage drainage facilities as shown.

71-7.01B MATERIALS

Not Used

71-7.01C CONSTRUCTION

Not Used

71-7.01D PAYMENT

Not Used

71-8–71-15 RESERVED

DIVISION VIII MISCELLANEOUS CONSTRUCTION

72 SLOPE PROTECTION

72-1 GENERAL

72-1.01 GENERAL

Section 72-1 includes general specifications for constructing slope protection.

72-1.02 MATERIALS

Construct slope protection or slope paving using minor concrete.

Unless otherwise specified, fabric must be Class 8 RSP fabric.

72-1.03 CONSTRUCTION

Earthwork must comply with section 19.

If placement of fabric is required, place the fabric before placing slope protection, slope paving, and gabions.

Before placing the fabric, the surface of the slope must be free of loose or extraneous material and sharp objects that may damage the fabric.

Handle and place the fabric under manufacturer's instructions. Place the fabric loosely on the slope such that it conforms to the surface without damage to the fabric when the cover material is placed.

Join the edges of the fabric with either overlapped joints or stitched seams.

If the fabric is joined with overlapped joints, the adjacent borders of the fabric must be overlapped by at least 24 inches. Overlap in the same direction that the cover material is placed.

If the fabric is joined by stitched seams, stitch with contrasting colored yarn. Use the size and composition of yarn that is recommended by the fabric manufacturer. Use 5 to 7 stitches per inch of seam. The strength of a stitched seam must be the same as that specified for the fabric, except if the stitched seams are oriented up and down a slope, the strength may be reduced to a value that it is at least 80 percent of that specified for the fabric.

Do not operate equipment or drive vehicles directly on the fabric.

If the fabric is damaged and the Engineer determines that it cannot be repaired, replace the fabric.

If the Engineer determines that the fabric can be repaired, then repair it by covering the damaged area with new fabric. If the repair is made using overlapped joints, the overlap must be at least 3 feet.

72-1.04 PAYMENT

The Department does not pay for additional fabric used for overlaps.

Payment for rock slope protection fabric is not included in the payment for rock slope protection.

72-2 ROCK SLOPE PROTECTION

72-2.01 GENERAL

Section 72-2 includes specifications for constructing RSP.

Use the class of rock and the method for placement described.

72-2.02 MATERIALS

72-2.02A General

Reserved

72-2.02B Rock

For method A and B placement and the class of RSP described, comply with the rock gradation shown in the following table:

Rock Gradation

Nominal RSP class by median particle diameter[b]		Nominal median particle weight W_{50}[c,d]	d_{15}[c] (inches)		d_{50}[c] (inches)		d_{100}[c] (inches)	Placement
Class[a]	Diameter (inches)		Min	Max	Min	Max	Max	Method
I	6	20 lb	3.7	5.2	5.7	6.9	12.0	B
II	9	60 lb	5.5	7.8	8.5	10.5	18.0	B
III	12	150 lb	7.3	10.5	11.5	14.0	24.0	B
IV	15	300 lb	9.2	13.0	14.5	17.5	30.0	B
V	18	1/4 ton	11.0	15.5	17.0	20.5	36.0	B
VI	21	3/8 ton	13.0	18.5	20.0	24.0	42.0	A or B
VII	24	1/2 ton	14.5	21.0	23.0	27.5	48.0	A or B
VIII	30	1 ton	18.5	26.0	28.5	34.5	48.0	A or B
IX	36	2 ton	22.0	31.5	34.0	41.5	52.8	A
X	42	3 ton	25.5	36.5	40.0	48.5	60.5	A
XI	46	4 ton	28.0	39.4	43.7	53.1	66.6	A

[a]For RSP Classes I–VIII, use Class 8 RSP fabric. For RSP Classes IX–XI, use Class 10 RSP fabric.
[b]Intermediate or B dimension (i.e., width) where A dimension is length and C dimension is thickness.
[c]d%, where % denotes the percentage of the total weight of the graded material.
[d]Values shown are based on the minimum and maximum particle diameters shown and an average specific gravity of 2.65. Weight will vary based on specific gravity of rock available for the project.

Rock material must comply with the requirements shown in the following table:

Rock Material Requirements

Quality characteristic	Test method	Requirement
Apparent specific gravity (min)	California Test 206	2.5
Absorption (max, %)	California Test 206	4.2
Durability index (min)	California Test 229	52

Notes:
Durability absorption ratio (DAR) = course durability index/(percent absorption + 1)
If the DAR is greater than 10, the absorption may exceed 4.2 percent.
If the DAR is greater than 24, the durability index may be less than 52.

Select rock such that the shapes provide a stable structure for the required section. If the slope is steeper than 2:1, do not use rounded boulders and cobbles. Angular shaped rock may be used on any planned slope. Flat or needle-shaped rock must not be used unless the individual rock thickness is greater than 0.33 times the length.

72-2.02C Fabric

Fabric must be RSP fabric that complies with the class shown in the following table:

Fabric Class

Class	Largest rock gradation class used in slope protection
8	Classes I–VIII
10	Classes IX–XI

72-2.03 CONSTRUCTION

72-2.03A General

Excavate the footing trench along the toe of the slope.

Local surface irregularities of the RSP must not vary from the planned slope by more than 1 foot as measured at right angles to the slope.

At the completion of slope protection work, fill voids in the footing trench with excavated material. Compaction is not required.

72-2.03B Placement Method A

Do not place rocks by dumping.

Place larger rocks in the footing trench.

Place rocks on the slope such that their longitudinal axis is normal to the face of the embankment.

Place foundation course rocks such that they are in contact with the ground surface.

For rocks above the foundation course, place them such that each rock has a 3-point bearing on underlying rocks; do not bear them on smaller rocks which may be used for chinking voids.

72-2.03C Placement Method B

Rocks may be placed by dumping and may be spread in layers by bulldozers or other suitable equipment.

Place rocks such that:

1. There is a minimum of voids
2. Larger rocks are in the toe course and on the outside surface of the slope protection

72-2.04 PAYMENT

If RSP is paid by the ton, the payment quantity is the weight determined from scale weighings.

If RSP is paid by the cubic yard, the payment quantity is the volume determined from the dimensions shown or ordered.

72-3 CONCRETED-ROCK SLOPE PROTECTION

72-3.01 GENERAL

Section 72-3 includes specifications for constructing concreted-rock slope protection.

Use the class of rock and the method for placement described.

72-3.02 MATERIALS

72-3.02A General

Reserved

72-3.02B Concrete

If colored slope protection is described, color the concrete by mixing a fine, ground, synthetic mineral oxide into the concrete. The synthetic mineral oxide must be specifically manufactured for coloring concrete.

The color of the completed concrete after curing and when air dry must match color no. 30450 of FED-STD-595.

Use the 1-inch-maximum combined aggregate gradation in the concrete.

The water content of the concrete must allow gravity flow into the interstices with limited spading and brooming.

72-3.02C Rock

Rocks for concreted-rock slope protection must comply with the gradation shown in the following table:

Concreted-Rock Gradation

Nominal RSP class by median particle diameter[b]		Nominal median particle weight W_{50}[c,d] Weight[a]	d_{15}[c]		d_{50}[c]		d_{100}[c]
Class[a]	Size (inches)		Min	Max	Min	Max	Max
I	6	20 lb	3.7	5.2	5.7	6.9	12.0
II	9	60 lb	5.5	7.8	8.5	10.5	18.0
III	12	150 lb	7.3	10.5	11.5	14.0	24.0
V	18	1/4 ton	11.0	15.5	17.0	20.5	36.0
VII	24	1/2 ton	14.5	21.0	23.0	27.5	48.0

[a]Use Class 8 RSP fabric.
[b]Intermediate or B dimension (i.e., width) where A dimension is length and C dimension is thickness.
[c]d%, where % denotes the percentage of the total weight of the graded material.
[d]Values shown are based on the minimum and maximum particle diameters shown and an assumed specific gravity of 2.65. Weight will vary based on specific gravity of rock available for the project.

Rock for concreted-rock slope protection must comply with the requirements shown in the following table:

Rock Material Requirements

Quality characteristic	Test method	Requirement
Apparent specific gravity (min)	California Test 206	2.5
Absorption (max, %)	California Test 206	4.2
Durability index (min)	California Test 229	52

Notes:
Durability absorption ratio (DAR) = course durability index/(percent absorption + 1)
If the DAR is greater than 10, the absorption may exceed 4.2 percent
If the DAR is greater than 24, the durability index may be less than 52

Select rock such that the shapes provide a stable structure for the required section. If the slope is steeper than 2:1, do not use rounded boulders and cobbles. Angular shaped rock may be used on any planned slope. Flat or needle-shaped rock must not be used unless the individual rock thickness is greater than 0.33 times the length.

72-3.02D Weep Tubes

Weep tubes must:

1. Be schedule 80, perforated PVC pipe complying with section 68-2.02D
2. Have a 2-inch nominal diameter

72-3.03 CONSTRUCTION

72-3.03A General

Excavate a footing trench along the toe of the slope.

Mix the coloring agent uniformly and homogeneously with the concrete.

Local surface irregularities of the concreted-rock slope protection must not vary from the planned slope by more than 1 foot as measured at right angles to the slope.

At the completion of slope protection work, fill voids in the footing trench with excavated material. Compaction is not required.

72-3.03B Placement Method A

Placement Method A must comply with section 72-2.03B.

72-3.03C Placement Method B

Placement Method B must comply with section 72-2.03C.

72-3.03D Placing Weep Tubes

Wrap each weep tube in filter fabric.

Place weep tubes and secure them such that they contact the face of the fabric on the slope and extend at least 2 inches beyond the outer surface of the rock. If placement of fabric on the slope is not required, the end of the tube near the slope must be covered with a cap made of the same material as the weep tube. Ensure that concrete will not plug the tube and perforations.

72-3.03E Placing Concrete

The surface of the rock to be concreted must be cleaned of adhering soil and then moistened. At any one location, place the concrete in a continuous operation during a work day. Deposit concrete by use of chutes, tubes, buckets, pneumatic equipment, or other mechanical methods. Do not allow the concrete to flow more than 10 feet across the slope protection.

Immediately after depositing, spade and rod the concrete into place with suitable spades, trowels, or other suitable means. The minimum concrete penetration must comply with the requirements shown in the following table:

Minimum Concrete Penetration

	Rock class				
	VII	V	III	II	I
Penetration (inches)	18	14	10	8	6

After placing the concrete, thoroughly brush the rocks to expose the top surfaces. Outer rocks must project above the concrete by a height of 0.25–0.32 times the rock diameter. After completion of any 10-foot strip, do not allow workmen or loads on the surface for at least 24 hours.

Cure the concreted-rock slope protection by one of the methods specified for curing concrete. As an alternative, you may cure the concreted-rock slope protection by sprinkling a fine spray of water every 2 hours during the daytime for a period of 3 days. If colored concrete is described and you use the curing compound method, apply curing compound no. 6.

72-3.04 PAYMENT

If concreted-rock slope protection is paid by the ton, the payment quantity is the weight determined from scale weightings.

If concreted-rock slope protection is paid by the cubic yard, the payment quantity is the volume determined from the dimensions shown or ordered.

72-4 SMALL-ROCK SLOPE PROTECTION

72-4.01 GENERAL

Section 72-4 includes specifications for constructing small-rock slope protection.

72-4.02 MATERIALS

Rock must be cobble, gravel, crushed gravel, crushed rock, or any combination of these.

If the rock layer is shown as 7 inches thick, comply with the gradation requirements shown in the following table:

Rock Gradation for 7-inch-Thick Layer

Sieve size	Percentage passing
5 inch	100
4 inch	90–100
3 inch	25–40
2 inch	0–10

If the rock layer is shown as 5 inches thick, comply with the gradation requirements shown in the following table:

Rock Gradation for 5-inch-Thick Layer

Sieve size	Percentage passing
4 inch	100
3 inch	90–100
2 inch	25–40
1 inch	0–10

If the rock layer is shown as 4-inches thick, comply with gradation requirements shown in the following table:

Rock Gradation for 4-inch Thick Layer

Sieve size	Percentage passing
3 inch	100
2 inch	90–100
1 inch	25–40
3/4 inch	0–10

Granular material must contain at least 90 percent crushed particles when tested under California Test 205.

72-4.03 CONSTRUCTION

Local surface irregularities of the small-rock slope protection must not vary from the planned slope by more than 2 inches as measured at right angles to the slope.

Small rocks may be placed by dumping and may be spread by bulldozers or other suitable equipment. During spreading, do not crack the rock.

72-4.04 PAYMENT

The payment quantity for small-rock slope protection is the volume determined from the dimensions shown or ordered.

72-5 CONCRETE SLOPE PROTECTION, GUTTER LINING, DITCH LINING, AND CHANNEL LINING

72-5.01 GENERAL

Section 72-5 includes specifications for shaping slopes, preparing the foundation, and constructing any of the following:

1. Concrete slope protection
2. Lined gutters
3. Ditch linings
4. Channel linings
5. Support walls
6. Cut-off stubs
7. Cut-off walls
8. Footings
9. Aprons

Construct slope protection, gutter lining, ditch lining, and channel lining using minor concrete or shotcrete.

Reinforcement must comply with section 52.

72-5.02 MATERIALS

Pervious backfill material must comply with section 19-3.02D.

Expansion joint filler must comply with section 51-2.01B(1).

Shotcrete must comply with section 53.

If colored slope protection is described, color the concrete by mixing a fine, ground, synthetic mineral oxide into the concrete. The synthetic mineral oxide must be specifically manufactured for coloring concrete.

The color of the completed concrete after curing and when air dry must match color no. 30450 of FED-STD-595.

Weep tubes must:

1. Be schedule 80, perforated PVC pipe complying with section 68-2.02D
2. Have a 2-inch nominal diameter

72-5.03 CONSTRUCTION

Evenly grade the foundation, including all surfaces where concrete is to be placed, such that no point on the graded surface is above the designated plane.

Wrap each tube in fabric.

Place weep tubes as shown or ordered.

Placing concrete must comply with section 51.

At each weep tube and drain hole, place a securely tied sack that contains 1 cubic foot of pervious backfill. The sack material must comply with the specifications for fabric in section 72-2.02C.

Mix the coloring agent uniformly and homogeneously with the concrete.

Spread and tamp concrete until it is thoroughly compacted and mortar flushes to the surface. If the slope is too steep to allow the use of concrete wet enough to flush with tamping, tamp the concrete until it is consolidated and immediately trowel on a mortar surface that is 1/4 inch thick. The mortar must consist of 1 part portland cement and 3 parts fine aggregate.

After striking-off to grade, hand-float the concrete with floats that are at least 4 inches wide and 30 inches long. Broom the entire surface with a stiff-bristle broom to produce a uniform surface. Brooming must be done when the surface is set enough to prevent deep scarring and must be accomplished by drawing the broom down the slope, leaving marks parallel to the edge of the slope. The Engineer may direct you to apply a fine spray of water to the surface immediately before brooming. Edges and joints must be edged with a 1/4-inch-radius edger before the brooming.

Install transverse expansion joints at 20-foot intervals. Fill the expansion joints with 1/2-inch-thick expansion joint filler.

After placing the concrete, fill the footing trenches with excavated material. Compaction is not required.

Cure concrete slope protection, gutter lining, ditch lining, and channel lining by with one of the methods specified for curing condrete. If colored concrete is described and you use the curing compound method, apply curing compound no. 6.

Construct, finish, and cure shotcrete slope protection under section 53.

72-5.04 PAYMENT

The payment quantity for concrete (slope protection) constructed with minor concrete or shotcrete is the product of (1) the area measured along the slope lines of the completed concrete slope protection and (2) the thickness shown for the concrete slope protection.

The Department does not pay for additional concrete placed due to over excavation.

72-6 BROKEN-CONCRETE SLOPE PROTECTION

Reserved

72-7–72-10 RESERVED

72-11 SLOPE PAVING

72-11.01 GENERAL

72-11.01A General

72-11.01A(1) Summary

Section 72-11.01 includes general specifications for constructing slope paving.

Construct slope paving using minor concrete or shotcrete.

Reinforcement must comply with section 52.

72-11.01A(2) Definitions

Reserved

72-11.01A(3) Submittals

Reserved

72-11.01A(4) Quality Assurance

Reserved

72-11.01B Materials

Shotcrete must comply with section 53.

The aggregate size used in minor concrete must be from 3/4 to 1 inch.

If colored slope paving is described, color the concrete by mixing a fine ground, synthetic mineral oxide into the concrete. The synthetic mineral oxide must be specifically manufactured for coloring concrete. The color of the completed concrete after curing and when air dry must match color no. 30450 of FED-STD-595.

Expanded polystyrene and premolded expansion joint filler must comply with section 51-2.

72-11.01C Construction

72-11.01C(1) General

Construct concrete curbs before constructing sidewalks or slope paving. Concrete curbs must comply with section 73.

Mix the coloring agent uniformly and homogeneously with the concrete.

Before applying concrete or shotcrete, evenly grade foundations such that no point on the graded slope is above the slope plane shown.

Thoroughly compact foundations. Foundations must contain enough moisture to provide a firm foundation and to prevent absorption of water from the concrete or shotcrete. Foundations must be free of surface water.

Schedule the construction of the slope paving such that the work, including placing and finishing concrete or shotcrete and applying curing compound, is completed on the same day that the work is started.

If the Engineer determines that the size of the slope paving is too large to be constructed without an intermediate construction joint, place a joint at an authorized location. Complete a section of concrete or shotcrete bounded by permissible construction joints within the same day.

Cure slope paving by the curing compound method using curing compound no. 6.

72-11.01C(2) Minor Concrete

Construct and finish minor concrete slope paving under section 51-1.

Spread and tamp the concrete until it is thoroughly compacted and mortar flushes to the surface. If the slope is too steep to allow the use of concrete wet enough to flush with tamping, then tamp the concrete until it is consolidated and immediately trowel on a mortar surface that is 1/4 inch thick. The mortar must consist of 1 part portland cement and 3 parts fine aggregate.

After striking-off to grade, hand-float the concrete with floats that are at least 4 inches wide and 30 inches long. Broom the entire surface with a stiff-bristled broom to produce a uniform surface. Brooming must be done when the surface is set enough to prevent deep scarring and must be accomplished by drawing the broom down the slope, leaving marks parallel to the slope. The Engineer may order you to apply a fine spray of water to the surface immediately before brooming.

72-11.01C(3) Shotcrete

Construct and finish shotcrete slope paving under section 53.

After the shotcrete has been placed to the depth shown, check the surface with a straightedge. Place additional mortar to bring any low spots or depressions up to the proper grade.

The finish of the shotcrete slope paving must be uniform without humps or hollows of more than 1/2 inch in 10 feet.

72-11.01D Payment

The payment quantity for slope paving (concrete) constructed with minor concrete or shotcrete is the product of (1) the area computed from measurements along the slope of the actual areas constructed and (2) the thickness shown for the concrete slope paving.

The Department does not pay for additional concrete or shotcrete placed due to overexcavation.

72-11.02 EXPOSED AGGREGATE SLOPE PAVING

72-11.02A General

Section 72-11.02 includes specifications for constructing slope paving with an exposed aggregate finish.

72-11.02B Materials

Construct exposed aggregate slope paving using minor concrete.

Coarse aggregate must comply with the 1 inch by no. 4 primary size coarse aggregate specified in section 90-1.02C(4)(b).

Concrete set retarders must be commercial-quality and manufactured specifically for use on the top surface of concrete. The retarder must effectively slow down the setting time of the cement and fine aggregate matrix long enough to permit exposing the aggregates.

72-11.02C Construction

Mix the coloring agent uniformly and homogeneously with the concrete.

Place and consolidate the concrete such that the coarse aggregate remains uniformly distributed throughout the concrete.

You may apply a concrete set retarder to the surface of the concrete after placing, consolidating, and finishing of the concrete is complete. Apply the set retarder under the manufacturer's instructions.

When the mass of the concrete is set enough to allow for removing the matrix of cement and fine aggregate, expose the coarse aggregate:

1. With a water spray, coarse brooming, abrasive blasting, or a combination of these procedures. Removal methods must not dislodge or loosen the coarse aggregate from embedment in the mortar.
2. To an approximate depth from 3/16 to 3/8 inch. Exposed aggregate surfaces must be uniform in appearance.

Immediately after the cement mortar has hardened enough to resist further removal, clean all cement film and other loose material from the exposed aggregate and all other surfaces with stiff brooms and water.

Cure concrete under section 90-1.03B except when operations for exposing the aggregate are underway. You may use the water curing method. If you remove an area of curing compound during the curing period, keep the area continuously wet until the end of the curing period or until you reapply the curing compound.

72-11.02D Payment

Not Used

72-11.03 SLOPE PAVING WITH CONCRETE PAVERS

72-11.03A General

72-11.03A(1) Summary

Section 72-11.03 includes specifications for constructing slope paving using concrete pavers.

72-11.03A(2) Definitions

Reserved

72-11.03A(3) Submittals

If using pre-mixed mortar, submit the manufacturer's instructions for the mixing proportions and procedures.

72-11.03A(4) Quality Assurance

Reserved

72-11.03B Materials

72-11.03B(1) General

Reserved

72-11.03B(2) Concrete Pavers

Concrete pavers for slope paving must comply with ASTM C90 for solid units. The surface exposed to view must have a split face texture. The nominal size of the concrete pavers must be 8 by 2 by 16 inches.

72-11.03B(3) Mortar

Hydrated lime must comply with ASTM C207, Type S.

Mortar sand must be commercial-quality and free of organic impurities and lumps of clay and shale.

Mortar for laying concrete pavers must consist by volume of 1 part cement, from 0 to 0.5 part hydrated lime, and from 2.25 to 3 parts mortar sand. Add enough water to make a workable mortar. Accurately measure and thoroughly mix each batch of mortar. Do not retemper mortar more than 1 hour after mixing.

Reduce the amount of lime as necessary to prevent leaching and efflorescence on the finished surface.

You may use a premixed packaged mortar blend of cement, lime, and sand, without color, that requires only water to prepare for use as brick mortar or grout. Packages of the premixed mortar must show the manufacture's name, brand, weight, and color identification.

72-11.03B(4) Bond Coat

The bond coat must be either dry-set mortar or latex-portland cement mortar. Organic adhesive must not be used for the bond coat. Mix the bond coat under the manufacturer's instructions. The consistency of the mixture must be such that ridges formed with the recommended notched trowel do not flow or slump. You may rework the bond coat provided no water or materials are added.

72-11.03B(5) Grout

Grout must be suitable for grouting quarry tile and must comply with ANSI Standard: A 108.5. Grout must consist, by volume, of 1 part cement, up to 1/5 part lime, 2 parts of sand, and an amount of water to provide a grout with a consistency that can be forcibly compressed into joints.

You may use a premixed packaged grout blend of cement, lime, and sand that is suitable for grouting quarry tile and requires only water to prepare for use as brick grout. Packages of the premixed grout must show the manufacturer's name, brand, weight, and color identification.

72-11.03C Construction

72-11.03C(1) General

Joints must be straight and of uniform and equal width.

Protect surfaces of completed masonry, concrete, and other materials exposed to view from spillage, splatters, and other deposits of cementitious materials from masonry construction. Remove these deposits without damage to the materials or exposed surfaces. Stains, efflorescence, laitance, splashes, or spots on the faces of masonry exposed to view must be removed.

Apply cleaning agents under the paver manufacturer's instructions to a sample area determined by the Engineer. Do not continue with cleaning beyond the sample area until the Engineer authorizes the cleaning agent and the cleaning methods.

72-11.03C(2) Installation using a Bond Coat

Install concrete pavers on a bond coat over a mortar bedding.

Do not use air blown mortar.

Roughen and clean the concrete surfaces against which concrete pavers are to be placed, exposing the stone aggregate. Immediately before placing the paver units, flush the concrete surface with water and allow it to dry to a surface dry condition.

Prepare the concrete surfaces to receive a mortar setting bed under the specifications for horizontal construction joints in section 51-1.03D(4).

The mortar setting bed must be at least 1 inch thick and be finished parallel to the finished brick surface. Cure the setting bed for at least 24 hours before placing the bond coat.

Roughen and clean the surfaces of the cured setting bed. The surface must be free of laitance, coatings, oil, sand, dust, and loose particles.

Dampen the cured setting bed before placing the bond coat. Do not soak the setting bed.

Float the bond coat onto the cured setting bed with enough pressure to cover the surface evenly with no bare spots. The surface area to be covered with the bond coat must be no greater than the area that can be covered with concrete pavers while the bond coat is still plastic.

Comb the bond coat mortar with a notched trowel within 10 minutes before installing concrete pavers. Do not install the concrete pavers on a skinned-over mortar bond coat.

Back-butter the concrete pavers immediately before installing the units. Firmly press the concrete pavers into the freshly notched bond coat. Tap the concrete pavers to a true surface to attain 100 percent coverage of the bond coat with the back of each unit.

Head and bed mortar joints must be 1/2 inch thick.

Remove spacers, strings, ropes, pegs, glue, paper, and face mounting material before grouting the concrete pavers. Do not start grouting until at least 48 hours after installing concrete pavers.

Force a maximum amount of grout into the joints between and surrounding the concrete paver units. Tool the grout to a slightly concave cross section to a depth not more than 1/8 inch below the finished surface.

The finished grout must have a uniform color and must be smooth without voids, pinholes, or low spots.

Keep the concrete pavers continuously damp for at least 72 hours after grouting.

72-11.03C(3) Installation on a Mortar Bedding

The top surface of the air-blown mortar or concrete base must be lightly and evenly scored horizontally and vertically with a metal scratcher having grooves not more than 1 inch apart.

Cure the air-blown mortar or concrete base by the water method for at least 2 days.

Lay and embed the concrete pavers in approximately 1-inch thick mortar. Embedment must be shoved tight such that mortar is flushed into the joints to a depth of approximately 1/2 inch.

72-11.03D Payment

Not Used

72-12–72-15 RESERVED

72-16 GABIONS

72-16.01 GENERAL

72-16.01A Summary

Section 72-16 includes specifications for constructing gabion structures. Gabions consist of wire mesh baskets that are placed and then filled with rock.

72-16.01B Definitions

Reserved

72-16.01C Submittals

Submit a certificate of compliance for each shipment of gabion baskets to the job site.

Submit a certificate of compliance for the PVC coating. Identify any UV-resistance additive on the certificate of compliance.

72-16.01D Quality Assurance

72-16.01D(1) General

Reserved

72-16-.01D(2) Quality Control

If ordered, verify the unit weight of a rock-filled gabion. Verify the weight using the smallest standard gabion basket, filling method, and rock that will be used on the project. Use certified scales for weighing. Calculate the unit weight using the theoretical volume of the basket.

72-16.02 MATERIALS

72-16.02A General

The standard sizes for gabion baskets must be either of the following:

1. Mattress style that are 12 by 18 by 36 inches
2. Cubical style that are 36 by 36 by 36 inches

The width, height, or length of a standard basket must not vary more than 5 percent from the standard size shown.

Each gabion must be manufactured with the necessary panels that are properly spaced and secured such that the panels can be rotated into position without additional tying of the rotation joint.

72-16.02B Mesh

Use the same mesh for each style and size of gabion basket.

The size of wire used to manufacture mesh must comply with the requirements shown in the following tables:

Wire Size with PVC Coating

Gabion basket style	USA wire gauge	Mesh type
Cubical	12	Twisted
	11–9	Welded
Mattress	12	Twisted
	11	Welded

Wire Size without PVC Coating

Gabion basket style	USA wire gauge	Mesh type
Cubical	11	Twisted
	11–9	Welded
Mattress	11	Twisted
	11	Welded

Wire must comply with the requirements shown in the following table:

Wire Material Requirements

Quality characteristic	Test method	Requirement
Tensile strength (min, ksi)	ASTM A370	60
12-gauge wire:		
Diameter (min, in)	ASTM A641/A641M	0.106
Zinc coating (min, oz/sq.ft)	ASTM A641/A641M Class 3 and A90	0.75
11-gauge wire:		
Diameter (min, in)	ASTM A641/A641M	0.120
Zinc coating (min, oz/sq.ft)	ASTM A641/A641M Class 3 and A90	0.80
9-gauge wire:		
Diameter (min, in)	ASTM A641/A641M	0.144
Zinc coating (min, oz/sq. ft)	ASTM A641/A641M Class 3 and A90	0.85

Twisted-mesh wire must be formed with a nonraveling twist and into a uniform hexagonal pattern. For PVC-coated wire, use 10-gauge size for the selvage wires. For wire without a PVC coating, use 9-gauge size for the selvage wires.

Welded-mesh wires must:

1. Be formed into the grid pattern shown
2. Be welded by resistance welding
3. Comply with ASTM A1084 except weld shears must be:
   3.1. 600 lb minimum for 11-gauge wire
   3.2. 800 lb minimum for 9-gauge wire

Resistance welding after coating the wire with zinc is allowed if there are no large splashes, flakes, or flashes of zinc at the weld.

72-16.02C PVC Coating

If PVC coating is shown, coat the mesh wire, standard tie wires, standard binders, internal connecting wires, preformed stiffeners, and selvage wire.

A PVC coating must be UV resistant. A suitable UV-resistance additive must be blended with the PVC. If the gabions are exposed to natural sunlight, the color of the PVC coating must be gray and resistant to fading.

Apply the zinc coating before applying the PVC coating. Application of the PVC coating must comply with the manufacturer's instructions.

Evaluate the PVC coating by infrared spectral scan. The scan must closely match those of tested and accepted materials already on file at the Transportation Laboratory.

The minimum thickness of the PVC coating must be 0.015 inch when measured radially at any cross-section transverse to the wire length.

PVC coating will be visually inspected. There must be no nicks, cuts, holidays, or abraded areas. Minor cuts, nicks, and other minor imperfections due to manufacturing are allowed along the selvage-wrapped edges of the twisted wire mesh.

You are not required to coat the ends of the wires where they have been trimmed along wire or panel edges during the normal manufacturing processes.

72-16.02D Joints

Standard tie wire and standard spiral binder wire must comply with the requirements shown in the following table.

Tie Wire and Spiral Binder Wire Material Requirements

Quality characteristic	Test method	Requirement
Tensile strength (min, ksi)	ASTM A370	60
Tie wire 13.5-gauge wire Diameter (max, in) Diameter (min, in) Zinc coating (min, oz/sq ft)	 ASTM A641/A641M ASTM A641/A641M A641/A641M Class 3 and ASTM A90	 0.086 0.082 0.70
Spiral binder wire 9-gauge wire Diameter (max, in) Diameter (min, in) Zinc coating (min, oz/sq ft)	 ASTM A641/A641M ASTM A641/A641M ASTM A641/A641M Class 3 and ASTM A90	 0.148 0.144 0.85

Spiral binders must have a 3-inch separation between continuous successive loops.

If shown, you may use alternative fasteners.

For PVC-coated wire, alternative fasteners must comply with ASTM A313/A313M, tensile Type 302, Class 1.

For wire without PVC coating, alternative fasteners must comply with ASTM A764 and:

1. Interlocking fasteners must be Class I, Finish 2 with a Class 3 zinc finish coating
2. Overlapping fasteners must comply with Class II, Finish 1 with a Class 3 zinc finish coating

72-16.02E Internal Connecting Wire

Internal connecting wires must be a minimum size of 13.5-gauge. The wire must comply with the specifications for tie wire in section 72-16.02D.

You may use preformed stiffeners instead of internal connecting wires. Preformed stiffeners must comply with the specifications for tie wire in section 72-16.02D and be installed under the manufacturer's instructions.

72-16.02F Fabric

If gabions are shown for downdrains use woven tape fabric. Woven tape fabric must comply with ASTM D4491, have a mass of at least 8 oz/sq yd, and have a maximum permeability of 7.5 gal/minute/sq ft.

72-16.02G Rock

Rock for filling gabions must comply with the testing and corresponding specifications in section 72-2.02B.

Rocks for gabion baskets equal to or greater than 18 inches in height must vary in size and comply with the gradation requirements shown in the following table:

Rock Gradation for 18-Inch or Larger Baskets

Screen size (in)	Percentage passing
12	100
4	0–5

Rocks for gabion baskets that are 12 inches in height must vary in size and comply with the gradation requirements shown in the following table.

Rock Gradation for 12-Inch Baskets

Screen size (in)	Percentage passing
8	100
4	0–5

The unit weight of a rock-filled gabion must be at least 110 lb/ cu ft.

72-16.03 CONSTRUCTION

72-16.03A General

Areas where gabions are to be placed must be constructed to the lines and grades shown.

If fabric is shown, place the fabric on the subgrade, backslope, and sides of the excavations. If earth fill is to be placed over the gabions, place the fabric on top of the gabions before placing the earth fill.

Gabions must be divided by diaphragm panels such that baskets are 36-inch long cells.

72-16.03B Assembly

Individually assemble empty gabion baskets and successively join the baskets. Assemble the individual mesh panels, base, front, ends, back, diaphragms, and lid, and successive gabions such that the strength and flexibility along the joints is comparable to a single panel.

Assemble the gabions as empty units. Rotate panels and diaphragms into position and join them along the vertical edges.

For twisted wire mesh, construct joints using alternating double and single half hitches and locked loops made at 4-inch nominal spacing. Use 13.5-gauge standard tie wire. Do not construct joints with simple spiraling or looping without locking, of the tie wire.

For welded wire mesh, construct joints using either of the following:

1. Standard tie wire and alternating double and single half hitches and locked loops, in every mesh opening along the joint
2. 9-gauge spiral binders with the spiral binder passing through every mesh opening along the joint. Crimp both ends of the spiral binder and secure it in place.

You may use temporary fasteners to hold panels at gabion-to-gabion joints. The temporary fasteners may remain in place.

Use either interlocking fasteners or overlapping fasteners. Place a fastener at each mesh opening along the joint. For PVC coated wire, the spacing of fasteners must be at least 10 fasteners per 36 inches. For wire without PVC coating, the spacing of fasteners must be at least 10 fasteners per 40 inches.

Set individual gabion baskets in place. Successively join the basket to the adjacent basket with 13.5-gauge tie wire or 9-gauge standard spiral binder before filling the basket with rock. In 1 pass, the tie wire or spiral binder must secure all selvage or end wires of the panels along the joint.

If forming successive gabion-to-gabion joints with alternative fasteners, use 1 alternative fastener at each mesh opening. The alternative fastener must contain and secure all wires along the joint.

Join gabion baskets along the front, back, and ends, including the top and bottom of adjacent gabions.

Step and stagger multi-layered gabion configurations. Join each layer of gabion to the underlying layer along the front, back, and ends.

Join shear key and counterfort gabions to the underlying gabions along the front, back, and ends.

For transitional gabions, fold, cut, and fasten the gabion baskets as shown or as authorized.

72-16.03C Filling

Before filling each gabion basket, straighten any kinks and folds in the wire and align the baskets.

Place rock in the basket and preserve the alignment. Avoid bulges and minimize voids. Exposed rock surfaces must have a smooth and neat appearance. Sharp rocks must not project through the wire mesh.

Use internal connecting wires or preformed stiffeners to produce a flat, smooth external surface.

When filling 36-inch-high gabions, place the rock in 12-inch-deep layers. When filling 18-inch-high gabions, place the rock in 9-inch-deep layers. Install internal connecting wires or preformed stiffeners before adding additional layers.

The last layer of rock must slightly overfill the gabion basket such that the lid will rest on rock when the lid is closed.

Lids must be tied along the front, end, and diaphragms with 13.5-gauge tie wire or 9-gauge standard spiral binder. In 1 pass, the tie wire or spiral binder must secure all selvage or end wires of the panels along the lid.

If securing the lid with alternative fasteners, use 1 alternative fastener at each mesh opening. The alternative fastener must contain and secure all wires along the lid.

72-16.04 PAYMENT

The payment quantity for gabion is the volume determined from the dimensions shown or the actual volume of gabions placed.

72-17 EXISTING SLOPE PROTECTION

72-17.01 GENERAL

72-17.01A General

Section 72-17 includes specifications for performing work on existing slope protection.

Work performed on existing slope protection must comply with section 15.

72-17.01B Material

Not Used

72-17.01C Construction

Not Used

72-17.01D Payment

Not Used

72-17.02 REMOVE SLOPE PAVING

72-17.02A General

Section 72-17.02 includes specifications for removing slope protection.

72-17.02B Materials

Not Used

72-17.02C Construction

Not Used

72-17.02D Payment

The payment quantity for remove slope paving is the area of the slope paving measured before starting removal

72-18–72-25 RESERVED

73 CONCRETE CURBS AND SIDEWALKS

73-1 GENERAL

73-1.01 GENERAL

Section 73-1 includes general specifications for constructing concrete curbs, sidewalks, and their appurtenances, such as gutter depressions and island paving; and curb ramps and driveways.

Steel dowels, reinforcing steel, and welded wire reinforcement must comply with section 52.

73-1.02 MATERIALS

73-1.02A General

Concrete for curbs, sidewalks and their appurtenances must be minor concrete containing at least 463 pounds of cementitious material per cubic yard.

For extruded or slip form curb construction, the maximum aggregate size must be from 3/8 to 1 inch. The cementitious material content must be at least 505 pounds per cubic yard if a maximum of 3/8-inch aggregate is used.

Preformed expansion joint filler must comply with ASTM D1751.

Mortar must comply with section 51-1.02F.

Form oil must:

1. Be commercial quality or an equivalent coating
2. Allow the ready release of forms
3. Not discolor the concrete

73-1.02B Detectable Warning Surfaces

A detectable warning surface must be on the Authorized Material List for detectable warning surfaces and must match yellow color no. 33538 of FED-STD-595.

73-1.03 CONSTRUCTION

73-1.03A General

Construct contraction joints by (1) scoring concrete with a grooving tool and rounding corners with an edger tool or (2) saw cutting hardened concrete to a depth of at least 1 inch. Immediately apply curing compound to the exposed surfaces of saw cut joints.

Construct expansion joints at each side of structures and at the ends of curb returns. Fill expansion joints with 1/4-inch-thick preformed joint filler. Finish the concrete adjacent to expansion joints with an edger tool. Do not construct expansion joints within 20 feet of an island nose. Shape the preformed joint filler to match the surface contour of the concrete.

73-1.03B Subgrade Preparation

Remove soft or spongy basement material to a depth of 6 inches below the subgrade elevation for curbs, gutter depressions, island paving, and driveways and 3 inches below the subgrade elevation for sidewalks and curb ramps. Backfill the subgrade with earth, sand, or gravel to produce a stable foundation.

Apply water to the subgrade and thoroughly compact it before placing concrete.

Prepare subgrade to required grade and cross section. Verify that the finished surface of the subgrade does not project into the concrete cross section at any point by:

1. Using a template supported on the side forms for the fixed form method
2. Measuring from the offset guide line or survey marks for the extruded or slip form method

73-1.03C Fixed Form Method

Set forms to the required alignment, grade, and dimensions.

Forms must:

1. Be smooth on the side placed against concrete.
2. Have a straight upper edge.
3. Be rigid enough to withstand the pressure of fresh concrete without distortion. Use enough stakes, clamps, spreaders, and braces to ensure rigidity.
4. Be clean of debris and old concrete.
5. Coated with form oil before placing concrete.

You may use either benders or thin plank forms on curves, grade changes, or curb returns.

Wet the subgrade and forms immediately before placing the concrete.

Place the preformed joint filler at expansion joints in the correct position before placing concrete against the filler.

Place and compact the concrete without segregation.

73-1.03D Extruded and Slip Form Methods

Wet the subgrade immediately before placing the concrete.

Feed concrete into the extrusion machine at a uniform rate. Restrain forward travel of the extrusion machine to produce a well-compacted mass of concrete requiring no further finishing other than a light brushing. The brush may be filled with water. Do not finish the concrete surface with a brush application of grout.

If you use a slip form machine, automatically control the alignment, grade, and cross slope by one of the following methods:

1. Sensing from preset string lines
2. String line control of the alignment and grade and automatic control of the cross slope

The slip form machine must have traveling forms rigid enough to produce the required cross section. The machine must produce a dense, homogeneous concrete, true to grade and cross section and require minimum handwork. Consolidate the concrete with internal vibrators or other authorized method.

Use a smaller, maximum size of aggregate with an extruded or slip form machine if it is required to produce concrete (1) free from surface pits larger than 3/16 inch in diameter and (2) with well-defined web marks of water on the surface.

You may construct expansion joints by sawing through the concrete cross section to its full depth. The width of the cut must provide a tight fit for the joint filler. Insert preformed joint filler into sawed joints and mortar it in place.

If a joint is cut before the concrete has hardened:

1. Protect the adjacent surfaces with close fitting, firmly supported shields
2. Complete the saw cut and insertion of the preformed joint filler before curing the concrete

If a joint is cut after the concrete has hardened:

1. Mortar preformed joint filler in place using heavy trowel pressure
2. Cover the exposed portions of the concrete in the vicinity of the saw cut with an additional application of curing compound

After the concrete has cured, check the joint filler for a tight fit. If any loose joints are found, mortar the joint in place and recheck after the mortar has cured. Repeat as necessary to achieve a tight fit.

73-1.03E Curing

Cure concrete using the curing compound method with pigmented curing compound.

Completely coat the exposed faces of the concrete with curing compound.

73-1.04 PAYMENT

Not Used

73-2 CURBS

73-2.01 GENERAL

Section 73-2 includes specifications for constructing curbs.

73-2.02 MATERIALS

Not Used

73-2.03 CONSTRUCTION

73-2.03A General

If curbs are constructed over existing pavement, use steel dowels and reinforcing steel or adhesive to anchor the curb to the existing pavement.

Anchor steel dowels in drilled holes with mortar made from equal parts by volume of portland cement, sand, and water. You may use anchor bolts instead of anchored steel dowels if authorized.

If adhesive is used, remove all dust, loose material, or oil from the surface of the existing pavement by either wire brushing or blast cleaning.

Construct contraction and expansion joints at right angles to the line of the curb. Space contraction joints at 20-foot intervals. For curbs adjacent to existing concrete, align the curb joints with the existing concrete's pavement joints.

The top and face of the finished curb must be true and straight. The top surface of the curb must be uniform in width and free from humps, sags, or other irregularities. Clean any discolored concrete by abrasive blast cleaning or other authorized method.

Except for curbs on structures, you may place curbs with an extrusion machine or a slip form paver if:

1. Finished curb is true to line and grade
2. Concrete contains the maximum quantity of water that maintains the curb's shape without support
3. Required surface texture is attained

Check the flatness of the top and face of the curb and the surface of the gutter with a 10-foot straightedge. The surfaces must be flat to within 0.01 foot except at grade changes or curves.

73-2.03B Fixed Form Method

Set fixed forms the full depth of the back and face of the curb.

The back forms may be constructed with 1/2-inch-thick bender boards.

Cleat the back forms together as required to attain the full depth of the curb.

Use form clamps to prevent interference with finishing activities.

Before removing the forms, finish the surface true to grade with a straightedge float at least 10 feet in length. Operate the straightedge float longitudinally over the concrete surface.

Remove the forms from the face of the curb from 1 to 6 hours after placing the concrete. Do not remove the forms if the concrete is plastic enough to slump.

After removing the forms, immediately use a steel trowel to attain a smooth finish. The smooth finish must extend (1) to within 0.17 foot of the flow line or (2) to the flow line of a curb with an integral gutter. After smoothing the curb's face, apply a fine-brush finish parallel to the line of the curb.

73-2.03C Extruded or Slip Form Methods

For an extrusion machine, use the Department's survey marks to determine the offset guide line for setting the grade for the top of the curb. The extrusion machine must have a grade-line gauge or pointer that allows continual comparison between the curb placement and the offset guide line.

The machine must be capable of vertical adjustment during forward travel to construct curbs of varying height as determined by the offset guide line.

You may operate the extrusion machine on rails or forms set at a uniform depth below the established grade of the top of curb.

73-2.04 PAYMENT

Not Used

73-3 SIDEWALKS, GUTTER DEPRESSIONS, ISLAND PAVING, CURB RAMPS, AND DRIVEWAYS

73-3.01 GENERAL

73-3.01A Summary

Section 73-3 includes specifications for constructing sidewalks, gutter depressions, island paving, curb ramps, and driveways.

73-3.01B Definitions

Reserved

73-3.01C Submittals

Submit a 5-year manufacturer's replacement warranty against defects in a prefabricated detectable warning surface.

73-3.01D Quality Assurance

73-3.01D(1) General

Reserved

73-3.01D(2) Warranties

The 5-year manufacturer's replacement warranty for a prefabricated detectable warning surface must cover defects in dome shape, color fastness, sound-on-cane acoustic quality, resilience, and attachment. The 5-year warranty period starts at Contract acceptance.

73-3.01D(3) Quality Control

Reserved

73-3.02 MATERIALS

Not Used

73-3.03 CONSTRUCTION

Construct expansion joints at:

1. All returns and opposite expansion joints in the adjacent curb
2. 60-foot intervals where there is no adjacent curb

Construct contraction joints to create rectangular patterns from 12 to 20 square feet in the surface of sidewalks.

Install a prefabricated detectable warning surface under the manufacturer’s instructions.

Broom finish the surface of sidewalks, gutter depressions, curb ramps, and driveways. Make the broom finish perpendicular to the path of travel on surfaces used by pedestrians. You may apply water to the surface immediately before brooming.

The finished surface must not vary more than 0.02 foot from a 10-foot straightedge except at grade changes.

If placing pavement around or adjacent to manholes, pipe inlets, or other miscellaneous structures in sidewalk, gutter depression, island paving, curb ramps, or driveway areas, do not finish the miscellaneous structures to final grade until the pavement is finished beyond the miscellaneous structure.

If using fixed forms, strike off and compact fresh concrete until a layer of mortar is brought to the surface. Finish the surface with a float to grade and cross section and trowel smooth.

Leave forms in place for sidewalks, gutter depressions, island paving, curb ramps, and driveways for at least 12 hours after surface finishing.

Clean any discolored concrete by abrasive blast cleaning or other authorized method.

73-3.04 PAYMENT

The payment quantity for minor concrete (curb ramp) does not include detectable warning surface.

73-4 TEXTURED CONCRETE AND COLORED CONCRETE SURFACES

73-4.01 GENERAL

73-4.01A Summary

Section 73-4 includes specifications for texturing and coloring concrete surfaces. Texture concrete by imprinting with stamps, tools, brooms, or other methods to attain the pattern or impressions shown.

73-4.01B Definitions

Reserved

73-4.01C Submittals

Submit the manufacturer's data for the color hardener and curing and finishing compounds for each color of a concrete surface colored by the dry-shake method.

73-4.01D Quality Assurance

73-4.01D(1) General

Reserved

73-4.01D(2) Quality Control

Construct test panels for textured or colored concrete under section 51-1.01D(2)(c).

73-4.01D(3) Department Acceptance

The Department accepts textured or colored concrete surfaces based on a visual comparison with the test panel.

73-4.02 MATERIALS

Aggregate for textured or colored concrete surfaces must comply with the gradation requirements for fine aggregate.

Aggregate used in grout for textured and colored concrete surfaces must comply with the gradation requirements shown in the following table:

Aggregate Gradation for Grout

Sieve size	Percentage passing
No. 4	100
No. 8	90–100
No. 16	60–100
No. 30	35–70
No. 50	15–35
No. 100	2–15

Color pigments for the dry-shake method must comply with ASTM C979.

73-4.03 CONSTRUCTION

Protect the surrounding exposed surfaces during the placement, finishing, and curing of colored concrete.

Screed the concrete to the grade and cross section shown, and strike off and compact the concrete until a layer of mortar is brought to the surface. Wood float the concrete to produce a uniform surface.

For the dry-shake method, apply the color hardener in 2 applications while the concrete surface is plastic. Use at least 60 lb of hardener per 100 sq ft of concrete surface. Wood float the surface after each application of hardener. Trowel the surface only after final floating.

Texture the concrete while it is in the plastic stage. For a texture that requires a concrete stamp, use the stamp under the manufacturer's instructions.

Do not texture or grout the grooved area and detectable warning surface on a curb ramp.

Cure the concrete surfaces using the curing compound method with curing compound no. 6.

Place any grout after the (1) initial curing of the textured concrete and (2) removal of curing seal and other deleterious substances. The method of removal must not stain or discolor areas of textured concrete to remain exposed after grouting. Spread and consolidate the grout over the textured concrete under the manufacturer's instructions. Remove excess grout with a squeegee and damp burlap rags or other authorized method. Apply curing seal.

73-4.04 PAYMENT

Not Used

73-5–73-9 RESERVED

73-10 EXISTING CURBS AND SIDEWALKS

73-10.01 GENERAL

Section 73-10 includes specifications for performing work on existing curbs, sidewalks, and their appurtenances, such as gutter depressions and island paving.

Work performed on existing curbs and sidewalks must comply with section 15.

73-10.02 MATERIALS

Not Used

73-10.03 CONSTRUCTION

If you repair any part of a curb, sidewalk, curb ramp, driveway, or gutter depression, remove and replace the entire section between contraction or expansion joints. At contraction joints, saw cut a true line at least 1-1/2 inches deep before concrete removal. Removal of concrete includes the removal of detectable warning surfaces.

Install a prefabricated detectable warning surface on an existing curb ramp under the manufacturer's instructions.

73-10.04 PAYMENT

Detectable warning surface placed on existing concrete is paid for as a separate bid item.

73-11–73-15 RESERVED

74 PUMPING EQUIPMENT AND CONTROLS

74-1 GENERAL

74-1.01 GENERAL

74-1.01A Summary

Section 74-1 includes general specifications for installing pumping equipment and the control systems.

74-1.01B Definitions

Reserved

74-1.01C Submittals

74-1.01C(1) General

If you use the drainage pumps to maintain total pumping capacity before Contract acceptance, submit:

1. Shop drawings for the drainage inlet bulkhead and safeguards
2. Maintenance work plan

74-1.01C(2) Shop Drawings

Plans and detail drawings may be 22 by 34 inches.

Submit shop drawings for the pumping equipment including:

1. System layout
2. Piping connections
3. Appurtenances
4. Other materials required for the equipment installation
5. Mounting details and anchorage details

Submit shop drawings for the electrical equipment including:

1. Electrical equipment schematics
2. Control diagrams
3. Wiring diagrams
4. Conductor numbers for control and power conductors

Do not use project plan reproductions or the manufacturer's standard printed data for electrical layout drawings.

Submit shop drawings for the installation of drainage pump equipment and pumping plant electrical equipment after product data submittals are authorized.

If the drainage pump and pumping plant electrical equipment require changes to the pump plant metal work or other construction details, submit revised shop drawings.

74-1.01C(3) Product Data

Submit at least 5 copies of product data. Each copy must be bound together and include an index stating equipment names, manufacturers, and model numbers. Two copies will be returned.

Product data must include:

1. Catalog cuts including:
    1.1. Manufacturer's name
    1.2. Catalog or part number
    1.3. Size
    1.4. Capacity
    1.5. Electrical ratings
    1.6. Finish
    1.7. Maintenance and adjustment requirements
    1.8. Identification symbols described
    1.9. Installation instructions
2. Performance data

3. Installation instructions

74-1.01C(4) Samples

The Engineer may request material samples of submitted equipment.

74-1.01C(5) Work Plans

74-1.01C(5)(a) General

Reserved

74-1.01C(5)(b) Performance Testing Plan

Submit a work plan for performance testing of pumping plant equipment. The work plan must include methods for:

1. Blocking pipes at their entrance point into the storage box
2. Removing all debris from the pumping plant, storage box, debris sump and pump sump before testing
3. Locating and installing bulkheads in the storage boxes, if used
4. Performing an operational test, including pump controller operation
5. Supplying water
6. Disposing of water

74-1.01C(5)(c) Maintenance Plan

Submit a work plan for maintaining the existing pumping plant's total pumping capacity and maintaining the pumping plant as specified in section 74-1.03E. The work plan must include:

1. Pumping plant maintenance procedures and schedule.
2. Alternatives for maintaining total pumping capacity as specified in section 74-1.03E.
3. Description of the proposed pumping equipment. If using alternative 2 or 3 specified in section 74-1.03E, include auxiliary pump curves, equipment ratings, quantity, and power supply.
4. Method for water disposal.

74-1.01C(6) Maintenance and Operation Manual

Submit a maintenance and operations manual before completion of the work. Submit 1 copy of PDF files on a CD or DVD and 2 copies in print format in 3-ring binders with tabbed dividers. The manual must include all authorized action submittals for drainage pump equipment and pumping plant electrical equipment. Organize each binder as follows:

1. Index
2. Part lists
3. Operating instructions
4. Maintenance instructions
5. Wiring schematics, with control and power conductor numbers identified
6. Certified pump curves

Incomplete or inadequate documents are returned for correction and resubmittal.

Submit all paperwork delivered with the pumping plant equipment to the Engineer.

74-1.01D Quality Assurance

74-1.01D(1) General

Notify the Engineer at least 10 days before testing. The pump plant must be complete before testing is performed.

Furnish all water and electrical energy necessary for testing. If authorized, you may use the pumping plant discharge system.

74-1.01D(2) Quality Control

74-1.01D(2)(a) General

Reserved

74-1.01D(2)(b) Operational Tests

Perform the operational tests in the Engineer's presence. The Engineer verifies the pump nameplates before testing.

Fill the pump sump and storage boxes with water. Fill boxes as required until the operational tests and performance tests are authorized. If authorized, you may add bulkheads in the storage boxes.

Perform operational tests of the pumping plant to demonstrate:

1. Proper rotation of each pump
2. Manual operation of the pumps separately and combined
3. Automatic operation of the pumps separately and combined

74-1.01D(2)(c) Performance Tests

After acceptance of the operational tests, the Engineer will run performance tests on the installed pumping plant equipment under section 74-1.01C(5)(b). Performance tests include two 5-minute tests for each pump.

Performance tests must show that each installed drainage pump complies with at least (1) 97 percent of the factory certified performance curve and (2) the design pump rates shown. Each pump must not load its motor more than the actual full load nameplate amperage, regardless of head. The motor service factor will not be applied.

Remove bulkheads and blocking from pipes after performance testing is complete.

74-1.01D(2)(d) Drainage Pump Final Inspection

If you use the drainage pumps installed under the Contract to maintain the total pumping capacity for the pumping plant drainage area before Contract acceptance, remove and disassemble the pumps after your final use of the pumps.

Remove and disassemble the pumps before Contract acceptance. The Engineer performs a final inspection of the pumps.

Worn, damaged, or otherwise unsatisfactory parts must be replaced. Assemble and reinstall the pumps.

Test the drainage pumps used before Contract acceptance under section 74-1.01C(5)(b) after the Engineer's final inspection and before Contract acceptance.

74-1.02 MATERIALS

74-1.02A General

Anchorages must comply with the specifications for concrete anchorage devices in section 75-3.02C.

74-1.02B Delivery, Storage, and Handling

Deliver products to the job site in an undamaged condition in the manufacturer's original sealed container or other packaging system. Packaging must be complete with labels and instructions for handling, storing, unpacking, protecting, and installing.

Store and handle products (1) under the manufacturer's written instructions and (2) such that you prevent damage, deterioration, or loss, and maintain warrantee requirements.

74-1.03 CONSTRUCTION

74-1.03A General

Reserved

74-1.03B Painting

Painting metal work must comply with section 59.

Paint uncoated drainage pump equipment, including metal work, as machinery under section 59-2.01C(4).

Paint all wood surfaces under section 78-4.02 before installation.

Paint the pump number on each drainage pump motor and on each discharge pipe 5 feet above every landing. The numbers must be stenciled and at least 1-1/2 inches tall. Paint an arrow showing the direction of the drainage pump rotation on each discharge pipe 4-1/2 feet above every landing. The arrows must be stenciled and at least 6 inches long. Use 2 applications of commercial-quality white gloss enamel.

Paint surfaces before they become unreachable because of assembly operations.

Painting must not impair legibility, life expectancy, or function of the following items:

1. Brass surfaces
2. Nameplates
3. Warning plates
4. Push buttons
5. Operating handles
6. Electrical cover plates
7. Plastic parts
8. Locks

Repair exposed nongalvanized threads or damaged galvanizing under section 75-1.02B.

Clean, prime, and touch up damaged areas of painted surfaces. Use the same type of primer, paint, and color as the damaged finish.

Do not use cold galvanizing aerosol cans for repair or touch-up work.

74-1.03C Care and Cleaning

Do not install pumping plant equipment until the structural portion of the pump sump is substantially complete. You may install anchors and embedded equipment whenever required by the structural work.

Protect the installed equipment from damage.

Clean equipment, enclosures, galvanized and noncorrodible metal surfaces, and wood surfaces in the pumping plant after installation under section 59-1.03D.

Remove debris from the pump house, pump sump, storage boxes, and premises at Contract acceptance.

74-1.03D Maintenance Instructions

Supply an 11-by-17 inch fused-laminate copy of:

1. Maintenance instructions in a galvanized sheet-metal frame. Install the frame on an interior pump house wall.
2. Control system schematic diagram. Install the diagram on the inside of a motor control center door.

74-1.03E Total Pumping Capacity and Maintenance Requirements

The Department will not issue relief from maintenance and protection until Contract acceptance.

For existing pumping plants:

1. Stage removal activities such that the total pumping capacity is maintained
2. Provide pumping plant maintenance

Upon completion of pumping plants:

1. Maintain total pumping capacity
2. Provide pumping plant maintenance

Furnish electrical energy necessary for maintaining the total pumping capacity and maintenance requirements.

Pumping plant maintenance must include:

1. Removing dirt and debris from the storage boxes, entrance bay, pump sump and drainage inlets

2. Performing adjustments and repairs for proper operation of drainage pump equipment and pumping plant electrical equipment

Keep a pump house logbook of pumping plant maintenance activities. Include the maintenance dates, work performed, and the name of the employee doing the work.

Maintain the total pumping capacity at the corresponding dynamic head shown. Use one of the following alternatives to maintain the total pumping capacity:

1. Stage activities such that the entire pumping plant is complete and able to maintain total pumping capacity.
2. Furnish an auxiliary pumping system with a capacity equal to the total pumping capacity. This system must include a power supply, controls, temporary drainage system, sump pumps, and discharge piping.
3. Combination of the above 2 alternatives.

Dispose of water. If authorized, you may use the pumping plant discharge system.

74-1.03F Use of Pumps before Contract Acceptance

Section 74-1.03F applies if you use the drainage pumps installed under the Contract to maintain total pumping capacity before Contract acceptance.

The pumping plant must be complete. Storage boxes, screens, pump sumps, and pumping plant equipment must be authorized before use.

Drainage water must be settled before entering the pumping plant. Drainage water must flow through safeguards and drainage inlet bulkheads to remove non-suspended solids. Non-suspended solids include debris, soil, sand, and gravel.

Safeguards include stilling ponds, basins, check dams, and weirs. Safeguards must:

1. Intercept the drainage water and effectively stop non-suspended solids by settling
2. Deliver settled water to paved surfaces, pipes, or other nonerodible channels leading to the drainage inlets
3. Be maintained such that the safeguards function as intended

Construct bulkheads around drainage inlets discharging to the pump sump and storage boxes. Drainage inlet bulkheads must consist of burlap sacks filled with pervious material.

74-1.04 PAYMENT

Not Used

74-2 DRAINAGE PUMPING EQUIPMENT

74-2.01 GENERAL

74-2.01A Summary

Section 74-2 includes specifications for installing drainage pumping equipment.

74-2.01B Definitions

Reserved

74-2.01C Submittals

74-2.01C(1) General

Reserved

74-2.01C(2) Product Data

Submit product data for the following items:

1. Drainage pumps
2. Flexible expansion couplings
3. Wall louvers
4. Flap valves

5. Pressure gauges
6. Pump house doors

The drainage pump data must include:

1. Pump components
2. Representative pump curve showing the motor does not develop more than 95 percent of its nameplate horsepower anywhere on the curve
3. Hp, kVA, kW, power factor, and voltage
4. Starting and running currents
5. Thermal and magnetic trip settings
6. Starter overloads current setting
7. Motor nameplate data, including:
   7.1. Full load speed
   7.2. Full load current
   7.3. Voltage
   7.4. Locked rotor kVA per rated horsepower or code letter

74-2.01C(3) Certificates of Compliance

Submit certificates of compliance for factory certified impeller balancing and factory certified drainage pump tests. Certification documents must be in US customary units.

Submit the factory original hard copy and 2 copies as PDF files on 2 CDs or DVDs. Send to OSD, Documents Unit. The Department will not accept a facsimile copy. Notify the Engineer of the submittal. Include in the notification the date and contents of the submittal.

Factory-certified test documents for each drainage pump must include:

1. Generated pump curve from the cutoff head to the minimum dynamic head shown. Show on the pump curve:
   1.1. Identified test points used to generate the pump curve.
   1.2. Plot of the design pump rates and dynamic heads shown on the pump curve.
   1.3. Identified and plotted test point horsepower and efficiencies on the pump curve.
2. Data that confirms the pump develops from 97 to 100 percent of the motor nameplate power at the point the pump requires maximum power.
3. Motor rpm.
4. Impeller final diameter.

74-2.01D Quality Assurance

74-2.01D(1) General

Reserved

74-2.01D(2) Regulatory Requirements

Drainage pumps must be factory certified under ANSI/HI 14.6. Each pump certification must be for the actual motor, pump, and trimmed impeller combination delivered to the job site.

The impeller balancing must be factory certified under ISO 1940-1, ISO Balance Quality Grade G6.3, at the supplied motor rpm.

74-2.02 MATERIALS

74-2.02A General

Reserved

74-2.02B Drainage Pumps and Pumping Apparatus

74-2.02B(1) General

Reserved

74-2.02B(2) Drainage Pump

Drainage pumps must be submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal wastewater pumps complying with ANSI/HI 1.1-1.2 and ANSI/HI 1.3. Pumps must be assembled and tested at the factory. Do not use a base elbow mounted pump. Drainage pumps must be coated with the manufacturer's standard finish for the intended use.

Drainage pumps must be the rpm and voltage shown and comply with the design pump rates and dynamic heads shown.

Drainage pumps must have cast iron:

1. Casings
2. Brackets
3. Volutes with open inlet
4. Horizontal pump discharges

Drainage pumps must have a base support engineered to allow design flow into the volute and support the assembled weight of the drainage pump. Base support legs must be bolted to the floor.

Drainage pumps must have (1) replaceable bronze wear rings on the impeller and casing, and (2) non-magnetic stainless steel external nuts and bolts.

Drainage pump impellers must be:

1. Dynamically balanced.
2. Made from ductile iron or bronze.
3. Nonclog type, open or semi-open design for sludge, and able to handle solids up to 3 inches.
4. Trimmed to develop from 97 to 100 percent of the motor nameplate power at the point of maximum load and still deliver at least the design pump rates and dynamic heads shown.
5. Keyed and secured to the shaft. The impeller balancing must not weaken or deform the impeller.

Drainage pumps must have a stainless steel shaft with factory-sealed lubricated roller bearings, tandem double-mechanical seals of tungsten carbide or silicon carbide with an oil reservoir, and have internal moisture sensors in the oil reservoir.

Motors must be a standard efficiency, NEMA code letter "A" through "G", 3-phase NEMA Design B motor with cable assembly. The cable assembly must include a 4-conductor power cable and a 5-conductor control cable. The motor with cable assembly must be rated for Class 1, Division 1 locations.

Motors must have NEMA Class F insulation, built-in thermal protection, with lifting eyes or lugs.

The cables must be listed for *Extra Hard Service* for Class 1, Division 2 locations. Each cable must include an equipment grounding conductor with green or green with yellow stripe insulation. The cables must be long enough to be installed from the motor to the enclosure shown without splicing. Install cable connectors for termination in the junction box.

Each drainage pump must have a motor nameplate and pump identification nameplate. Attach identical nameplates to the inside of the corresponding starter compartment door on the motor control cabinet.

74-2.02B(3) Pumping Apparatus

Flap valves must have an iron body with pipe flange frame and bronze mating surfaces.

Fasteners, expansion anchors, nuts, bolts, and washers must be Type 316 stainless steel.

Pressure gauges must be a compound gauge complying with ASME B40.100, Grade A, and must have:

1. 4-inch liquid filled dial, with stainless steel case and cover.
2. Reset screw.
3. 1/4-inch MPT bottom inlet.
4. Range from 30 inches Hg vacuum to 30 psi.
5. Gauge guard and gauge cock. The gauge guard must be a 1/2 by 1/4 inch, PVC or CPVC body, PTFE or Viton diaphragm, and rated for 0 to 250 psi. The gauge cock must be a 1/2-inch NPT brass ball valve.

74-2.02C Pump House Doors, Louvers, and Fans

74-2.02C(1) General

Fabricate pump house doors and frames under ANSI/SDI A250.8 or ANSI/NAAMM-HMMA 861.

Hinges must comply with ANSI/BHMA A156.1. Locksets must comply with ANSI/BHMA A156.2. Door gasketing must comply with ANSI/BHMA A156.22. Thresholds must comply with ANSI/BHMA A156.21.

Galvannealed steel sheet must be commercial steel, Type B, complying with ASTM A1008/A1008M with at least an A60 metallic coating complying with ASTM A653/A653M.

74-2.02C(2) Pump House Doors

The pump house door consists of the door, frame, and door hardware. Furnish the factory applied finish coating system for the exterior locations.

The pump house doors must be at least 1-3/4 inches thick, full flush, seamless hollow metal construction. The doors must comply with ANSI/SDI A250.4, physical endurance Level A, and the following:

1. Fabricate face sheets, vertical stiffeners, and top and bottom channels from 0.053-inch-thick galvannealed steel sheet.
2. Fabricate the steel-stiffened core using vertical stiffeners that extend the full-door height. Install stiffeners not more than 6 inches apart and spot weld to both face sheets no more than 5 inches on center. Fill the spaces between the stiffeners with glass-fiber insulation or mineral-fiber insulation.
3. Top and bottom channels must be continuous and spot welded to both face sheets. The top channel must be flush and the bottom channel must be inverted.
4. Include moisture vents in the bottom channel.

The door frames must:

1. Be fabricated from 0.067-inch-thick galvannealed steel sheet, 5-1/2 by 2 inches in section
2. Include galvannealed steel sheet grout guards at least 0.016 inches thick
3. Have continuously welded (1) face joints and (2) miter corners that are flush and made smooth
4. Include an integral stop
5. Include a steel channel or angle stiffener head reinforcement at least 0.093 inch thick for openings wider than 48 inches

Floor anchors must be welded to the bottom of jambs and mullions with at least 4 spot welds for each anchor. There must be at least 3 jamb anchors on each side.

Hinges must be Type A2111 or A5111, heavy weight, stainless steel pin, 5 knuckle, ball bearing, and non-removable pin with set screw. Hinge fasteners must be supplied by the hinge manufacturer.

Locksets must be series 4000 bored, operational grade 1, security grade 1, with a nonhanded steel lock chassis and self-aligning trim with concealed through bolts. Locksets must be function F75 with knobs, chromium roses, and a 1/2-inch steel square corner latchbolt.

Weatherstripping must have a polyurethane seal. The overhead door drips must have a 2-1/2 inch projection and be full width. The door shoe with rain drips must be mill finished aluminum with a neoprene insert, end covers, and formed rain drip. Thresholds must be nominal 6 inches wide, mill aluminum with factory non slip finish and span the full width of the opening shown.

74-2.02C(3) Wall Louvers

Wall louvers must be continuous channel frame with nonvision, inverted Y blades. Wall louvers must:

1. Have a frame fabricated from 18 gauge electro-galvanized steel
2. Have dual 12 gauge security grilles with through bolted screws on the inside
3. Have a bronze insect and bird screen in a removable frame fastened on the inside
4. Be factory primed and finished with enamel or powder coated epoxy

74-2.02C(4) Fans

Reserved

74-2.02D Pipe, Joints, and Fittings

74-2.02D(1) General

Reserved

74-2.02D(2) Steel Pipe

Galvanized steel pipe must be standard weight complying with ASTM A53/A53M. Threaded fittings must be galvanized steel or galvanized malleable iron.

Welded steel pipe must comply with section 70-3, except that electrically insulated connections must not be used. Coat pipe under section 70-3.02B(3).

Steel pipe must be flanged. Flanges may be a factory threaded or welded type. Flange dimensions must comply with ASME B16.5, Class 150.

Threaded flanges must be ductile iron complying with ANSI/AWWA C115/A21.15.

Welded flanges must be steel hub slip-on type complying with ANSI/AWWA C207, Class D. Galvanize welded flange pipe sections under section 75-1.02B.

Gaskets must be a full face SBR rubber flange type complying with ASME B16.5, Class 150.

Steel flange bolts, washers, and nuts must be nonmagnetic stainless steel.

74-2.02D(3) Ductile Iron Pipe

Ductile iron pipe must comply with ANSI/AWWA C151/A21.51.

Pipe and fitting joints must be a gasketed mechanical joint type complying with ANSI/AWWA C111/A21.11.

Pipe fittings must comply with ANSI/AWWA C110/A 21.10 and ASME B16.1, Class 125.

Pipe and fittings must have an asphaltic coating complying with ANSI/AWWA C151/A21.51, and an epoxy lining complying with ANSI/AWWA C116/A21.16.

74-2.02D(4) Flexible Expansion Couplings

Flexible expansion couplings must be gasketed short-sleeve type having:

1. Mild steel middle ring with pipe stop
2. 2 rubber-compounded wedge-section ring gaskets
3. 2 mild steel follower rings
4. Mild steel bolts to compress the gaskets

Galvanize all ferrous parts after fabrication. Assemble couplings such that a permanent watertight joint is obtained.

74-2.02E Bracing and Hardware

Brace drainage pumps and other equipment to prevent movement during operation. The bracing method must comply with California Seismic Hazard Zone requirements in the CBC.

Slots for bolt and U-bolt holes in bracing and clips must be 2 bolt diameters wide. The slot holes must be parallel to the axis of the member. Install cut washers under bolt heads and nuts for slotted hole locations.

Galvanize braces, frames, and other metal hardware under section 75-1.02B.

Pumping plant metal work must comply with section 75-4.

74-2.02F Storage Cabinets

Storage cabinets must:

1. Be wall mounted, steel, and bolted or welded construction
2. Have double doors with a single locking handle or magnet catch, and padlock staples
3. Have 2 adjustable shelves
4. Be from 24 to 28 inches wide, 10 to 12 inches deep, and 30 to 33 inches tall

5. Be factory primed and finish painted

74-2.03 CONSTRUCTION

74-2.03A General

Install pressure gauges with gauge guards and gauge cocks. Mount the gauges vertically.

Furnish specialty tools required for the assembly or adjustment of equipment. Mount the tools in the storage cabinet. Install tools too large for the cabinet on adjacent brackets.

74-2.03B Pump House Doors

Install pump house doors under ANSI/BHMA A156.115.

Check door frames for squareness, alignment, twist, and plumbness before and after installation and adjust if necessary. The tolerances are ±1/16 inch.

Check the door frame as follows:

1. Squareness at the door rabbet on a line 90 degrees from the jamb perpendicular to frame head
2. Alignment at jambs on a horizontal line parallel to the plane of the wall
3. Twist at opposite face corners of jambs on parallel lines and perpendicular to the plane of the wall
4. Plumbness at jambs on a perpendicular line from head to floor

Fill the space between the door frame and wall with grout. The grout slump must not exceed 4 inches. Do not deform or damage frames during grouting. Remove grout and other bonding materials from exposed surfaces of doors and frames immediately after grout work.

If grout contains an antifreezing agent, field apply a bituminous coating to the backside of frames.

Fit the door in the frame and shim as necessary. Install weatherstripping on the top and sides of the frame. Install a door shoe on the door. Install an overhead door drip over the door. Use weatherproof silicone sealant and adhesive as the threshold bedding sealant.

Furnish a padlock for the pump house door until Contract acceptance. The Department furnishes padlocks after Contract acceptance.

74-2.04 PAYMENT

Not Used

74-3 PUMPING PLANT ELECTRICAL EQUIPMENT

74-3.01 GENERAL

74-3.01A Summary

Section 74-3 includes specifications for installing pumping plant electrical equipment.

74-3.01B Definitions

Reserved

74-3.01C Submittals

74-3.01C(1) General

Submit the toll-free telephone number of the designated service organization for manufacturer's field services as an informational submittal.

74-3.01C(2) Product Data

Submit product data for:

1. Power and metering equipment
2. Pump control
3. Conduit
4. Conductors and cables
5. Nameplates and warning plates
6. Miscellaneous materials

74-3.01D Quality Assurance

74-3.01D(1) General

Reserved

74-3.01D(2) Regulatory Requirements

Electrical equipment must comply with section 86 and be NRTL certified.

Materials and workmanship must comply with section 86 and the following:

1. 8 CA Code of Regs § 3200 et seq.
2. 19 CA Code of Regs § 1.00 et seq.
3. NFPA 820, "Standard for Fire Protection in Wastewater Treatment and Collection Facilities"

74-3.01D(3) Manufacturer's Field Services

At Contract acceptance, provide 12 months of full maintenance for the pump controller by qualified employees of the pump controller manufacturer's designated service organization. Maintenance must include the manufacturer's routine preventive maintenance, adjustments for proper operation, and all required parts and supplies.

74-3.01D(4) Field Quality Control

A factory-authorized service representative must inspect, test, and adjust the pump controller for proper installation, operation, components, and connections.

74-3.01D(5) Training

Train 6 Department personnel in the programming, connection, operation, troubleshooting, and maintenance of the pump controller. The training must be for at least 4 hours at the job site.

The training instructor must be a factory-authorized representative of the pump controller manufacturer.

The training must include:

1. Books, manuals, and other training material for Department personnel
2. Equipment required for the pump controller training
3. Hands-on experience in programming techniques and operation

74-3.02 MATERIALS

74-3.02A General

All magnetic coils of relays, starters, and other electrical equipment must be wound for an operating range having a mean equal to the voltage applied.

74-3.02B Power and Metering Equipment

74-3.02B(1) General

Reserved

74-3.02B(2) Service Pedestal Equipment

Reserved

74-3.02B(3) Motor Control Center Equipment

Panelboards must be a factory-assembled panelboard interior with metal cover, single-phase, 3-wire, 120/240 V(ac), and must have:

1. 2-pole, 50 A main circuit breaker and molded case branch circuit breakers
2. Phase, neutral, and ground buses that are hard-drawn copper, 98 percent conductivity
3. Separate, isolated neutral bus
4. Ground bus bonded to the cabinet
5. Directory frame mounted on the inside of the door

Current switches must be self-powered, solid state, alternating current sensing switches having the following:

1. Single-pole, normally open contact rated 1-ampere at 240 V(ac)
2. 1/2-inch-diameter through-hole
3. Low range current sensing level from 1 to 15 A
4. High-range current sensing level from 15 to 300 A

Time meters must be 120 V(ac) and non-resettable from 0 to 99,999.9 hours.

Selector switches must:

1. Be single-pole, 2-position-maintained, 10 A, 120 V(ac) rotary types
2. Have contacts rated at 120 V(ac) and 35 percent power factor
3. Have an inductive pilot duty rating of:
    3.1. 60 A make
    3.2. 6 A break
    3.3. 10 A continuous

Pilot lights must be panel mounted, 120 V(ac), high-visibility LEDs with a colored plastic lens and screw cap.

Control relays must be 120 V(ac), 3-pole, double-throw general purpose relays with a clear plastic case and 11-pin plug base with 10 A contacts. Control relays must include a matching barrier type, 11-contact relay socket with 10 A contacts and screw terminals.

Time delay relays must:

1. Be 120 V(ac), electronic on-delay types
2. Have double-pole, double-throw, double-break 10 A contacts, having a range from 0.6 to 60 seconds
3. Have time delays set for:
    3.1. TDR1: 5 seconds
    3.2. TDR2: 20 seconds

Intrinsically safe relays must be:

1. Solid-state, completely self-contained, latching types
2. NRTL approved for use with Class I, Division 2 location sensors
3. 120 V(ac) with single-pole, double-throw, 0.3 A contact with:
    3.1. Maximum turn-on time of 5 milliseconds
    3.2. Maximum output current of 100 mA at 28 V(dc)

Push buttons must:

1. Be heavy duty, general purpose types
2. Have 1 normally open, momentary contact rated at 120 V(ac) and 35 percent power factor
3. Have an inductive pilot duty rating of:
    3.1. 60 A make
    3.2. 6 A break
    3.3. 10 A continuous

Terminal blocks must comply with NEMA ICS 4 and be:

1. DIN rail mounted or attached to the enclosure
2. Rated for 30 A at 600 V(ac)
3. Made from molded plastic
4. Equipped with:
    4.1. High-pressure clamp connectors
    4.2. Nameplates screwed to each block or a computer printed plastic label attached with adhesive
    4.3. Identified conductor numbers

74-3.02C Pump Control

74-3.02C(1) General

The automatic operation of the drainage pump must be controlled by the water level monitoring system and pump controller.

74-3.02C(2) Water Level Monitoring System

The water level monitoring system must be a trapped air level monitoring type that calculates the water depth using air pressure that is converted to an electrical signal. The system must include an air compressor, 3-way solenoid valve, pressure transducer, polyethylene air tube, and a compression bell.

The system must:

1. Operate from 0 to 32 feet of water head
2. Be accurate to ±0.1 feet for ambient conditions ranging from 0 to 200 degrees F
3. Isolate the pressure transducer during the purge cycle of the air column

The air compressor must:

1. Have a 120 V(ac), ±1/20 hp shaded pole motor with integral overload protection
2. Include an aluminum piston with polytetrafluoroethylene-sleeved cylinder
3. Have a capacity of at least 0.65 cu ft/min at 50 psi
4. Be capable of initializing against a 250 psi head

The solenoid valve must be a 120 V(ac), direct acting, three-way type having a NEMA Type 1 plastic body and compression connections.

The pressure transducer must output a 4 to 20-mA signal.

The polyethylene air tube must be a 0.04-inch-thick wall type complying with ASTM D1248, Class A.

74-3.02C(3) Pump Controller

The pump controller must (1) control the pumps based on the output signal of the water level monitoring system, (2) interface with the monitoring system, and (3) generate alarms. The controller must be 120 V(ac), solid state, industrial grade with software stored in nonvolatile memory.

The controller must process the 4-20 mA signal from the water level monitoring system and operate the pumps as follows:

1. Alternate pumps for each lead pump operation
2. Energize the lead pump at the water level shown
3. Energize the lag pump at the water level shown
4. De-energize the lead pump at the water level shown
5. De-energize the lag pump at the water level shown
6. If the pump controller energizes both pumps simultaneously, energize the lead pump first and then energize the lag pump 10 seconds later

The controller must output a 120 V(ac) signal when the high or low alarms are energized. The controller must energize the trapped air level monitoring system air compressor to purge the air system. The purge interval must be adjustable from 1 to 8 hours. The compressor run time must be adjustable from 5 to 30 seconds.

The controller must have (1) an LED display with 1/2-inch-high letters that computes to 1 decimal place and (2) use faceplate-mounted, gold contact switches for programming. Do not use software for programming control levels.

The controller must have:

1. At least 6 output relays with 120 V(ac), 10 A rated contacts
2. LED indicators mounted on plug-in bases
3. Test push button and potentiometer for system testing

System testing must bypass the pressure transducer input to allow manual adjustment of the signal.

The controller must have at least 6 programmable levels each programmable from 0 to 32 feet. The controller must be capable of programming the following levels for the elevations shown:

1. High alarm
2. Low alarm
3. Lead pump on
4. Lead pump off
5. Lag pump on
6. Lag pump off

The pump controller must include an internal power supply with:

1. 120 V(ac) input with V(dc) and current outputs to suit the equipment
2. Panel or channel mounting capability
3. Convection cooling
4. Wiring that is completely enclosed
5. Adjustment range of at least ±5 percent
6. Operational temperature range from 32 to 120 degrees F

74-3.02D Conduit

Conduit and fittings must be Type 1 complying with section 86.

Flexible conduit and fittings must be Type 4 complying with section 86.

74-3.02E Conductors and Cable

74-3.02E(1) General

Do not rewire manufacturer's stock items specified in section 74-3.01C(2).

74-3.02E(2) Conductors

Conductors must comply with section 86, except conductors must be stranded copper and comply with the following:

1. In enclosures, install Type MTW
2. In wet, underground, or outdoor locations, install Type XHHW-2
3. For all other locations, install Type THHN

74-3.02E(3) Conductor and Cable Identification

Identify conductors by number. Use one of the following methods:

1. Clear, heat-shrinkable tubing sealed over adhesive-backed paper or cloth wrap-around markers
2. Preprinted, white, heat-shrinkable tubing

74-3.02F Nameplates and Warning Plates

74-3.02F(1) General

Nameplate and warning plates must be predrilled, multilayer, multicolor, plastic labels with mechanically engraved inscriptions.

Secure plates to equipment using screws or rivets. Do not use adhesives except on the inside face of enclosure doors.

If authorized, you may secure nameplates to an adjacent surface.

74-3.02F(2) Nameplate and Warning Plate Identification

Nameplate and warning plate inscriptions must be as shown.

Nameplate letters must be white, upper case Helvetica, and 1/4 inch in height. Leave at least a 3/8-inch black background on all 4 sides.

Equipment control switch nameplate letters must be white, upper case Helvetica, and 1/8 inch in height. Leave at least a 3/8-inch black background on all 4 sides. Secure the nameplate to the equipment directly beneath the switch.

Warning plate letters must be white, upper case Helvetica, and 1/4 inch in height. Leave at least a 3/8-inch red background on all 4 sides.

74-3.02G Miscellaneous Materials

Enclosures must be minimum NEMA Type 1.

Floor coverings must comply with ASTM D178 and be rated for at least 20,000 volts dielectric strength, when tested under ASTM D149. Floor covering must be at least 1/4 inch thick.

Float switches must:

1. Be 120 V(ac), 8 A, single pole, double throw, mechanically-activated, wide-angle types
2. Have an inert synthetic leak-proof, shockproof, and corrosion-resistant casing
3. Have a 16-gauge, 2-conductor, SJOW sealed cable

Room lights must:

1. Be NRTL listed for damp locations
2. Be ceiling mounted, heavy duty, industrial type fixtures
3. Have a fiber-reinforced polymer housing with steel wireway
4. Have a hinged acrylic lens with closed-cell gasket and ABS or stainless steel latches
5. Include 2 T8 lamps with an electronic, instant-start ballast
6. Include the manufacturer's emergency battery pack

Sump lights must:

1. Be NRTL listed and labeled for Class 1, Division 2 locations
2. Be wall mounted, nonmetallic type fixtures
3. Have a fiber-reinforced polymer housing
4. Have a hinged polycarbonate or acrylic lens with nonmetallic latches
5. Have nonmetallic lampholders
6. Include 2 T8 lamps with an electronic, instant-start ballast

Entry lights must be outdoor, wall-mounted metal-halide luminaire type having a die-cast frame with hinged door and 1-piece front and bottom prismatic-glass lens.

Indicator lights must:

1. Be UL listed for wet locations.
2. Have a vapor-tight, cast-metal base with pin socket.
3. Have an impact and heat resistant colored polycarbonate threaded globe with neoprene gasket. .
4. Have a threaded, die-cast-aluminum guard.
5. Include a twin tube, 18 W, 120 V(ac), compact fluorescent lamp with integral ballast.

Light switches must:

1. Be NRTL listed, specification grade
2. Have 20 A, 120/277 V(ac), silver alloy contacts
3. Be suitable for stranded conductor wiring
4. Be ivory color

Duplex plug receptacles must be NEMA Type 5-20R, specification grade, ivory color, and suitable for stranded conductor wiring.

Junction and outlet boxes must comply with NEMA FB 1. Boxes must be cast iron with threaded hubs, have cast iron covers with gaskets, and be at least 4 by 4 by 1-7/8 inches. For weatherproof device boxes, use covers with gasketed, hinged flaps.

Sump light switches at remote pump station must:

1. Be single-pole, 2-position maintained, 10 A, 120 V(ac) rotary switches
2. Have contacts rated at 120 V(ac) and 35 percent power factor
3. Have an inductive pilot duty rating of:
   3.1. 60 A make
   3.2. 6 A break
   3.3. 10 A continuous

Remote pump stations must be deadfront NEMA Type 4X enclosures having the following:

1. Hinged interior door and mounting panel on the back
2. Push buttons, duplex plug receptacle, nameplates, and sump light switch on the hinged interior door
3. Terminal blocks on the mounting panel
4. Hasp for a padlock

Seal failure relays must be (1) compatible with the drainage pump and (2) be a factory assembled unit having 1 normally open and 1 normally closed contact, each rated at 120 V(ac). Seal failure relays must have individual pump leak-indicator lights.

Pull boxes must comply with section 86.

Supporting devices must be corrosion resistant. Concrete anchorage devices must be Type 316 stainless steel.

74-3.03 CONSTRUCTION

74-3.03A General

Do not install electrical equipment on unpainted wood panels.

74-3.03B Installation

74-3.03B(1) General

Reserved

74-3.03B(2) Conduit, Conductors, and Cable

Do not install conduits behind ladders or within 15 inches of the ladder-rung vertical centerline.

Install flexible conduit with approximately 6 inches of slack between terminations.

Flexible conduits and their fittings are considered a discontinuity and must be shunted by bonding jumpers. Install bonding jumpers inside the flexible conduit. Do not use the flexible conduit as the ground.

Install conductors and cables under section 87 and as follows:

1. Pull conductors to prevent damage to the sheath or insulation.
2. Install conductors and cables entering equipment and boxes with drip loops to prevent water reaching the current-carrying parts or other conduits.
3. Remove insulation without damaging the conductor.
4. Identify conductors by number at each termination.

Feeder and branch circuit conductors that are ungrounded must have continuously color-coded insulation. Conductors no. 6 AWG or larger may use colored tape. If used, apply tape at each connection and where accessible. Ungrounded conductor color-coding must be as shown in the following table:

Ungrounded Conductor Color-Coding

System	Color code
120/240V(ac)-Single phase	Black, blue
120/240V(ac)-Three phase	Black, orange, blue
120/208V(ac)-Three phase	Black, red, blue
480/277V(ac)-Three phase	Brown, purple, yellow

74-3.03B(3) Motor Control Center

Use concrete anchorage devices to anchor the motor control center sections to the concrete slab. Shim each section to make the motor control center level.

The motor control center sections must fit through the pump house doorway or roof access opening. Any modifications required for installation must be pre-approved by the manufacturer and must not change performance.

Install current switches in the starter compartments. Loop power conductors around the sensing coil multiple times.

74-3.03B(4) Panel LP

The panelboard directory must list the equipment controlled and the area designation. The directory must be printed using Times New Roman font and at least 12-point font size. Place the directory in the panelboard door frame with a transparent protective cover.

74-3.03B(5) Miscellaneous Materials

Secure hangers, brackets, supports, and electrical equipment to surfaces using:

1. Concrete anchorage devices into concrete or solid masonry surfaces
2. Machine screws or bolts into metal surfaces
3. Wood screws into wood construction surfaces

74-3.03C Conductor Splices

Do not splice the drainage pump cables between the pumps and the enclosure shown.

Conductor splices must be made only in (1) fixtures, (2) junction boxes, and (3) gutters.

Splices must be made using either pressure connectors listed by a NRTL or soldered joints made by soldering irons. Do not use open flame soldering.

Insulate splices using the following sequence:

1. Apply 2 half-lapped layers of self-fusing, oil and flame-resistant, synthetic rubber tape covered by 2 half-lapped layers of pressure-sensitive, adhesive, PVC electrical tape at least 7 mils thick.
2. After taping the splice, apply an electrical insulating coating. The coating must be (1) fast drying, (2) resistant to oil, acids, alkalis, and corrosive atmospheric conditions, and (3) compatible with the tape.

74-3.04 PAYMENT

Not Used

74-4 BOOSTER PUMPS

74-4.01 GENERAL

74-4.01A Summary

Section 74-4 includes specifications for installing booster pumps.

74-4.01B Definitions

Reserved

74-4.01C Submittals

74-4.01C(1) General

Reserved

74-4.01C(2) Shop Drawings

Submit shop drawings for each booster pump.

74-4.01C(3) Product Data

Submit product data for the booster pump, including the following components:

1. Pump, including pump curve and motor information

2. Valves
3. Pump controller
4. Booster pump enclosure
5. Pressure gauge
6. Appurtenances

74-4.01C(4) Closeout Submittals

Submit closeout submittals as a Maintenance and Operations Manual before completion of the work. Submit 2 copies as PDF files on CDs or DVDs. Submit 1 copy as fused-laminate prints in a 3 ring binder with tabbed dividers. Organize each manual as follows:

1. Index
2. Parts list
3. Operating instructions
4. Maintenance instructions
5. Pump curve

74-4.01D Quality Assurance

The requirements of section 74-1.01D do not apply to the booster pump.

Notify the Engineer 5 business days before testing the booster pump. Test the booster pump in the Engineer's presence after connecting the booster pump to the irrigation system.

The discharge water from testing must not cause erosion, damage to equipment or plantings, or interfere with ongoing work.

The pump must not load the motor to more than the product of the nameplate (1) amperage and (2) service factor. The flow rate must not vary from the pump curve by more than 5 percent at 100 percent motor speed.

Test each booster pump at the following test points:

1. Zero flow rate (cutoff head)
2. Maximum flow rate
3. Design heads shown
4. Steady-state flow for each irrigation controller station

Record the following for each test point:

1. Motor rpm
2. Motor voltage
3. Motor amperage
4. Suction pressure of the pump
5. Discharge pressure of the pump

After testing, run the booster pump through 3 successful, complete irrigation controller cycles.

If the booster pump fails testing, adjust system components as necessary and retest.

74-4.02 MATERIALS

74-4.02A General

The concrete for the foundation and pad of the booster pump must be minor concrete.

74-4.02B Manufactured Units

74-4.02B(1) General

The booster pump must consist of a factory assembled and tested skid-mounted system with the following components: pump, pump controller, booster pump enclosure, manifold, inlet and outlet valves, sensors, fittings, and appurtenances.

The system working pressure must be at least 150 psi.

The booster pump must be listed and labeled by a NRTL.

74-4.02B(2) Components

74-4.02B(2)a General

Reserved

74-4.02B(2)(b) Pumps

Pumps must consist of a close-coupled pump and motor. Pumps must be (1) end suction, centrifugal type with mechanical seals, (2) coated with the manufacturer's standard finish for exterior use, and (3) single or multiple stage. Booster pumps must have a horizontal or vertical configuration.

For horizontal pumps:

1. Casing must be close-grained cast iron with a replaceable bronze wearing ring
2. Impeller must be (1) dynamically balanced, (2) made from bronze, and (3) keyed and secured to the shaft by a stainless steel washer and cap screw
3. Impeller shaft must be either steel with a bronze sleeve or stainless steel with no sleeve

For vertical pumps:

1. Casing must be close-grained cast iron with replaceable stainless steel wearing ring
2. Motor pedestal must be close-grained cast iron
3. Impeller must be (1) dynamically balanced, (2) made from stainless steel, and (3) keyed and secured to the shaft by a stainless steel washer and cap screw
3. The impeller shaft must be stainless steel

Motors must be standard efficiency, NEMA code letter "G" or smaller, open drip proof, and NEMA Design B.

74-4.02B(2)(c) Ball Valves

Ball valves must have a 2-piece bronze body with full size port, chrome-plated or brass ball, and be rated for at least 400 psi.

74-4.02B(2)(d) Butterfly Valves

Butterfly valves must have a ductile iron body with molded seat liner made from EPDM or PTFE, bi-directional stainless steel stem, locking lever with extended neck, and be rated for at least 250 psi.

74-4.02B(2)(e) Pump Controller

The pump controller must consist of an enclosure, VFD, main disconnect, circuit breakers, motor starter, motor protector, and a pressure transducer.

The pump controller must keep the pump running when the flow of water fluctuates between the changing of the irrigation controller stations. The pump controller must have a potentiometer or keypad for adjusting the motor speed.

The enclosure must be a NEMA Type 12 enclosure and rated for the horsepower, voltage, and phase shown. The ground bus must be bonded to the enclosure. The circuit breaker must be rated as shown.

The following equipment must be on the front of the enclosure:

1. 2-way switch for automatic mode or manual mode.
2. Main disconnect. You may use the main breaker as the main disconnect if it is accessible on the front of the enclosure.
3. High-visibility pilot lights rated for 120 V(ac), with a colored plastic lens and screw caps. Include pilot lights for the following conditions:
    3.1. Power on
    3.2. Run
    3.3. No flow

The VFD must:

1. Be listed and labeled by a NRTL
2. Have 5 percent input impedance at the rated motor horsepower
3. Be mounted in the enclosure
4. Have a LCD screen with operator interface
5. Process the analog input signal from the pressure transducer and:
   5.1. Determine water pressure
   5.2. Set the pump motor speed
   5.3. Determine "no-flow" conditions

When the pressure transducer signal indicates a "no flow" condition in the manifold, the VFD must stop the pump regardless of demand. The VFD must have an adjustable time delay for the "no flow" condition. Upon resumption of flow in the manifold, it must reset and resume automatic mode.

The VFD and the 2-way switch must operate the booster pump as follows:

1. Automatic mode must start and stop the pump based on digital input signals from multiple irrigation controllers
2. Manual mode must start the pump regardless of the input signal

Pressure transducer must be stainless steel, rated for at least 300 psi working pressure and send a 4-20 mA output signal to the VFD.

74-4.02B(2)(f) Booster Pump Enclosures

The booster pump enclosure and lid must be fabricated from stainless steel or marine grade aluminum. The lid must have a continuous hinge, gas springs or equivalent lid supports, and a hasp for padlocking.

Gas springs must use their entire stroke without forcing the lid beyond its fully opened position. Side louvers must have internal bronze insect screens and be mounted on each end. The enclosure must include at least 1 thermostatically controlled exhaust fan with bronze insect screens.

74-4.02B(2)(g) Pressure Gauges

Pressure gauges must:

1. Comply with ASME B40.100, Grade B
2. Include a 2-1/2-inch glycerin filled dial, stainless steel case and cover, reset screw, and 1/4-inch NPT bottom inlet
3. Read from 0 to 200 psi

74-4.02B(2)(h) Appurtenances

Manifolds must be steel pipe or copper pipe. Steel pipe must comply with ASTM A53, Grade B. Copper pipe must comply with ASTM B88, Type K.

The skid must be (1) either steel or aluminum channel with risers as necessary, and (2) all welded construction. Welding must comply with AWS D1.1 for steel construction or AWS D1.2 for aluminum construction.

Fasteners, expansion anchors, nuts, bolts, and washers must be Type 316 stainless steel.

Nameplates must comply with section 74-3.02F.

74-4.02B(3) Fabrication

Fabricate the booster pump as follows:

1. Install the inlet and outlet valves inside the booster pump enclosure.
2. Use threaded or flanged fittings on the pump inlet and outlet connections.
3. Fabricate the pump so that it is removable without disassembling the manifolds.
4. Install pressure gauges in the manifolds on the suction and discharge sides of the pump.
5. Install the pressure transducer in the manifold.
6. Mount the pump controller inside the enclosure.
7. Attach the enclosure to the skid.

74-4.03 CONSTRUCTION

74-4.03A General

Support the connected water piping outside the enclosure. Do not use the booster pump to support the connected piping.

Install a padlock after installing the booster pump. The Department furnishes a padlock at Contract acceptance.

Place the maintenance and operations manual binder inside the enclosure.

74-4.03B Foundation and Pad

Pour a concrete foundation and pad where the booster pump is shown. The foundation must be at least 3 inches wider than the skid on all 4 sides. Place the pad against the foundation on the door side of the enclosure. The pad must be the same width as the foundation and at least 36 inches long.

Conduit risers must be located inside the skid footprint.

74-4.03C Skid Installation

Use concrete anchorage devices to mount the booster pump skid on the foundation. Use at least 4 sets of tapered steel leveling wedges to level the skid. Use 2 wedges placed taper-to-taper at each point of support. The steel wedges must remain in place in the completed work.

After suction and discharge piping has been installed and tightened in place, level the skid and tighten the concrete anchor hex nuts against the base.

Fill the voids under the base with mortar complying with section 51-1.02F. Retighten the mounting bolts after the voids have been filled.

74-4.03D Nameplates

Install nameplates under section 74-3.02F. Install nameplates on:

1. Pump
2. Pump controller
3. Switches
4. Main disconnect
5. Circuit breakers
6. Panel lights

74-4.04 PAYMENT

Not Used

74-5–74-10 RESERVED

75 MISCELLANEOUS METAL

75-1 GENERAL

75-1.01 GENERAL

75-1.01A Summary

Section 75 includes specifications for fabricating and installing miscellaneous metals.

Welding must comply with AWS D1.1.

75-1.01B Definitions

Reserved

75-1.01C Submittals

Reserved

75-1.01D Quality Assurance

75-1.01D(1) General

Reserved

75-1.01D(2) Qualifications

Welders and welding operators must be qualified under AWS D1.1.

75-1.01D(3) Department Acceptance

The following miscellaneous metal materials are inspected at the fabrication site:

1. Miscellaneous iron and steel
2. Miscellaneous metal (bridge)

Notify the Engineer:

1. When materials listed above have been delivered to the fabrication site
2. At least 10 days before starting fabrication

75-1.02 MATERIALS

75-1.02A General

Materials must comply with the requirements shown in the following table:

Miscellaneous Metal Materials

Material	Requirement
Steel bars, plates, and shapes	ASTM A36/A36M, A575, or A576 (AISI or M Grades 1016–1030)
Steel fastener components for general applications:	
Bolts and studs	ASTM A307
Anchor bolts	ASTM F1554 [a]
HS bolts and studs	ASTM A449, Type 1 [a]
HS threaded rods	ASTM A449, Type 1 [a]
HS nonheaded anchor bolts	ASTM F1554, Grade 105, Class 2A [a]
Nuts	ASTM A563, including appendix X1 [b]
Washers	ASTM F844
Hardened washers	ASTM F436, Type 1, including S1 supplementary requirements
Components of HS steel fastener assemblies for use in HS joints:	
Bolts	ASTM F3125, Grade A325, Type 1
Tension control bolts	ASTM F3125, Grade F1852, Type 1
Nuts	ASTM A563, including appendix X1 [b]
Hardened washers	ASTM F436, Type 1, Circular, including S1 supplementary requirements
Direct tension indicators	ASTM F959, Type 325, zinc-coated
Stainless steel fasteners, alloys 304 & 316, for general applications:	
Bolts, screws, studs, threaded rods, and nonheaded anchor bolts	ASTM F593
Nuts	ASTM F594 or F836M
Washers	ASTM A240/A240M and ASME B18.22M
Gray iron castings:	
Inside a roadbed	AASHTO M 306
Outside a roadbed	AASHTO M 306 except only AASHTO M 105, Class 35B is allowed
Ductile iron castings	ASTM A536, Grade 80-55-06
Carbon-steel castings	ASTM A27/A27M, Grade 65-35, Class 1
Malleable iron castings	ASTM A47/A47M, Grade 32510
Cast iron pipe	Commercial quality
Steel pipe	Commercial quality, welded or extruded
Other parts for general applications	Commercial quality

[a]Use hardened washers.

[b]Zinc-coated nuts tightened beyond snug or wrench tight must be furnished with a dry lubricant complying with supplementary requirement S2 in ASTM A563.

Remove burrs, rough and sharp edges, and other flaws.

Straighten warped pieces after fabricating and galvanizing.

75-1.02B Galvanizing

Galvanize miscellaneous metal materials under the schedules and specifications shown in the following table:

Galvanizing Schedules and Specifications

Material	Schedule[a]	Specification
Rolled, pressed, and forged steel shapes, plates, bars, and strip ≥ 1/8 inch thick	Except for pregalvanized standard pipe, galvanize material after fabrication into the largest practical sections	ASTM A123/A123M
Steel <1/8 inch thick	Galvanize before or after fabrication	Galvanized before fabrication: ASTM A653/A653M, Coating Designation G210 Galvanized after fabrication: ASTM A123/A123M except the weight of zinc coating must average at least 1.2 oz/sq ft of surface area with no individual specimen having a coating weight of less than 1.0 oz/sq ft
Standard pipe	--	ASTM A53/A53M except the zinc coating for fence pipes and structural shapes except for metal line posts for barbed and woven wire fences must average at least 1.2 oz/sq ft of surface area with no individual specimen having a coating weight of less than 1.0 oz/sq ft
Iron and steel hardware except threaded studs, bolts, nuts, and washers specified to comply with ASTM A307; F3125, Grade A325; A449; A563; F436; or F1554[b]	Galvanize after fabrication	ASTM A153/A153M
Rail elements, backup plates, terminal sections, and end and return caps of guardrail	--	AASHTO M 180

[a]Fabrication includes shearing, cutting, punching, forming, drilling, milling, bending, welding, and riveting.
[b]For threaded studs, bolts, nuts, and washers specified to comply with ASTM A307; F3125, Grade A325; A449; A563; F436; or F1554, galvanize under their ASTMs.

Galvanizing is not required for stainless steel, monel metal, and similar corrosion-resistant parts.

Galvanizing is not required for the following miscellaneous bridge metal:

1. Portions of plates, shapes, or other items embedded more than 2 inches in concrete.
2. Embedded steel pipe ending at or below the surface of encasing concrete.
3. Items described to receive other finishes.

Clean welded areas before galvanizing to remove slag or other material that would interfere with the adherence of the zinc.

Galvanize parts of fastener assemblies separately before assembly.

Tapping of nuts or other internally threaded parts to be used with zinc-coated bolts, anchor bars, or studs must (1) be performed after galvanizing and (2) comply with thread dimensions and overtapping allowances in ASTM A563.

Repair damaged galvanized surfaces as follows:

1. Clean by thoroughly wire brushing damaged areas and removing loose and cracked coating.
2. Paint cleaned areas with 2 applications of organic zinc-rich primer from the Authorized Material List for organic zinc-rich primers. Do not use aerosol cans.

75-1.02C–75-1.02H Reserved

75-1.03 CONSTRUCTION

Not Used

75-1.04 PAYMENT

Except for final-pay-item miscellaneous metal materials, the payment quantity for miscellaneous metal material is the weight determined from scale weighings.

75-2 MISCELLANEOUS IRON AND STEEL

75-2.01 GENERAL

Section 75-2 includes specifications for fabricating miscellaneous iron and steel.

75-2.02 MATERIALS

75-2.02A General

Raised pattern plates must be commercial quality.

75-2.02B Frames, Grates, and Covers

Grates must be produced from one of the following:

1. Structural steel complying with either of the following
   1.1. ASTM A36/A36M
   1.2. ASTM A576, Grades 1021, 1022, 1026, 1029, or 1030
2. Ductile iron castings
3. Carbon-steel castings

Manhole frames and covers must comply with AASHTO M 306.

Galvanize cast iron manhole frames and covers for sidewalks after fabrication and before assembling component parts. Coat other cast iron items with commercial-quality asphalt except machined surfaces of manhole frames and covers for decks.

Drainage inlet frames and grates except those on bridges need not be galvanized or coated with asphalt.

Match-mark frames and grates and frames and covers in pairs before delivery to the job site. Grates and covers must fit into their frames without rocking.

75-2.03 CONSTRUCTION

Not Used

75-2.04 PAYMENT

A frame and cover pair is 1 measurement unit. A frame and grate pair is 1 measurement unit.

75-3 MISCELLANEOUS BRIDGE METAL

75-3.01 GENERAL

75-3.01A Summary

Section 75-3 includes specifications for fabricating and installing miscellaneous bridge metal.

Miscellaneous bridge metal consists of:

1. Structural steel and cast steel portions of bearing plates, bars, rockers, assemblies, and other expansion or fixed bearing devices in concrete structures
2. Equalizing bolts and expansion joint armor in concrete structures
3. Expansion joint armor in steel structures
4. Manhole frames and covers, frames and grates, ladder rungs, guard posts, and access door assemblies

5. Deck drains, area drains, retaining wall drains, and drainage piping not included in bridge deck drainage system

75-3.01B Definitions

Reserved

75-3.01C Submittals

75-3.01C(1) General

Submit a certificate of compliance for anchorage devices.

Submit a work plan for placing the nonskid surface showing:

1. Application method
2. Spread rate of epoxy and grit
3. Number of coats

75-3.01C(2) Bridge Deck Drainage System

Submit a certificate of compliance for fiberglass pipe and fittings; include laboratory test results.

75-3.01D Quality Assurance

75-3.01D(1) General

Reserved

75-3.01D(2) Quality Control

75-3.01D(2)(a) General

Test spring latches and other mechanical devices before delivery to the job site; they must operate smoothly and properly.

75-3.01D(2)(b) Bridge Deck Drainage System

After installing the drainage system and final cleanup of the deck and drainage areas, test each drain pipe and facility except short free fall pipes in the Engineer's presence by discharging 100 gallons of water into the drain. The test must demonstrate the proper operation of the drain pipe and facility. If the test indicates obstructions in the pipe, clear the pipe and repeat the test until the drain pipe and facility are unobstructed.

75-3.01D(2)(c) Nonskid Surface

Before applying any nonskid material, demonstrate the method of application to the Engineer by preparing a 1 sq ft test sample applied on hardboard at least 1/4 inch thick. The nonskid surface must have a total thickness of 1/8–3/16 inch.

75-3.01D(3) Department Acceptance

Reserved

75-3.02 MATERIALS

75-3.02A General

Fabricate the parts shown in the table below from the corresponding materials shown:

Miscellaneous Metal Parts

Part	Material
Bearing assemblies	ASTM A36/A36M
Access opening covers	Commercial-quality sheet steel
Access doors	Galvanized sheet steel complying with ASTM A653/A653M, Coating Designation G210 [Z600]
Springs for deck drain grating latches	Commercial-quality, stainless steel spring wire containing a nominal composition of 18% chromium and 8% nickel
Pipe bends	Commercial-quality tube bends or fabricated bends of equal smoothness. Do not use miter-joint bends.
Metal parts of anchorage devices except iron castings for CIP inserts	Steel or stainless steel
Iron castings for CIP inserts	Malleable iron or ductile iron

Fabricate expansion joint armor from steel plates, angles, or other structural shapes. Shape the armor to the section of the concrete deck and match-mark it in the shop.

Cast steel and cast iron must comply with section 55.

Transition fittings between pipes of different diameters must be:

1. Smooth and uniform, without sags, projections, or offsets
2. At least 4 inches in length for each 1-inch reduction in pipe diameter.

Sealing compound for caulking and adhesive sealing must be polysulfide or polyurethane complying with ASTM C920, Type S, Grade NS, Class 25, Use O.

75-3.02B Bolted and Threaded Bar Connections

HS bolted connections must comply with the specifications for HS steel fasteners and bolted connections in section 55.

Equalizing bolts must be bolts or threaded bars. Threaded bars shown as prestressing steel must comply with the specifications for plain bars in ASTM A722/A722M, including supplementary requirements. Nuts must comply with section 50-1.02H and the 1st paragraph of section 50-1.03B(2)(c).

Abrasives used for blast cleaning must comply with section 59-1.02B.

Thread locking systems must be on the Authorized Material List for anaerobic thread locking systems and must comply with the requirements thereon.

75-3.02C Anchorage Devices

75-3.02C(1) General

Concrete anchorage devices must be on the Authorized Material List for stud mechanical expansion anchors, shell-type mechanical expansion anchors, resin caspsule anchors, or cast-in-place inserts.

Concrete anchorage devices must be (1) mechanical expansion anchors or resin capsule anchors installed in drilled holes or (2) CIP concrete inserts.

An anchorage device must be a complete system, including threaded studs, hex nuts, and cut washers. Thread dimensions for externally threaded anchorage devices before zinc coating must comply with ASME B1.1 having Class 2A tolerances or ASME B1.13M having Grade 6g tolerances. Thread dimensions for internally threaded concrete anchorage devices must comply with ASTM A563.

Except for mechanical expansion anchors and iron castings for CIP inserts, metal parts of anchorage devices must be hot-dip or mechanically galvanized.

75-3.02C(2) Mechanical Expansion Anchors

Mechanical expansion anchors must be (1) hot-dip or mechanically galvanized, (2) made from stainless steel, or (3) coated with electrodeposited zinc complying with ASTM B633.

Mechanical expansion anchors must be the integral stud type or the shell type with internal threads and an independent stud. Do not use self-drilling mechanical expansion anchors.

When tested under California Test 681, mechanical expansion anchors must withstand the application of a sustained tension test load of at least the values shown in the following table for at least 48 hours with a movement of at most 0.035 inch:

Mechanical Expansion Anchor Sustained Tension Test Load

Stud diameter (inches)	Sustained tension test load (pounds)
3/4[a]	5,000
5/8	4,100
1/2	3,200
3/8	2,100
1/4	1,000

[a]Maximum stud diameter allowed for mechanical expansion anchors

75-3.02C(3) Resin Capsule Anchors

When tested under California Test 681, resin capsule anchors must withstand the application of a sustained tension test load of at least the values shown in the following table for at least 48 hours with a movement of at most 0.010 inch:

Resin Capsule Anchor Sustained Tension Test Load

Stud diameter (inches)	Sustained tension test load (pounds)
1-1/4	31,000
1	17,900
7/8	14,400
3/4	5,000
5/8	4,100
1/2	3,200
3/8	2,100
1/4	1,000

75-3.02C(4) Cast-in-Place Concrete Inserts

CIP concrete inserts must be ferrule loop or cast iron.

Iron castings for CIP inserts must be mechanically galvanized.

When tested under California Test 682, CIP inserts must withstand the minimum ultimate test loads shown in the following table:

CIP Insert Ultimate Tension Test Load

Stud diameter (inches)	Ultimate tensile load (pounds)
1-1/4	25,000
1-1/8	19,800
1	16,000
7/8	11,600
3/4	7,200
5/8	6,600
1/2	4,200

75-3.02D Bridge Deck Drainage System

75-3.02D(1) General

Reserved

75-3.02D(2) Pipe Connections and Joints

Self-tapping screws for sleeve connections must:

1. Be stainless steel with hex-heads
2. Be installed in holes drilled to fit the screws
3. Comply with ASTM A276, Type 304, for a project in a non-freeze-thaw area
4. Comply with ASTM A276, Type 316, for a project in a freeze-thaw area

Drain pipe joints must be watertight, smooth, and free from projections or offsets over 1/16 inch on the inside. Mechanical couplings in piping must be gasketed short-sleeve type consisting of:

1. Mild steel middle ring with pipe stop
2. 2 rubber compound wedge section ring gaskets
3. 2 mild steel follower rings
4. Mild steel bolts to compress the gaskets

75-3.02D(3) Fiberglass Pipes and Fittings

You may use fiberglass pipes and fittings with the same diameters and minimum bend radii as shown instead of welded pipe.

Fiberglass pipe and fittings must:

1. Comply with ASTM D2996
2. Have a minimum short-term rupture strength of 30,000 psi

For joining pipe and fittings, use the adhesive type recommended by the manufacturer.

Fiberglass pipe not enclosed in a box girder cell or encased in concrete must be made from UV-resistant resin pigmented with concrete-gray color or be coated with a concrete-gray resin-rich exterior coating. Do not use paint.

Fiberglass pipe with UV protection must withstand at least 2,500 hours of accelerated weathering when tested under ASTM G154 with UVB-313 lamps. The resting cycle must be 4 hours of UV exposure at 140 degrees F and then 4 hours of condensate exposure at 120 degrees F. After testing, the pipe surface must show no fiber exposure, crazing, or checking and only slight chalking or color change.

75-3.02D(4) PVC Pipes and Fittings

For drainage pipe NPS 8 or smaller encased in concrete or enclosed in a box girder cell and exposed for at most 20 feet within the cell, you may use PVC pipe and fittings with the same diameters and minimum bend radii shown instead of welded pipe.

PVC pipe and fittings must be schedule 40, complying with ASTM D1785.

75-3.02E Bearing Devices

Reserved

75-3.02F Nonskid Surface

Epoxy must comply with section 95-1.02C, 95-1.02D, or 95-1.02G.

Grit must be:

1. Commercial-quality aluminum oxide, silicon carbide, or almandite garnet grit particles
2. Screen size no. 12–30 or no. 14–35
3. Applied uniformly at a rate of at least 0.3 pounds per square foot of surface area.

75-3.03 CONSTRUCTION

75-3.03A General

Straighten warped sections of expansion joint armor before placing. Secure the expansion joint armor in the correct position during concrete placement.

75-3.03B Bolted and Threaded Bar Connections

Where cleaning is described, clean nuts, bolts, threaded bars, and plate washers under SSPC-SP 6 or SSPC-SP 2 before painting.

Surfaces blast cleaned under SSPC-SP 6 must have a dense, uniform, angular anchor pattern of at least 1.5 mils when measured under ASTM D4417. Paint blast-cleaned surfaces the same day blast cleaning is performed unless otherwise authorized.

Reclean surfaces that rust or become contaminated before paint is applied.

Paint surfaces with 2 applications of organic zinc-rich primer from the Authorized Material List for organic zinc-rich primers. Do not use aerosol cans. For threads engaged by nuts, apply the 2nd application to the nuts and threads after installation.

75-3.03C Anchorage Devices

Install mechanical expansion anchors, resin capsule anchors, and CIP inserts under the manufacturer's instructions.

If the manufacturer's instructions do not include torque requirements, tighten nuts used to attach equipment or fixtures to anchorage devices to the installation torque requirements shown in the following table:

Torque Requirements

Stud diameter (inches)	Installation torque requirements (ft-lb)		
	Shell-type mechanical expansion anchors	Integral-stud-type mechanical expansion anchors	Resin capsule anchors and CIP inserts
1-1/4	--	--	400
1	--	--	230
7/8	--	--	175
3/4	80	175	150
5/8	35	90	75
1/2	22	50	30
3/8	11	25	18
1/4	4	7	--

Install concrete anchorage devices such that the attached equipment or fixtures bear firmly against the concrete.

Install shell-type mechanical expansion anchors such that the top surface of the anchor body remains 1/2 to 1 inch below the concrete surface after expansion. After installation of shell-type mechanical expansion anchors and before mounting equipment or fixtures, demonstrate to the Engineer that the expansion anchors are firmly seated within these tolerances.

75-3.03D Bridge Deck Drainage System

Securely cover deck drain grates and other grating openings to prevent intrusion of debris until after final cleanup of the deck and drainage areas.

Provide a transition section where a pipe under a walkway or other improved area must be of a smaller diameter than the downdrain pipe.

Couplings used to connect PVC or fiberglass pipe to steel must be threaded or flanged. For PVC or fiberglass pipe, do not use the sleeve connections shown.

If fiberglass pipe is used, support spacing for fiberglass pipe must be the same as shown for welded steel pipe. Each pipe support must have a width of at least 1-1/2 inches.

If PVC pipe is used, pipe support spacing for PVC pipe must be at most 6 feet.

75-3.03E Bearing Devices

Bearing assemblies or masonry plates placed on mortar pads must comply with section 55-1.03C(3).

Set bearing plates level. Set rockers and expansion devices to comply with the temperature at the time of erection or to the specified setting.

75-3.03F Nonskid Surface

Where a nonskid surface is shown on steel plates, apply an epoxy mixed with grit.

The finish color of the nonskid surface must be light gray.

Before applying epoxy and grit to a galvanized surface, prepare the surface under section 59-3.03.

If authorized, you may use a commercial-quality nonskid surface made of a 2-component UV-resistant epoxy and grit if the quality is equal to the epoxy-grit mixture specified.

75-3.04 PAYMENT

The payment quantity for miscellaneous metal does not include the weight of epoxy and grit for a nonskid surface.

75-4 PUMPING PLANT METAL WORK

75-4.01 GENERAL

Section 75-4 includes specifications for installing pumping plant metal work.

Pumping plant metal work consists of fabricated and cast metal parts used for constructing pumping plants, including (1) metal parts in the pumphouse, outside stairway, storage box, and discharge box and (2) and the roadway-type inlet frames and grates at the pumping plant site.

Pipe handrailing must comply with section 83-2.09.

75-4.02 MATERIALS

Concrete anchorage devices must comply with section 75-3.02C.

Except in walkway areas, cast iron manhole covers and frames and cast iron grates and frames must be dipped in commercial-quality asphalt.

Manhole covers and frames for pumping plant discharge boxes must be watertight and certified by the manufacturer to be rated to the pressure shown.

75-4.03 CONSTRUCTION

Provide 1 heavy-duty, galvanized steel, safety padlock hasp and staple assembly. The assembly must be securely attached to door and frame and have:

1. Vertical staple consisting of a rod with a diameter of at least 1/8 inch
2. Slotted leaf at least 6 inches in length

75-4.04 PAYMENT

The payment quantity for pumping plant metal work does not include (1) metal parts installed under section 74 and (2) road-type inlet frames and grates paid for as a separate bid item.

75-5 CATTLE GUARD

75-5.01 GENERAL

75-5.01A Summary

Section 75-5 includes specifications for constructing cattle guards.

Earthwork for cattle guards must comply with section 19-3.

Concrete foundations and drain holes for cattle guards must comply with section 51.

Bar reinforcement must comply with section 52.

75-5.01B Definitions

Reserved

75-5.01C Submittals

Submit design details for the equivalent cattle guard design if used.

75-5.01D Quality Assurance

Reserved

75-5.02 MATERIALS

You may use an equivalent cattle guard design consisting of a prefabricated rail assembly and wings supported on a concrete foundation. The Engineer may authorize minor variations in dimensions to allow the use of the fabricator's standard methods of fabrication.

The equivalent design cattle guard must support HS-20 live loading.

Weld using low hydrogen electrodes.

75-5.03 CONSTRUCTION

If a cattle guard is installed at an existing fence, attach the cattle guard to the fence.

The completed cattle guard must bear uniformly on the foundation. The finished grade must not vary more than 1/4 inch from the adjacent roadway surface. Make any adjustment to the roadway surface needed to comply with this tolerance.

75-5.04 PAYMENT

Not Used

75-6 RIGID FALL PROTECTION

Reserved

75-7 ISOLATION CASINGS

Reserved

75-8 TIE ROD ASSEMBLIES

Reserved

75-9–75-12 RESERVED

76 WELLS

76-1 GENERAL

Reserved

76-2 WATER WELLS

Reserved

76-3 EXPLORATION HOLES

Reserved

76-4 MONITOR WELLS

Reserved

76-5 REHABILITATE EXISTING WATER WELLS

Reserved

76-6 DESTROY WELLS

Reserved

76-6–76-10 RESERVED

77 LOCAL INFRASTRUCTURE

77-1 RESERVED

78 INCIDENTAL CONSTRUCTION

78-1 GENERAL

78-1.01 GENERAL

Section 78 includes specifications for constructing incidental bid items that are not closely associated with other sections.

78-1.02 MATERIALS

Not Used

78-1.03 CONSTRUCTION

Not Used

78-1.04 PAYMENT

Not Used

78-2 SURVEY MONUMENTS

78-2.01 GENERAL

Section 78-2 includes specifications for constructing survey monuments.

Notify the Engineer at least 7 days before you construct a survey monument or adjust a monument cover to grade. Do not disturb a survey monument without authorization.

Work performed on existing monuments must comply with section 15.

78-2.02 MATERIALS

Concrete must be minor concrete with a maximum 1-inch aggregate.

The Department furnishes the survey marker disks.

The frames and covers must be fabricated from cast steel or gray cast iron.

The frames, covers, and hardware must comply with section 55.

The covers must fit into the frames without rocking.

Granular material must be gravel, crushed gravel, crushed rock, or any combination of these and must not exceed 1-1/2 inches in greatest dimension.

78-2.03 CONSTRUCTION

You may cast the monuments in place in neat holes without the use of forms unless forms are shown.

Thoroughly consolidate the concrete and cure it by the water method.

Locate the monument such that the point being referenced falls within 1/2 inch from the center of the disk when the disk is placed in the center of the monument.

Place the survey marker disk before the concrete reaches its initial set. Firmly embed the disk in the concrete.

If base and surfacing are not shown around a monument, fill any space around it with earth. Water and tamp the earth into place.

Unless the surplus excavated material is hazardous, uniformly spread it along the adjacent roadway where designated by the Engineer.

78-2.04 PAYMENT

Not Used

78-3 RESERVED

78-4 MISCELLANEOUS COATINGS

78-4.01 GENERAL

78-4.01A General

Section 78-4.01 includes general specifications for applying miscellaneous coatings to new and existing installations.

Apply miscellaneous coatings under the specifications for coating structural steel in section 59-1.

78-4.01B Materials

Water for rinsing must comply with the specifications for water for pressure rinsing in section 59-1.02A.

78-4.01C Construction

Not Used

78-4.01D Payment

Not Used

78-4.02 PAINTING TIMBER

78-4.02A General

Section 78-4.02 includes specifications for preparing and painting timber installations.

78-4.02B Materials

Not Used

78-4.02C Construction

78-4.02C(1) General

Reserved

78-4.02C(2) Surface Preparation

Remove cracked or peeled paint, loose chalky paint, dirt, and other foreign material immediately before painting. The moisture content of the timber must be not more than 20 percent at the time of initial paint application.

78-4.02C(3) Application

Paint new timber with 1 coat of wood primer followed by 2 coats of exterior paint. You may apply the 1st coat before erection if authorized.

Paint previously painted timber with 2 coats of exterior paint. Prime bare wood with 1 coat of wood primer.

After the timber is in place, putty the cracks, checks, nail holes, and other depressions flush with the surface. Let dry before applying the 1st coat of exterior paint.

78-4.02D Payment

Not Used

78-4.03 PAINTING CONCRETE

78-4.03A General

78-4.03A(1) General

78-4.03A(1)(a) Summary

Section 78-4.03A includes general specifications for preparing and painting concrete surfaces.

78-4.03A(1)(b) Definitions

Reserved

78-4.03A(1)(c) Submittals

Submit the coating manufacturer's application instructions at least 7 days before use.

78-4.03A(1)(d) Quality Assurance

78-4.03A(1)(d)(i) General

Reserved

78-4.03A(1)(d)(ii) Test Panels

Reserved

78-4.03A(2) Materials

78-4.03A(2)(a) General

Coatings for concrete must be white.

78-4.03A(2)(b) Paint

Coatings for concrete must comply with the specifications for acrylic emulsion paint for exterior masonry.

78-4.03A(2)(c) Sealer

Reserved

78-4.03A(2)(d) Sealing Compound

Reserved

78-4.03A(3) Construction

78-4.03A(3)(a) General

Do not paint new concrete until it is at least 28 days old. Anywhere metal is adjacent to a joint, seal the joint between surfaces to be painted and the adjacent metal with a sealing compound before applying the paint.

78-4.03A(3)(b) Surface Preparation

Prepare concrete surfaces under SSPC-SP 13/NACE no. 6.

Pressure rinse the prepared surfaces before applying the coating. The surfaces must be thoroughly dry at the time of painting. You may use artificial drying methods if authorized.

78-4.03A(3)(c) Application

Apply at least 2 coats under the manufacturer's instructions and SSPC-PA 7. Protect adjacent surfaces during painting using an authorized method.

78-4.03A(4) Payment

Not Used

78-4.03B Simulated Stone Masonry and Textured Concrete

Reserved

78-4.03C–78-4.03G Reserved

78-4.04 STAINING CONCRETE AND SHOTCRETE

78-4.04A General

78-4.04A(1) General

78-4.04A(1)(a) Summary

Section 78-4.04 includes specifications for preparing and staining concrete and shotcrete surfaces.

78-4.04A(1)(b) Definitions

Reserved

78-4.04A(1)(c) Submittals

Submit the stain manufacturer's product data and application instructions at least 7 days before starting staining activities.

78-4.04A(1)(d) Quality Assurance

78-4.04A(1)(d)(i) General

Reserved

78-4.04A(1)(d)(ii) Test Panels

Stain the authorized test panel complying with section 51-1.01D(2)(c) or section 53-3.01D(3).

The test panel must be:

1. Stained using the same personnel, materials, equipment and methods to be used in the work
2. Accessible for viewing
3. Displayed in an upright position near the work
4. Authorized for staining before starting the staining work

If ordered, construct additional test panels until a satisfactory color is attained. The preparing and staining of additional test panels is change order work.

The Engineer uses the authorized stained test panel to determine the acceptability of the stained surface.

Dispose of the test panels after the staining work is complete and authorized. Notify the Engineer before disposing of the test panels.

78-4.04A(2) Materials

78-4.04A(2)(a) General

Reserved

78-4.04A(2)(b) Stain

Stain must:

1. Contain dilute acid that penetrates and etches the surfaces
2. Be a water-based solution of inorganic metallic salts
3. Be a commercial-quality product designed specifically for exterior applications
4. Produce abrasion-resistant color deposits

78-4.04A(2)(c) Sealer

Reserved

78-4.04A(2)(d) Sealing Compound

Reserved

78-4.04A(3) Construction

78-4.04A(3)(a) General

Anywhere metal is adjacent to a joint, seal the joint between the surfaces to be stained and the adjacent metal with a sealing compound before applying the stain.

78-4.04A(3)(b) Surface Preparation

Test surfaces for acceptance of the stain before applying the stain. Clean surfaces that resist accepting the stain and retest until passing.

Before staining, the surfaces must be:

1. At least 28 days old
2. Prepared under SSPC-SP 13/NACE no. 6
3. Thoroughly dry

78-4.04A(3)(c) Application

Apply the stain under the manufacturer's instructions. Apply the stain uniformly to avoid excessive rundown. Work the stain into the concrete using a nylon bristle brush in a circular motion.

After the last coat of stain has dried, rinse the stained surfaces with water and wet scrub them with a stiff-bristle nylon brush until the rinse water runs clear. Collect all rinse water.

Protect adjacent surfaces during staining.

Drips, puddles, or other irregularities must be worked into the surface.

78-4.04A(4) Payment

Not Used

78-4.04B Sculpted Shotcrete and Textured Concrete

78-4.04B(1) General

78-4.04B(1)(a) Summary

Section 78-4.04B includes specifications for preparing and staining sculpted shotcrete and textured concrete surfaces.

78-4.04B(1)(b) Definitions

Reserved

78-4.04B(1)(c) Submittals

78-4.04B(1)(c)(i) General

Reserved

78-4.04B(1)(c)(ii) Contractor Qualifications

Submit the following documentation of the staining subcontractor's experience at least 10 days before the prestaining meeting:

1. Summary of the staining subcontractor's experience that demonstrates compliance with section 78-4.04B(1)(d)(ii).
2. List of at least 3 projects completed in the last 5 years that demonstrate the staining subcontractor's ability to stain textured concrete or sculpted shotcrete surfaces similar to the surfaces for this project. For each project include:
   2.1. Project description
   2.2. Name and phone number of the owner
   2.3. Staining completion date
   2.4. Color photos of the completed stained surface

78-4.04B(1)(c)(iii) Staining Quality Work Plan

Submit a staining quality work plan at least 10 days before the prestaining meeting. The work plan must include details for preparing and staining the surfaces to achieve the required color, including:

1. Number of applications that will be used to apply the stain
2. For each application of the stain, a description of:
   2.1. Manufacturer, color, finish, and percentage strength mixture of the stain that will be applied
   2.2. Methods and tools that will be used to apply the stain
3. Methods for protecting adjacent surfaces during staining
4. Rinse water collection plan for containing all liquid, effluent, and residue resulting from preparing and staining the surfaces

78-4.04B(1)(d) Quality Assurance

78-4.04B(1)(d)(i) General

Reserved

78-4.04B(1)(d)(ii) Contractor Qualifications

The staining subcontractor must:

1. Have experience staining textured concrete or sculpted shotcrete surfaces to simulate the appearance of natural rock formations or stone masonry

2. Have successfully completed at least 3 projects in the past 5 years involving staining of concrete or sculpted shotcrete surfaces similar to the surfaces for this project

78-4.04B(1)(d)(iii) Prestaining Meeting

Before starting staining activities, conduct a meeting to discuss the staining quality work plan. Meeting attendees must include the Engineer and all staining subcontractors.

78-4.04B(2) Materials

Not Used

78-4.04B(3) Construction

Not Used

78-4.04B(4) Payment

The payment quantity for prepare and stain concrete or prepare and stain shotcrete is the area measured along the stained vertical or sloped wall face.

78-4.05 ROCK STAINING

78-4.05A GENERAL

78-4.05A(1) Summary

Section 78-4.05 includes specifications for preparing and staining rock.

Preparing and staining rock includes preparing and staining the exterior surface of landscape boulders, damaged or scarred native rock, rock energy dissipaters, rock slope protection, and gabion surfaces.

78-4.05A(2) Definitions

Reserved

78-4.05A(3) Submittals

Submit a work plan describing the methods to (1) control overspray and spillage and (2) protect adjacent surfaces.

Submit the stain manufacturer's product data, including the product sheet and the application instructions.

78-4.05A(4) Quality Assurance

78-4.05A(4)(a) General

Reserved

78-4.05A(4)(b) Test Plot

Apply the stain to a rock test plot of at least 3 by 3 feet at a location designated by the Engineer. Notify the Engineer at least 7 days before staining the test plot. Prepare and stain the test plot with the same personnel, materials, tools, equipment, and methods to be used in staining the final surfaces. Separate test plots are required for staining rock slope protection and native rock.

If ordered, prepare and stain additional test plots. The preparing and staining of additional test plots is change order work.

Obtain authorization of the test plot before starting the staining work. The Engineer uses the authorized test plot to determine the acceptability of the staining work. If the test plot is not incorporated into the work, dispose of it after the staining work is complete and authorized. Notify the Engineer before disposing of the test plot.

78-4.05B MATERIALS

78-4.05B(1) General

Reserved

78-4.05B(2) Stain

Reserved

78-4.05C CONSTRUCTION

78-4.05C(1) General

Reserved

78-4.05C(2) Preparation

Before applying the stain:

1. Identify and obtain authorization for the areas to be stained
2. Remove oils, dirt, and other contaminants from the surfaces to be stained
3. Dry all surfaces to be stained

78-4.05C(3) Application

Stain the exposed surfaces under the manufacturer's instructions to achieve a color consistent with the color of the authorized test plot.

Control overspray and protect adjacent surfaces.

Keep stained surfaces dry for at least 20 days after the application of the stain.

78-4.05D PAYMENT

The payment quantity for rock stain is the area measured along the slope face.

78-4.06 ANTI-GRAFFITI COATING

78-4.06A General

78-4.06A(1) Summary

Section 78-4.06 includes specifications for applying a sacrificial anti-graffiti coating to surfaces.

78-4.06A(2) Definitions

Reserved

78-4.06A(3) Submittals

Submit the manufacturer's application and removal instructions at least 7 days before starting work.

78-4.06A(4) Quality Assurance

Reserved

78-4.06B Materials

Anti-graffiti coating must:

1. Be a nontoxic, sacrificial, nonflammable, water-based coating designed for protecting concrete from graffiti
2. Be compatible with the concrete surface treatment
3. Have a clear matte finish when dry
4. Be removable with a hot pressure washer

78-4.06C Construction

Test surfaces for acceptance of the coating before applying. Clean surfaces that resist accepting the coating and retest until passing.

Apply the anti-graffiti coating under the manufacturer's instructions in at least 2 even coats.

78-4.06D Payment

Not Used

78-4.07 STAINING GALVANIZED SURFACES

Reserved

78-4.08 PAINTING ELECTRICAL MATERIAL

78-4.08A General

Section 78-4.08 includes specifications for preparing and painting electrical material.

78-4.08B Materials

Polymeric coating for steel service equipment enclosures must comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Coating hardness (min)	ASTM D3363	HB
Salt spray resistance (336 hours)	ASTM B117	9
Adhesion, Method B (min)	ASTM D3359	5

The steel service equipment enclosure finish coat color must match color no. 14672 of FED-STD-595.

78-4.08C Construction

78-4.08C(1) General

Clean and paint electrical material.

The coating must be free from flow lines, streaks, blisters, and other defects that would impair serviceability or detract from the general appearance.

Prepare and finish conduit and conduit fittings above ground as specified for the adjacent standard or post.

Stencil the equipment number neatly on the standard or adjacent structure. Obtain the number from the Engineer.

78-4.08C(2) Traffic Signal Faces and Fittings

Finish the interiors of the metal signal visor, louver, and the front face of backplates with 2 applications of lusterless black, exterior-grade, latex paint formulated for application to properly prepared metal surfaces. Painting is not required if the equipment has a good factory finish.

Apply 2 coats of lusterless dark olive green, exterior-grade, latex paint formulated for application to properly prepared metal surfaces to the following electrical equipment:

1. Signal section
2. Signal head mounting, brackets and fittings
3. Outside of visor
4. Pedestrian push button housing
5. Pedestrian signal section and visor
6. Back face of back plate

The color must match color chip no. 68 filed at METS.

78-4.08D Payment

Not Used

78-4.09–78-4.15 RESERVED

78-5 PARKING BUMPERS

78-5.01 GENERAL

78-5.01A Summary

Section 78-5 includes specifications for constructing parking bumpers.

Section 90 does not apply to concrete for parking bumpers.

78-5.01B Definitions

Reserved

78-5.01C Submittals

Submit product data for parking bumpers.

78-5.01D Quality Assurance

Reserved

78-5.02 MATERIALS

Parking bumpers must be steel-reinforced PC units. The concrete must be air entrained and have a minimum compressive strength of 4,000 psi.

Each unit must be from 4 to 6 inches high, from 6 to 9 inches wide, and from 6 to 8 feet long. All units for a project must be the same size.

Each unit must have chamfered corners, transverse drainage slots on the underside, and at least 2 factory-formed or drilled vertical holes through the parking bumper for anchoring it to the substrate.

The units must be free of pockets, sand streaks, honeycombs, and other obvious defects. Corners must be uniform, straight, and sharp.

The mounting hardware must be galvanized steel.

78-5.03 CONSTRUCTION

Verify that pavement is in suitable condition to start installation under the manufacturer's instructions.

Start installation only after unsatisfactory conditions have been corrected.

Install parking bumpers under the manufacturer's instructions.

78-5.04 PAYMENT

Not Used

78-6–78-20 RESERVED

78-21 RESETTING AND RELOCATING MAILBOXES

78-21.01 GENERAL

Section 78-21 includes specifications for resetting and relocating mailboxes..

Reset and relocate newspaper boxes as specified for mailboxes.

78-21.02 MATERIALS

Each new post must be redwood complying with the specifications for roadway sign posts in section 82.

78-21.03 CONSTRUCTION

During construction:

1. Move each mailbox to clear the way for your activities. Each mailbox must be accessible for delivery at all times.
2. Install each mailbox on a post set in the ground or on an authorized temporary support.

When construction is complete, install each mailbox on a new post.

Place each post in a hole. Backfill the space around the post with earth placed in layers about 4 inches thick. Moisten and thoroughly compact each layer.

78-21.04 PAYMENT

Resetting or relocating 1 mailbox on 1 post is 1 measurement unit.

Resetting or relocating 1 mailbox and 1 or more newspaper boxes on 1 post is1 measurement unit.

Resetting or relocating 1 newspaper box on 1 post is 1 measurement unit.

The measurement units for resetting or relocating multiple mailboxes on 1 post are the number of mailboxes on the post.

The number of measurement units equals the number of units shown to be reset or relocated regardless of the number of moves required.

78-22 OBLITERATING ROADS AND DETOURS

78-22.01 GENERAL

Section 78-22 includes specifications for obliterating roads and detours.

78-22.02 MATERIALS

Not Used

78-22.03 CONSTRUCTION

If a part of the surfacing is to remain in place, make a full-depth saw cut to a true line along the edge of the surfacing before obliteration.

Obliterate a road or detour by doing one of the following:

1. Placing an earth cover at least 6 inches thick
2. Plowing, pulverizing, or scarifying to a minimum depth of 6 inches or to the bottom of the impermeable underlying base, whichever is the greater depth

If you obliterate by placing an earth cover, scarify the existing base and surfacing for its full depth and break up the base and surfacing such that the material contains no lumps larger than 1 foot in greatest dimension before the earth cover is placed.

If you obliterate by plowing, pulverizing, or scarifying, break the bituminous material into parts at most 4 inches in greatest dimension and mix with an equal quantity of underlying material. After obliteration, grade the area such that it blends with the surrounding terrain and is well drained.

78-22.04 PAYMENT

Not Used

78-23–78-50 RESERVED

79 RESERVED

80 FENCES

80-1 GENERAL

80-1.01 GENERAL

Section 80-1 includes general specifications for constructing fences.

80-1.02 MATERIALS

A temporary fence must comply with the plan details and specifications for a permanent fence of the same type except:

1. Used materials may be incorporated in the fence if the materials are good, sound, and suitable for the intended purpose
2. Materials may be commercial quality if the dimensions and sizes of the materials are equal to or greater than the dimensions and sizes shown or specified in section 80
3. Post must be either metal or wood
4. The Department does not require:
   4.1. Galvanizing or painting of steel elements
   4.2. Treating wood with a wood preservative
   4.3. Concrete footings for metal posts

For concrete for a metal post or brace footing or for a deadman, use:

1. Commercial-quality aggregates and cementitious material
2. At least 470 pounds of cementitious material per cubic yard

A reinforcing bar must comply with ASTM A706/A706M.

80-1.03 CONSTRUCTION

Remove earth, trees, brush, and other obstructions that interfere with fence construction.

Connect new fences to existing fences.

Measure post spacing parallel to the ground slope. Place each post in a vertical position except where the Engineer orders you to set the post perpendicular to the ground surface.

Place a corner post with a brace for each direction of strain at each junction with an existing fence.

Fasten the wire in the new and existing fences to each post.

If ordered at a structure, connect the new fence to the structure such that stock can pass freely through or under the structure; otherwise, install an end post and connect the fence to it.

Crown each concrete footing to shed water.

After constructing a fence, uniformly spread the surplus excavated material along the adjacent roadway where designated by the Engineer.

80-1.04 PAYMENT

The payment quantity for fence is the length measured:

1. Parallel to the ground slope
2. Along the fence

The payment quantity does not include the width of openings.

80-2 BARBED WIRE AND WIRE MESH FENCES

80-2.01 GENERAL

80-2.01A Summary

Section 80-2 includes specifications for constructing barbed wire and wire mesh fences.

80-2.01B Definitions

alignment angle: Change in a line where the angle of deflection is less than:

1. 5 degrees for a steel post barbed wire or wire mesh fence
2. 15 degrees for a wood post barbed wire or wire mesh fence

corner: Change in a line where the angle of deflection exceeds:

1. 5 degrees for a steel post barbed wire or wire mesh fence
2. 15 degrees for a wood post barbed wire or wire mesh fence

fence, Type BW: Barbed wire fence consisting of 5 lines of barbed wire.

fence, Type WM: Wire mesh fence consisting of wire mesh fabric and 3 lines of barbed wire.

80-2.01C Submittals

Reserved

80-2.01D Quality Assurance

Reserved

80-2.02 MATERIALS

80-2.02A General

Reserved

80-2.02B Metal Posts and Braces

Line posts must comply with ASTM A702 except packaging of posts is not required. Each post must be Class B steel. You may omit the anchor plate if the post is set in a concrete footing with a minimum cross-sectional dimension of 6 inches and a depth equal to the full penetration of the post.

Each end, latch, pull, and corner post must have:

1. Minimum resisting section modulus of 0.32 cubic inch in any direction
2. Length of at least 7 feet
3. Weight of at least 3.1 lb/ft

Each brace and brace post must have:

1. Length of at least 7 feet
2. Weight of at least 1.93 lb/ft

80-2.02C Wood Posts and Braces

80-2.02C(1) General

Each wood post and brace must be treated except where untreated wood is specified.

Each wood line post to be driven must be machine pointed at the small end.

Sweep must not exceed 0.08 foot in 6 feet.

80-2.02C(2) Untreated

Each untreated wood post and brace must be:

1. Redwood, cedar, Douglas fir, or Southern yellow pine
2. Straight and free from loose or unsound knots, shakes over 1/3 the post thickness, or other defects that would make it unfit structurally for the intended purpose

Post knots must be sound, tight, well spaced, and not over 2 inches on any face.

Each untreated wood line post and brace may be split material and must have:

1. Length of at least 7 feet
2. Perimeter of at least 16 inches
3. Each cross-sectional dimension of at least 4 inches

Each untreated wood end, corner, and brace post must be sawed or hewed and have:

1. Length of at least 8 feet
2. Nominal size of at least 6 by 6 inches

80-2.02C(3) Treated

Each treated wood post and brace must be:

1. Douglas fir, Hem-Fir, Southern yellow pine
2. Round or sawed rectangular
3. Free of heart center

Each Douglas fir, Hem-Fir, and Southern yellow pine post and brace must be graded under section 57.

Each sawed post and brace must be of the minimum grade and species shown in the following table:

Grades and Species

Nominal size	Minimum grade	Species
4 by 4 inch	Construction light framing	Douglas fir
	No. 1 structural light framing	Hem-Fir
	No. 2 structural light framing	Southern yellow pine
6 by 6 inch	Select structural posts and timbers No. 1	Douglas fir
	Select structural posts and timbers	Hem-Fir
	No. 1 timbers	Southern yellow pine

Each round post and brace must be free from:

1. Decay
2. Shakes over 1/3 the post diameter
3. Splits longer than the thickness or diameter of the post
4. Loose or unsound knots
5. Multiple crooks
6. Other defects that would weaken the post or brace or otherwise make it structurally unsuitable for the intended purpose

Pressure treat each post and brace under section 57 and AWPA U1, Use Category UC4A, Commodity Specification A or B.

Treat posts after pointing.

Instead of the imprint specified in section 57, the treating plant may hammer stamp either end of a treated post and brace with the symbol or name of the company performing the treatment.

For each round post and brace:

1. Peel to remove the outer bark and inner cambium bark except minimal strips of inner bark may remain if not over 1/2 inch wide or over 3 inches long
2. Trim knots flush with sides
3. Remove spurs and splinters
4. Cut ends square

Each line post and brace must be 7 feet long. Any other post must be 8 feet long. Each length may be at most 1 inch shorter and 2 inches longer.

The small end of each round line post and brace must have a cross-sectional dimension between 3-1/2 and 5 inches. The small end of any other round post must have a cross-sectional dimension between 5-1/2 and 7 inches.

The taper from end to end of each round post and brace must not exceed 1-1/2 inches.

Each sawed rectangular line post must have a nominal size of at least 4 by 4 inches. Any other sawed rectangular post must have a nominal size of at least 6 by 6 inches.

80-2.02D Barbed Wire

Barbed wire must:

1. Comply with ASTM A121
2. Have 2 point barbs
3. Be one of the following:
   3.1. 12-1/2 gauge, Class 1
   3.2. 13-1/2 gauge, Class 3
   3.3. 15-1/2 gauge, Class 3

Vertical stays must:

1. Comply with ASTM A641
2. Be 12-1/2 gauge
3. Have a Class 3 zinc coating

80-2.02E Wire Mesh

Wire mesh must:

1. Comply with ASTM A116, Type Z, Grade 60, Class 1
2. Be 32 inches wide
3. Have 8 horizontal wires with vertical stays spaced 6 inches apart

The top and bottom wires must be 10 gauge.

The intermediate wires and vertical stays must be 12-1/2 gauge.

80-2.02F Tension Wires, Hardware, and Grounding Materials

Tension wire must be 8-gauge galvanized wire complying with ASTM A641.

Galvanized bolts and nuts for attaching braces and straps to metal posts and galvanized devices for holding barbed wire and wire mesh in position must be commercial quality.

Each staple used to fasten barbed wire and wire mesh fabric to wood posts must:

1. Comply with ASTM F1667
2. Be at least 1-3/4 inches long
3. Be manufactured from 9-gauge galvanized wire

Wire ties used to fasten barbed wire and wire mesh to metal posts must be at least 11-gauge galvanized wire complying with ASTM F626. Clips and hog rings used for metal posts must be at least 9-gauge galvanized wire complying with ASTM F626.

Wire used to tie the lower line of barbed wire to the top wire of wire mesh must be 12-gauge galvanized wire.

Each ground rod must:

1. Be galvanized or copper-coated steel
2. Be 8 feet long
3. Have a diameter of at least 1/2 inch

Conductor must be no. 6 solid copper or equal.

80-2.02G Gateways

Fence materials and end post bracing must comply with the specifications and plans for the fence type in which the gateway is constructed.

Except for the length, end bars must comply with the line post specifications and plans.

Vertical stays for gateways must be:

1. Pretwisted
2. 9.5-gauge galvanized wire
3. Evenly spaced between end bars at 66-inch maximum intervals

Wire loops must be 6-gauge galvanized wire.

The chain for the latching device must be commercial-quality short-link steel coil chain. The latching bar for the latching device must be commercial-quality steel pipe. Bolts and nuts for attaching the chain to the end posts and latching bar must be commercial quality and galvanized.

80-2.03 CONSTRUCTION

Excavate high points that interfere with placing the fence fabric to the clearance shown.

Brace adjacent line posts at alignment angles with diagonal tension wires unless impractical. If impractical, brace as specified for bracing corner posts.

Set each metal diagonal brace and metal corner, end, latch, gate, and pull post in a concrete footing.

You may drive metal line posts.

Set solid each wood line post one of the following ways:

1. Drive it into place.
2. Install it firmly in a drilled hole of the same dimension as the post.
3. Install it in a drilled or dug hole larger than the dimension of the post, backfill around the post, and compact the backfill.

Install each wood post that is not a line post in a drilled or dug hole larger than the dimension of the post, backfill around the post, and compact the backfill.

Install each round post in a drilled hole butt end down.

Attach the wire mesh and barbed wire to each post.

Securely fasten tension wires to wood posts. Make a single or double loop around each post at each attachment point and staple the wire to the post. Use wire ties, hog rings, or wire clips to fasten the wires to the metal posts.

Connect each wood brace to its adjacent post with a 3/8-by-4-inch steel dowel. Twist the tension wires until the installation is rigid.

Stretch barbed wire and wire mesh fabric and fasten to each wood or steel end, corner, or gate post. Apply tension according to the manufacturer’s instructions using a mechanical stretcher or other device designed for such use. If no tension is specified by the manufacturer, use 250 lb for the required tension. Evenly distribute the pull over the longitudinal wires in the wire mesh such that no more than 50 percent of the original depth of the tension curves is removed. Do not use a motorized vehicle, truck, or tractor to stretch the wire.

Attach barbed wire and wire mesh fabric to the private-property side of posts. On curved alignments, place the wire mesh and barbed wire on the face of the post against which the normal pull of the wire mesh and wire will be exerted. Terminate the wire mesh and barbed wire at each end, corner, pull, and gate post in the new fence line. Attach wire mesh and barbed wire to each wood or steel end, corner, pull, or gate post by wrapping each horizontal strand around the post and tying it back on itself with at least 4 tightly-wound wraps.

At line posts, fasten the wire mesh to the post at the top and bottom and at intermediate points not exceeding 10 inches apart. Fasten each line of barbed wire to each line post. Use wire ties or clips to fasten the wires to metal posts under the post manufacturer’s instructions. Drive staples crosswise with the grain of the wood and pointed slightly downward. Drive staples just short of actual contact with the wires to allow free longitudinal movement of those wires and to prevent damage to the wire’s protective coating. Secure all wires to posts to maintain horizontal alignment.

Two splices per 50 feet of fence in barbed wire and wire mesh are allowed. Use commercially-available galvanized mechanical wire splices or a wire splice created by tying off wire. Install mechanical wire splices with a tool designed for that purpose under the manufacturer's instructions. Tie off the wire as follows:

1. Carry the ends of each wire 3 inches past the tied-off knot location and wrap them around the wire for at least 6 turns in opposite directions.
2. Remove the splice tool and close the space by pulling the end of the wires together.
3. Cut the unused ends of the wire close and neat.

Fence fabric and fence wires of fences using wood line posts must be grounded. Ground by substituting a metal fence post for a wood post at intervals of at most 500 feet with at least 1 metal post in any length of fence over 200 feet between openings. With wire, tightly fasten each line of barbed wire and alternate longitudinal wires of the fence to the metal post.

Where an electric transmission, distribution, or secondary line crosses a wood-post fence, ground the fence with a ground rod installed directly below the crossing point. Drive the rod vertically until the top is 6 inches below the ground surface. Connect the ground rod to the fence with a conductor. The connections must be either brazed or fastened with authorized noncorrosive clamps.

Where a power line runs parallel or nearly parallel to and within 100 feet of the wood post fence, ground the fence with a ground rod at each end post or at intervals of at most 1,500 feet.

If you cannot reach the specified vertical ground rod penetration, install an authorized equivalent grounding system.

After you attach fencing to untreated wood posts, cut off any long post that makes the fence look nonuniform.

80-2.04 PAYMENT

Not Used

80-3 CHAIN LINK FENCES

80-3.01 GENERAL

80-3.01A Summary

Section 80-3 includes specifications for constructing chain link fences.

80-3.01B Definitions

corner: Change in a line where the angle of deflection exceeds 30 degrees.

diamond count: Number of mesh openings in each height of chain link fence.

fence, Type CL: Chain link fence. *Type CL* is followed by a number representing the width in feet of the fence fabric. The number is shown in the bid item description.

fence, Type CL, slatted: Chain link fence with wood or plastic slats inserted vertically in the chain link fabric.

posts and braces: Framework that supports the metal fabric for chain link fence. Posts and braces include round and roll-formed cross sections used as line, end, latch, or corner posts and braces.

80-3.01C Submittals

If you use the protective coating system specified in section 80-3.02B, submit a certificate of compliance for the system.

Submit a certificate of compliance for posts and braces that includes the information specified in ASTM F1043, section 9, "Quality Control Provisions."

80-3.01D Quality Assurance

Reserved

80-3.02 MATERIALS

80-3.02A General

Galvanize or coat ferrous materials.

Do not use materials imperfectly galvanized or coated or with serious abrasions.

For barbed wire on a chain link fence, comply with section 80-2.02D.

80-3.02B Posts and Braces

The base metal for posts and braces must be commercial-quality, weldable steel complying with AASHTO M 181, Type 1, except for the protective coating requirements.

Posts and braces must comply with the strength requirements in ASTM F1043:

1. Group IA, regular grade, for round posts
2. Group II-L for roll-formed posts and braces
3. Group IC, 50,000 psi yield, for round steel pipes

Group IC, 50,000 psi yield, for round steel pipes may be used instead of group IA, regular grade steel round pipes of the same diameter.

Galvanize posts and braces under section 75-1.02B except, instead of galvanizing, tubular posts and braces may have a protective coating system complying with the following:

1. Exterior surfaces of tubular posts and braces must have a combination coating consisting of hot-dip galvanized primer followed by a chromate conversion coating and then a finish coat of clear, cross-linked organic coating. For this combination coating:
   1.1. Thickness of the zinc coating must be at least 0.9 mil as determined from the average results of at least 2 samples and at least 0.8 mil on an individual sample.
   1.2. Chromate conversion coating must be at least 15 µg/sq in.
   1.3. Total thickness of the combination coating must be at least 1.7 mils.
   1.4. Exterior clear-coated surface of the pipe must have demonstrated the ability to resist 1,000 hours of exposure to salt fog with a maximum of 5 percent red rust when tested under ASTM B117.
   1.5. Clear finish coat must not have any film cracking after 500 hours of exposure in an artificial weathering device under one of the following:
      1.5.1. ASTM G152, cycles 1, or 3 Carbon Arc artificial weathering device.
      1.5.2. ASTM G155, cycles 1, or 2 Xenon Arc artificial weathering device.
   1.6. Clear finish coat must not have blistering or cracking after 500 hours of exposure to 100 percent relative humidity under ASTM D2247.
2. Interior surfaces must have a zinc coating or a cross-linked organic coating containing a corrosion inhibitor. For these coatings:
   2.1. Coating thickness must be at least 0.3 mil.
   2.2. Interior coated surface must have demonstrated the ability to resist 300 hours of exposure to salt fog with a maximum of 5 percent red rust when tested under ASTM B117.

Obtain authorization of the protective coating system before you use it. Any change to the protective coating system is a new system that requires authorization.

Each post length must be at least the depth of the concrete footing plus the height of the fabric less 4 inches. The length does not include any top fixture or other top tension wire support integral with the post.

Each post must have provisions to securely hold the top tension wire in position and allow for post removal and replacement without damaging the wire. Fit each tubular post with a rainproof top.

Post tops, extension arms, stretcher bars, and other fittings and hardware must be:

1. Steel or malleable or wrought iron
2. Galvanized after fabrication under section 75-1.02B

80-3.02C Fabric

Chain link fabric must comply with AASHTO M181 for Type I fabric with a Class C coating or ASTM F1345, Class 2, unless vinyl-clad fabric is described in the fence bid item; in which case, the fabric must comply with AASHTO M181 for Type IV fabric with a medium or dark green Class A coating.

The wire for the fabric must be:

1. 11 gauge for a fence 84 inches or less in height
2. 9 gauge for a fence over 84 inches in height and for a slatted chain link fence

Chain link fabric for nonslatted fence must have the diamond count corresponding to the fabric height shown in the following table:

Diamond Counts

Fabric height (inches)	36	42	48	60	72	84	96
Diamond count	10-1/2	12-1/2	13-1/2	17-1/2	20-1/2	24-1/2	27-1/2

Chain link fabric for slatted fence must have 3-1/2-inch-vertical and 5-inch-horizontal mesh.

Knuckle finish fabric on the top and bottom edges.

80-3.02D Tension Wires, Hog Rings, Turnbuckles, Truss Tighteners, Truss Rods, and Stretcher Bars and Bar Bands

Tension wire must be commercial-quality 7-gauge coil spring steel.

Tie wires and hog rings must be at least 9-gauge steel.

Post clips must be at least 6-gauge steel.

Galvanize tension and tie wires, hog rings, and post clips under ASTM A116, coating Class 3.

Turnbuckles and truss tighteners must be:

1. Commercial-quality steel, malleable iron, or wrought iron
2. Galvanized under section 75-1.02B
3. Equal in tensile strength to the truss rod

Truss tighteners must have a strap thickness of at least 1/4 inch.

Each truss rod must be steel and have a diameter of at least 3/8 inch.

Each stretcher bar must be at least 1/4 by 3/4 inch.

Each stretcher bar band must be at least 1/8 by 3/4 inch.

80-3.02E Slats

Slats must be wood or plastic.

Wood slats must be one of the following:

1. Clear redwood
2. Medium-weight wood produced from the species *Shorea (Meranti)*

Each wood slat must have:

1. Thickness of at least 1/4 inch
2. Width about 2-5/8 inch
3. Length enough to fill the vertical openings of the fabric

Each plastic slat must:

1. Be a HDPE with UV inhibitors
2. Have a flat tubular cross section with:

2.1. Wall thickness of about 0.03 inch
2.2. Depth of about 0.325 inch
2.3. Width of about 2.38 inches
2.4. Length equal to the fence height

The plastic slat material must comply with the requirements shown in the following table:

Plastic Slat Material Requirements

Quality characteristic	Test method	Requirement
Melt index	ASTM D1238	0.24
Density	ASTM D1505	0.951
Low temperature brittleness (°F)	ASTM D746	-76
Tensile strength (psi)	ASTM D638	3,700

80-3.03 CONSTRUCTION

Brace each end, latch, and corner post to the nearest line post with either of the following:

1. Diagonal brace used as a compression member
2. Horizontal brace used as a compression member and truss rods used as tension members

Brace each gate post to the nearest line post with a horizontal brace used as a compression member and truss rods used as tension members.

Equip each steel truss rod with a turnbuckle or truss tightener.

Brace line posts horizontally and truss in both directions at intervals of at most 1,000 feet unless the fabric is installed by stretching with equipment.

Fasten chain link fabric on the side of the posts designated by the Engineer.

Stretch and securely fasten the fabric to the posts.

Fasten the top and bottom edges of the fabric to the tension wires. Stretch the tension wires tight.

Install the bottom tension wire on a straight grade between posts by excavating high points of the ground. Do not fill in low points.

Fasten the fabric to end, latch, corner, and gate posts with stretcher bars and stretcher bar bands at 1-foot intervals except the fabric may be fastened to end and corner posts by threading through loops formed on the posts.

Fasten the fabric to line posts with tie wires or post clips and to tension wires with tie wires or hog rings. Space the fasteners at about 14 inches on line posts and about 18 inches on tension wires. Give wire ties at least 1 complete turn. Close each hog ring with the ends overlapping. Wrap tension wires around terminal posts. The top of the fabric to the top tension wire must be at most 2 inches.

If supporting arms for barbed wire are shown, extend each arm upward from the top of the fence at an angle of about 45 degrees. Fit it with clips or other means for attaching 3 lines of barbed wire. Attach the top outside wire to the supporting arm at a point about 12 inches above the top of the chain link fabric and 12 inches out from the fence line. Attach the other wires to the arm spaced evenly between the top of the fence and the top outside wire.

For a chain link fence with slats, install slats vertically in the mesh openings such that the slats fit snugly. Fasten them in a way that prevents easy removal or displacement.

80-3.04 PAYMENT

Not Used

80-4 WILDLIFE EXCLUSION FENCES

80-4.01 GENERAL

80-4.01A General

Section 80-4 includes specifications for constructing wildlife exclusion fences.

Constructing a wildlife exclusion fence includes the installation of any signs specified in the special provisions.

80-4.01B Materials

Each T post must:

1. Comply with ASTM A702
2. Be metal and have an anchor plate
3. Be painted black or galvanized

80-4.01C Construction

Not Used

80-4.01D Payment

Not Used

80-4.02 DESERT TORTOISE FENCES

80-4.02A General

Section 80-4.02 includes specifications for constructing desert tortoise fences.

80-4.02B Materials

80-4.02B(1) Permanent Desert Tortoise Fences

80-4.02B(1)(a) General

Each wire tie and hog ring for a permanent desert tortoise fence must comply with section 80-2.02F.

Each hold down pin must:

1. Be U-shaped, with 2 minimum 6-inch long legs
2. Have pointed ends
3. Be at least 11-gauge wire
4 Be galvanized
5. Be commercial quality

80-4.02B(1)(b) Hardware Cloth

The hardware cloth must:

1. Comply with ASTM A740
2. Be welded or woven galvanized steel wire fabric
3. Be made of at least 14-gauge wire
4. Be 36 inches wide

80-4.02B(1)(c) Barbless Wire

The barbless wire must:

1. Comply with ASTM A641/A641M
2. Be at least 14-gauge wire
3. Have a Class 1 zinc coating

80-4.02B(1)(d) Posts

Each post must:

1. Comply with ASTM F1083
2. Be standard weight, schedule 40 steel pipe with a nominal pipe size of 1 inch
3. Be galvanized steel fence post conforming to ASTM A702

80-4.02B(2) Temporary Desert Tortoise Fences

The materials for a temporary desert tortoise fence must comply with section 80-4.02B(1), except the hardware cloth must be made of at least 16-gauge wire.

80-4.02C Construction

80-4.02C(1) General

Extend the hardware cloth a minimum of 24 inches above the ground.

Plumb the posts and pull the hardware cloth taut. Correct any alignment issues.

80-4.02C(2) Permanent Desert Tortoise Fences

Excavate the ground to form a trench before installing the posts and hardware cloth. Embed the posts at maximum 5-foot intervals into the ground. If T posts are used, use 5-foot lengths and embed the posts to match the above-ground height shown for the posts.

Securely fasten the hardware cloth to the posts with wire ties and to barbless wire with hog rings as shown. Pass the wire ties through the hardware cloth. Encircle the posts and barbless wire with the ties and tie them by twisting a minimum of 3 complete turns.

Bend the twisted ends of the ties down to prevent possible snagging. Close hog rings with their ends overlapping.

Bury the hardware cloth a minimum of 12 inches into the ground. Install the cloth in 1 continuous piece. You may cut the cloth into shorter segments if authorized.

Overlap the hardware cloth segments at posts, with a minimum overlap of 6 inches centered at a post. Wire tie the overlapped cloth to posts as shown. Prevent fraying by threading barbless wire along the vertical edges of the hardware cloth on either side of the post or use 3 equally spaced hog rings (6 hog rings per location) along each wire cloth edge.

Where bedrock or caliche substrate is encountered, use the bent hardware cloth detail if authorized. Transitions from buried-to-bent or bent-to-buried configuration must occur at a post location with a minimum 6-inch overlap of the hardware cloth as shown. The maximum spacing for hold down pins is 24 inches on center. Anchor in place with hold down pins the beginning and end corners of the hardware cloth placed on the ground.

Backfill the removed earth material into the trench created to install the hardware cloth and posts. Use an 8 lb or heavier hand tamper to compact the backfill around the posts and hardware cloth. Install a post at each corner of the cloth segments.

If a gate must be installed, attach the hardware cloth to the gate frame such that there is contact along the entire length of the gate between the finished ground surface and the lower edge of the cloth. Install the gate under section 80-10.

80-4.02C(3) Temporary Desert Tortoise Fences

Fold the horizontal edge of the hardware cloth at a 90° angle toward the tortoise habitat area. Ensure the clearance to the ground at the bend is from 0 to 2 inches.

Where the hardware cloth overlaps, secure the bend piece with one of the following:

1. Barbless wire threaded along the width of the cloth
2. Minimum of 4 hog rings equally spaced along the edge

Fasten the bent piece to the ground with hold down pins pushed completely into the ground.

When the temporary fence is no longer needed, compact soil into post holes with an 8 lb or heavier hand tamper.

80-4.02D Payment

Not Used

80-4.03–80-4.09 RESERVED

80-5–80-9 RESERVED

80-10 GATES

80-10.01 GENERAL

80-10.01A Summary

Section 80-10 includes specifications for constructing gates in fences.

Constructing a gate in an existing fence includes removal of the fence.

80-10.01B Definitions

gate unit for a barbed wire or wire mesh fence: 1 gate with fittings, hardware, and gate posts with braces.

gate unit for a chain link fence: 1 gate with fittings, hardware, and gate and latch posts with braces.

80-10.01C Submittals

Reserved

80-10.01D Quality Assurance

Reserved

80-10.02 MATERIALS

Each drive gate for a chain link fence must be the width shown in the bid item description.

Each drive gate for a barbed wire or wire mesh fence must be at least 48 inches and at most 58 inches high.

Each walk gate must be 4 feet wide.

A gate greater than 8 feet in width must have vertical stays such that no panel exceeds 8 feet in width.

A gate frame must be made with pipe at least 1-1/2 inch in diameter. Interior vertical stays must be made with pipe at least 1 inch in diameter. Pipe must comply with the specifications for posts and braces in section 80-3.02B.

Each gate frame panel must be cross trussed with adjustable truss rods at least 3/8 inch in diameter.

Fasten and reinforce each corner of a gate frame with a malleable iron or pressed steel fitting or by welding.

Each pressed steel fitting must:

1. Have a nominal thickness before galvanizing of at least 0.135 inch
2. Be fastened to develop the strength of connected members

Welds must be smooth and develop the strength of the connected member.

Galvanize fittings, latches, rods, and other gate hardware under section 75-1.02B.

Fabric for gates in a barbed wire or wire mesh fence must comply with the specifications for nonslatted chain link fence in section 80-3.

Fabric for gates in chain link fences must comply with the specifications for the fabric for the fence in which the gate is installed.

Attach chain link fence fabric to the gate frame using stretcher bars and tie wires as specified for fence construction. Space tension connectors at 1-foot intervals.

For a chain link walk gate installed in an existing fence, the gate mounting hardware must not contain open-end slots for the fastening bolts.

Each gate must have a combination steel or malleable iron catch and locking attachment that does not rotate around the latch post.

80-10.03 CONSTRUCTION

Hang each gate with at least 2 steel or malleable iron hinges at least 3 inches in width such that the gate is securely clamped to the gate post and permits the gate to be swung back against the fence. The bottom hinge must have a socket to take the ball end of the gate frame.

Construct a center rest with a catch and stops to hold gates open.

For a walk gate constructed in an existing fence, remove a line post and install the gate such that the gate is centered on the hole of the removed post. When not working on the walk gate, close the opening made in the existing fence with existing fence fabric or 6-foot chain link fabric.

80-10.04 PAYMENT

The gate payment quantity is the quantity of gate units.

80-11–80-14 RESERVED

80-15 EXISTING FENCES

80-15.01 GENERAL

80-15.01A General

Section 80-15 includes specifications for performing work on existing fences.

Work performed on existing fences must comply with section 15.

80-15.01B Materials

Not Used

80-15.01C Construction

Not Used

80-15.01D Payment

The bid items for work performed on existing fences and gates are measured as specified for the construction of new fences and gates.

80-15.02 RECONSTRUCT FENCES

80-15.02A General

Section 80-15.02 includes specifications for reconstructing fences.

80-15.02B Materials

Not Used

80-15.02C Construction

Prevent livestock from escaping during fence reconstruction.

At the junction of the reconstructed fence and cross fence, place corner posts with braces and join the fences.

Install gates to be reused at the locations designated by the Engineer.

If the amount of fence to be disassembled exceeds the amount needed for reconstruction, dispose of the excess fencing.

80-15.02D Payment

Not Used

80-15.03 SALVAGE FENCES

80-15.03A General

Section 80-15.03 includes specifications for salvaging fences.

80-15.03B Materials

Not Used

80-15.03C Construction

Package salvaged chain link fabric in 50-feet segments per pallet. Group salvaged end and corner posts in 1 assembly per bundle.

80-15.03D Payment

Not Used

80-15.04–80-15.08 RESERVED

80-16–80-20 RESERVED

DIVISION IX TRAFFIC CONTROL DEVICES

81 MISCELLANEOUS TRAFFIC CONTROL DEVICES

81-1 GENERAL

81-1.01 GENERAL

Section 81-1 includes general specifications for fabricating, installing, and placing miscellaneous traffic control devices.

Traffic control devices must comply with the *California MUTCD*.

81-1.02 MATERIALS

Not Used

81-1.03 CONSTRUCTION

Not Used

81-1.04 PAYMENT

Not Used

81-2 DELINEATORS

81-2.01 GENERAL

81-2.01A Summary

Section 81-2 includes specifications for fabricating and installing delineators.

81-2.01B Definitions

Reserved

81-2.01C Submittals

Submit a certificate of compliance for:

1. Metal target plates
2. Enamel coating

81-2.01D Quality Assurance

When tested under California Test 671, the enamel coating on a metal target plate must have satisfactory resistance to weathering, humidity, salt spray, and chemicals. The enamel coating must have:

1. Satisfactory adherence and impact resistance.
2. Pencil lead hardness of at least HB.
3. 60-degree specular gloss of at least 80 percent.
4. Excitation purity of no more than 3 percent:
   4.1 As received.
   4.2 After 1,000 hours in an artificial weathering device when tested under ASTM G155, Table X3.1, Cycle 1.
5. Daylight luminous directional reflectance (Y value) of at least 70.

The Department may sample metal target plates for testing as shown in the following table:

Metal Target Plate Sampling

Production stage	Lot size	Sample size
Finished target plates	Less than 5,000	5 target plates
	5,000–10,000	10 target plates
Flat sheet stock	10,000 sq ft or less[a]	Five 12-by-24-inch specimens
Coil stock	5,000 lb or less	Two 12-by-12-inch specimens or one 12-by-24-inch specimen

[a]Flat sheet stock must be identifiable with parent coil stock.

The Department rejects the entire lot if any sample does not comply with section 81 or zinc-coated steel sheets show any evidence of damage to or removal of the zinc coating.

If the Department chooses to resample, the sample quantity may be twice the number shown in the table titled "Metal Target Plate Sampling."

81-2.02 MATERIALS

81-2.02A General

A delineator must be on the Authorized Material List for signing and delineation materials. A delineator consists of a post and 2 target plates.

81-2.02B Wood Posts

Wood posts must comply with section 82-3.02C.

81-2.02C Metal Posts

The steel for a metal post must comply with ASTM A36/A36M.

A metal post must be galvanized under section 75.

81-2.02D Flexible Posts

A flexible post must be:

1. White except where shown as yellow
2. Free from burns, discoloration, contamination, and other objectionable marks or defects that affect appearance or serviceability

81-2.02E Target Plates

Galvanize steel sheets under section 75. Zinc-coated steel sheets must comply with ASTM A653/A 653M, Commercial Steel, Types A, B, and C.

The nominal thickness of a zinc-coated steel sheet must be at least 0.038 inch.

Prepare zinc-coated surfaces to produce optimum adherence of the enamel coating without damaging or removing the zinc coating.

An aluminum target plate must be aluminum alloy 3003-H14. You may use other alloys having equivalent properties if authorized.

The nominal thickness of an aluminum sheet must be at least 0.050 inch.

Prepare the aluminum sheets for the enamel coating by cleaning to remove contaminants and uniformly applying an acid-chromate-fluoride, acid-chromate-fluoride phosphate, or equivalent chemical anticorrosion conversion coating.

Cut each target plate to size and shape and punch the mounting bolt holes. The surfaces and edges of each target plate must be free from fabrication defects.

Coat the pretreated metal target plate with an opaque white coating on both sides using a 1-coat or 2-coat system. When tested under California Test 671, the dry film for the:

1. 1-coat system must be uniform and have an average thickness of at least 0.75 mil with no individual measurement less than 0.65 mil.
2. 2-coat system must consist of 0.10- to 0.20-mil-thick primer and have an average thickness of at least 0.75 mil, including primer and top coat, with no individual measurement less than 0.65 mil.

For a 1-coat painting system, fabricate the zinc-coated steel target plate, including shearing, cutting, and punching, before starting the enameling process.

The enamel coating on a metal target plate must be the product of a commercial manufacturer. Apply the enamel coating by spray, dip, roller, continuous roller coating, or other authorized method.

The coating must be smooth and substantially free from flow lines, paint washout, streaks, blisters, and other defects that might impair serviceability or detract from the general appearance.

A finished metal target plate must be free from dents and defects. The maximum edge-to-edge surface deviation from a horizontal plane must not exceed 1/8 inch.

81-2.02F Hardware

Attach a target plate with either (1) 1/4-inch galvanized steel or aluminum nuts and bolts or (2) 3/16-inch blind aluminum rivets and washers.

81-2.02G–81-2.02L Reserved

81-2.03 CONSTRUCTION

Drive the post in place where soil conditions allow if the driving method does not damage the post. Drill pilot holes if ground conditions are such that the post cannot be driven without being damaged.

Install the target plates after the post is set in place.

After setting the post, fill any space around it with rock-free earth. Thoroughly tamp and water the fill material such that it holds the post securely in position.

Unless the surplus material is hazardous, uniformly spread it along the adjacent roadway where designated by the Engineer.

Before Contract acceptance, spot paint any exposed areas where the paint is damaged and clean any exposed areas that are soiled.

81-2.04 PAYMENT

Not Used

81-3 PAVEMENT MARKERS

81-3.01 GENERAL

81-3.01A Summary

Section 81-3 includes specifications for placing pavement markers.

81-3.01B Definitions

Reserved

81-3.01C Submittals

Submit a certificate of compliance for each type of pavement marker used.

81-3.01D Quality Assurance

Reserved

81-3.02 MATERIALS

81-3.02A General

A pavement marker must be on the Authorized Material List for signing and delineation materials.

Pavement markers must be packaged in a way that prevents damage.

Each package must be marked with:

1. Manufacturer's name
2. Type
3. Color
4. Quantity
5. Lot number
6. Date of manufacture

Protect pavement markers from moisture during shipment to the job site and when stored at the job site.

81-3.02B Reserved

81-3.02C Retroreflective Pavement Markers

The exterior surface of a retroreflective pavement marker must be smooth and contain 1 or 2 retroreflective faces of the specified color.

The base of the marker must be rough textured and free from gloss and substances that could reduce the adhesive bond. The base must be flat within a 0.05-inch tolerance.

A retroreflective pavement marker must comply with the requirements shown in the following table:

Retroreflective Pavement Marker Requirements

Quality characteristic	Test method	Requirement		
Bond strength (min, psi)[a]	California Test 669	500		
Compressive strength (min, lb)[b]		2,000		
Compressive strength, recessed markers (min, lb)		1,200		
Abrasion resistance, specific intensity minimum requirements after abrasion		Pass		
Water soak resistance		No delamination of the body and lens system or loss of reflectance		
Reflectance		Specific intensity		
		Clear	Yellow	Red
0° incidence angle (min)		3.0	1.5	0.75
20° incidence angle (min)		1.2	0.60	0.30
1 year after placement		0.30	0.15	0.08

[a]The marker body or filler material must not fail before reaching 500 psi under the bond strength test.
[b]The marker must not deform more than 0.125 inch at a load of less than 2,000 lb, and delamination of the shell and filler material must not exceed 0.125 inch regardless of the compressive load required to break the marker.

81-3.02D Hot Melt Bituminous Adhesive

Standard hot melt bituminous adhesive must comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Penetration, 100 g, 5 seconds, 77 °F (dmm)	ASTM D5	10–20
Softening point (min, °F)	ASTM D36	200
Flash point, COC (min, °F)	ASTM D92	550
Filler content (percent by weight) (insoluble in 1,1,1 trichloroethane)	ASTM D2371	65–75
Brookfield thermosel viscosity, no. 27 spindle, 20 rpm, 400 °F (centipoise)	ASTM D4402	3,000–6,000

Flexible hot melt bituminous adhesive must comply with the requirements shown in the following table:

Quality characteristic	Test method	Requirement
Penetration, 100 g, 5 seconds, 77 °F (max, dmm)	ASTM D5	30
Softening point (min, °F)	ASTM D36	200
Ductility, 2 in/min, 77 °F (min, in)	ASTM D113	6
Ductility, 0.4 in/min, 39 °F (min, in)		2
Flexibility	California Test 440	No breaks or cracks
Brookfield thermosel viscosity, no. 27 spindle, 20 rpm, 375 °F (centipoise)	ASTM D4402	2,500–6,000
Bond strength to concrete (min, psi)	California Test 440	100
Bond strength to retroreflective pavement marker (min, psi)	California Test 440	120

The filler material must be Type PC, Grade III, calcium carbonate complying with ASTM D1199. The fineness of the filler material must comply with the gradation requirements shown in the following table:

Sieve size	Percentage passing
No. 100	100
No. 200	95
No. 325	75

81-3.02E Epoxy Adhesive

The epoxy adhesive must be either rapid set or standard set.

81-3.03 CONSTRUCTION

81-3.03A General

Establish the alignment for placing pavement markers.

Do not place pavement markers over longitudinal or transverse joints in the pavement surface.

Place pavement markers when the pavement surface is dry.

Before placing pavement markers, remove undesirable material from the pavement surface, including dirt, curing compound, grease, oil, loose or unsound layers, and paint. Regardless of the pavement's age or type, clean the surface by abrasive blast cleaning except where you apply hot melt bituminous adhesive on clean asphalt concrete or on a new clean seal coat.

Apply pavement markers to the pavement with bituminous adhesive, flexible bituminous adhesive, standard set epoxy, or rapid set epoxy adhesive. Apply markers in pavement recesses with flexible bituminous adhesive.

Comply with the manufacturer's installation instructions for the type of adhesive used.

Completely cover the pavement surface where the pavement marker is to be applied or the bottom of the pavement marker with the adhesive without leaving any voids. Place the marker into position and firmly apply pressure until contact is made with the pavement. Apply enough adhesive such that it protrudes around the marker's edges after pressing it into place.

Place retroreflective pavement markers such that each retroreflective face is perpendicular to a line parallel to the roadway centerline.

The Engineer determines when the adhesive has set long enough for newly installed pavement markers to bear traffic.

81-3.03B Hot Melt Bituminous Adhesive

If using hot melt bituminous adhesive, place pavement markers on asphalt concrete or a new seal coat (1) after the surface or seal coat has been open to traffic for at least 7 days and (2) when the pavement and ambient air temperatures are above 50 degrees F.

Indirectly heat hot melt bituminous adhesive in an applicator with continuous agitation or recirculation. Do not heat hot melt bituminous adhesive above the manufacturer's maximum safe heating temperature.

Place pavement markers immediately after applying hot melt bituminous adhesive. Remove any adhesive from the marker's exposed lenses using a soft rag moistened with the manufacturer's instructed solvent.

81-3.03C Epoxy Adhesive

If using epoxy adhesive, place pavement markers on asphalt concrete or a new seal coat (1) after the surface or seal coat has been open to public traffic for at least 14 days and (2) at the pavement and ambient air temperatures complying with the epoxy adhesive manufacturer's instructions.

Use automatic mixing equipment for the epoxy adhesive. The equipment must:

1. Have positive displacement pumps.
2. Properly meter the 2 components of the epoxy adhesive in the specified ratio of ±5 percent by volume of either component.

The voids in an undisturbed sample of cured, mixed epoxy adhesive obtained from the extrusion nozzle of the mixing equipment must not exceed 4 percent.

At the start of each day, check the ratio of the 2 components in the presence of the Engineer by (1) disconnecting the mixing heads or (2) using suitable bypass valves and filling 2 suitable containers with the unmixed components. The mixing head must properly mix the 2 components until black or white streaks are not visible in the mixed material.

Apply epoxy adhesive and place pavement markers before the epoxy starts to thicken. Apply enough epoxy such that it flows and protrudes around the marker's edges when a slight pressure is applied to the marker.

81-3.03D Pavement Recesses

Locate pavement recesses along the line or lines of new or existing stripes.

Do not construct recesses on existing structures.

The equipment used for recess construction must be power operated, mechanical, and capable of removing pavement to the dimensions shown.

Remove residue with a vacuum before it is blown by traffic or wind. Do not allow the residue to flow across the pavement or into gutters or drainage facilities.

81-3.04 PAYMENT

Not Used

81-4–81-7 RESERVED

81-8 EXISTING PAVEMENT MARKERS AND DELINEATORS

81-8.01 GENERAL

Section 81-8 includes specifications for performing work on existing pavement markers and delineators.

Work performed on existing pavement markers and delineators must comply with section 15.

81-8.02 MATERIALS

Not Used

81-8.03 CONSTRUCTION

81-8.03A General

Not Used

81-8.03B Remove Pavement Markers

Remove pavement markers and the underlying adhesive by methods that cause the least possible damage to the pavement or surfacing.

When removing ceramic-type pavement markers, use screens or other protective devices to contain fragments.

Remove fragments from the removal work before opening the lanes to traffic.

81-8.03C Reserved

81-8.04 PAYMENT

Not Used

81-9–81-10 RESERVED

82 SIGNS AND MARKERS

82-1 GENERAL

82-1.01 GENERAL

82-1.01A Summary

Section 82-1 includes general specifications for fabricating and installing sign panels and markers and constructing roadside signs.

Signs and markers must comply with the *California MUTCD*, *California Sign Specifications,* and the FHWA publication *Standard Highway Signs and Markings*. For the *California Sign Specifications*, go to the Department's Traffic Operations website.

82-1.02 MATERIALS

Not Used

82-1.03 CONSTRUCTION

Not Used

82-1.04 PAYMENT

Not Used

82-2 SIGN PANELS

82-2.01 GENERAL

82-2.01A Summary

Section 82-2 includes specifications for furnishing sign panels.

Furnishing sign panels includes fabricating and installing sign panels.

82-2.01B Definitions

background: Dominant sign color.

legend: Letters, numerals, tildes, bars, arrows, route shields, symbols, logos, borders, artwork, and miscellaneous characters that are intended to convey specific meanings on traffic signs.

82-2.01C Submittals

Submit a certificate of compliance for:

1. Aluminum sheeting
2. Retroreflective sheeting
3. Screened-process colors
4. Nonreflective, opaque, black film
5. Protective-overlay film

Upon request, submit test samples of sign panels and materials at various stages of production. The samples must be at least 12 by 12 inches and include the background material and legend.

At least 15 days before starting sign fabrication, submit at least 3 copies of your QC plan for sign panels. The QC plan must include:

1. Contact information for the person responsible for sign QC
2. Acceptance criteria for incoming raw materials at the fabrication plant
3. Type, method, and frequency of QC testing at the fabrication plant
4. Types and brand names of retroreflective sheeting
5. List of the retroreflective sheeting manufacturer's approved process colors, protective overlay film, and black nonreflective film, including the manufacturer's name and product name for each item
6. Manufacturer's installation and splicing instructions for the retroreflective sheeting
7. Manufacturer's instructions for cleaning each product
8. Method of packaging, transporting, and storing signs

82-2.01D Quality Assurance

The Department may inspect signs at the fabrication plant or the job site. The Department rejects formed panel signs with holes that are slanted or incorrectly spaced. The Engineer will reject damaged signs, defective signs, and signs with spelling errors before or after installation.

The Department rejects a laminated panel if a 0.010-inch-thick by 1/2-inch-wide feeler gauge can be inserted to a depth of more than 1/2 inch between the extruded aluminum frame and the aluminum sheeting.

If instrumental testing under ASTM D4956 is disputed, the Engineer's visual inspection will determine the color of the retroreflective sheeting, screened process colors, and film.

82-2.02 MATERIALS

82-2.02A General

A sign panel must be produced at a fabrication plant.

The sign must be imprinted with the following information:

1. Phrase *Property of the State of California*
2. Sign fabricator's name
3. Month and year of fabrication
4. Type of retroreflective sheeting
5. Sheeting manufacturer's identification and lot number for the retroreflective sheeting

The sign information must:

1. Be imprinted in 1/4-inch upper-case letters and numerals on the back, lower right of each sign panel such that it will not be blocked by a sign post or mounting frame
2. Be imprinted at the fabrication plant by die-stamping on aluminum panels or by an equivalent method for fiberglass-reinforced plastic signs, such as affixing a die-stamped aluminum tag
3. Not be painted, screened, inked, or engraved
4. Be imprinted such that it does not damage the face of the sign

For a sign composed of multiple panels, the legend must be placed across joints such that it does not affect the size, shape, spacing, and appearance of the legend on the assembled sign.

For a formed panel sign, the retroreflective sheeting for the background and legend must be wrapped around the interior vertical edges of each panel.

A sign with a protective-overlay film must be marked at the fabrication plant with a 3/8-inch-diameter dot. The dot must be placed on the lower border of the sign before applying the protective-overlay film. The fabricator determines the application method and exact location of the dot except the dot must not be placed on the legend or near bolt holes. The dot must be black if placed on a white border and white if placed on a black border.

The exposed portion of the mounting hardware on the sign face, including rivets used to attach sheeting to framing members, must have a factory- or field-applied finish that closely matches the color of the background and legend of the sign face.

The face of a fabricated sign must be uniform, flat, smooth, and free from defects, scratches, chips, wrinkles, gel, hard spots, streaks, extrusion marks, and air bubbles. The front, back, and edges of sign panels must not have bends, router chatter marks, burns, sharp edges, loose rivets, delaminated skins, excessive adhesive over-spray, or aluminum marks.

Protect, transport, and store sign panels fabricated with screened-process colors under the retroreflective sheeting manufacturer's instructions.

Transport sign panels such that the faces of the panels are protected from damage and weather. Ship panels on pallets, in crates, or in tier racks. Ship panels vertically on edge, not stacked horizontally. Place padding and protective materials between the panels as necessary. Keep panels dry during transit.

Do not store sign panels directly on the ground. Keep sign panels dry at all times and store the panels:

1. In a dry environment
2. On edge vertically whether indoors or outdoors
3. In enclosed, climate-controlled trailers or containers in areas of high heat and humidity
4. Indoors whenever the panels will be stored more than 30 days

82-2.02B Aluminum Sheeting

A sign panel must be fabricated from aluminum sheeting of an alloy and temper complying with ASTM B209.

The aluminum sheeting must be pretreated for corrosion resistance as specified in ASTM B449. The surface of the sheeting must be cleaned, deoxidized, and coated with a light, tightly-adherent chromate conversion coating free from powdery residue. The conversion coating must be Class 2 with a weight from 10 to 35 mg/sq ft and an average weight of 25 mg/sq ft. After the cleaning and coating process, the aluminum sheeting must be protected from exposure to grease, oils, dust, and contaminants.

The aluminum sheeting must be free from buckles, warps, dents, cockles, burrs, and other defects resulting from fabrication.

The base plate for standard route markers must be die cut.

82-2.02C Retroreflective Sheeting

Retroreflective sheeting used for the background and legend must comply with ASTM D4956 and must be on the Authorized Material List for signing and delineation materials.

Type III, IV, VIII, IX, and XI retroreflective sheeting must have Class 1, 3, or 4 adhesive backing. Type II retroreflective sheeting may have Class 1, 2, 3, or 4 adhesive backing. The adhesive backing must be pressure sensitive and fungus resistant.

Retroreflective sheeting must be applied to sign panels at the fabrication plant under the retroreflective sheeting manufacturer's instructions without appreciable stretching, tearing, or other damage.

The orientation of the legend must comply with the retroreflective sheeting manufacturer's instructions.

The retroreflective sheeting on a sign panel with a minor dimension of 48 inches or less must be a single, contiguous sheet without splices except for the splices produced during the manufacture of the retroreflective sheeting. A sign panel with a minor dimension greater than 48 inches may have 1 horizontal splice in the retroreflective sheeting other than the splices produced during the manufacture of the retroreflective sheeting.

Unless the retroreflective sheeting manufacturer's instructions require a different method, splices in the retroreflective sheeting must overlap by at least 1 inch. The retroreflective sheeting on either side of a splice must not exhibit a color difference under incident and reflected light.

82-2.02D Process Colors and Film

The type of material recommended by the retroreflective sheeting manufacturer must be used for:

1. Screened-process colors
2. Nonreflective, opaque, black film
3. Protective-overlay film

The fabricator must perform all patterns, layouts, and set-ups necessary for the screening process.

The fabricated surface of the applied screened-process color must be flat and smooth.

Colored retroreflective sheeting must be used for the background except signs with green, red, blue, or brown backgrounds may use reverse-screened-process color on white retroreflective sheeting for the background color.

The coefficient of retroreflection for reverse-screened-process colors used on white retroreflective sheeting must be at least 70 percent of the coefficient of retroreflection specified in ASTM D4956 for the corresponding colored retroreflective sheeting.

The legend must be a black, screened-process color or nonreflective, opaque, black film.

Screened-process colors and nonreflective, opaque, black film must have outdoor weatherability characteristics equivalent to those specified for retroreflective sheeting in ASTM D4956.

Nonreflective, opaque, black film must be a vinyl or acrylic material.

Cured, screened-process colors must not peel off if transparent cellophane tape with a tensile breaking strength of at least 14 lb/in width measured under ASTM D3759/D3759M is applied over the color and removed in a single, quick motion at a 90 degree angle to the sign's face.

82-2.02E Single-Sheet Aluminum Panels

The aluminum sheeting for framed and unframed panels must be aluminum alloy 6061-T6 or 5052-H38.

A single-sheet aluminum panel must not have a vertical splice in the aluminum sheeting. A panel with a depth greater than 48 inches may have 1 horizontal splice in the sheeting.

For a framed panel, the framing members must be aluminum channel or rectangular aluminum tubing. The lengths of the framing members must be within ±1/8 inch of the lengths shown.

Aluminum channels or rectangular aluminum tubing must be welded together using the inert gas-shielded arc welding process and E4043 aluminum-electrode filler wires. The filler diameter must be equal to the wall thickness of the smallest welded channel or tubing.

The aluminum sheeting must be attached to the frame with 3/16-inch-diameter rivets. The rivets must be placed at least 1/2 inch from the web channel edges. The rivets must be made of aluminum alloy 5052 and be anodized or treated with a conversion coating to prevent corrosion.

A fabricated single-sheet, aluminum panel must be within ±1/8 inch of the dimensions shown. The panel must be flat to within ±1/32 in/ft of the panel dimensions as measured by a straightedge placed in any direction across the plane of the panel.

82-2.02F Fiberglass-Reinforced Plastic Panels

A fiberglass-reinforced plastic panel must:

1. Be on the Authorized Material List for signing and delineation materials
2. Comply with ASTM D3841
3. Be weather-resistant, Grade II, thermoset polyester laminate

The plastic must:

1. Be acrylic modified and UV stabilized for outdoor weatherability.
2. Contain additives designed to suppress fire ignition and flame propagation. When tested under ASTM D635, the extent of burning must not exceed 1 inch.
3. Be stabilized to prevent the release of solvents and monomers. The front and back surfaces of the laminate must be clean and free from contaminates and releasing agents that could interfere with the bonding of the retroreflective sheeting.

The color of the panel must be uniform gray, Munsell color notation N7.5 to N8.5 as specified in ASTM D1535.

The panel must be cut from a single piece of laminate. Mounting bolt holes must be predrilled. Predrilled bolt holes, panel edges, and the front and back surfaces of the panel must be true and smooth. The panel surface must not have visible cracks, pinholes, foreign inclusions, warping, and wrinkles that might affect performance.

The panel must be:

1. At least 0.135 inch thick
2. Flat to within ±1/32 in/ft of the panel dimensions as measured by a straightedge placed in any direction across the plane of the panel
3. Within ±1/8 inch of the dimensions shown

82-2.02G Laminated Panels

82-2.02G(1) General

A laminated panel must have a honeycomb core and extruded aluminum frame laminated between 2 sheets of aluminum to produce a flat, rigid panel.

The face sheet must be a single contiguous sheet of 0.063-inch-thick aluminum sheeting, alloy 6061-T6 or 5052-H32. The back sheet must be a single, contiguous sheet of 0.040-inch-thick aluminum sheeting, alloy 3003-H14.

The core material must be 0.26 lb/sq ft phenolic-impregnated kraft paper that:

1. Is impregnated with 18 percent phenolic resin
2. Has 1/2-inch honeycomb cell size
3. Is fungus resistant under MIL-STD-401B

The adhesive used to laminate the face and back sheets to the honeycomb core and extruded aluminum frame must produce a bond that is strong, permanent, and resistant to oil and water.

The panel must withstand a wind load of 33 lb/sq ft with a bending safety factor of 1.25 when tested for the simple span lengths shown in the following table:

Panel type	Nominal panel thickness	Simple span length
A	1 inch	9'-0"
B	1 inch	9'-0"
	2-1/2 inches	14'-6"
H	2-1/2 inches	14'-6"

The tensile strength of the panel must be at least 40 lb/sq in when tested under ASTM C297 and C481, Cycle B, after aging. Instead of spraying with hot water, the specimen must be immersed in water at 160 degrees F.

An individual laminated panel must not exceed 24 feet in length and 5 feet in depth. An individual panel must be fabricated as a single unit without horizontal and vertical joints, splices, or seams.

Use 2 panels for signs exceeding 5 feet in depth. You may use 3 panels to avoid placing the legend over a horizontal joint if authorized.

Welds are not required on the side of the framing members where the face and back sheets will be placed.

After lamination, 3/16-inch-diameter rivets must be placed at each corner of the perimeter frame through the face and back sheets. The rivets must be made of aluminum alloy 5052 and be anodized or treated with a conversion coating.

Sealant must be placed at the corners of the perimeter frame to prevent water intrusion.

The face of a fabricated panel must be flat to within ±3/32 in/ft of the panel dimensions as measured by a straightedge placed in any direction across the plane of the panel. Wherever the panels adjoin, the gap between the adjoining edges must not deviate by more than 1/32 inch from a straightedge placed from corner to corner. Nonadjoining edges must not deviate by more than 1/8 inch from a straightedge placed from corner to corner. The face and back sheets must be flush with the perimeter frame. All panel edges must be smooth.

A panel must be from −1/2 to +1/8 inch of the dimensions shown. The difference in the length between adjoining panels of multiple-panel signs must not be greater than 1/2 inch.

82-2.02G(2) Roadside Laminated Panels

A laminated panel for a roadside sign must be Type B or Type H.

For a Type B panel:

1. Channel edges must be welded together to form the perimeter frame
2. Vertical tube spacers must be welded to the frame

For a Type H panel:

1. Channel edges must be screwed to the tube channel edges with self-tapping hex head stainless steel screws to form the perimeter frame.
2. Centerline panel tube must be welded to the perimeter frame along the horizontal centerline of the panel. The centerline panel tube must be a single, contiguous extrusion without joints.
3. Vertical tube spacers must be welded to the perimeter frame and to the centerline panel tube.

82-2.02G(3) Overhead Laminated Panels

A laminated panel for an overhead sign must be Type A.

An individual panel must not exceed 24 feet in length or 5 feet in depth.

If a panel length is not shown for a sign exceeding 24 feet in length, the Engineer determines the length.

The channel edges must be screwed to the modified H sections with self-tapping hex head stainless steel screws to form the perimeter frame.

Aluminum mounting clamps for A-1 hardware must be cast aluminum alloy with a tensile strength of at least 25 kips/sq in. The installed bolt torque must not exceed 100 in-lb.

82-2.02H Formed Panels

A formed panel must be fabricated from a single, contiguous sheet of 0.063-inch-thick aluminum sheeting, alloy 5052-H32.

Aluminum sheeting must be attached to struts with 3/16-inch-diameter anodized aluminum rivets. The rivets must be placed through the sign face at the spacing shown after applying the background material and legend.

The formed edges must be square. The drilled mounting holes must be straight and perpendicular to the front and back surfaces of the formed edges.

A fabricated formed-panel sign must be within ±1/16 inch of the dimensions shown and flat to within ±1/8 in/ft of the panel dimensions in any direction as measured by a straightedge placed in any direction across the plane of the panel.

82-2.03 CONSTRUCTION

82-2.03A General

Deliver sign panels to the job site with the background and legend permanently affixed to the panels.

Do not chip or bend sign panels.

Immediately replace sign panels exhibiting damage or flaws, including a significant color difference between daytime and nighttime.

Obtain authorization before repairing sign panels at the job site.

Use the following hardware to mount the type of sign panel shown:

1. Lag screws, nuts, bolts, and washers for roadside signs
2. Braces and wood block spacers for roadside signs
3. Type A-1 and Type A-2 mounting hardware for overhead laminated-panel signs
4. Type A-3 mounting hardware for overhead formed-panel signs

82-2.03B Laminated Panels

For laminated multiple-panel signs, place an H-section closure extrusion in the top channel of the lower panel before mounting the upper panel. When mounted, the bottom channel of the adjoining upper panel must fit together to enclose the H-section closure extrusion for the full length of the panel without gaps.

82-2.04 PAYMENT

The payment quantity for furnishing any type of sign panel is the area determined from the dimensions shown.

82-3 ROADSIDE SIGNS

82-3.01 GENERAL

82-3.01A Summary

Section 82-3 includes specifications for constructing roadside signs.

Roadside signs include Type N (CA), Type P (CA), and Type R (CA) marker panels.

82-3.01B Definitions

roadside sign: Traffic sign with 1 or more sign panels attached to a supporting structure consisting of 1 or 2 posts, a signal standard, or a lighting standard.

82-3.01C Submittals

Reserved

82-3.01D Quality Assurance

When delivered to the job site, treated posts must comply with the specified grading requirements and have a moisture content of not more than 25 percent when tested under ASTM D4444 with an authorized moisture meter.

82-3.02 MATERIALS

82-3.02A General

A roadside sign includes sign panels, fastening hardware, back braces, straps and saddle brackets, and frame assemblies for multiple sign panels.

82-3.02B Metal Posts

A mounting for a roadside sign to be installed on a barrier or railing must be fabricated from (1) welded or seamless steel pipe complying with ASTM A53/A53M, Grade B, and (2) structural steel complying with ASTM A36/A36M.

Bolted connections must comply with section 56-2.02D. Concrete anchorage devices must comply with section 75-3.

After fabrication, all metal parts for mounting a roadside sign must be galvanized under section 75-1.02B.

82-3.02C Wood Posts

A wood post must be the allowable grade and species for the sizes shown in the following table:

Nominal post size[a]	Allowable grades and species
4 by 4 inches	Select heart redwood
	No. 1 heart structural redwood, 1050f
	No. 2 heart structural redwood, 900f
	No. 1 structural light framing Douglas fir, free of heart center
	No. 1 structural light framing Hem-Fir, free of heart center
	No. 1 structural light framing Southern yellow pine, free of heart center
4 by 6 inches	Select heart grade redwood
	Select heart structural grade redwood, 1100f
	No. 1 heart structural redwood, 950f
	No. 2 structural joists and planks, Douglas fir, free of heart center
	No. 1 structural joists and planks Hem-Fir, free of heart center
	No. 2 structural joists and planks Southern yellow pine
Greater than 4 by 6 inches	Select heart redwood
	No. 1 heart structural redwood, 950f
	No. 1 posts and timbers, also known as no. 1 structural, Douglas fir, free of heart center
	Select structural posts and timbers Hem-Fir, free of heart center; and no. 1 timbers Southern yellow pine, free of heart center

[a]Sizes shown are minimum dressed dry sizes

The posts must be graded under section 57-2.01B(2). The sweep must not exceed 0.08 foot in 10 feet.

When tested under ASTM D4444 with an authorized moisture meter, the moisture content of Douglas fir, Hem-Fir, and Southern yellow pine posts must be not more than 25 percent in the outer 1 inch at the post's midpoint before preservative treatment.

Douglas fir and Hem-Fir posts must be treated under section 57-2.01B(3) and under AWPA U1, Use Category UC4A, Commodity Specification A. Posts must be incised, and the minimum retention of preservative must comply with AWPA requirements.

82-3.02D Laminated Wood Box Posts

The Department furnishes a laminated wood box post with an attached metal cap at the top of each post.

82-3.02E Sign Panel Fastening and Mounting Hardware

Frame assemblies for multiple sign installations must be fabricated from an aluminum alloy or structural steel complying with ASTM A36/A36M. Frames fabricated from structural steel must be hot-dip galvanized after fabrication.

Back braces for a sign must be made of commercial-quality, mild steel and hot-dip galvanized after fabrication.

Straps and saddle brackets for mounting sign panels on lighting standards, sign structure posts, and traffic signal standards must be stainless steel complying with ASTM A167, Type 302B. Theft-proof bolts must be stainless steel with a chromium content of at least 17 percent and a nickel content of at least 8 percent.

Bolts, except theft-proof bolts, lag screws, metal washers, and nuts must be made of commercial-quality steel and hot-dip galvanized after fabrication. Fiber washers must be commercial quality.

Galvanizing must comply with section 75-1.02B.

82-3.03 CONSTRUCTION

82-3.03A General

You may cut the ends of wood posts at the job site. If cutting or boring is performed after treating posts with preservative, manually apply preservative to the cuts and holes under section 57-2.01B(3).

Treat wood block spacers inserted between the post and sign panel on single-post installations with wood preservative under section 57-2.01B(3).

If you do not immediately use laminated wood box posts, neatly stack them on dunnage.

Do not paint wood posts and block spacers unless described otherwise.

Drill 2 holes in each wood post to provide the breakaway feature shown.

Make breakaway saw cuts and holes for the saw cuts in laminated wood box posts after installation of the posts. Do not splice the posts. You may make 1 trim cut at the bottom of the post.

The line between the center of the top of a post and the center of the post at ground level must not deviate from a plumb line by more than 0.02 foot in 10 feet.

Backfill the space around wood posts with earth or sand that is free of rocks or other deleterious material. Backfill around laminated wood box posts with granular material. Place the backfill material in layers approximately 1/3 foot thick. Moisten and thoroughly compact each layer.

Backfill the space around metal posts with minor concrete that contains at least 470 pounds of cementitious material per cubic yard.

Unless surplus excavated material is hazardous, uniformly spread it along the adjacent roadway where designated by the Engineer.

82-3.03B Sign Panel Installation

Install lag screws by turning the lag screw into pilot holes using a wrench. Bore the pilot holes with a bit diameter equal to the root diameter of the lag screw thread.

Apply PVC tape, polyethylene tape, or other authorized corrosion-resistant barrier to the areas on metal sign surfaces or hardware that will be in contact with treated wood. Before inserting bolts, fill the bolt holes with the hardware manufacturer's recommended corrosion-protection grease that will not melt or run at a temperature of 150 degrees F. The corrosion-resistant barrier and grease is not required if wood posts and blocks are treated with pentachlorophenol in hydrocarbon solvent.

82-3.04 PAYMENT

An installed roadside sign consisting of one or more sign panels attached to:

1. 1 post is 1 measurement unit of roadside sign - one post
2. 2 posts is 1 measurement unit of roadside sign - two post
3. 1 or 2 laminated wood box posts is 1 measurement unit of install roadside sign (laminated wood box post)

The payment quantity for metal (rail mounted sign) and metal (barrier mounted sign) is determined by the scale weight of the pipe posts, base plates, anchorage assemblies, and other metal parts used to mount a roadside sign on a barrier or railing.

The payment quantity for roadside signs installed by the strap and saddle bracket method on electroliers, sign structure posts, and traffic signal standards and by the mast arm hanger method on traffic signal mast arms is the quantity of the sign panels on these elements.

Payment for furnishing sign panels is not included in the payment for roadside signs.

82-4 SIGN OVERLAYS

82-4.01 GENERAL

Section 82-4 includes specifications for installing sign overlays.

82-4.02 MATERIALS

Sign overlay materials must comply with section 82-2.02.

A self-plugging blind rivet for installing a sign overlay must have a 3/16-by-5/8-inch shank.

82-4.03 CONSTRUCTION

Drill the rivet holes with a no. 10 drill bit. If the overlay is not prepunched, the maximum rivet spacing is 16 inches.

If the existing sign panel is porcelain-enameled steel, drill the rivet holes with a diamond bit. Cover the exposed metal around the hole with a thin coat of silicone adhesive.

82-4.04 PAYMENT

Not Used

82-5 MARKERS

82-5.01 GENERAL

82-5.01A Summary

Section 82-5 includes specifications for fabricating and installing markers, including highway post markers.

82-5.01B Definitions

Reserved

82-5.01C Submittals

Submit a certificate of compliance for:

1. Metal target plates
2. Enamel coating
3. Retroreflective sheeting

82-5.01D Quality Assurance

When tested under California Test 671, the enamel coating on metal target plates must have satisfactory resistance to weathering, humidity, salt spray, and chemicals. The enamel coating must have:

1. Satisfactory adherence and impact resistance
2. Pencil lead hardness of HB minimum
3. 60-degree specular gloss of 80 percent minimum
4. Excitation purity of 3 percent maximum:
   - 4.1 As received
   - 4.2 After 1,000 hours in an artificial weathering device as specified in ASTM G155, Table X3.1, Cycle 1
5. Daylight luminous directional reflectance, Y value, of 70 minimum

The Department may sample metal target plates for testing at the production stages for the lot and sample sizes shown in the following table:

Metal Target Plate Sampling

Production stage	Lot size	Sample size
Finished target plates	Less than 5,000	5 target plates
	5,000–10,000	10 target plates
Flat sheet stock	10,000 sq ft or less[a]	Five 12-by-24-inch specimens
Coil stock	5,000 lb or less	Two 12-by-12-inch specimens or one 12-by-24-inch specimen

[a]Flat sheet stock must be identifiable with parent coil stock.

The Department rejects the entire lot if either of the following occurs:

1. Any sample does not comply with section 82
2. Zinc-coated steel sheets show any evidence of damage to or removal of the zinc coating

If the Department chooses to resample, the sample size may be twice the number shown in the table titled "Metal Target Plate Sampling."

82-5.02 MATERIALS

82-5.02A General

A marker must be on the Authorized Material List for signing and delineation materials.

82-5.02B Wood Posts

A wood post must comply with section 82-3.02C.

82-5.02C Metal Posts

Steel for a metal post must comply with ASTM A36/A36M.

A metal post must be galvanized under section 75-1.02B.

82-5.02D Flexible Posts

A flexible post must be white except where shown as yellow.

The flexible post must be free from burns, discoloration, contamination, and other objectionable marks or defects that affect appearance or serviceability.

82-5.02E Target Plates

A target plate for a Type K-1 (CA) or a Type K-2 (CA) object marker must be the same color and material as the flexible post.

A target plate for highway post marker or Type L-1 (CA) or Type L-2 (CA) object marker installed on a metal post must be manufactured from an aluminum sheet or zinc-coated steel sheet.

Galvanize steel sheets under section 75-1.02B. Zinc-coated steel sheets must comply with ASTM A653/A653M, Commercial Steel, Types A, B, and C.

The nominal thickness of a zinc-coated steel sheet must be at least 0.038 inch.

Prepare zinc-coated surfaces to produce optimum adherence of the enamel coating without damaging or removing the zinc coating.

An aluminum target plate must be aluminum alloy 3003-H14. You may use other alloys having equivalent properties if authorized.

The nominal thickness of an aluminum sheet must be at least 0.050 inch.

Prepare the aluminum sheets for the enamel coating by a suitable cleaning method to remove contaminants and by uniformly applying an acid-chromate-fluoride, acid-chromate-fluoride phosphate, or equivalent chemical anticorrosion conversion coating.

Cut the target plate to size and shape and punch the mounting bolt holes. The surfaces and edges of the plate must be free from fabrication defects.

Coat the pretreated metal target plate with an opaque white coating on both sides using a 1-coat or 2-coat system. When tested under California Test 671, the dry film for the:

1. 1-coat system must be uniform and have an average thickness of at least 0.75 mil with no individual measurement less than 0.65 mil
2. 2-coat system must consist of 0.10- to 0.20-mil-thick primer and have an average thickness of at least 0.75 mil, including primer and top coat, with no individual measurement less than 0.65 mil

If using a 1-coat painting system, fabricate a zinc-coated steel target plate, including shearing, cutting, and punching, before starting the enameling process.

The enamel coating on a metal target plate must be the product of a commercial manufacturer. Apply the enamel coating by spray, dip, roller, or continuous roller coating. You may use other methods if authorized.

The coating must be smooth and substantially free from flow lines, paint washout, streaks, blisters, and other defects that might impair serviceability or detract from the general appearance.

A finished metal target plate must not have dents or defects. The maximum edge-to-edge surface deviation from a horizontal plane must not exceed 1/8 inch.

82-5.02F Reflectors

A reflector for a marker must be made of a Type III or higher grade retroreflective sign sheeting shown on the Authorized Material List for signing and delineation materials.

82-5.02G Hardware

Use (1) 1/4-inch galvanized steel or aluminum nuts and bolts or (2) 3/16-inch blind aluminum rivets and washers to attach a target plate to a post.

Use 5/16-inch galvanized steel bolts, nuts, and washers to attach a marker panel to a post.

82-5.02H Highway Post Markers

A highway post marker is shown in the Bid Item List as a milepost marker.

Letters and numerals on a highway post marker must be made with opaque black paint or film. The paint and film must have an equivalent outdoor weatherability as the retroreflective sheeting specified in ASTM D4956. Nonreflective, opaque, black film must be vinyl or acrylic material.

Film for letters and numerals must be computer cut and have pressure-sensitive adhesive.

82-5.02I–82-5.02L Reserved

82-5.03 CONSTRUCTION

Drive posts in place where soil conditions allow the driving without damage to the posts. Drill pilot holes if the ground conditions are such that the posts cannot be driven without being damaged.

Install target plates and marker panels after the posts are set in place.

After setting the posts, fill the space around them with rock-free earth. During placement, thoroughly tamp and water the fill material such that the post is held securely in position.

Unless surplus excavated material is hazardous, uniformly spread it along the adjacent roadway where designated by the Engineer.

Use stencils to paint letters and numerals on highway post markers.

Before Contract acceptance, spot paint all exposed areas where the paint is damaged and clean all exposed areas that are soiled.

82-5.04 PAYMENT

Not Used

82-6–82-8 RESERVED

82-9 EXISTING ROADSIDE SIGNS AND MARKERS

82-9.01 GENERAL

Section 82-9 includes specifications for performing work on existing roadside signs and markers.

Work performed on existing roadside signs and markers must comply with section 15.

82-9.02 MATERIALS

Not Used

82-9.03 CONSTRUCTION

82-9.03A General

Remove roadside signs only when replacement signs are installed or when the existing signs are no longer required for traffic. Reset or relocate each roadside sign the same day it is removed.

Single sheet aluminum signs to be salvaged must be banded on a pallet with a total weight of not more than 500 lb/pallet.

Reset or relocate roadside signs using existing posts.

If an existing post is deteriorated or broken, notify the Engineer. If ordered, use a new post.

Any new post and its installation, ordered for reasons other than damage you cause is change order work.

82-9.03B Installation of Sign Panels on Existing Frames

Install sign panels on existing frames with fastening hardware under section 82-2.03A.

82-9.03C Installation of Removable Sign Panel Frames

Install sign panels on removable sign panel frames with fastening hardware under section 82-3.02E.

82-9.03D Relocate Markers

Reserved

82-9.03E Reset Markers

Reserved

82-9.04 PAYMENT

Payment for furnishing sign panels of any type is not included in the payment for install sign panel on existing frame.

Remove sign panel and remove sign panel frame consisting of a single removable sign panel frame with attached sign panels is 1 measurement unit.

Payment for furnishing sign panels is not included in the payment for furnish removable sign panel frame with sign panels attached and install removable sign panel frame.

Each sign installation is 1 measurement unit, regardless of the number of posts or sign panels involved.

83 RAILINGS AND BARRIERS

83-1 GENERAL

83-1.01 GENERAL

Section 83-1 includes general specifications for constructing railings and barriers.

Excavation and backfill must comply with section 19.

83-1.02 MATERIALS

83-1.02A General

Reserved

83-1.02B Steel Parts and Hardware

Welding must comply with AWS D1.1. Grind welds on exposed surfaces flush with the adjacent surfaces.

Galvanize completed steel parts and hardware for railings and thrie beam barrier under section 75-1.02B.

After galvanizing, the railing and barrier elements must be free of fins, abrasions, rough or sharp edges, and other surface defects and must not be kinked, twisted, or bent. If straightening is necessary, use an authorized method. Elements with kinks, twists, or bends may be rejected.

Clean and regalvanize (1) abraded or damaged galvanized surfaces of steel rail elements and posts and (2) ends of steel rail elements cut after galvanizing. If authorized, you may repair the surfaces under section 75-1.02B instead of regalvanizing.

83-1.02C Mortar

Mortar must comply with the specifications for mortar in section 51-1, except the mortar must consist of 1 part by volume of cement and 3 parts by volume of clean sand.

83-1.02D Markers

Markers must comply with section 82.

83-1.03 CONSTRUCTION

83-1.03A General

At locations exposed to traffic, schedule construction activities such that at the end of each day no post holes are open and no posts are installed without the blocks and rail elements assembled and mounted.

After constructing railings, barriers, terminal systems, crash cushions, and vegetation control, uniformly spread the surplus excavated material along the adjacent roadway where designated by the Engineer unless the material is hazardous.

83-1.03B Mortar

Cure mortar by either the water method or the curing compound method using curing compound no. 6.

83-1.03C Median Barriers

Trim existing median plantings to clear the work area for median barrier construction. Dispose of the trimmings.

Do not remove an existing median barrier more than 500 feet in advance of the barrier being constructed.

At the end of each day's activities, reset the existing median barrier without mesh or glare screen and anchor the barrier in an authorized way such that no gap is left between the reset barrier and the barrier being constructed. You may place Type K temporary railing instead of resetting the existing barrier.

83-1.04 PAYMENT

Except for midwest guardrail system and double midwest guardrail system, the payment quantity for railings is the length measured along the face of the railing, including end and intermediate posts, with no deductions for gaps in the railing for lighting and sign supports.

83-2 METAL RAILINGS AND BARRIERS

83-2.01 GENERAL

83-2.01A General

83-2.01A(1) General

Section 83-2 includes specifications for constructing metal railings and barriers.

83-2.01A(2) Materials

Plastic blocks for midwest guardrail systems and thrie beam barrier must be on the Authorized Material List for highway safety features.

Grease used to coat the inside surfaces of foundation tubes to receive wood posts must not melt or run at a temperature of 149 degrees F.

83-2.01A(3) Construction

For midwest guardrail systems and thrie beam barrier, install posts, foundation tubes, and soil plates in soil.

83-2.01A(4) Payment

Not Used

83-2.01B Minor Concrete Vegetation Control

Reserved

83-2.02 MIDWEST GUARDRAIL SYSTEMS

83-2.02A General

83-2.02A(1) Summary

Section 83-2.02 includes specifications for constructing midwest guardrail systems.

The reinforcing steel in the concrete anchors for Type CA end anchor assemblies must comply with section 52.

83-2.02A(2) Definitions

Reserved

83-2.02A(3) Submittals

Submit 2 certified copies of mill test reports as an informational submittal for each heat of steel from which the rail elements and steel posts are formed or fabricated.

For end anchor assemblies and rail tensioning assemblies, submit:

1. 2 certified copies of the mill test reports for each manufactured length of cable used.
2. 1 sample of the cable for testing. The cable must be 39 inches in total length and must be properly fitted with a swaged fitting and right-hand thread stud at both ends as specified in section 83-2.02B(2), including a clevis if shown.

83-2.02A(4) Quality Assurance

Reserved

83-2.02B Materials

83-2.02B(1) General

83-2.02B(1)(a) General

Railing parts must be interchangeable with similar parts, regardless of the source.

83-2.02B(1)(b) Steel Components and Hardware

Workmanship for steel components and hardware must be equivalent to good commercial practice. Edges, bolt holes, and surfaces must be free of torn metal, burrs, sharp edges, and protrusions.

Fabricate the metal work in the shop. Do not punch, cut, or weld in the field.

Rail elements, end caps, and return caps must comply with AASHTO M 180 for Class A, Type I, W-beam guardrail, except within 0.5 miles of the coast the components must comply with AASHTO M 180 for Class A, Type II, W-beam guardrail.

Bolts, nuts, and other fittings must comply with AASHTO M 180.

Instead of the rolled steel section shown, you may substitute a welded section built up from structural steel plates if:

1. Depth, width, and average thicknesses of the welded section are at least equal to those of the rolled section
2. Steel plates of the welded section comply with ASTM A36/A36M
3. Flanges of the welded section are welded to the web with continuous fillet welds on each side of the web

The rail element metal must withstand a cold bend, without cracking, of 180 degrees around a mandrel of a diameter equal to 2.5 times the plate thickness.

If the radius of curvature of a rail element is 150 feet or less, shape the rail element in the shop. Stencil the radius of curvature on the back of each rail element in 2-1/2-inch-high numerals.

Fabricate steel posts from steel complying with ASTM A36/A36M.

Bolts must have shoulders of a shape that will prevent the bolts from turning. The holes in the rail elements must be of a shape similar to the bolt shoulder.

The bolted connection of the rail element to the post must withstand a 5,000 lb pull at 90 degrees to the line of the railing.

83-2.02B(1)(c) Wood Posts and Blocks

The grade and species of wood posts and blocks must be no. 1 timbers, also known as no. 1 structural, Douglas fir or no. 1 timbers Southern yellow pine. Wood posts and blocks must be graded under section 57-2.01B(2), except allowances for shrinkage after mill cutting must not exceed 5 percent of the American Softwood Lumber Standard, PS 20, minimum sizes when installed.

Wood posts and blocks must be rough or S4S. The size tolerance of rough sawn blocks in the direction of the bolt holes must not exceed ±1/4 inch.

After fabrication, the wood posts and blocks must be pressure treated under section 57-2.01 and AWPA U1, Use Category UC4A, Commodity Specification A.

83-2.02B(1)(d) Bolt Hole Grease

Grease used to fill bolt holes in wood posts and blocks must be recommended for corrosion protection by the manufacturer. The grease must not melt or run at a temperature of 149 degrees F.

83-2.02B(1)(e) Components for Connection to a Concrete Surface

Components for connecting midwest guardrail systems to vertical concrete surfaces, such as bridge railings, barriers, retaining walls, and abutments, must comply with the following requirements:

1. Metal box spacers and plate washers must be fabricated from steel complying with ASTM A36/A36M.
2. Metal box spacers must be fabricated from separate plates and welded or press-formed and welded.
3. HS bolts must comply with ASTM F3125, Grade A325/A325M, or ASTM A449, or be fabricated from steel rods complying with ASTM A449. The bolts or rods must comply with the mechanical requirements in ASTM F3125, Grade A325/A325M after galvanizing. The nuts and washers must comply with ASTM F3125, Grade A325/A325M.
4. For connecting guardrail to existing bridge railings or barriers, the epoxy adhesive used in the sand and the epoxy adhesive mixture for repairing spalled or damaged areas around the anchor bolt holes must be a 2-component, commercial-quality epoxy adhesive manufactured especially for making epoxy-sand mortar.

83-2.02B(2) End Anchor Assemblies and Rail Tensioning Assemblies

Section 83-2.02B(2) applies to end anchor assemblies and rail tensioning assemblies.

Concrete used to construct the anchors for end anchor assemblies must comply with the specifications for minor concrete.

Fabricate the metal components of anchor assemblies in compliance with good shop practice.

Fabricate the anchor plates, metal plates, foundation tubes, and soil plates from steel complying with ASTM A36/A36M.

Fabricate the anchor rods from steel complying with ASTM A36/A36M, ASTM A572, or ASTM A576, Grade 1018, 1019, 1021, or 1026. Hot forge the eyes or form the eyes with CJP welds. After fabricating and before galvanizing, thermally stress relieve anchor rods with eyes that were formed with any part of the eye below 1,600 degrees F during forming or with eyes that were closed by welding. The completed anchor rod after galvanizing must develop a strength of 50,000 lb.

Instead of using built-up fabrication, you may press-form the anchor plates from steel plate with or without welded seams.

Bolts and nuts must comply with ASTM A307.

Anchor cables must be 3/4-inch, preformed 6 x 19 wire strand core or independent wire rope core, galvanized under Federal Specification RR-W-410, right regular lay, manufactured from improved plow steel with a minimum breaking strength of 23 tons. The overall length of each cable anchor assembly must be at least 6.5 feet.

Use cable clips and a cable thimble to attach the cable to the anchor rod where shown. Thimbles must be commercial-quality, galvanized steel. Cable clips must be commercial-quality, drop-forged, galvanized steel.

Swaged fittings must be machined from hot-rolled steel bars complying with AISI C 1035 and annealed suitable for cold swaging. Galvanize the swaged fitting before swaging. To keep the stud in the proper position, drill a lock pin hole through the head of the swaged fitting and install a 1/4-inch plated steel spring pin. Stamp the manufacturer's identifying mark on the body of the swaged fitting.

Before galvanizing, mill a 3/8-inch slot in the stud end for the locking pin. Studs must comply with ASTM A449 after galvanizing.

The swaged fittings, stud, and nut assembly must develop the specified breaking strength of the cable.

Ship cable assemblies as a complete unit, including studs and nuts.

Clevises must be drop-forged galvanized steel and must develop the specified breaking strength of the cable.

For anchor rods to be buried in earth, coat the portions to be buried with a 20-mil minimum thickness of one of the following:

1. Coal tar enamel complying with AWWA C 203
2. Coal tar epoxy complying with either of the following:
   2.1. SSPC-Paint 16, Coal Tar Epoxy-Polyamide Black Paint
   2.2. U.S. Army Corps of Engineers Specifications, Formula C-200a, Coal Tar-Epoxy (Black) Paint

83-2.02B(3) Type WB-31 Transition Railings

Section 83-2.02B(3) applies to Type WB-31 transition railings.

Ten-gauge rail elements must comply with AASHTO M 180 for Class B, Type I, thrie beam element, except within 0.5 miles of the coast the 10-gauge rail elements must comply with AASHTO M 180 for Class B, Type II, thrie beam element.

Other rail elements and end caps must comply with AASHTO M 180 for Class A, Type I, thrie beam element, except within 0.5 miles of the coast the rail elements and end caps must comply with AASHTO M 180 for Class A, Type II, thrie beam element.

83-2.02C Construction

83-2.02C(1) General

83-2.02C(1)(a) General

At locations where traffic is adjacent to midwest guardrail system work, all materials required to complete the guardrail work at a location must be available before you start work at the location.

Construct midwest guardrail systems using:

1. Wood or steel line posts.
2. Wood blocks for line posts. You may use plastic blocks for steel line posts where shown.
3. Only 1 type of post and block for any 1 continuous length of guardrail.

83-2.02C(1)(b) Posts

Place the posts at equal intervals, except you may space the end posts closer to the adjacent posts if authorized.

Drive wood posts with or without pilot holes, or place the posts in drilled holes. Backfill any space around the wood posts with selected earth that is free of rock. Place the earth in 4-inch-thick layers. Moisten and thoroughly compact each layer.

Drive steel posts with or without pilot holes. If pilot holes are used, backfill any space around the steel posts with dry sand or pea gravel after driving.

Drive steel foundation tubes with soil plates attached with or without pilot holes, or place them in drilled holes. Backfill any space around the foundation tubes with selected earth that is free of rock. Place the earth in 4-inch-thick layers. Moisten and thoroughly compact each layer. Coat the inside surfaces of the foundation tubes to receive wood terminal posts with grease. Insert the posts into the tubes by hand. Do not drive the posts. You may slightly round the post edges to facilitate insertion.

83-2.02C(1)(c) Bolt Holes and Cuts in Wood Posts and Blocks

If copper naphthenate, ammoniacal copper arsenate, ammoniacal copper zinc arsenate, ammoniacal copper quat, or copper azole is used to treat wood posts and blocks, before inserting the bolts, fill the bolt holes with grease.

You may field bore the 2-3/8-inch-diameter holes shown for breakaway wood guardrail terminal posts.

If you perform field cutting or boring after treatment, thoroughly swab, spray, or brush the cuts and holes with 2 applications of the same type of preservative as initially used or treat the cuts and holes with copper naphthenate under AWPA Standard M4. Preservative application in the field must comply with the 1st and 2nd paragraphs of section 57-2.01C(3)(b).

83-2.02C(1)(d) Rail Elements

The edges and center of the rail elements must contact each post block.

Splice the rail elements at 12.5-foot maximum intervals. Locate the splices at midspan between posts.

Rail element splices must be lapped at least 12-1/2 inches and bolted.

Lap the rail elements such that the exposed ends do not face approaching traffic.

The rail elements must have full bearing at joints.

Install end caps and return caps under the manufacturer's instructions.

83-2.02C(1)(e) Connection to a Concrete Bridge Railing or Barrier

If connecting a midwest guardrail system to a new concrete bridge railing or barrier, drill anchor bolt holes in the concrete or form holes using metal or PVC sleeves.

If connecting a midwest guardrail system to an existing concrete bridge railing or barrier, drill anchor bolt holes in the concrete.

Repair any areas around the holes that were spalled or otherwise damaged during drilling using an epoxy adhesive and sand mixture in proportions of 1:4 to 1:6. The epoxy adhesive must comply with section 83-2.02B(1)(e). Mix the 2 components and the epoxy-sand mixture under the manufacturer's instructions.

83-2.02C(1)(f) Anchor Bolts Set With Epoxy

For anchor bolts set with epoxy, place the anchor bolts in holes filled with a 2-component epoxy mixture complying with the specifications for load bearing applications.

83-2.02C(2) End Anchor Assemblies

Place the concrete for end anchors for Type CA end anchor assemblies against the undisturbed material of the excavated holes. If ordered, form the top 12 inches of the holes.

Tighten the anchor cables for Type CA end anchor assemblies after the concrete anchor has cured for at least 5 days.

Backfill the holes excavated in the slope to construct buried post end anchors with selected earth. Place the earth in layers approximately 1 foot thick. Moisten and thoroughly compact each layer.

83-2.02C(3) Type WB-31 Transition Railings

Reserved

83-2.02D Payment

Except for midwest guardrail systems located within the pay limits of (1) a terminal system, (2) a transition railing, (3) an end anchor assembly, or (4) a railing tensioning assembly, the payment quantity for midwest guardrail system is the length measured along the face of the rail element from end post to end post of the completed railing and includes buried post anchors. The point of measurement at the end post is the center of the bolt attaching the rail element to the end post. If midwest guardrail system is connected to a structure, barrier, wall, or abutment, the point of measurement is the midpoint between the 2 bolts attaching the rail element to the structure, barrier, wall, or abutment.

The payment quantity for double midwest guardrail system is the length measured from end post to end post along the center line of the guardrail.

An end anchor assembly (Type CA) with 2 cables attached to 1 concrete anchor is 1 measurement unit.

83-2.03 THRIE BEAM BARRIERS

83-2.03A General

Section 83-2.03 includes specifications for constructing thrie beam barrier.

Thrie beam barrier must comply with the specifications for midwest guardrail systems in section 83-2.02.

Single thrie beam barrier work includes transition sections between W beam and thrie beam elements.

83-2.03B Materials

Rail elements, terminal connectors, end caps, and return caps must comply with AASHTO M 180 for Class A, Type I, thrie beam guardrail, except within 0.5 miles of the coast the components must comply with AASHTO M 180 for Class A, Type II, thrie beam guardrail.

Ten-gauge rail elements for transition railings must comply with AASHTO M 180 for Class B, Type I, thrie beam element, except within 0.5 miles of the coast the 10-gauge rail elements must comply with AASHTO M 180 for Class B, Type II, thrie beam element.

Other rail elements and end caps for transition railings must comply with AASHTO M 180 for Class A, Type I, thrie beam element, except within 0.5 miles of the coast the rail elements and end caps must comply with AASHTO M 180 for Class A, Type II, thrie beam element.

Use steel posts for thrie beam barrier on bridges. Use wood posts for approach barrier transitions to connect to concrete structures and for posts set in steel foundation tubes at trailing end anchors. At all other locations, use either wood or steel posts. Use only 1 type of post in any 1 continuous length of barrier.

Use wood blocks with wood and steel posts. You may use plastic blocks with steel posts where shown.

For thrie beam barrier on bridges:

1. Threaded rods must comply with ASTM A307
2. Anchor bolts must comply with ASTM F1554, Grade 55
3. Plates must comply with section 55

83-2.03C Construction

Toenailing wood blocks to wood posts is not required.

If the spacing between the posts must be varied from the standard spacing, you may modify the rail elements at the job site if authorized. Repair damaged galvanizing under section 75-1.02B.

For thrie beam barrier on bridges:

1. If cored or drilled holes for anchor bolts must be offset to avoid existing main reinforcing steel, the corresponding base plate anchor bolt holes may be slotted to adjust to the new anchor bolt locations. Slotting must not reduce the edge distance of the hole to less than 7/8 inch.
2. Drilling of anchor bolt holes and bonding of bolts must comply with the specifications for drilling and bonding dowels in section 51-1.03E(3).

If median barrier delineation is shown, match the barrier marker spacing to the raised pavement marker spacing on the adjacent median edgeline pavement delineation.

83-2.03D Payment

The payment quantity for single thrie beam barrier is the length measured from end post to end post along the face of the rail element of the installed barrier. The quantity does not include any portion of single thrie beam barrier within the pay limits of transition railing (Type STB).

The payment quantity for single thrie beam barrier constructed on each side of a bent underneath a structure or on each side of other obstructions is the length measured along each face of the installed barriers.

The payment quantity for double thrie beam barrier is the length measured from end post to end post along the center line of the installed barrier. The quantity does not include any portion of double thrie beam barrier within the pay limits of transition railing (Type DTB).

The point of measurement at the end posts of single and double thrie beam barriers is the center of the bolt or rod attaching the rail element to the end post.

If a single thrie beam barrier is constructed on each side of a median obstruction and the single barriers merge into a double barrier, the post with 2 blocks attached is the end post for measuring the length of the single and double thrie beam barriers.

The division point for determining the payment quantities of double thrie beam barrier (bridge) and double thrie beam barrier is the face of the paving notch of the bridge.

83-2.04 TERMINAL SYSTEMS

83-2.04A General

83-2.04A(1) General

Section 83-2.04 includes specifications for constructing terminal systems.

83-2.04A(2) Materials

Not Used

83-2.04A(3) Construction

Not Used

83-2.04A(4) Payment

Not Used

83-2.04B Alternative In-Line Terminal Systems

Reserved

83-2.04C Alternative Flared Terminal Systems

Reserved

83-2.04D–83-2.04H Reserved

83-2.05 CALIFORNIA BRIDGE RAILS

83-2.05A General

83-2.05A(1) Summary

Section 83-2.05 includes specifications for constructing California bridge rail.

Concrete must comply with section 51.

Reinforcement must comply with section 52.

California ST-20S bridge rail work includes the handrailing.

83-2.05A(2) Definitions

Reserved

83-2.05A(3) Submittals

Submit shop drawings for the California bridge rail. The shop drawings must include:

1. Details for venting and pickup holes in rails and sleeves
2. Railing layout
3. Complete details for the construction of the work, including construction methods, sequence of shop and field assembly, and installation procedures

Submit 7 copies of the shop drawings. Allow 25 days for review. Upon authorization, the Engineer returns 2 copies to you for use during construction.

83-2.05A(4) Quality Assurance

Reserved

83-2.05B Materials

83-2.05B(1) General

Reserved

83-2.05B(2) Reinforced Concrete

In freeze-thaw areas:

1. Concrete must contain at least 675 pounds of cementitious material per cubic yard
2. Bar reinforcing steel must comply with section 52-2.02

83-2.05B(3) Metal Components

Structural shapes, structural tubing, plates, bars, bolts, nuts, and washers must comply with section 55-1.02. Other fittings must be commercial quality.

Formed steel sections must be uniform in appearance.

Stud bolts must comply with the specifications for studs in clause 7 of AWS D1.1.

Ferrous metal parts must be galvanized under section 75-1.02B.

Railings must conform to the curvature by means of a series of short chords, from center-to-center of rail posts, except (1) tubing for railings described as conforming to the curvature must be shop bent to fit the curvature and (2) tubing with a horizontal curve radius less than 900 feet must be shop bent or fabricated to fit the curvature. Joints must be matchmarked.

83-2.05B(4) Coatings

Organic zinc-rich primer used to paint the exposed bolt threads must be on the Authorized Material List for organic zinc-rich primers.

83-2.05C Construction

Railings must present a smooth, uniform appearance in their final position, conforming closely to the horizontal and vertical lines shown or ordered.

Erect railings carefully and true to line and grade. Posts must be normal to the profile grade. Transverse to the profile grade, railings must be plumb within a tolerance not to exceed 0.02 foot in 10 feet. Adjacent rail elements must align with each other within 1/16 inch.

In freeze-thaw areas, cure concrete by the water method.

After installing the rail, paint the exposed bolt threads with 2 applications of organic zinc-rich primer.

83-2.05D Payment

The payment quantity for California bridge rail is the length measured from end to end along the face of the railing, including reinforced concrete end blocks and intermediate posts.

83-2.06 CHAIN LINK RAILINGS

83-2.06A General

Section 83-2.06 includes specifications for constructing chain link railings.

83-2.06B Materials

Structural shapes, plates, bars, and bolts must comply with section 55-1.02.

Structural tubing steel must comply with ASTM A500/A500M or A501.

Frame members carrying electrical conductors must be rigid metal conduit manufactured of mild steel complying with UL 6, Electrical Rigid Metal Conduit - Steel. Hot dip galvanize the interior and exterior surfaces of the rigid metal conduit.

Truss rods, post tops, and other required fittings and hardware must be steel, malleable iron, or wrought iron. Post tops and other closures must be watertight. Fittings and hardware must fasten properly to the posts and other members.

Cable used in the frame must:

1. Be wire rope
2. Be 5/16 inch in diameter
3. Have a minimum breaking strength of 5,000 lb
4. Be galvanized under Federal Specification RR-W-410

Crimped sleeve clamps and stud socket assemblies must:

1. Be metal
2. Develop the strength of the cable
3. Be the same color as the cable

Tension wires must be at least 7-gauge coil spring steel.

Post clips must be at least 9-gauge steel.

Wire ties or hog rings must be 9-gauge, commercial-quality steel wire.

Galvanize the tension wires, post clips, wire ties, and hog rings under ASTM A116, Coating Type Z, Class 3.

You may substitute one of the following for the steel wire ties or hog rings:

1. 6-gauge (0.192-inch minimum diameter) aluminum wire ties complying with ASTM B211 or B211M, Alloy 1100-H18

2. 6-gauge (0.192-inch minimum diameter) aluminum hog rings complying with ASTM B211 or B211M, Alloy 6061-T94 or Alloy 5052-H38

Chain link fabric must be 11 gauge and must comply with one of the following:

1. AASHTO M 181, Type I, Class C
2. AASHTO M 181, Type IV, Class A
3. ASTM F1345, Class 2

Chain link fabric must be woven into approximately 1-inch mesh.

All of the railings for a single structure must be the same color.

83-2.06C Construction

Give wire ties at least 1 complete turn. Bend the wire tie ends away from pedestrian traffic.

Tighten truss rods and cables with turnbuckles or other fittings.

Install a thimble at each cable loop.

Stretch and fasten the chain link fabric securely to the posts, other members, and tension wires. Stretch the tension wires tightly.

Wherever necessary to conform to horizontal or vertical curvature, rework and fit the fabric to present a smooth, neat, and workmanlike appearance.

Provide openings in the fabric as required by other facilities. Reinforce the openings with at least 1 turn of 6-gauge wire.

Attach pipe handrailing to chain link railing where shown. Pipe handrailing must comply with section 83-2.09.

83-2.06D Payment

Not Used

83-2.07 CABLE RAILINGS

83-2.07A General

Section 83-2.07 includes specifications for constructing cable railings.

83-2.07B Materials

Concrete for the post footings must comply with the specifications for minor concrete.

Pipe for posts and braces must be standard steel pipe or pipe complying with section 80-3.02B.

Truss rods, post tops, cable clamps, eye bolts, thimbles, and other required fittings must be commercial-quality steel, malleable iron, or wrought iron. Post tops must be watertight. The eye of the eye bolts must be either drop forged or formed with a complete penetration weld. The eye must develop 100 percent of the bolt strength.

Turnbuckles must:

1. Be commercial quality
2. Have jaw or eye ends
3. Have a minimum breaking strength of 2,700 lb
4. Be steel pipe type or drop-forged steel

Crimped sleeve clamps and stop sleeve clamps must:

1. Be nonferrous metal
2. Develop the strength of the cable
3. Be the same color as the cable

Cables must:

1. Be wire strand or rope
2. Have a minimum diameter of 1/4 inch
3. Have a minimum breaking strength of 1,800 lb
4. Be galvanized under Federal Specification RR-W-410

83-2.07C Construction

Tension the cables to provide taut railings between posts.

Install a thimble at each cable loop.

83-2.07D Payment

Not Used

83-2.08 TUBULAR HANDRAILINGS

83-2.08A General

Section 83-2.08 includes specifications for constructing tubular handrailings.

83-2.08B Materials

The materials for tubular handrailing components must comply with the specifications shown in the following table:

Material	Specification
Rail and post tubes	ASTM A500/A500M, Grade B
Rolled bars and plates	ASTM A36/A36M
Rail splice sleeves	ASTM A36/A36M
Bolts	ASTM F3125, Grade A325/A325M
Threaded rods	ASTM A449
Nuts for bolts and threaded rods	ASTM A563/A563M
Washers for bolts and threaded rods	ASTM F436/F436M

Bolts and threaded rods furnished under ASTM A449 must comply with the mechanical requirements specified in ASTM A449 after galvanizing.

Rail tubes must be shop bent or fabricated to fit the horizontal curve if the radius is less than 900 feet.

If the vertical radius of the tubular handrailing is 30 feet or less, that portion of the railing must be either shop bent or built up from 1/4-inch-thick structural steel plates. The built-up tubular rail elements must match the seamless tubing in appearance.

The difference between out-to-out rail splice sleeve dimensions and the clear inside dimensions of the tubular steel rail elements must not exceed 3/16 inch after galvanizing.

83-2.08C Construction

Tubular handrailings must present a smooth, uniform appearance in their final position, conforming closely to the horizontal and vertical lines shown or ordered.

Before the tubular handrailing parts are assembled, clean the bearing surfaces and surfaces to be in permanent contact. If the railing is mounted on a concrete surface, the post bases must be true and flat to provide uniform bearing.

Carefully handle the materials such that no parts are bent, broken, abraded, or otherwise damaged. Do not use manufacturing, handling, or installation methods that damage or distort the members or damage the galvanizing.

Adjust the vertical position of the tubular handrailing to compensate for the camber and dead load deflection of the superstructure. The Engineer determines the adjustment amount before the railing is installed.

The metal railing posts to which the chain link railing attaches must fit the mounting brackets, pipe sleeves, and other connection fittings.

Where necessary, install shims at posts and rail elements to provide uniform bearing and conformance with the horizontal lines and vertical grade lines. Shims at steel posts must be commercial-quality, galvanized sheet steel.

83-2.08D Payment

Not Used

83-2.09 PIPE HANDRAILINGS

83-2.09A General

Section 83-2.09 includes specifications for constructing pipe handrailings.

83-2.09B Materials

Rail elements must be commercial-quality standard steel pipe.

Brackets, bolts, nuts, and other fittings must be commercial-quality structural steel, except standard steel pipe fittings may be used where shown.

83-2.09C Construction

Erect pipe handrailings carefully and true to line and grade.

83-2.09D Payment

Not Used

83-2.10–83-2.14 RESERVED

83-3 CONCRETE BARRIERS

83-3.01 GENERAL

83-3.01A Summary

Section 83-3 includes specifications for constructing concrete barriers and wildlife passage ways in concrete barriers.

Concrete must comply with section 51.

Reinforcement must comply with section 52.

Drill and bond dowels under section 51.

Concrete barrier work includes:

1. Bar reinforcing steel, including the length that extends from the barrier into decks, walls, and footings
2. Constructing Type L wildlife passage ways
3. Constructing steel plate barriers at overhead sign foundations, electroliers, drainage structures, and other locations shown

For Type 80SW concrete barriers:

1. Tubular handrailing and tubular lower rail must comply with the specifications for tubular handrailings in section 83-2.08
2. Threaded rods for the tubular handrailing and resin capsule anchors for the tubular lower rail must comply with section 75-3

Type K concrete barrier must comply with the specifications for Type K temporary railing in section 12-3.20 and the plans for Type K temporary railing, except removable panels must not be used and the barriers must remain in place at the completion of the work.

Thrie beam barrier elements, end caps, and hardware required to construct Type M wildlife passage ways must comply with section 83-2.03.

83-3.01B Definitions

Reserved

83-3.01C Submittals

If the extrusion or slip form method is to be used and the reinforcement is not fixed in place before placing the concrete, submit a QC plan for the extrusion or slip form construction method. The QC plan must include:

1. Contingency plan for correcting problems in production, transportation, or placement
2. Procedure for splicing concrete barrier reinforcement
3. Procedure for positioning reinforcement during extrusion or slip form operations
4. Test procedure for verifying the final positions of the longitudinal reinforcement
5. Test report form to be used that shows the station of the test, the position of the reinforcement relative to the top of the barrier, and the clearance cover from the faces of the barrier to the reinforcement

Submit the test report forms within 48 hours after constructing the concrete barrier.

Submit a certificate of compliance for a new or used Type 60K portable concrete barrier that is not cast on the job site.

For the tubular handrailing on a Type 80SW concrete barrier, submit 2 copies of the threaded rod layouts before placing the barrier reinforcement.

83-3.01D Quality Assurance

83-3.01D(1) General

Reserved

83-3.01D(2) Quality Control

83-3.01D(2)(a) General

Reserved

83-3.01D(2)(b) Barrier Smoothness

Test the smoothness of the top and exposed faces of barriers using a 10-foot straightedge laid on the surfaces.

83-3.01D(2)(c) Barrier Reinforcement Positions

For the extrusion or slip form construction method, if the reinforcement is not fixed in place before placing the concrete, verify the final positions of the horizontal reinforcement at 100-foot intervals, evaluated a minimum of 20 feet behind the trailing extrusion or slip form edge, by testing the position of the reinforcement relative to the top of the barrier and the clearance cover from the faces of the barrier to the reinforcement.

83-3.01D(3) Department Acceptance

The Department rejects concrete barriers with any reinforcement that does not comply with section 83-3.03A(6)(c)(iii).

83-3.02 MATERIALS

83-3.02A General

Reserved

83-3.02B Concrete

83-3.02B(1) General

Concrete for Type 60 series concrete barriers must comply with the specifications for minor concrete, except the concrete must contain at least 550 pounds of cementitious material per cubic yard.

In non-freeze-thaw areas, concrete for concrete barriers other than Type 60 series must contain at least 590 pounds of cementitious material per cubic yard.

In freeze-thaw areas, concrete for concrete barriers must contain at least 675 pounds of cementitious material per cubic yard.

For Type 60F, 60GE, and 60SF concrete barriers, the concrete paving between the tops of the 2 walls of the barrier and the optional concrete slab at the base between the 2 walls of the barrier must comply with the specifications for minor concrete.

83-3.02B(2) Concrete for Extrusion or Slip form Methods

Minor concrete for extruded or slip formed concrete barriers must comply with the following:

1. Maximum aggregate size must be no larger than 1-1/2 inches and no smaller than 3/8 inch.
2. If the 3/8-inch maximum size aggregate is used, the concrete must contain at least 675 pounds of cementitious material per cubic yard.
3. Combined aggregate gradation must produce concrete of the shape and surface texture specified.
4. Consistency must be such that after extrusion or slip forming, the concrete maintains the shape of the barrier without support.

You may make the concrete by continuously batching the materials by volume and mixing in a continuous mixer under the batching and mixing requirements in ASTM C685/C685M.

83-3.02C Bar Reinforcing Steel

In freeze-thaw areas, bar reinforcing steel for concrete barriers must be epoxy coated under section 52-2.02.

83-3.02D Steel Plates and Hardware

Structural steel plates and hardware required to join the concrete barrier at gaps caused by overhead sign foundations, electroliers, drainage structures, and at other locations shown must comply with section 75-3.02A.

83-3.02E Granular Backfill

For Type 60F, 60GE, and 60SF concrete barriers, the granular material for backfill between the 2 walls of concrete barrier must:

1. Be earthy material suitable for the purpose intended
2. Have no rocks, lumps, or clods exceeding 1-1/2 inches in greatest dimension

83-3.02F Type K Concrete Barrier Reflectors

Type K concrete barrier reflectors must be Type K temporary railing reflectors on the Authorized Material List for signing and delineation materials.

The adhesive used to mount reflectors on a Type K concrete barrier must comply with the manufacturer's instructions.

83-3.02G Connection of a Concrete Barrier to a Structure

Sheet metal, neoprene strip, and grease at the connection of a concrete barrier to a structure must comply with the following:

1. Sheet metal must be commercial-quality galvanized sheet steel that is smooth and free of kinks, bends, or burrs. Joints in the sheet metal must be butt joints sealed with plastic duct-sealing tape.
2. Neoprene strip must comply with the specifications for neoprene in section 51-2.04.
3. Grease must comply with SAE AS8660.

Expanded polystyrene at the connection of a concrete barrier to a structure and at a concrete barrier transition at a bridge column must comply with section 51-2.01B(1).

83-3.02H Type 60K Portable Concrete Barriers

Type 60K portable concrete barrier must consist of interconnected new or undamaged used PC portable concrete barrier units.

For Type 60K portable concrete barrier:

1. Concrete must comply with the specifications for minor concrete, except weighmaster certificates and certificates of compliance are not required.
2. Steel plates must comply with ASTM A36/A36M. After fabrication, galvanize the steel plates under section 75-1.02B.
3. Connection pins must be round bars complying with ASTM A36/A36M.

83-3.03 CONSTRUCTION

83-3.03A General

83-3.03A(1) General

Reserved

83-3.03A(2) Closing Gaps in Concrete Barriers

During construction on highways open to traffic, if a gap is left in the concrete barrier, such as for equipment or special drainage features, close the gap by temporary or permanent means when work is not actively in progress at the location of the gap.

83-3.03A(3) Adjusting Barrier Height

If the concrete barrier height is adjusted, the Engineer determines the adjustment amount before the concrete is placed.

If a concrete barrier is constructed on AB, adjust the barrier height to compensate for irregularities in the surface of the finished AB.

For a concrete barrier constructed on a recently completed bridge, adjust the barrier height to compensate for the camber and dead load deflection of the superstructure. Construct the barrier after the falsework has been released and as long after the superstructure construction as the progress of the work will allow.

For a concrete barrier constructed on existing pavement or on an existing structure, adjust the barrier height to compensate for irregularities in the existing grade.

83-3.03A(4) Locating Expansion Joints

Locate concrete barrier expansion joints at deck, pavement, and principal wall joints. The expansion joint filler material must be the same size as the joint or a minimum of 1/2 inch.

83-3.03A(5) Placing Barriers

The concrete barrier must present a smooth, uniform appearance in its final position, conforming closely to the horizontal and vertical lines shown or ordered. The barrier must be free of lumps, sags, or other irregularities.

You may place the portion of the barrier that is below finished grade to the neat lines of the excavation.

83-3.03A(6) Barrier Construction Methods

83-3.03A(6)(a) General

Construct Type 60 series concrete barriers by one of the following methods:

1. Cast-in-place-with-fixed-forms method
2. Extrusion or slip form method
3. Combination of both methods

Construct concrete barriers other than Type 60 series by the cast-in-place-with-fixed-forms method.

83-3.03A(6)(b) Cast-In-Place-with-Fixed-Forms Method

Concrete barriers constructed by the cast-in-place-with-fixed-forms method must comply with section 51.

Do not use PC mortar blocks to support the reinforcing steel on the traffic side of barriers.

83-3.03A(6)(c) Extrusion or Slip form Method

83-3.03A(6)(c)(i) General

Reserved

83-3.03A(6)(c)(ii) Placing Concrete

For concrete barriers constructed using an extrusion or slip form machine or other similar type of equipment, the concrete must be well compacted and dense and the exposed surfaces must comply with section 51. You may be required to submit evidence of successful operation of the extrusion or slip form machine or other equipment.

Feed the concrete to the extrusion or slip form machine at a uniform rate. Operate the machine under enough uniform restraint to the forward motion to produce a well-compacted concrete mass free from surface pits larger than 1 inch in diameter and requiring no further finishing other than that specified in section 83-3.03A(7).

83-3.03A(6)(c)(iii) Placing Reinforcing Bars

For concrete barriers constructed using extrusion or slip form methods, place the horizontal reinforcing bars continuously.

If the reinforcement is not fixed in place before placing the concrete, the reinforcement must not deviate more than 1 inch from the positions shown when tested under section 83-3.01D(2)(c).

83-3.03A(6)(c)(iv) Maintaining Barrier Grades

The grade for the top of concrete barriers constructed using extrusion or slip form methods must be indicated by an offset guide line set from survey marks established by the Engineer. The forming portion of the extrusion or slip form machine must be readily adjustable vertically during the forward motion of the machine to conform to the predetermined grade line. A grade line gauge or pointer must be attached to the machine such that a continual comparison can be made between the barrier being placed and the established grade line as indicated by the offset guide line.

Instead of the above method for maintaining the barrier grade, the extrusion or slip form machine may be operated on rails or forms set at a uniform depth below the predetermined finished top of the barrier grade or on existing pavement or bridge decks.

83-3.03A(6)(c)(v) Constructing Expansion Joints

For concrete barriers constructed using extrusion or slip forming methods, construct expansion joints using one of the following methods:

1. Comply with section 51.
2. Saw through the barrier section to its full depth. Insertion of joint filler is not required.

If you saw or form the joints before the concrete has hardened, firmly support the adjacent portions of the barrier with close fitting shields.

If you saw or form the joints after applying curing compound, treat the exposed barrier faces in the vicinity of the joint with curing compound after sawing or forming the joints.

83-3.03A(7) Finishing

Before applying the curing compound, the surface finish of Type 60 series concrete barriers must be free from surface pits larger than 1 inch in diameter and you must give the surface a final soft brush finish with strokes parallel to the line of the barriers. Do not finish the surface with a brush application of grout.

To facilitate finishing, remove fixed forms for CIP Type 60 series concrete barriers as soon as possible after the concrete has set enough to maintain the barrier shape without support.

At least 7 days after placing Type 60 series concrete barriers, give the exposed surfaces a light abrasive blast finish to achieve a uniform appearance.

The final surface finish of concrete barriers other than Type 60 series must be a Class 1 surface finish complying with section 51-1.03F(3). Any alternative method of final surface finishing must be authorized.

83-3.03A(8) Curing

Cure the exposed surfaces of concrete barriers under section 90-1.03B by the curing compound method using curing compound no. 6. For concrete barriers on bridges and walls that do not support soundwalls,

you may instead cure the formed surfaces of the barriers by the forms-in-place method if you keep the forms in place for at least 12 hours after placing the concrete.

For Type 60 series concrete barriers, apply the curing compound using a mechanical sprayer capable of applying the curing compound to at least 1 entire side and the top of the concrete barrier in 1 application at a uniform rate of coverage. Protect the spray against wind.

In freeze-thaw areas, cure concrete barriers on bridges and walls under section 90-1.03B by the water method.

For Type 80 series concrete barriers, keep the forms in place for at least 36 hours after placing the concrete.

83-3.03A(9) Smoothness

The top and exposed faces of barriers must comply with the following smoothness requirements when tested under section 83-3.01D(2)(b):

1. For Type 60 series concrete barriers, the top must not vary more than 0.02 foot from the edge of the straightedge and the faces must not vary more than 0.04 foot from the edge of the straightedge.
2. For concrete barriers other than Type 60 series, both the top and faces must not vary more than 0.02 foot from the edge of the straightedge.

83-3.03A(10) Installing Tubular Handrailings

For a tubular handrailing mounted on a Type 80SW concrete barrier, drill and bond the threaded rods under the specifications for drilling and bonding dowels in section 51-1.

83-3.03A(11) Installing Barrier Markers

Where concrete barrier markers are shown, cement the markers to the barrier under the manufacturer's instructions. Match the barrier marker spacing to the raised pavement marker spacing on the adjacent median edgeline pavement delineation.

83-3.03A(12) Installing Reflectors

Where shown, install reflectors on Type K concrete barriers. Mount the reflectors using an adhesive complying with section 83-3.02F.

83-3.03A(13) Placing Granular Backfill

For Type 60F, 60GE, and 60SF concrete barriers, place the granular material for backfill between the 2 walls of the concrete barrier must be placed without compaction.

83-3.03B Concrete Barriers at Existing Structures

For a concrete barrier constructed on an existing structure, bond the dowels in drilled holes in the existing concrete.

For a concrete barrier constructed to the face of an existing concrete structure, match the existing weep holes.

83-3.03C Connection of a Concrete Barrier to a Structure

At the connection of a concrete barrier to a structure, apply a uniform film of grease to the upper surface of the neoprene strip before placing the sheet metal.

83-3.03D Concrete Barrier Transitions

For a concrete barrier transition:

1. Remove portions of the existing concrete barrier where shown
2. Roughen the contact surfaces of the existing concrete barrier
3. Drill and bond dowels into the existing concrete barrier

83-3.03E Type 60K Portable Concrete Barriers

Set Type 60K portable concrete barriers on a firm, stable foundation. Grade the foundation to provide uniform bearing throughout the entire barrier length.

Place and maintain the abutting ends of the PC concrete units in alignment without substantial offset to each other. Position the PC concrete units straight on tangent alignments and on a true arc on curved alignments. The minimum curve radius for horizontal alignments is 164 feet.

The final surface finish of Type 60K portable concrete barriers must comply with section 51-1.03F(2).

Place the fabrication date and your name or logo on each panel. The fabrication date and name or logo must be 4 inches or less in height and must be located 12 inches or less above the bottom of the rail panel.

Cure the exposed surfaces of concrete elements by the water method, the forms-in-place method, or the curing compound method. Curing compound must be curing compound no. 1.

83-3.03F Wildlife Passage Ways

Construct wildlife passage ways in concrete barriers where shown.

Construct the passage way opening by forming the opening in the concrete barrier or, after the concrete barrier is constructed, by saw cutting the outline of the opening and removing the concrete and bar reinforcing steel within the limits of the opening.

The completed opening for the wildlife passage way must be clear and unobstructed for the dimensions shown.

For a Type M wildlife passage way, you may be required to remove concrete barrier. Before removing the concrete barrier, make a saw cut of approximately 1 inch in depth on the face of the barrier along the removal limits.

83-3.04 PAYMENT

The payment quantity for concrete barriers other than Types 60F, 60GE, and 60SF is the length measured along the top of the barrier.

The payment quantity for Type 60F, 60GE, and 60SF concrete barriers is the length measured once along the centerline between the 2 walls of the barrier.

The payment quantity for concrete barriers includes the length of gaps in the concrete barrier where steel plate barrier is attached to the concrete barrier.

83-4 CRASH CUSHIONS

83-4.01 GENERAL

83-4.01A General

Section 83-4 includes specifications for constructing crash cushions.

83-4.01B Materials

Not Used

83-4.01C Construction

Not Used

83-4.01D Payment

Not Used

83-4.02–83-4.10 RESERVED

83-5–83-10 RESERVED

83-11 EXISTING RAILINGS AND BARRIERS

83-11.01 GENERAL

83-11.01A General

Section 83-11 includes specifications for performing work on existing railings, barriers, terminal systems, and crash cushions.

Work performed on existing railings, barriers, terminal systems, and crash cushions must comply with section 15.

83-11.01B Materials

Concrete must comply with the specifications for minor concrete.

Reinforcement must comply with section 52.

83-11.01C Construction

If a portion of a guardrail or thrie beam barrier is to remain in place, removing, salvaging, reconstructing, relocating, or resetting work includes:

1. Resetting end caps, return caps, and buried post anchors
2. Providing connections to existing and new facilities, including connections to concrete

83-11.01D Payment

The payment quantities for removing, salvaging, reconstructing, relocating, and resetting existing railings and barriers are measured as specified for measuring new railings and barriers.

83-11.02 EXISTING GUARDRAILS

83-11.02A General

83-11.02A(1) General

Section 83-11.02 includes specifications for performing work on existing guardrail.

83-11.02A(2) Materials

Not Used

83-11.02A(3) Construction

Not Used

83-11.02A(4) Payment

Not Used

83-11.02B Remove Guardrails

83-11.02B(1) General

Section 83-11.02B includes specifications for removing guardrail.

83-11.02B(2) Materials

Not Used

83-11.02B(3) Construction

Where removing guardrail, remove any concrete anchors and steel foundation tubes.

83-11.02B(4) Payment

Not Used

83-11.02C Salvage Guardrails

83-11.02C(1) General

Section 83-11.02C includes specifications for salvaging guardrail.

83-11.02C(2) Materials

Not Used

83-11.02C(3) Construction

Remove, disassemble, clean, prepare, mark, bundle, package, tag, haul, and stockpile the guardrail to be salvaged.

Comply with the requirements for number per bundle for the guardrail components shown in the following table:

Component	Number per bundle
Rail	25
Wood posts, 6 by 8 inches	30
Wood posts, 10 by 10 inches	20
Steel posts	10
Blocks	50

Tag incomplete bundles and show the quantity contained.

83-11.02C(4) Payment

Not Used

83-11.02D Reconstruct Guardrails

Reserved

83-11.02E Adjust Guardrails

Reserved

83-11.02F–83-11.02J Reserved

83-11.03 EXISTING METAL BRIDGE RAILINGS

83-11.03A General

83-11.03A(1) General

Section 83-11.03 includes specifications for performing work on existing metal bridge railings.

83-11.03A(2) Materials

Not Used

83-11.03A(3) Construction

Not Used

83-11.03A(4) Payment

Not Used

83-11.03B Reconstruct Metal Bridge Railings

83-11.03B(1) General

83-11.03B(1)(a) Summary

Section 83-11.03B includes specifications for reconstructing metal bridge railings.

83-11.03B(1)(b) Definitions

Reserved

83-11.03B(1)(c) Submittals

Submit 2 copies of shop drawings showing the details of the refabrication of the removed materials and the fabrication of the new materials. Include a list of the new materials, the type of metal, and the metal specifications.

83-11.03B(1)(d) Quality Assurance

Reserved

83-11.03B(2) Materials

Not Used

83-11.03B(3) Construction

Remove, refabricate, and install the metal bridge railing of the type shown.

Refabrication of removed material, fabrication of new material, and installation of the railing must comply with the specifications for a new metal bridge railing of the type being reconstructed.

Perform aluminum welding by the inert-gas-shielded arc welding process. Finish exposed aluminum welds to a neat surface.

Repair abraded and damaged galvanized surfaces on the removed material under section 75-1.02B.

83-11.03B(4) Payment

The payment quantity for reconstruct metal railing (bridge) is the length measured along the face of the reconstructed railing and includes the length of gaps in the railing for lighting and sign supports.

83-11.03C–83-11.03G Reserved

83-11.04–83-11.08 RESERVED

84 MARKINGS

84-1 GENERAL

84-1.01 GENERAL

Section 84-1 includes general specifications for applying and constructing markings.

Markings must comply with the CA MUTCD.

84-1.02 MATERIALS

Not Used

84-1.03 CONSTRUCTION

Not Used

84-1.04 PAYMENT

Not Used

84-2 TRAFFIC STRIPES AND PAVEMENT MARKINGS

84-2.01 GENERAL

84-2.01A Summary

Section 84-2 includes specifications for applying traffic stripes and pavement markings.

84-2.01B Definitions

pavement marking: Transverse marking such as (1) a limit line, (2) a stop line, or (3) a word, symbol, shoulder, parking stall, or railroad-grade-crossing marking.

traffic stripe: Longitudinal centerline or lane line used for separating traffic lanes in the same direction of travel or in the opposing direction of travel or a longitudinal edge line marking the edge of the traveled way or the edge of a lane at a gore area separating traffic at an exit or entrance ramp. A traffic stripe is shown as a traffic line.

84-2.01C Submittals

For each lot or batch of thermoplastic, paint, and glass beads, submit:

1. Certificate of compliance, including the product name, lot or batch number, and manufacture date
2. METS notification letter stating that the material is authorized for use, except for thermoplastic
3. SDS
4. Material data sheet for thermoplastic primer

For each lot or batch of thermoplastic, submit a manufacturer's certificate of compliance with test results for the tests specified in section 84-2.01D. The date of test must be within 1 year of use.

For glass beads used in drop-on applications and in thermoplastic formulations, submit a certificate of compliance and test results for each lot of beads specifying the EPA test methods used and tracing the lot to the specific test sample. The testing for lead and arsenic content must be performed by an independent testing laboratory.

Submit retroreflectivity readings for traffic stripes and pavement markings at locations with deficient retroreflectivity determined by the Engineer.

84-2.01D Quality Assurance

Before starting permanent application of two-component painted traffic stripes or markings, apply a test stripe of the paint on roofing felt or other suitable material in the presence of the Engineer. The test section must be at least 50 feet in length.

Test each lot of glass beads for arsenic and lead under EPA Test Method 3052 and 6010B or 6010C.

The Engineer will perform a nighttime, drive-through, visual inspection of the retroreflectivity of the traffic stripes and pavement markings and notify you of any locations with deficient retroreflectivity. Measure the retroreflectivity of the deficient areas using a retroreflectometer under ASTM E1710 and the sampling protocol specified in ASTM D7585.

Each lot or batch of thermoplastic must be tested under California Test 423 for:

1. Brookfield Thermosel viscosity
2. Hardness
3. Yellowness index, white only
4. Daytime luminance factor
5. Yellow color, yellow only
6. Glass bead content
7. Binder content

During the installation of thermoplastic traffic stripes or markings at the job site, apply a test stripe of the thermoplastic on suitable material in the presence of the Engineer. The test stripe must be at least 1 foot in length. The test stripe will be tested for yellow color, daytime luminance factor, and yellowness index requirements.

84-2.02 MATERIALS

84-2.02A General

Traffic stripes and pavement markings must be retroreflective. Within 30 days of applying traffic stripes and pavement markings, the retroreflectivity of the stripes and markings must be a minimum of 250 $mcd \cdot m^{-2} \cdot lx^{-1}$ for white and 125 $mcd \cdot m^{-2} \cdot lx^{-1}$ for yellow when measured under ASTM E1710.

84-2.02B Thermoplastic

Thermoplastic must comply with State Specification PTH-02SPRAY, PTH-02HYDRO, or PTH-02ALKYD.

For recessed thermoplastic stripes and pavement markings, mark packages of thermoplastic with the words *For Recessed Application.*

84-2.02C Paint

The paint for traffic stripes and pavement markings must comply with the specifications for the paint type and color shown in following table:

Paint Specifications

Paint type	Color	Specification
Waterborne traffic line	White, yellow, and black	State Specification PTWB-01R2
Acetone-based	White, yellow, and black	State Specification PT-150VOC(A)
Waterborne traffic line for the international symbol of accessibility and other curb markings	Blue, red, and green	Federal Specification TT-P-1952E

The color of painted traffic stripes and pavement markings must comply with ASTM D6628.

84-2.02D Glass Beads

Glass beads applied to paint must comply with State Specification 8010-004.

Glass beads applied to molten thermoplastic material must be Type 2 beads complying with AASHTO M 247. The glass beads must have a coating that promotes adhesion of the beads to thermoplastic.

At least 75 percent of the beads by count must be true spheres that are colorless and do not exhibit dark spots, air inclusions, or surface scratches when viewed under 20X magnification.

Each lot of glass beads used in pavement markings must contain less than 200 ppm each of arsenic and lead when tested under EPA Test Methods 3052 and 6010B or 6010C.

84-2.02E Thermoplastic Traffic Stripes and Pavement Markings with Enhanced Wet-Night Visibility

A thermoplastic traffic stripe or pavement marking with enhanced wet-night visibility consists of a single uniform layer of thermoplastic and 2 layers of glass beads.

The 1st layer of glass beads must be on the Authorized Material List for high-performance glass beads. The color of the glass beads must match the color of the stripe or marking to which they are being applied.

The 2nd layer of glass beads must comply with AASHTO M 247, Type 2.

The glass beads used in both layers must be surface treated for use with thermoplastic under the bead manufacturer's instructions.

Within 14 days of applying a thermoplastic traffic stripe or pavement marking with enhanced wet-night visibility, the retroreflectivity must be a minimum of 700 $mcd \cdot m^{-2} \cdot lx^{-1}$ for white stripes and markings and 500 $mcd \cdot m^{-2} \cdot lx^{-1}$ for yellow stripes and markings when measured under ASTM E1710.

84-2.02F Two-Component Painted Traffic Stripes and Pavement Markings

A two-component painted traffic stripe or pavement marking consists of 1 coat of paint and 2 applications of retroreflective glass beads of 2 gradations.

The large-gradation glass beads must be on the Authorized Material List for two-component traffic striping paints and large-gradation retroreflective glass beads.

The small-gradation glass beads must comply with AASHTO M 247, Type 1.

The glass beads must have an adhesion-promoting and water-repellant coating complying with the paint manufacturer's instructions.

You may use alternative types of glass beads recommended by the paint manufacturer if authorized.

The daytime and nighttime color of the painted traffic stripes and pavement markings must comply with ASTM D6628.

84-2.02G Recessed Two-Component Painted Traffic Stripes and Pavement Markings

Reserved

84-2.02H Traffic Stripe and Pavement Marking Tape

Reserved

84-2.02I–84-2.02M Reserved

84-2.03 CONSTRUCTION

84-2.03A General

Establish the alignment for traffic stripes and the layouts for pavement markings with a device or method that will not conflict with other traffic control devices.

Protect existing retroreflective pavement markers during work activities.

Remove existing pavement markers that are coated or damaged by work activities and replace each with an equivalent marker on the Authorized Material List for signing and delineation materials.

A completed traffic stripe must:

1. Have clean, well-defined edges without running or deformation
2. Be uniform
3. Be straight on a tangent alignment and on a true arc on a curved alignment

The width of a completed traffic stripe must not deviate from the width shown by more than 1/4 inch on a tangent alignment and 1/2 inch on a curved alignment.

The length of the gaps and individual stripes that form a broken traffic stripe must not deviate by more than 2 inches from the lengths shown. The gaps and stripes must be uniform throughout the entire length of each section of broken traffic stripe so that a normal striping machine can repeat the pattern and superimpose successive coats on the applied traffic stripe.

A completed pavement marking must have well-defined edges without running or deformation.

A completed thermoplastic traffic stripe or thermoplastic pavement marking must be free from runs, bubbles, craters, drag marks, stretch marks, and debris.

Protect newly placed traffic stripes and pavement markings from traffic and other deleterious activities until the paint is thoroughly dry or the thermoplastic is hard enough to bear traffic.

84-2.03B Surface Preparation

Use mechanical wire brushing to remove dirt, contaminants, and loose material from the pavement surface that is to receive the traffic stripe or pavement marking.

Use abrasive blast cleaning to remove laitance and curing compound from the surface of new concrete pavement that is to receive the traffic stripe or pavement marking.

84-2.03C Application of Stripes and Markings

84-2.03C(1) General

Apply thermoplastic for a pavement marking with a stencil or a preformed marking.

Apply paint for a pavement marking by hand with a stencil and spray equipment.

You may use permanent tape for a traffic stripe or a pavement marking instead of paint or thermoplastic. The permanent tape must be on the Authorized Material List for signing and delineation materials. Apply the tape under the manufacturer's instructions.

Immediately remove drips, overspray, improper markings, paint, and thermoplastic tracked by traffic with an authorized method.

Apply a traffic stripe or a pavement marking only to a dry surface during a period of favorable weather when the pavement surface is above 50 degrees F.

The glass beads must be embedded in the coat of paint or thermoplastic to a depth of 1/2 their diameters.

Verify the rate of application of the glass beads by stabbing the glass bead tank with a calibrated rod.

Where a new broken traffic stripe joins an existing broken traffic stripe, allow enough overlap distance between the new and existing striping patterns to ensure continuity at the beginning and end of the transition.

84-2.03C(2) Thermoplastic Traffic Stripes and Pavement Markings

84-2.03C(2)(a) General

Do not thin the primer. Apply the primer under the manufacturer's instructions:

1. To all roadway surfaces except for asphaltic surfaces less than 6 months old
2. At a minimum rate of 1 gallon per 300 square feet
3. To allow time for the thermoplastic primer to dry and become tacky prior to application of the thermoplastic

Use preheaters with mixers having a 360-degree rotation to preheat the thermoplastic material.

Apply the thermoplastic in a single uniform layer by spray or extrusion methods.

Completely coat and fill voids in the pavement surface with the thermoplastic.

84-2.03C(2)(b) Extruded Thermoplastic Traffic Stripes and Pavement Markings

Apply extruded thermoplastic at a temperature from 400 to 425 degrees F unless a different temperature is recommended by the manufacturer.

Apply extruded thermoplastic for a traffic stripe at a rate of at least 0.36 lb of thermoplastic per foot of 6-inch-wide solid stripe. The applied thermoplastic traffic stripe must be at least 0.060 inch thick.

An applied thermoplastic pavement marking must be from 0.100 to 0.150 inch thick.

Apply glass beads to the surface of the molten thermoplastic at a rate of at least 8 lb of beads per 100 sq ft.

84-2.03C(2)(c) Sprayable Thermoplastic Traffic Stripes and Pavement Markings

Apply sprayable thermoplastic under State Specification PTH-02SPRAY at a temperature from 350 to 400 degrees F.

Apply sprayable thermoplastic at a rate of at least 0.24 lb of thermoplastic per foot of 6-inch-wide solid stripe.

The applied sprayable thermoplastic material must be at least 0.040 inch thick.

84-2.03C(2)(d) Recessed Thermoplastic Traffic Stripes and Pavement Markings

Construct recesses for double traffic stripes in a single pass.

Keep the recesses dry and free from debris. Apply primer to the recesses.

After constructing the recesses, apply the thermoplastic traffic stripes and pavement markings before the end of the same work shift.

84-2.03C(2)(e) Thermoplastic Traffic Stripes and Pavement Markings with Enhanced Wet-Night Visibility

Use a ribbon-extrusion or screed-type applicator to apply thermoplastic traffic stripes with enhanced wet-night visibility. Operate the striping machine at a speed of 8 mph or slower during the application of the stripe and glass beads.

Apply the stripe at a rate of at least 0.57 lb of thermoplastic per foot of 6-inch-wide solid stripe. The applied thermoplastic traffic stripe must be at least 0.090 inch thick.

Apply thermoplastic pavement marking at a rate of at least 1.06 lb of thermoplastic per square foot of marking. The applied thermoplastic pavement marking must be at least 0.100 inch thick.

Apply thermoplastic traffic stripe and both types of glass beads in a single pass. First apply the thermoplastic, followed immediately by consecutive applications of high-performance glass beads and then AASHTO M 247, Type 2, glass beads. Use a separate applicator gun for each type of glass bead.

You may apply glass beads by hand on pavement markings.

Uniformly distribute glass beads on traffic stripes and pavement markings. Apply high-performance glass beads at a rate of at least 6 lb of glass beads per 100 sq ft of stripe or marking. Apply AASHTO M 247, Type 2, glass beads at a rate of at least 8 lb of glass beads per 100 sq ft of stripe or marking. The combined weight of the 2 types of glass beads must be greater than 14 lb of glass beads per 100 sq ft of stripe or marking.

84-2.03C(3) Painted Traffic Stripes and Pavement Markings

84-2.03C(3)(a) General

Do not thin paint for traffic stripes and pavement markings. Mix the paint by mechanical means until it is homogeneous. Thoroughly agitate the paint during its application.

Use mechanical means to paint traffic stripes and pavement markings and to apply glass beads for traffic stripes.

The striping machine must be capable of superimposing successive coats of paint on the 1st coat and on existing stripes at a speed of at least 5 mph.

The striping machine must:

1. Have rubber tires
2. Be maneuverable enough to produce straight lines and normal curves in true arcs
3. Be capable of applying traffic paint and glass beads at the specified rates
4. Be equipped with:
   - 4.1. Pointer or sighting device at least 5 feet long extending from the front of the machine
   - 4.2. Pointer or sighting device extending from the side of the machine to determine the distance from the centerline for painting shoulder stripes
   - 4.3. Positive acting cutoff device to prevent depositing paint in gaps of broken stripes
   - 4.4. Shields or an adjustable air curtain for line control

4.5. Pressure regulators and gauges that are in full view of the operator for a pneumatically operated machine
4.6. Paint strainer in the paint supply line
4.7. Paint storage tank with a mechanical agitator that operates continuously during painting activities
4.8. Glass bead dispenser located behind the paint applicator nozzle that is controlled simultaneously with the paint applicator nozzle
4.9. Calibrated rods for measuring the volumes of paint and glass beads in the paint and glass bead tanks

Air-atomized spray equipment must:

1. Be equipped with oil and water extractors and pressure regulators
2. Have adequate air volume and compressor recovery capacity
3. Have properly sized orifices and needle assemblies for the spray gun tip

Where the configuration or location of a traffic stripe is such that the use of a striping machine is not practicable, you may apply the traffic paint and glass beads by other methods and equipment if authorized. The Engineer determines if the striping machine is not practicable for a particular use.

For an existing surface, apply traffic stripes and pavement markings in 1 coat.

For a new surface, except for the black stripe between the 2 yellow stripes of a double traffic stripe, apply traffic stripes and pavement markings in 2 coats. The 1st coat of paint must be dry before applying the 2nd coat.

Paint a 1-coat, 3-inch-wide black stripe between the two 6-inch-wide yellow stripes of a double traffic stripe.

If the two 6-inch-wide yellow stripes are applied in 2 coats, apply the black stripe concurrently with the 2nd coat of the yellow stripes.

Apply each coat of paint for any traffic stripe in 1 pass of the striping machine, including the glass beads, regardless of the number, width, and pattern of the individual stripes. Do not paint traffic stripes and pavement markings if:

1. Freshly painted surfaces could become damaged by rain, fog, or condensation
2. Atmospheric temperature could drop below 40 degrees F for acetone-based paint and 50 degrees F for waterborne paint during the drying period

On 2-lane highways:

1. If the 1st coat of the centerline stripe is applied in the same direction as increasing post miles, use the right-hand spray gun of the 3 spray guns used to apply the double yellow stripe to apply a single yellow stripe.
2. If the 1st coat of the centerline stripe is applied in the same direction as decreasing post miles, use the left-hand spray gun of the 3 spray guns used to apply the double yellow stripe to apply a single yellow stripe.
3. Apply the 2nd coat of centerline striping in the opposite direction of the 1st coat.

Apply 1-coat paint at an approximate rate of 107 sq ft/gal.

Apply 2-coat paint at the approximate rate shown in the following table:

Two-Coat Paint Application Rates

Paint type	Coverage (sq ft/gal)	
	1st coat	2nd coat
Waterborne paint	215	215
Acetone-based paint	360	150

Apply glass beads at an approximate rate of 5 lb of beads per gallon of paint.

The Engineer determines the exact application rate of the paint and glass beads.

Verify the application rate of paint by stabbing the paint tank with a calibrated rod. If the striping machine has paint gauges, the Engineer may measure the volume of paint using the gauges instead of stabbing the paint tank with a calibrated rod.

84-2.03C(3)(b) Two-Component Painted Traffic Stripes and Pavement Markings

Do not apply paint for two-component painted traffic stripes and pavement markings until authorized.

Apply the paint only to clean, completely dry surfaces when the pavement surface temperature is above 39 degrees F and the ambient temperature is above 36 degrees F.

Comply with the paint manufacturer's instructions for the temperature of the paint during its application.

The striping machine must not travel faster than 10 mph when applying the paint and glass beads.

Apply the paint and glass beads in 1 pass in the following order:

1. Paint
2. Large-gradation glass beads
3. Small-gradation glass beads

Apply the glass beads with 2 separate applicator guns.

Uniformly distribute the glass beads on traffic stripes and pavement markings.

You may apply the glass beads by hand methods on pavement markings.

Apply the large-gradation glass beads at a minimum rate of 11.7 lb of beads per gallon of paint.

Apply the small-gradation glass beads at a minimum rate of 8.3 lb of beads per gallon of paint.

84-2.03C(3)(c) Recessed Two-Component Painted Traffic Stripes and Pavement Markings

Reserved

84-2.03C(4) Reserved

Reserved

84-2.03C(5)–84-2.03C(10) Reserved

84-2.04 PAYMENT

The payment quantity for a traffic stripe is the length measured along the line of the traffic stripe without deductions for gaps in the broken traffic stripe.

The payment quantity for a pavement marking is the area covered.

A double extruded thermoplastic traffic stripe consisting of two 6-inch-wide yellow stripes is measured as 2 traffic stripes.

A double sprayable thermoplastic traffic stripe consisting of two 6-inch-wide yellow stripes is measured as 1 traffic stripe.

A double traffic stripe consisting of two 6-inch-wide yellow stripes separated by a 3-inch-wide black stripe is measured as a single traffic stripe.

84-3 CONTRAST TREATMENT

84-3.01–84-3.10 RESERVED

84-4–84-7 RESERVED

84-8 RUMBLE STRIPS

84-8.01 GENERAL

84-8.01A Summary

Section 84-8 includes specifications for constructing rumble strips.

84-8.01B Definitions

rumble strip: Band of raised material or indentations formed or grooved in the traveled way on the centerline or shoulders that is used to alert or warn drivers.

84-8.01C Submittals

Reserved

84-8.01D Quality Assurance

Reserved

84-8.02 MATERIALS

Not Used

84-8.03 CONSTRUCTION

84-8.03A General

Select the method and equipment for constructing ground-in indentations.

Do not construct rumble strips:

1. On structures, approach slabs, or concrete weigh-in-motion slabs
2. At intersections
3. Bordering two-way left turn lanes, driveways, or other high-volume turning areas
4. Within 6 inches of any concrete pavement joint

Modify rumble strip spacing to avoid locating a groove on a concrete pavement joint.

Construct rumble strips within 2 inches of the alignment shown. Rumble strip equipment must be equipped with a sighting device that enables the operator to maintain the rumble strip alignment.

Indentations must comply with the dimensions shown and not vary more than:

1. 10 percent in length
2. 0.06 inch in depth
3. 10 percent in width
4. 1 inch in center-to-center spacing between rumble strips

Grind or remove and replace noncompliant rumble strip indentations at locations determined by the Engineer. Ground surface areas must be neat and uniform in appearance.

Grinding equipment must be equipped with a vacuum attachment to remove residue from the roadbed.

The noise level created by the combined grinding activities must not exceed 86 dBA when measured at a distance of 50 feet at right angles to the direction of travel.

Break rumble strips before and after intersections, driveways, railroad crossings, freeway gore areas, and freeway ramps. Place breaks and break distances as shown. You may adjust breaks and the break distances as needed at low-volume driveways or other locations if authorized.

84-8.03B Rumble Strips in Concrete Pavement

Construct rumble strips by grinding indentations in concrete pavement.

Concrete pavement must be hardened before grinding the indentations. Do not construct indentations until (1) 10 days after concrete placement and (2) the concrete has developed a modulus of rupture of 550 psi when tested under California Test 523.

Remove grinding residue under section 13-4.03E(7).

84-8.03C Rumble Strips in Asphalt Concrete Pavement

Construct rumble strips in the top layer of HMA and asphalt concrete surfacing by the ground-in method.

Dispose of the removed material.

On ground areas, apply a fog seal coat under section 37-4.02.

84-8.04 PAYMENT

The payment quantity for any type of rumble strip is the length measured by the station along the length of the rumble strip without deductions for gaps between indentations.

84-9 EXISTING MARKINGS

84-9.01 GENERAL

Section 84-9 includes specifications for removing existing markings.

Work performed on existing markings must comply with section 15.

84-9.02 MATERIALS

Not Used

84-9.03 CONSTRUCTION

84-9.03A General

Reserved

84-9.03B Remove Traffic Stripes and Pavement Markings

Remove traffic stripes before making any change to the traffic pattern.

Completely remove traffic stripes and pavement markings, including any paint in the gaps, by methods that do not remove pavement to a depth of more than 1/8 inch.

Submit your proposed method for removing traffic stripes and pavement markings at least 7 days before starting the removal work. Allow 2 business days for the review.

Remove pavement marking such that the old message cannot be identified. Make any area removed by grinding rectangular. Water must not puddle in the ground areas. Fog seal ground areas on asphalt concrete pavement.

Sweep up or vacuum any residue before it can (1) be blown by traffic or wind, (2) migrate across lanes or shoulders, or (3) enter a drainage facility.

84-9.03C Remove Traffic Stripes and Pavement Markings Containing Lead

Reserved

84-9.03D Remove Contrast Treatment

If contrast treatment is shown to be removed, remove it by a method that does not damage the pavement.

Sweep up or vacuum any residue before it can (1) be blown by traffic or wind, (2) migrate across lanes or shoulders, or (3) enter a drainage facility.

84-9.03E–84-9.03J Reserved

84-9.04 PAYMENT

The payment quantity for remove traffic stripe is the measured length multiplied by:

1. 1.34 for a single 8-inch-wide traffic stripe
2. 2 for a double traffic stripe
3. 3 for a triple traffic stripe

The payment quantity for remove traffic stripe does not include the gaps in broken traffic stripes. Payment for removal of paint evident in a gap is included in the payment for remove traffic stripe of the type involved.

If no bid item is shown on the Bid Item List for remove pavement marking, remove pavement marking is paid for as remove traffic stripe of the types shown in the Bid Item List and the payment quantity for 1 square foot of pavement marking is 3 linear feet.

84-10–84-15 RESERVED

85 RESERVED

DIVISION X ELECTRICAL WORK

86 GENERAL

86-1.01 GENERAL

86-1.01A Summary

Section 86 includes general specifications for furnishing electrical equipment and materials.

Electrical equipment and materials must comply with part 4 of the *California MUTCD* and 8 CA Code of Regs, chapter 4, subchapter 5, "Electrical Safety Orders."

Galvanized equipment and materials must comply with section 75-1.02B.

86-1.01B Definitions

accessible pedestrian signal: Accessible pedestrian signal as defined in the *California MUTCD*.

accessible walk indication: Activated audible and vibrotactile action during the walk interval.

actuation: Actuation as defined in the *California MUTCD*.

ambient sound level: Background sound level in dB at a given location.

ambient sound sensing microphone: Microphone that measures the ambient sound level in dB and automatically adjusts the accessible pedestrian signal speaker's volume.

audible speech walk message: Audible prerecorded message that communicates to pedestrians which street has the walk interval.

channel: Discrete information path.

CALiPER: Commercially Available LED Product Evaluation and Reporting. A U.S. Department of Energy program that individually tests and provides unbiased information on the performance of commercially available LED luminaires and lights.

controller assembly: Assembly for controlling a system's operations, consisting of a controller unit and auxiliary equipment housed in a waterproof cabinet.

controller unit: Part of the controller assembly performing the basic timing and logic functions.

correlated color temperature: Absolute temperature in kelvin of a blackbody whose chromaticity most nearly resembles that of the light source.

detector: Detector as defined in the *California MUTCD*.

electrolier: Assembly of a lighting standard and luminaire.

fastening hardware [ICF1]: Bolts, nuts, washer, fasteners, hex nuts, lock nuts, or other metal components to secure or lock down a device or equipment.

flasher: Device for opening and closing signal circuits at a repetitive rate.

flashing beacon control assembly: Assembly of switches, circuit breakers, terminal blocks, flasher, wiring, and other necessary electrical components housed in a single enclosure for operating a beacon.

house side lumens: Lumens from a luminaire directed to light up areas between the fixture and the pole, such as sidewalks at intersection or areas off the shoulders on freeways.

illuminance gradient: Ratio of the minimum illuminance on a 1-foot square of sign panel to that on an adjacent 1-foot square of sign panel.

inductive loop detector: Detector capable of being actuated by an inductance change caused by a vehicle passing or standing over the loop. An inductive loop detector includes a loop or group of loops installed in the roadway and a lead-in cable installed and connected inside a controller cabinet.

junction temperature: Temperature of the electronic junction of the LED device. The junction temperature is critical in determining photometric performance, estimating operational life, and preventing catastrophic failure of the LED.

L70: Extrapolated life in hours of the luminaire when the luminous output depreciates 30 percent from the initial values.

lighting standard: Pole and mast arm supporting the luminaire.

link: Part of a system which provides a data connection between a transmitter and receiver.

LM-79: Test method from the Illumination Engineering Society of North America specifying the test conditions, measurements, and report format for testing solid state lighting devices, including LED luminaires.

LM-80: Test method from the Illumination Engineering Society of North America specifying the test conditions, measurements, and report format for testing and estimating the long-term performance of LEDs for general lighting purposes.

luminaire: Assembly that houses the light source and controls the light emitted from the light source.

mid-span access method: Procedure in which fibers from a single buffer tube are accessed and spliced to a multi buffer tube cable without cutting the unused fibers in the buffer tube, or disturbing the remaining buffer tubes in the cable.

National Voluntary Laboratory Accreditation Program: U.S. Department of Energy program that accredits independent testing laboratories.

optical time domain reflectometer (OTDR): Fiber optic test equipment that is used to measure the total amount of power loss between two points and over the corresponding distance. It provides a visual and printed display of the relative location of system components such as fiber sections, splices and connectors as well as the losses that are attributed to each component and or defects in the fiber.

pedestrian change interval: Pedestrian change interval as defined in the *California MUTCD*.

powder coating: Coating applied electrostatically using exterior-grade, UV-stable, polymer powder.

power factor: Ratio of the real power component to the complex power component.

power meter: A portable fiber optic test equipment that, when coupled with a light source, is used to perform end-to-end attenuation testing. Its display indicates the amount of power injected by the light source at the designed wavelength of the system under testing that arrives at the receiving end of the link.

pretimed controller assembly: Assembly operating traffic signals under a predetermined cycle length.

programming mechanism: Device to program the accessible pedestrian signal operation.

pull box: Box with a cover that is installed in an accessible place in a conduit run to facilitate the pulling in of wires or cables.

push button information message: Push button information message as defined in the *California MUTCD.*

push button locator tone: Push button locator tone as defined in the *California MUTCD*.

segment: A continuous cable terminated by 2 splices, 2 connectors or 1 splice and 1 connector.

signal face: Signal face as defined in the *California MUTCD*.

signal head: Signal head as defined in the *California MUTCD*.

signal indication: Signal indication as defined in the *California MUTCD*.

signal section: Signal section as defined in the *California MUTCD*.

signal standard: Pole with or without mast arms carrying 1 or more signal faces.

street side lumens: Lumens from a luminaire directed to light up areas between the fixture and the roadway, such as traveled ways and freeway lanes.

surge protection device: Subsystem or component that protects equipment against short-duration voltage transients in power line.

total harmonic distortion: Ratio of the rms value of the sum of the squared individual harmonic amplitudes to the rms value of the fundamental frequency of a complex waveform.

traffic-actuated controller assembly: Assembly for operating traffic signals under the varying demands of traffic as registered by detector actuation.

traffic phase: Traffic phase as defined in the *California MUTCD*.

vehicle: Vehicle as defined in the *California Vehicle Code*.

vibrotactile pedestrian device: Vibrotactile pedestrian device as defined in the *California MUTCD*.

86-1.01C Submittals

86-1.01C(1) General

Within 15 days after Contract approval, submit a list of equipment and materials you propose to install.

Submit the list before shipping equipment and materials to the job site. The list must include:

1. Manufacturer's name
2. Make and model number
3. Month and year of manufacture
4. Lot and serial numbers
5. Contract number
6. Your contact information

Submit confirmation of the vendor's acceptance of the order for the electrical equipment and materials as an informational submittal.

Submit 3 sets of computer-generated, schematic wiring diagrams for each cabinet.

Diagrams, plans, and drawings must be prepared using graphic symbols in IEEE 315, "Graphic Symbols for Electrical and Electronic Diagrams."

Submit a schedule of values within 15 days after Contract approval.

Do not include costs for the traffic control system in the schedule of values.

Submit a manufacturer's maintenance manual or combined maintenance and operation manual as an informational submittal. The manual must have a master item index that includes:

1. Specifications
2. Design characteristics
3. General operation theory
4. Function of all controls
5. Troubleshooting procedure
6. Parts list, descriptions, stock numbers, and settings
7. Block circuit diagram
8. Layout of components
9. Schematic diagrams

Submit a digital file for geographic information system mapping for:

1. Conduit
2. Pull Boxes
3. Cabinets
4. Enclosures

The digital file must consist of:

1. Longitudinal and latitude coordinates, in accordance with the WGS84 reference coordinate system. The coordinates must be in decimal format having 6 significant figures after the decimal point. Coordinates must be read at the center of pull boxes, cabinet and enclosures; and on top of conduit at 200 foot intervals before backfill.
2. Type, depth and size for conduits.
3. Type for pull boxes, cabinets and enclosures.

86-1.01C(2) Pull Boxes

Submit the manufacturer's installation instructions for pull boxes, including:

1. Quantity and size of entries that can be made without degrading the strength of the pull box below the load rating
2. Locations where side entries can be made
3. Acceptable method for creating the entry

Submit load-rating test reports for pull boxes from a laboratory that is accredited to International Standards Organization/International Electrotechnical Commission 17025 by the American Association for Laboratory Accreditation (A2LA) or the ANSI-ASQ National Accreditation Board (ANAB).

86-1.01C(3) LED Luminaires

Submit for an LED luminaire:

1. Maximum power in watts
2. Maximum designed junction temperature
3. Heat sink area in square inches
4. Designed junction-to-ambient thermal resistance calculation with thermal resistance components clearly defined
5. L70 in hours when extrapolated for the average nighttime operating temperature
6. Life expectancy based on the junction temperature
7. Manufacturer's data sheet for the power supply, including the rated life

Submit the manufacturer's QC test data for LED luminaires as an informational submittal.

86-1.01C(4) Low-Pressure Sodium Luminaires

Submit the manufacturer's QC test data for low-pressure sodium luminaires as an informational submittal.

86-1.01C(5) Service Equipment Enclosures

Submit shop drawings for a service equipment enclosure to METS.

86-1.01C(6) Signal Heads

Submit a certificate of compliance and the manufacturer's QC test data for signal heads as an informational submittal.

86-1.01C(7) LED Signal Modules

Submit the manufacturer's QC test data for LED signal modules as an informational submittal.

86-1.01C(8) Visors

Submit a certificate of compliance and the manufacturer's QC test data for visors as an informational submittal.

86-1.01C(9) LED Countdown Pedestrian Signal Face Modules

Submit the manufacturer's QC test data for LED countdown pedestrian signal face modules as an informational submittal.

86-1.01C(10) Accessible Pedestrian Signals

Submit the manufacturer's QC test data for accessible pedestrian signals as an informational submittal.

86-1.01D Quality Assurance

86-1.01D(1) General

Electrical equipment must comply with one or more of the following standards:

1. ANSI
2. ASTM
3. EIA/ECIA
4. NEMA
5. NETA
6. UL/NRTL
7. TIA

Materials must comply with:

1. FCC rules
2. ITE standards
3. NEC
4. California Electrical Code

86-1.01D(2) Source Quality Control

Service equipment enclosures and cabinets must be inspected and tested at the source.

86-1.01D(3) Department Acceptance

Deliver material and equipment for testing to METS.

Allow 30 days for testing. The Department notifies you when testing is complete.

If the Department accepts the material or equipment, you must pick it up from the test site and deliver it to the job site.

If the Department rejects material or equipment, remove it within 5 business days after you are notified it is rejected. If it is not removed within that period, the Department may remove it and ship it to you and deduct the costs of labor, material and shipping.

Resubmit a new sample and allow 30 days for retesting. The retesting period starts when the replacement material or equipment is delivered to METS.

86-1.02 MATERIALS

86-1.02A General

Anchor bolts, anchor bars or studs, and nuts and washers must comply with section 75-1.02.

Bolt threads must accept galvanized standard nuts without requiring tools or causing removal of protective coatings.

86-1.02B Conduit and Accessories

86-1.02B(1) General

Conduit and fittings must comply with the requirements shown in the following table:

Conduit and Fitting Requirements

Type	Requirement
1	Must be hot-dip galvanized rigid steel complying with UL 6 and ANSI C80.1. The zinc coating must comply with copper sulfate test requirements in UL 6. Fittings must be electrogalvanized and certified under UL 514B.
2	Must comply with requirements for Type 1 conduit and be coated with PVC or polyethylene. The exterior thermoplastic coating must have a minimum thickness of 35 mils. The internal coating must have a minimum thickness of 2 mils. Coated conduit must comply with NEMA RN 1, or NRTL PVC-001.
3	Must be Type A, extruded, rigid PVC conduit complying with UL 651 or must be HDPE conduit complying with UL 651A.
4	Must have an inner, flexible metal core covered by a waterproof, nonmetallic, sunlight-resistant jacket, and must be UL listed for use as a grounding conductor. Fittings must be certified under UL 514B.
5	Must be intermediate steel complying with UL 1242 and ANSI C80.6. The zinc coating must comply with copper sulfate test requirements specified in UL 1242. Fittings must be electrogalvanized and certified under UL 514B.

Bonding bushings installed on metal conduit must be insulated and either a galvanized or zinc-alloy type.

Conduit used for horizontal directional drilling must be high density polyethylene Type IPS, DR 9 and comply with ASTM F714. The conduit material must comply with ASTM D3350.

Conduit for fiber optic cable systems must be high density polyethylene schedule 40 high density polyethylene, complying with NEMA TC-7, except for horizontal directional drilling.

Sealing plug must:

1. Be reusable
2. Withstand a pressure of 5 psi
3. Provide an airtight seal
4. Seal conduit and innerducts simultaneously

Sealing plug for empty conduit must have a rope tie.

Innerduct must be:

1. HDPE tubing or fabric mesh pouch.
2. Nominal 1 inch inside diameter, with a minimum Standard Dimension Ratio (SDR) rating of 11
3. Continuous without splices or joints.
4. Ribbed inside and outside when used inside a conduit.
5. Ribbed inside and smooth on the outside for direct burial.
6. Unique color throughout the entire length of the conduit segment.
7. Shipped and stored on a reel, covered to protect colors from UV deterioration. The reel must be marked with:
   - 7.1. Manufacturer's name
   - 7.2. Contract number
   - 7.3. Size and length of the innerduct

Polyethylene for innerduct must:

1. Comply with ASTM D3485, D3035, D2239, and D2447, and NEMA TC7 and TC2
2. Have a tensile yield strength of a minimum 3300 psi under ASTM D638
3. Have a density of 59.6187 lb/ft3 ± 0.3121 lb/in3 under ASTM D1505

Tracer wire must be a minimum No. 12 solid copper conductor with orange insulation Type TW, THW, RHW, or USE.

86-1.02B(2) Structures Accessories

Steel hangers, steel brackets, and other fittings used to support conduit in or on a wall or bridge superstructure must comply with section 75-3.

Precast concrete cradles for conduit must be made of minor concrete and commercial-quality welded wire fabric. The minor concrete must contain a minimum of 590 lb of cementitious material per cubic yard. The cradles must be moist cured for a minimum of 3 days.

86-1.02C Pull Boxes

86-1.02C(1) General

A pull box cover must have a nonskid surface.

A metal pull box cover must include a fitting for a bonding conductor.

A pull box cover must have a marking on the top that is:

1. Clearly defined
2. Uniform in depth
3. Parallel to the longer side
4. From 1 to 3 inches in height

The cover marking must include CALTRANS and one of the following:

1. *SERVICE* for service circuits between a service point and service disconnect
2. *SERVICE IRRIGATION* for circuits from a service equipment enclosure to an irrigation controller
3. SERVICE BOOSTER PUMP for circuits from a service equipment enclosure to the booster pump
4. *TDC POWER* for circuits from a service equipment enclosure to telephone demarcation cabinet
5. *LIGHTING* for a lighting system
6. *SIGN ILLUMINATION* for a sign illumination system
7. *SIGNAL AND LIGHTING* for a signal and lighting system
8. *RAMP METER* for a ramp metering system
9. *TMS* for a traffic monitoring station
10. *FLASHING BEACON* for a flashing beacon system
11. *CMS* for a changeable message sign system
12. *INTERCONNECT* for an interconnect conduit and cable system
13. *CALTRANS* if more than one system is shared in the same pull box

The following circuits must not include CALTRANS in the cover marking:

1. Electrical service
2. Sprinkler-control
3. Telephone service

The load rating must be:

1. Stenciled or stamped on the inside and outside of the pull box
2. Stamped on the outside of the cover

If a transformer or other device must be placed in the pull box, include recesses for a hanger.

The hardware must be stainless steel containing 18 percent chromium and 8 percent nickel.

86-1.02C(2) Nontraffic Pull Boxes

A nontraffic pull box and cover must comply with ANSI/SCTE 77, "Specification for Underground Enclosure Integrity," for Tier 22 load rating and must be gray or brown.

The cover markings must be cast in the mold of the cover or be engraved on a metal or UV resistant ABS plate secured in the cover with stainless steel screws.

Each new pull box must have a cover with an electronic marker cast inside.

A pull box extension must be made of the same material as the pull box. The extension may be another pull box if the bottom edge of the pull box fits into the opening for the cover.

The bolts, nuts, and washers must be a captive design. Captive bolts for securing the cover of nontraffic pull boxes must be capable of withstanding a torque from 55 to 60 ft-lb and a minimum pull-out strength of 750 lb.

86-1.02C(3) Traffic Pull Boxes

A traffic pull box and cover must comply with AASHTO HS20-44 and AASHTO M 306.

The frame must be anchored to the box.

Nuts must be vibration-resistant, zinc-plated, carbon steel and have a wedge ramp at the root of the thread.

For a cast iron cover or before galvanizing a steel cover, the manufacturer must apply the cover marking by one of the following methods:

1. Use a cast iron strip at least 1/4 inch thick with letters raised a minimum of 1/16 inch. Fasten the strip to the cover with 1/4-inch, flathead, stainless steel machine bolts and nuts. Peen the bolts after tightening.
2. Use a sheet steel strip at least 0.027 inch thick with letters raised a minimum of 1/16 inch. Fasten the strip to the cover by spot welding, tack welding, or brazing with 1/4-inch stainless steel rivets or 1/4-inch, roundhead, stainless steel machine bolts and nuts. Peen the bolts after tightening.
3. Bead weld the letters on the cover such that the letters are raised a minimum of 3/32 inch.
4. Cast the logo into the cast iron cover.

The steel cover must:

1. Be countersunk approximately 1/4 inch to accommodate the bolt head. When tightened, the hold down bolt head must be no more than 1/8 inch above the top of the cover.
2. Have slot holes for lifting with a guard under the cover to prevent entry of more than 3 inches below the bottom surface of the cover without deflection to protect the pull box contents.

Hold-down bolts must be a Penta Head 1/2-13UNC and must have a thread lock material.

86-1.02C(4) Tamper Resistant Pull Boxes

86-1.02C(4)(a) General

Not Used

86-1.02C(4)(b) Tamper-Resistant Nontraffic Pull Box

A tamper resistant nontraffic pull box must include a pull box with one of the following:

1. Anchored cover
2. Lockable cover
3. Pull box insert

86-1.02C(4)(c) Tamper Resistant Traffic Pull Box

A tamper resistant traffic pull box must include a pull box with an anchored cover.

86-1.02C(4)(d) Anchored Cover

The anchored cover must:

1. Be of 1/2-inch-thick mild steel, hot dip galvanized, post fabrication.
2. Be hot dip galvanized after manufacturing with spikes removed from the galvanized surfaces.
3. Have a center space for a top lock nut that must be torqued to 200 ft-lb.
4. Have a center opening for a stainless steel threaded cap to cover the lock nut.
5. Weigh a minimum of 85 lb.
6. Include an all-around security skirt of 1/4-inch thick steel. The skirt must be sized to encase a nontraffic pull box or sized to fit within a traffic pull box.
7. Be welded to the skirt.

86-1.02C(4)(e) Lockable Cover

The lockable cover must:

1. Be manufactured from minimum 3/16-inch-thick galvanized steel or a polymer of minimum strength equal to 3/16 inch steel
2. Be secured to the pull box with a locking mechanism of equal or greater strength than the manufactured material
3. Have 1/2-by-2-inch slot holes for lifting
4. Have dimensions complying with one of the following:
   4.1. Department's standards for pull covers as shown if the lockable cover is secured to the inside lip of the pull
   4.2. Department's standards for LO and WO for the length and width as shown for pull box covers if the lockable cover is secured to the top of the pull box

86-1.02C(4)(f) Pull Box Insert

The pull box insert must:

1. Be made of minimum 3/16-inch-thick or 10 gauge mild hot-dipped galvanized steel
2. Have a minimum of 2 mounting brackets that rest under the side or end wall
3. Be lockable with a padlock having a minimum 3/8-inch shackle
4. Have dimensions complying with the Department's standards for LI and WI for the length and width as shown for pull box covers

86-1.02D Tapes

86-1.02D(1) General

Reserved

86-1.02D(2) Pull Tape

Pull tape must be a flat, woven, lubricated, soft-fiber, polyester tape with a minimum tensile strength of 1,800 lb. The tape must have sequential measurement markings every 3 feet.

86-1.02D(3) Warning Tape

Warning tape must comply with requirements shown in the following table:

Warning Tape Requirements

Description	Parameters
Thickness	Minimum 4 mil
Width	4 inches
Material	Orange color polyolefin film
Tensile strength of material	Minimum of 2800 psi
Elongation	Minimum of 500 percent elongation before breakage
Printed message content	CAUTION: CALTRANS FACILITIES BELOW
Printed message text height and color	1 inch, black color text over bright orange background
Message spacing intervals	3 feet

Warning tape must be water and corrosion resistant.

86-1.02E Piezoelectric Axle Sensors

Piezoelectric axle sensors must be Class II and must be for vehicle classification purposes.

Each sensor must:

1. Be 1/4 inch wide by 6 feet long by 1/16 inch thick.
2. Have a screen transmission cable attached. The screened transmission cable must be RG-58C/U coaxial cable, jacketed with high-density polyethylene, rated for direct burial and resistant to nicks and cuts.
3. Operate over a temperature range from -40 to 160 degrees F.
4. Have a signal to noise ratio equal to or greater than 10 to 1.
5. Have an output uniformity range of plus or minus 20 percent.
6. Have an output signal of a minimum 250 mV for a wheel load of 400 lb at 55 mph and 70 degrees F.
7. Have an insulation resistance greater than 500 MΩ.
8. Have a life cycle of a minimum 25 million equivalent single axle loadings.

86-1.02F Conductors and Cables

86-1.02F(1) General

Conductors and cables must be clearly and permanently marked the entire length of their outer surface with:

1. Manufacturer's name or trademark
2. Insulation-type letter designation
3. Conductor size
4. Voltage
5. Temperature rating
6. Number of conductors for a cable

The minimum insulation thickness and color code requirements must comply with NEC.

86-1.02F(2) Conductors

86-1.02F(2)(a) General

A conductor must be UL listed or NRTL certified and rated for 600 V(ac).

Conductors must be identified as shown in the following table:

Conductor Identification

Circuit	Signal phase or function	Identification			Copper Size
		Insulation color			
		Base	Stripe[a]	Band symbols	

Signals (vehicle)[a, b]	2, 6	Red, yellow, brown	Black	2, 6	14
	4, 8	Red, yellow, brown	Orange	4, 8	14
	1, 5	Red, yellow, brown	None	1, 5	14
	3, 7	Red, yellow, brown	Purple	3, 7	14
	Ramp meter 1	Red, yellow, brown	None	No band required	14
	Ramp meter 2	Red, yellow, brown	Black	No band required	14
Pedestrian signals	2p, 6p	Red, brown	Black	2p, 6p	14
	4p, 8p	Red, brown	Orange	4p, 8p	14
	1p, 5p	Red, brown	None	1p, 5p	14
	3p, 7p	Red, brown	Purple	3p, 7p	14
Push button assembly or accessible pedestrian signal	2p, 6p	Blue	Black	P-2, P-6	14
	4p, 8p	Blue	Orange	P-4, P-8	14
	1p, 5p	Blue	None	P-1, P-5	14
	3p, 7p	Blue	Purple	P-3, P-7	14
Traffic signal controller cabinet	Ungrounded circuit conductor	Black	None	CON-1	6
	Grounded circuit conductor	White	None	CON-2	6
Highway lighting pull box to luminaire	Ungrounded - line 1	Black	None	No band required	14
	Ungrounded - line 2	Red	None	No band required	14
	Grounded	White	None	No band required	14
Multiple highway lighting	Ungrounded - line 1	Black	None	ML1	10
	Ungrounded - line 2	Red	None	ML2	10
Lighting control	Ungrounded - Photoelectric unit	Black	None	C1	14
	Switching leg from Photoelectric unit or SM transformer	Red	None	C2	14
Service	Ungrounded - line 1 (signals)	Black	None	No band required	6
	Ungrounded - line 2 (lighting)	Red	None	No band required	8
Sign lighting	Ungrounded - line 1	Black	None	SL-1	10
	Ungrounded - line 2	Red	None	SL-2	10
Flashing beacons	Ungrounded between flasher and beacons	Red or yellow	None	F-Loc.[c]	14
Grounded circuit conductor	Push button assembly or accessible pedestrian signal	White	Black	No band required	14
	Signals and multiple lighting	White	None	No band required	10
	Flashing beacons and sign lighting	White	None	No band required	12
	Lighting control	White	None	C-3	14
	Service	White	None	No band required	14
Railroad preemption		Black	None	R	14

Spares		Black	None	No band required	14

Notes:
[a]On overlaps, the insulation is striped for the 1st phase in the designation, e.g., phase (2+3) conductor is striped as for phase 2.
[b]Band for overlap and special phases as required
[c]Flashing beacons having separate service do not require banding.

The insulation color must be homogeneous throughout the full depth of the insulation. The identification stripe must be continuous throughout the length of the conductor.

Conductors size no. 8 to size no. 2 must be aluminum except for bonding jumpers and equipment grounding conductors.

86-1.02F(2)(b) Aluminum Conductors

Aluminum conductors must comply with ASTM B800 and 801.

Insulation for aluminum conductors must be one of the following:

1. Type XHHW-2
2. Type USE, RHH, or RHW cross-linked polyethylene

86-1.02F(2)(c) Copper Conductors

86-1.02F(2)(c)(i) General

Copper wire must comply with ASTM B3 and B8.

Insulation for no. 14 to no. 4 conductors must be one of the following:

1. Type TW PVC under ASTM D2219
2. Type THW PVC
3. Type USE, RHH, or RHW cross-linked polyethylene

The insulation for no. 2 and larger conductors must be one of the above or THWN.

86-1.02F(2)(c)(ii) Bonding Jumpers and Equipment Grounding Conductors

A bonding jumper must be copper wire or copper braid of the same cross-sectional area as a no. 8 conductor or larger.

An equipment grounding conductor may be bare or insulated.

86-1.02F(2)(c)(iii) Inductive Loop Conductors

An inductive loop conductor must comply with the requirements shown in the following table:

Conductor Requirements for Inductive Loop Detectors

Loop wire	Requirement
Type 1	Type RHW-USE neoprene-jacketed or Type USE cross-linked polyethylene, insulated, no. 12, stranded copper wire with a minimum 40-mils insulation thickness at any point.
Type 2	Type THWN or Type XHHW, no. 14, stranded copper wire in a plastic tubing. The plastic tubing must be polyethylene or vinyl rated for use at 105 degrees C and resistant to oil and gasoline. The outside diameter of the tubing must be at most 0.27 inch with a wall thickness of at least 0.028 inch.

86-1.02F(2)(d) Reserved

86-1.02F(3) Cables

86-1.02F(3)(a) General

Not Used

86-1.02F(3)(b) Aluminum Cables

86-1.02F(3)(b)(i) General

Not Used

86-1.02F(3)(b)(ii) Direct Burial Cables

Direct burial cable must be aluminum.

The direct burial aluminum cable must:

1. Be a metal-clad type
2. Be UL listed or NRTL certified for direct burial and concrete encasement
3. Include conductors rated for 90 degrees C
4. Have a galvanized steel or aluminum interlocking metal tape sheath with PVC jacket
5. Have a minimum no. 6 AWG aluminum or copper-clad aluminum equipment grounding conductor

86-1.02F(3)(c) Reserved

86-1.02F(3)(d) Copper Cables

86-1.02F(3)(d)(i) General

Not Used

86-1.02F(3)(d)(ii) Conductor Signal Cables

A conductor signal cable must have a black polyethylene jacket with an inner polyester binder sheath. The cable jacket must be rated for 600 V(ac) and 75 degrees C. Filler material, if used, must be polyethylene.

The individual conductors in the cable must be solid copper complying with ASTM B286 with Type THWN insulation. The minimum thickness of insulation must comply with NEC for conductor sizes no. 14 to no.10. The minimum thickness of the nylon jacket must be 4 mils.

Cable must comply with the requirements shown in the following table:

Cable type	Conductor quantity and type	Cable jacket thickness (mils)		Maximum nominal outside diameter (inch)	Conductor color code
		Average	Minimum		

3CSC	3 no. 14	44	36	0.40	Blue/black, blue/orange, white/black stripe
5CSC	5 no. 14	44	36	0.50	Red, yellow, brown, black, white
9CSC	8 no. 14 1 no. 12	60	48	0.65	No. 12 - white, no. 14 - red, yellow, brown, black, and red/black, yellow/black, brown/black, white/black stripe
12CSC	11 no. 14 1 no. 12	60	48	0.80	No. 12 - white, no. 14 - red, yellow, brown, red/black stripe, yellow/black stripe, brown/black stripe, black/red stripe, black/white stripe, black, red/white stripe, brown/white stripe
28CSC	27 no. 14 1 no. 10	80	64	0.90	No. 10 - white no. 14 - red/black stripe, yellow/black stripe, brown/black stripe, red/orange stripe, yellow/orange stripe, brown/orange stripe, red/silver stripe, yellow/silver stripe, brown/silver stripe, red/purple stripe, yellow/purple stripe, brown/purple stripe, red/2 black stripes, brown/2 black stripes, red/2 orange stripes, brown/2 orange stripes, red/2 silver stripes, brown/2 silver stripes, red/2 purple stripes, brown/2 purple stripes, blue/black stripe, blue/orange stripe, blue/silver stripe, blue/purple stripe, white/black stripe, black/red stripe, black

86-1.02F(3)(d)(iii) Detector Lead-in Cables

Conductors for a loop detector lead-in cable must be two no. 16, 19-by-29, stranded, tinned copper wires with calculated cross-sectional areas complying with ASTM B286, Table 1 and the requirements shown in the following table:

Conductor Requirements for Loop Detector Lead-In Cables

Lead-in cable	Requirement
Type B	Insulated with 20 mils of high-density polyethylene. Conductors must be twisted together with at least 2 turns per foot, and the twisted pair must be protected with a copper or aluminum polyester shield. A minimum no. 20 copper drain wire must be connected to the equipment ground within the cabinet. Cable must have a high-density polyethylene or high-density polypropylene outer jacket with a nominal thickness of 32 mils. Include an amorphous, interior, moisture penetration barrier of nonhydroscopic polyethylene or polypropylene fillers.
Type C	Comply with International Municipal Signal Association Specification no. 50-2. A minimum no. 20 copper drain wire must be connected to the equipment ground within the cabinet.

86-1.02F(3)(d)(iv) Reserved

86-1.02F(3)(d)(v) Signal Interconnect Cables

A signal interconnect cable must be a 6-pair type with stranded, tinned, copper no. 20 conductors. The insulation for each conductor must be color-coded polypropylene with a minimum 13-mils nominal thickness. The conductors must be in color-coded, twisted pairs. Each pair must be wrapped with an aluminum polyester shield and have a no. 22 or larger, stranded, tinned, copper drain wire inside the shielded pair.

The cable jacket must be black HDPE rated for a minimum of 300 V(ac) and 60 degrees C. The jacket must have a minimum nominal wall thickness of 40 mils.

86-1.02F(3)(d)(vi) Communication Cables

86-1.02F(3)(d)(vi)(a) General

Not Used

86-1.02F(3)(d)(vi)(b) Category 5E Cables

A category 5E cable must be a 4-pair, unshielded, outdoor rated, nongel-filled type and comply with ANSI/TIA/EIA 568-B.

86-1.02F(3)(d)(vi)(c) Category 6 Cables

A category 6 cable must be a 4-pair, unshielded, outdoor rated, nongel-filled type and comply with ANSI/TIA/EIA 568-C.

86-1.02F(3)(d)(vi)(d) Telephone Cables

A telephone cable must be a 6-pair type with solid, tinned, copper no. 22 conductors and comply with RUS Bulletin 1735F-205 (PE-39).

86-1.02G Equipment Identification Characters

Equipment identification characters must be 2-1/2 inch, series D lettering, except on wood poles, they must be 3-inch lettering.

The characters must be self-adhesive reflective labels or paint, except on wood poles, they must be embossed on aluminum.

Labels must have a white back ground, all black capital characters, and must extend beyond the character by a minimum of 1/4 inch.

86-1.02H Splicing Materials

Splicing materials include:

1. Connectors
2. Electrical insulating coating
3. PVC electrical tape
4. Butyl rubber stretchable tape
5. PVC pressure-sensitive adhesive tape

6. Heat shrink tubing

Connectors must be C-shaped compression or butt type.

Electrical insulating coating must be a fast drying sealant with low nontoxic fumes.

PVC electrical tape must have a minimum thickness of 80 mils.

Butyl rubber stretchable tape with liner must have a minimum thickness of 120 mils.

PVC pressure-sensitive adhesive electrical tape must have a minimum thickness of 6 mils.

Electrical tapes must be self-fusing, oil- and flame-resistant, synthetic rubber and be UL listed or NRTL certified.

Heat-shrink tubing must be made of irradiated polyolefin tubing with a minimum wall thickness of 40 mils before contraction and an adhesive mastic inner wall. When heated, the inner wall must melt and fill the crevices and interstices of the covered splice area and the outer wall must shrink to form a waterproof insulation.

Heat-shrink tubing must comply with the requirements for extruded, insulating tubing at 600 V(ac) specified in UL Standard 468D and ANSI C119.1 and the requirements shown in the following table:

Heat-Shrink Tubing Requirements

Quality characteristic	Requirement
Shrinkage ratio of supplied diameter[a] (max, %)	33
Dielectric strength (min, kV/in)	350
Resistivity (min, Ω/in)	25×10^{13}
Tensile strength (min, psi)	2,000
Operating temperature (°C)	-40–90 (135 °C in emergency)
Water absorption (max, %)	0.5

[a]When heated to 125 °C and allowed to cool to 25 °C

86-1.02I Connectors and Terminals

Copper connectors must comply with UL-486A.

Aluminum connector must comply with UL-486 B.

Connectors and terminals must be rated for the conductors' size and material type and be prefilled with oxide-inhibiting compound.

Connectors and terminals for copper conductors must be a compression or crimp type.

Connectors and terminals for aluminum conductors must be a compression type.

86-1.02J Standards, Poles, Pedestals, and Posts

Standards for signals, lighting, and flashing beacons, poles for closed circuit television, pedestals for cabinets, posts for extinguishable message sign and posts for pedestrian push button assemblies must comply with section 56-3.

86-1.02K Luminaires

86-1.02K(1) General

Luminaire must be either LED or low-pressure-sodium type.

86-1.02K(2) LED Luminaires

LED luminaire must be on the Authorized Material List for LED luminaires and must:

1. Be self-contained, not requiring assembly.
2. Comply with UL 1598 for luminaires in wet locations.
3. Have a power supply with:
   3.1. ANSI/IEC rating of at least IP65.

3.2. 2 leads to accept standard 0-10 V(dc).
3.3. Dimming control compatible with IEC 60929, Annex E. If the control leads are open or the analog control signal is lost, the circuit must default to 100-percent power.
3.4. Case temperature self rise of 77 degrees F or less above ambient temperature in free air with no additional heat sinks.

4. Weigh no more than 35 lb.
5. Have a minimum operating life of 63,000 hours when operated for an average time of 11.5 hours at an average temperature of 70 degrees F.
6. Be designed to operate over a temperature range from -40 to 130 degrees F.
7. Be operationally compatible with photoelectric controls.
8. Have a correlated color temperature range from 3,500 to 6,500 K and a color rendering index of 65 or greater.
9. Have a maximum-effective projected area of 1.4 sq ft when viewed from either side or end.
10. Have a housing color that matches a color no. 26152 to 26440, 36231 to 36375, or 36440 of FED-STD-595.
11. Have an ANSI C136.41-compliant, locking-type, photocontrol receptacle with dimming connections and a watertight shorting cap.
12. Comply with LM-79, LM-80 and California Test 611.

The individual LEDs must be connected such that a catastrophic loss or a failure of 1 LED does not result in the loss of more than 20 percent of the luminous output of the luminaire.

The luminaire must be permanently marked inside the unit and outside of its packaging box. Marking consists of:

1. Manufacturer's name or trademark
2. Month and year of manufacture
3. Model, serial, and lot numbers
4. Rated voltage, wattage, and power in VA

An LED luminaire's onboard circuitry must include a surge protection device to withstand high-repetition noise transients caused by utility line switching, nearby lightning strikes, and other interferences. The device must protect the luminaire from damage and failure due to transient voltages and currents as defined in Tables 1 and 4 of ANSI/IEEE C64.41.2 for location category C-High. The surge protection device must comply with UL 1449 and ANSI/IEEE C62.45 based on ANSI/IEEE C62.41.2 definitions for standard and optional waveforms for location category C-High.

An LED luminaire and its associated onboard circuitry must comply with the Class A emission limits under 47 CFR 15(B) for the emission of electronic noise.

The fluctuations of line voltage must have no visible effect on the luminous output.

The operating voltage may range from 120 to 480 V(ac), 60 ± 3 Hz. Luminaire must operate over the entire voltage range or the voltage range must be selected from one of the following:

1. Luminaire must operate over a voltage range from 95 to 277 V(ac). The operating voltages for this option are 120 V(ac) and 240 V(ac).
2. Luminaire must operate over a voltage range from 347 to 480 V(ac). The operating voltage for this option is 480 V(ac).

LED luminaire must have a power factor of 0.90 or greater. The total harmonic distortion, current, and voltage induced into a power line by a luminaire must not exceed 20 percent. The L70 of the luminaire must be the minimum operating life or greater. Illuminance measurements must be calibrated to standard photopic calibrations.

The maximum power consumption and maintained illuminance of the LED luminaires must comply with the isofootcandle curves as shown.

LED luminaire must not allow more than 10 percent of the rated lumens to project above 80 degrees from vertical and 2.5 percent of the rated lumens to project above 90 degrees from vertical.

Luminaire must have passive thermal management with enough capacity to ensure proper heat dissipation and functioning of the luminaire over its minimum operating life. The maximum junction temperature for the minimum operating life must not exceed 221 degrees F.

The junction-to-ambient thermal resistance must be 95 degrees F per watt or less. The use of fans or other mechanical devices is not allowed for cooling the luminaire. The heat sink must be made of aluminum or other material of equal or lower thermal resistance. The luminaire must contain circuitry that automatically reduces the power to the LEDs so the maximum junction temperature is not exceeded when the ambient temperature is 100 degrees F or greater.

The luminaire's housing must be fabricated from materials designed to withstand a 3,000-hour salt spray test under ASTM B117. All aluminum used in housings and brackets must be made of a marine-grade alloy with less than 0.2 percent copper. All exposed aluminum must be anodized. A chromate conversion undercoating must be used underneath a thermoplastic polyester powder coat.

The housing must be designed to prevent the buildup of water on its top surface. Exposed heat sink fins must be oriented to allow water to run off the luminaire and carry dust and other accumulated debris away from the unit. The optical assembly of the luminaire must be protected against dust and moisture intrusion to at least an UL 60529 rating of IP66. The power supply enclosure must be protected to at least an UL 60529 rating of IP43.

The housing must have a slip fitter capable of being mounted on a 2-inch-diameter pipe tenon. Slip fitter must:

1. Fit on mast arms with outside diameters from 1-5/8 to 2-3/8 inches
2. Be adjustable to a minimum of ±5 degrees from the axis of the tenon in a minimum of 5 steps: +5, +2.5, 0, -2.5, -5
3. Have clamping brackets that:
    3.1. Are made of corrosion-resistant materials or treated to prevent galvanic reactions
    3.2. Do not bottom out on the housing bosses when adjusted within the designed angular range
    3.3. Do not permanently set in excess of 1/32 inch when tightened

Each refractor or lens must be made of UV-inhibiting high-impact plastic, such as acrylic or polycarbonate, or heat- and impact-resistant glass. The refractor or lens must be resistant to scratching. Polymeric materials, except for the lenses of enclosures containing either the power supply or electronic components of the luminaire, must be made of UL94 V-0 flame-retardant materials.

An LED luminaire and its internal components must be able to withstand mechanical shock and vibration.

If the components are mounted on a down-opening door, the door must be hinged and secured to the luminaire's housing separately from the refractor or flat lens frame. The door must be secured to the housing to prevent accidental opening. A safety cable must mechanically connect the door to the housing.

An LED luminaire must have a barrier-type terminal block secured to the housing to connect field wires. The terminal screws must be captive and equipped with wire grips for conductors up to no. 6.

The conductors and terminals must be identified and marked.

86-1.02K(3) Low-Pressure Sodium Luminaires

A low-pressure sodium luminaire must be an enclosed cutoff or semi-cutoff type and be self-contained, not requiring assembly.

The housing must be either (1) a minimum 1/16-inch-thick, corrosion-resistant, die-cast aluminum sheet and plate with concealed continuous welds or (2) a minimum 3/32-inch-thick, acrylonitrile-butadiene-styrene sheet material on a cast aluminum frame. The housing must provide mounting for all electrical components and a slip fitter. The housing must be divided into optical and power compartments that are individually accessible for service and maintenance.

The painted exterior surface of the luminaire must be finished with a fused coating of electrostatically applied polyester powder paint or other UV-inhibiting film. The color must be aluminum gray.

A sealing ring must be installed in the pipe tenon opening to prevent the entry of water and insects into the power and optical compartments. The ring must be made of high-temperature neoprene or equal material.

The power unit assembly must be accessible through a weather-tight, hinged cover secured to the housing with spring latches or captive screws.

The luminaire's hardware must be stainless steel or cadmium plated. Removable components must be secured with machine screws or bolts instead of sheet metal screws.

A semi-cutoff luminaire or a molded refractor-style cutoff luminaire must include a refractor. Other cutoff luminaires must include a flat lens. The refractor assembly and flat lens assembly must be designed to rigidly maintain their shape and be hinged and secured to the housing with spring latches.

The refractor must be either a 1-piece injection-molded polycarbonate with a minimum thickness of 3/32 inch or a 1-piece injection-molded acrylic with a minimum thickness of 1/8 inch. Alternate methods of manufacturing the refractor may be authorized provided minimum specified thicknesses are maintained.

The flat lens must be a 1-piece polycarbonate with a minimum thickness of 3/32 inch, mounted to a metal frame.

The lamp socket must be made of high-temperature, flame-retardant, thermoset material with self-wiping contacts or an equal. The socket must be rated for 660 W and 1,000 V(ac). The position of the socket and support must maintain the lamp in the correct relationship with the reflector and refractor for the designed light distribution pattern. The reflector may be an integral part of the housing.

The luminaire must comply with the isofootcandle curves as shown.

Low-pressure sodium lamp must:

1. Be a 180 W, single-ended, bayonet-base, tubular, gas-discharge lamp
2. Maintain a minimum of 93 percent of its initial lumens over its rated life
3. Reach 80 percent of its light output within 10 minutes
4. Restrike within 1 minute after a power outage or voltage drop at the lamp socket
5. Have ANSI L74/E designation

The lamp operating position must be at ±20 degrees from the horizontal.

Lamp must comply with the minimum performance requirements shown in the following table:

Minimum Performance Requirements

Quality characteristic	Requirement
Initial lumens (lm)	33,000
Rated average life at 10 h/start (h)	18,000

The low-pressure sodium lamp ballast must be an autotransformer or high-reactance type. The power factor must be not less than 90 percent when the ballast is operated at the nominal line voltage with a nominally-rated reference lamp. The lamp wattage regulation spread must not vary by more than ±6 percent for ±10 percent input voltage variation from nominal through life.

At the line voltage, the ballast must have a lamp current crest factor not exceeding 1.8 and ballast loss not exceeding 24 percent for a 180 W ballast.

The ballast must include a multi-circuit connector for quick disconnection.

86-1.02K(4) Reserved

86-1.02L Reserved

86-1.02M Photoelectric Controls

Photoelectric control types are as shown in the following table:

Photoelectric Control Types

Control type	Description
I	Pole-mounted photoelectric unit. Test switch housed in an enclosure.
II	Pole-mounted photoelectric unit. Contactor and test switch located in a service equipment enclosure.
III	Pole-mounted photoelectric unit. Contactor and a test switch housed in an enclosure.
IV	A photoelectric unit that plugs into a NEMA twist-lock receptacle, integral with the luminaire.
V	A photoelectric unit, contactor, and test switch located in a service equipment enclosure.

The pole-mounted adaptor for Type I, II, and III photoelectric controls must include a terminal block and cable supports or clamps to support the wires.

The enclosure for Type I and III photoelectric controls must be a NEMA 3R type. The enclosure must have a factory-applied, rust-resistant prime coat and finish coat. The enclosure must be hot-dip galvanized or painted to match the color of the lighting standard.

Photoelectric unit must:

1. Have a screen to prevent artificial light from causing cycling.
2. Have a rating of 60 Hz, 105-130 V(ac), 210-240 V(ac), or 105-240 V(ac).
3. Operate at a temperature range from -20 to 55 degrees C.
4. Consume less than 10 W.
5. Be a 3-prong, twist-lock type with a NEMA IP 65 rating, ANSI C136.10-compliant.
6. Have a fail-on state.
7. Fit into a NEMA-type receptacle.
8. Turn on from 1 to 5 footcandles and turn off from 1.5 to 5 times the turn-on level. Measurements must be made by procedures in *EEI-NEMA Standards for Physical and Electrical Interchangeability of Light-Sensitive Control Devices Used in the Control of Roadway Lighting.*

Type I, II, III, and V photoelectric controls must have a test switch to allow manual operation of the lighting circuit. Switch must be:

1. Single-hole mounting, toggle type
2. Single pole and single throw
3. Labeled *Auto-Test* on a nameplate

Photoelectric control's contactor must be:

1. Normally open
2. Mechanical-armature type with contacts of fine silver, silver alloy, or equal or better material
3. Installed to provide a minimum space of 2-1/2 inches between the contactor terminals and the enclosure's sides

The terminal blocks must be rated at 25 A, 600 V(ac), molded from phenolic or nylon material, and be the barrier type with plated-brass screw terminals and integral marking strips.

86-1.02N Fused Splice Connectors

The fused splice connector for 240 and 480 V(ac) circuits must simultaneously disconnect both ungrounded conductors. The connector must not have exposed metal parts except for the head of the stainless steel assembly screw. The head of the assembly screw must be recessed a minimum of 1/32 inch below the top of the plastic boss that surrounds the head.

The connector must protect the fuse from water or weather damage. Contact between the fuse and fuse holder must be spring loaded.

Fuses must:

1. Be standard, midget, ferrule type

2. Have a nontime-delay feature
3. Be 3/32 by 1-1/2 inches

86-1.02O Grounding Electrodes

Grounding electrode must be:

1. 1 piece
2. Minimum 10-foot length of one of the following:
   2.1. Galvanized steel rod or pipe not less than 3/4 inch in diameter
   2.2. Copper clad steel rod not less than 5/8 inch in diameter

86-1.02P Enclosures

86-1.02P(1) General

The enclosures must be rated NEMA 3R and include a dead front panel and a hasp with a 7/16-inch-diameter hole for a padlock.

The enclosure's machine screws and bolts must not protrude outside the cabinet wall.

The fasteners on the exterior of an enclosure must be vandal resistant and not be removable. The exterior screws, nuts, bolts, and washers must be stainless steel.

86-1.02P(2) Service Equipment Enclosures

A service equipment enclosure must be factory wired and manufactured from steel and galvanized or have factory-applied, rust-resistant prime and finish coats, except Types II and III.

Type II and III service equipment enclosures must:

1. Be made of 0.125-inch minimum thickness 5052-H32 aluminum sheet complying with ASTM B209.
2. Be manufactured using gas metal arc welding with bare aluminum welding electrodes. The electrodes must comply with AWS A5.10 Class ER5356.
3. Be manufactured using welding procedures, welders, and welding operators that comply with the requirements for welding procedures, welders, and welding operators in in AWS B2.1, "Specification for Welding Procedure and Performance Qualification."
4. Have full-seal weld exterior seams.
5. Exterior welds must be ground smooth and edges filed to a radius of at least 0.03 inch.
6. Have a surface finish that complies with MIL-A-8625 for a Type II, Class I coating, except the anodic coating must have a minimum thickness of 0.0007 inch and a minimum coating weight of 0.001 oz/sq in.

If a Type III enclosure houses a transformer of more than 1 kVA, the enclosure must have effective screened ventilation louvers of no less than 50 sq. in for each louver. The framed screen must be stainless no. 304 with a no. 10 size mesh and secured with at least 4 bolts.

The dead front panel on a Type III service equipment enclosure must have a continuous stainless steel or aluminum piano hinge. The panel must be secured with a latch or captive screws. No live part must be mounted on the panel.

The enclosure must be watertight and marked as specified in NEC to warn of potential electric-arc flash hazards.

Internal conductors for the photoelectric control unit must be 600 V(ac), 14 AWG (THHN) stranded machine tool wire. Where subject to flexing, 19 stranded wire must be used.

The meter area must be have a sealable, lockable, weather-tight cover that can be removed without the use of tools.

For Type III-A, III-B, and III-C enclosures, the meter socket must be a 5-clip type, and the landing lug must be suitable for multiple conductors.

For a Type III-D enclosure, the meter socket must be a 7-clip type, and the landing lug must be suitable for multiple conductors. The pedestal must comply with the Electric Utility Service Equipment Requirements Committee drawing no. 308 or 309.

Landing lugs must be (1) sized for the incoming service utility conductors, (2) compatible with either copper or aluminum conductors, and (3) made of copper or tin-plated aluminum. Live parts of the electrical equipment must be guarded against accidental contact.

The main and neutral busses of the enclosure must be made of tin-plated copper, be rated for 125 A, and be suitable for copper or aluminum conductors.

Each service equipment enclosure must have up to 2 main circuit breakers that will simultaneously disconnect ungrounded service-entrance conductors.

Circuit breaker for a service equipment enclosure must:

1. Be quick-break on either automatic or manual operation
2. Be trip indicating
3. Be internal-trip type
4. Be UL listed or NRTL certified and comply with UL 489 or equal
5. Be clearly marked with the frame size
6. Have an operating mechanism that is enclosed and trip-free from the operating handle on overload
7. Have the trip rating clearly marked on the operating handle
8. Have an interior made of copper

Circuit breakers used as disconnects must have a minimum interrupting capacity of 10,000 A, rms.

The interior of the enclosure must accept plug-in circuit breakers. A minimum of 6 standard single-pole circuit breakers, 3/4" nominal, must be provided for branch circuits.

Identify each circuit breaker and component by description using an engraved phenolic nameplate attached with stainless steel rivets or screws.

Nameplate must be installed:

1. Adjacent to the breaker on the dead front panel. The characters must be a minimum of 1/8 inch high.
2. Adjacent to the component on the back panel. The characters must be a minimum of 1/8 inch high.
3. At the top exterior of the door panel. The nameplate must include the system number, voltage, and number of phases engraved in minimum 3/16-inch-high characters.

A plastic-laminated wiring diagram must be attached inside the enclosure with brass eyelets by a UL-listed or NRTL-certified method.

86-1.02P(3) Lighting and Sign Illumination Enclosures

A lighting and sign illumination enclosure must be manufactured from steel and either galvanized, cadmium plated, or powder coated.

86-1.02Q Cabinets

86-1.02Q(1) General

Cabinets must be factory wired except for battery backup system cabinets.

The fasteners on the exterior of a cabinet, except for battery backup system cabinets, must be removable and vandal resistant. The exterior screws, nuts, bolts, and washers must be stainless steel.

Terminal blocks, circuit breakers, and a power supply must be UL approved.

86-1.02Q(2) Department-Furnished Controller Cabinets

A Department-furnished controller assembly consists of a Model 170E or 2070E controller unit, a wired controller cabinet, and all auxiliary equipment required to operate the system. The Department does not furnish anchor bolts.

86-1.02Q(3) Controller Cabinets

The controller cabinet must be a Model 334L, comply with TEES, and be on the Authorized Material List for traffic signal control equipment. The cabinet must have 3 drawer shelves. Each shelf must be attached to the tops of 2 supporting angles with 4 screws.

86-1.02Q(4) Telephone Demarcation Cabinets

86-1.02Q(4)(a) General

The doors of a telephone demarcation cabinet must be attached using stainless steel piano hinges.

86-1.02Q(4)(b) Type A Telephone Demarcation Cabinets

Reserved

86-1.02Q(4)(c) Type B Telephone Demarcation Cabinets

A Type B telephone demarcation cabinet consists of a mounting panel, outlets, circuit breaker, fan, dead front plates, and fuse.

The mounting panel must be made of 3/4-inch-thick ACX-grade plywood.

The mounting panel must be fastened to the cabinet with nuts, lock washers, and flat washers to 10 welded studs.

The cabinet must be made of 0.125-inch-thick anodized aluminum.

The cabinet door must be hung and secured with drawn latches, lockable with a padlock. The padlock latches must each have a minimum 7/16-inch-diameter hole.

Ventilation louvers must be located on the door.

The fan must be located in a ventilator housing and be controlled thermostatically. The thermostat control must have a range from 80 to 130 degrees F.

The thermostat and fan circuit must be protected with a fuse rated for 175 percent of the motor capacity. The fan capacity must be a minimum 25 cfm.

86-1.02Q(4)(d) Type C Telephone Demarcation Cabinets

Reserved

86-1.02Q(5) Battery Backup System Cabinets

The cabinet for a battery backup system must comply with TEES and be on the Authorized Material List for traffic signal control equipment.

86-1.02R Signal Heads

86-1.02R(1) General

A signal head consists of a signal mounting assembly, backplate, and signal face.

The head must have a terminal block attached to the back of one housing. The terminal block must have enough positions to accommodate all indications. Each position must be permanently labeled for the indications used.

The metal signal heads must not fracture or deflect more than half the lens diameter when tested under California Test 666.

The plastic signal heads must not fracture or deflect when tested under California Test 605.

The deflection must not be more than 10 degrees in either the vertical or horizontal plane after the wind load has been removed from the front of the signal face or more than 6 degrees in either the vertical or horizontal plane after the wind load has been removed from the back of the signal face.

86-1.02R(2) Signal Mounting Assemblies

Signal mounting assembly must include:

1. 1-1/2-inch-diameter steel pipe or galvanized conduit
2. Pipe fitting made of ductile iron, galvanized steel, bronze, or aluminum alloy, Type AC-84B, no. 380
3. Mast arm and post-top slip fitters and terminal compartments made of cast bronze or hot-dip galvanized ductile iron

The horizontal distance between the vertical centerlines of the terminal compartment or slip fitter and of each signal face must not exceed 11 inches except where required for proper signal face alignment or to allow programming of programmed visibility signal sections.

The mounting assembly must be watertight and free of sharp edges or protrusions that might damage conductor insulation. The assembly must have positive-locking serrated fittings that prevent signal faces from rotating when the fittings are mated with similar fittings on the faces.

Each terminal compartment must be fitted with a terminal block having a minimum of 12 positions, each with 2 screw-type terminals. Each terminal must accommodate at least five no. 14 conductors. The terminal compartment must have a cover for easy access to the terminal block.

86-1.02R(3) Backplates

The backplate material must be a homogeneous black color with a lusterless finish.

A metal backplate must be made of a minimum 1/16-inch-thick 3001-14 aluminum.

A plastic backplate must have a minimum thickness of 1/16 inch and be formed from sheet plastic or assembled from extruded, molded, or cast plastic sections. Sections must be factory joined using one of the following:

1. Appropriate solvent cement
2. Aluminum rivets and washers painted or permanently colored to match the backplate
3. No. 10 machine screws with flat washers, lock washers, and nuts painted to match the backplate

Each plastic backplate must be secured to the plastic signal face such that it resists removal or permanent deformation.

86-1.02R(4) Signal Faces

Signal face consists of signal sections with signal housings, LED modules, and visors.

Signal face must:

1. Be adjustable and allow for 360-degree rotation about the vertical axis
2. Comply with ITE publications ST-052-E, *Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Circular Signal Supplement* and ST-054, *Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement*
3. Be sealed with a neoprene gasket at the top opening

A metal signal face must have a metal backplate and visor.

A plastic signal face must have a plastic backplate and visor.

If a signal face is supported by a Type MAS slip fitter, spacers are required between the 2 sections. The spacers must be made of the same material as the housing. The vertical dimension of the spacers must allow proper seating of the serrations between the slip fitter and the 2 sections. The 2 sections must be joined with at least two no. 10 minimum machine screws through holes near the front of the housing and the spacers and matching holes in a reinforcing plate installed in the housing.

86-1.02R(4)(a) Signal Sections

86-1.02R(4)(a)(i) General

Signal section must have:

1 Opening at the top and bottom for a 1-1/2-inch pipe
2. Maximum height of 10-1/4 inches for an 8-inch section and 14-3/4 inches for a 12-inch section
3. Hinge pins, door-latching devices, and other exposed hardware manufactured of Type 304/304L or 305 stainless steel
4. Interior screws and fittings manufactured of stainless steel or steel with a corrosion-resistant plating or coating
5. Gaskets made of a material that is not degraded if installed in a section with metal or plastic housing

Sections must be capable of being joined together to form a signal face in any combination. This interchangeability is not required between metal and plastic sections.

Each section must be joined to an adjacent section by one of the following:

1. Minimum of 3 machine screws for 8-inch sections and 4 machine screws for 12-inch sections, installed through holes near the front and back of the housing. Each screw must be a no. 10 and have a nut, flat washer, and lock washer.
2. 2 machine screws, each with a nut, flat washer, and lock washer, installed through holes near the front of the housing and a fastener through the 1-1/2-inch pipe opening. The fastener must have 2 large, flat washers to distribute the load around the pipe's opening and 3 carriage bolts, each with a nut and lock washer. The minimum screw size must be no. 10, and the carriage bolt size must be 1/4 inch.

The holes for the machine screws must be either cast or drilled during signal section fabrication. Each hole must be surrounded by a minimum 1/8-inch-wide boss to allow contact between signal sections about the axis of the hole.

A serrated nylon washer must be inserted between each plastic signal section and the metal mounting assembly. Each serrated nylon washer must be from 3/16 to 1/4 inch thick. The serrations must match those on the signal section and the mounting assembly.

86-1.02R(4)(a)(ii) Programmed Visibility Signal Sections

Programmed visibility signal section must have:

1. Nominal 12-inch-diameter circular or arrow indication
2. Cap visor
3. Adjustable connection that:
   3.1. Provides incremental tilting from 0 to 10 degrees above or below the horizontal
   3.2. Maintains a common vertical axis through couplers and mountings

The terminal connection must allow external adjustment about the mounting axis in 5-degree increments.

The visibility of each signal section must be capable of adjustment or programming within the section.

The adjustment for the section must be preset at 4 degrees below the horizontal.

86-1.02R(4)(a)(iii) Signal Housings

The signal housing must:

1. Be die-cast aluminum, permanent mold-cast aluminum, or if specified, structural plastic
2. Comply with ITE publications ST-052-E, *Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Circular Signal Supplement* and ST-054, *Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement* if made of die-cast or permanent mold-cast aluminum
3. Have a 1-piece, hinged, square-shaped door that is:
   3.1. Designed to allow access for replacement of modules without the use of tools
   3.2. Secured such that it remains closed during loading tests
4. Have a watertight module or lens mounted in the door
5. Have a terminal block attached to the back, with the terminals permanently labeled for conductors to facilitate field wiring

Each housing must have reinforcement plates. Reinforcement plates must be either sheet aluminum, galvanized steel, or cast aluminum. Each plate must have a minimum thickness of 0.11 inch and a hole concentric with a 1-1/2-inch pipe-mounting hole in the housing. Reinforcement plates must be placed as specified in the following table:

Reinforcement Plate Placement

Material	Placement
Sheet aluminum	Inside and outside of housing
Galvanized steel	Inside of housing
Cast aluminum	Outside of housing

Reinforcement plates placed outside of the housing must be finished to match the signal housing color and be designed to allow a proper serrated coupling between the signal face and the mounting hardware. A minimum of three no. 10 machine screws must be installed through holes in each plate and matching holes in the housing. Each screw must have a round or binder head, a nut, and a lock washer.

A metal housing must have a metal visor.

Plastic housing must:

1. Be molded in a single piece or fabricated from 2 or more pieces joined into a single piece
2. Be a black color throughout, including the door, matching color no. 17038, 27038, or 37038 of FED-STD-595
3. Have UV stability
4. Be self-extinguishing

If reinforcing webs are used to connect the back of the housing to the top, bottom, and sides of the adjacent housing, reinforcement plates are not required.

The exterior of the housing must be painted as specified in sections 78-4.08 and 59.

86-1.02R(4)(b) LED Signal Modules

An LED signal module must be on the Authorized Material List for LED traffic signal modules.

An LED signal module must comply with ITE publications ST-052-E, *Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Circular Signal Supplement* and ST-054, *Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement*, except:

1. Maximum module weight must be 4 lb
2. Module must be a sealed unit with:
   2.1. 2 color-coded conductors for the power connection except lane control modules must use 3 color-coded conductors
   2.2. Printed circuit board that complies with TEES, chapter 1, section 6
   2.3. Lens that is:
      2.3.1. Convex or flat with a smooth outer surface
      2.3.2. Made of UV-stabilized plastic or glass
   2.4. 1-piece EPDM gasket
3. Module must include 3-foot-long conductors with attached quick-disconnect terminals
4. Identification must include:
   4.1. Month and year of manufacture
   4.2. 1-inch-diameter symbol of the module type with the module color written adjacent to the symbol in 0.50-inch-high letters
5. LED must be the ultra-bright type rated for 100,000 hours of continuous operation
6. Module must have an integral power supply

Individual LEDs must be wired such that a loss or failure of 1 LED will not result in a loss of more than 5 percent of the module's light output. Failure of an individual LED in a string must not result in a loss of an entire string or other indication.

The symbol for a 12-inch U-turn section must be a 15/16-inch-wide inverted *U* with an arrow on the left end.

A lane control section must be a combination module with a red *X* and green arrow. The conductor function and color code must be as shown in the following table:

Conductor Function and Color Code

Function	Color
Neutral	White
Red *X*	Red
Green arrow	Brown

The minimum power consumption for an LED signal module must be 5 W.

The maximum power consumption for an LED signal module must be as shown in the following table:

Maximum Power Consumption

LED signal module type	Power consumption (W)					
	Red		Yellow		Green	
	25 °C	74 °C	25 °C	74 °C	25 °C	74 °C
8-inch circular	8	13	13	16	12	12
12-inch circular	11	17	22	25	15	15
12-inch arrow	9	12	10	12	11	11
12-inch U-turn	9	12	10	12	11	11
Bicycle	11	17	22	25	15	15
Programmed visibility	11	17	22	25	15	15
Lane control (*X*)	9	12	--	--	--	--
Lane control (*Arrow*)	--	--	--	--	11	11

Red and green LED signal modules operating over a temperature range from -40 to 74 degrees C and yellow LED signal modules operating at 25 degrees C must maintain the minimum illumination values for 48 months as shown in the following tables:

Minimum Maintained Intensities for Circular Indications

Angle (v,h)	Intensities (cd)					
	8-inch			12-inch		
	Red	Yellow	Green	Red	Yellow	Green
2.5, ±2.5	133	267	267	339	678	678
2.5, ±7.5	97	194	194	251	501	501
2.5, ±12.5	57	113	113	141	283	283
2.5, ±17.5	25	48	48	77	154	154
7.5, ±2.5	101	202	202	226	452	452
7.5, ±7.5	89	178	178	202	404	404
7.5, ±12.5	65	129	129	145	291	291
7.5, ±17.5	41	81	81	89	178	178
7.5, ±22.5	18	37	37	38	77	77
7.5, ±27.5	10	20	20	16	32	32
12.5, ±2.5	37	73	73	50	101	101
12.5, ±7.5	32	65	65	48	97	97
12.5, ±12.5	28	57	57	44	89	89
12.5, ±17.5	20	41	41	34	69	69
12.5, ±22.5	12	25	25	22	44	44
12.5, ±27.5	9	16	16	16	32	32
17.5, ±2.5	16	32	32	22	44	44
17.5, ±7.5	14	28	28	22	44	44
17.5, ±12.5	10	20	20	22	44	44
17.5, ±17.5	9	16	16	22	44	44
17.5, ±22.5	6	12	12	20	41	41
17.5, ±27.5	4	9	9	16	32	32

Minimum Maintained Luminance for Indications

Indication type	Luminance (fL)		
	Red	Yellow	Green
Arrow	1,610	3,210	3,210
U-turn	1,610	3,210	3,210
Bicycle	1,610	1,610	1,610
Lane control (*X*)	1,610	--	--
Lane control (*Arrow*)	--	--	1,610

Minimum Maintained Luminance for Programmed Visibility Indications

Indication type	Luminance (cd)		
	Red	Yellow	Green
PV at angle v=2.5, h=±2.5	314	314	314

Conductors must be prewired to the terminal block.

86-1.02R(4)(c) Visors and Directional Louvers

The visor must be a tunnel type.

The visor must have a downward tilt from 3 to 7 degrees with a minimum length of 9-1/2 inches for nominal 12-inch round lenses and 7 inches for nominal 8-inch round lenses.

A metal visor must be formed from minimum 0.050-inch-thick aluminum alloy sheet.

A plastic visor must be either formed from sheet plastic or blow-molded. The plastic must be a black homogeneous color with a lusterless finish. A visor must withstand a wind load applied to its side for 24 hours without permanent deformation or removal from its door when tested under California Test 605 for plastic visors and California Test 666 for metal visors.

If directional louvers are used, the louvers must fit into full-circular signal visors. Louvers must consist of one of the following:

1. Outside cylinder constructed of sheet steel with a minimum nominal thickness of 0.030 inch and vanes constructed of sheet steel with a minimum nominal thickness of 0.016 inch
2. Outside cylinder and vanes constructed of 5052-H32 aluminum alloy of equal thickness

86-1.02S Pedestrian Signal Heads

86-1.02S(1) General

A pedestrian signal head consists of a pedestrian signal mounting assembly and a pedestrian signal face comprising of a pedestrian signal housing, an LED countdown pedestrian signal face module, and a front screen.

86-1.02S(2) Pedestrian Signal Mounting Assemblies

A pedestrian signal mounting assembly must comply with the specifications for a signal mounting assembly in section 86-1.02R, except mast arm slip fitters are not required.

86-1.02S(3) Pedestrian Signal Faces

86-1.02S(3)(a) General

Each pedestrian signal face must include a light-duty terminal block rated at 5 A and have 12 positions with no. 6-by-1/8-inch binder head screws. Each position must have 1 screw-type terminal.

The wiring and terminal block must comply with ITE publication ST-055-E*, Pedestrian Traffic Control Signal Indicators: Light Emitting Diode (LED) Signal Modules*.

86-1.02S(3)(b) Pedestrian Signal Housings

Pedestrian signal housing must comply with the specifications for a signal housing in 86-1.02R(4)(a)(iii), except the maximum overall dimensions must be 18-1/2 inches wide, 19 inches high, and 11-1/2 inches deep and without:

1. Visor
2. Watertight module or lens mounted in the door
3. Reinforcement plates

The housing must have a terminal block attached to the back. The terminal block must have enough positions to accommodate all indications. Each position must be permanently labeled for the indications used.

86-1.02S(3)(c) LED Countdown Pedestrian Signal Face Modules

An LED countdown PSF module must comply with ITE publication ST-055-E*, Pedestrian Traffic Control Signal Indicators: Light Emitting Diode (LED) Signal Modules*, except the material must comply with ASTM D3935 and the module must have:

1. Ultra-bright-type LED rated for 100,000 hours of continuous operation.
2. Lot number and month and year of manufacture permanently marked on the back of the module
3. Prominent and permanent vertical markings for accurate indexing and orientation within the pedestrian signal housing if a specific mounting orientation is required. Markings must be a minimum of 1 inch in height and include an up arrow and the word *up* or *top.*
4. Circuit board complying with TEES, chapter 1, section 6.

Individual LEDs must be wired such that a loss or failure of 1 LED will not result in a loss of more than 5 percent of the module's light output. Failure of an individual LED in a string must not result in a loss of an entire string or other indication.

Each symbol must be at least 9 inches high and 5-1/4 inches wide. The 2-digit countdown timer, *Upraised Hand*, and *Walking Person* indications must be electronically isolated from each other. The 3 indications must not share a power supply or interconnect circuitry.

The module must operate over the specified ambient temperature and voltage range and be readable both day and night at distances up to the full width of the area to be crossed. Upon initial testing at 25 degrees C, the module must have at least the luminance values shown in the following table:

Luminance Values

PSF module symbol	Luminance
Upraised hand and 2-digit countdown timer (fL)	1,094
Walking person (fL)	1,547

The module must not exceed the power consumption requirements shown in the following table:

Maximum Power Consumption Requirements

PSF module display	At 24 ºC	At 74 ºC
Upraised Hand	10.0 W	12.0 W
Walking Person	9.0 W	12.0 W
2-digit countdown timer	6.0 W	8.0 W

If the pedestrian change interval is interrupted, then the 2-digit countdown timer and display must reset to the full pedestrian change interval before being initiated the next time. The 2-digit countdown display on the PSF module must go dark within a second after displaying "0".

86-1.02S(3)(d) Front Screen

Pedestrian signal face must have a front screen that is one of the following types:

1. 3/8-inch-thick aluminum honeycomb screen with 0.2-inch-wide cells or a 1/2-inch-thick plastic screen with 3/8-inch-wide squares with 1/16-inch wall thickness that:
   1.1. Is installed so it tilts downward at an angle of 15 ± 2 degrees from the top and completely covers the message plate
   1.2. Includes a clear front cover made of either a minimum 1/8-inch-thick acrylic plastic sheet or a minimum 1/16-inch-thick polycarbonate plastic
   1.3. Is held firmly in place, including the cover, with stainless steel or aluminum clips or stainless steel metal screws
2. Polycarbonate screen that:
   2.1. Has a nominal thickness of 1/32 inch
   2.2. Is a 1-1/2-inch-deep eggcrate or Z-crate type
   2.3. Is mounted in a frame constructed of aluminum alloy or polycarbonate with a minimum thickness of 0.040 inch
   2.4. Is held in place with stainless steel screws

The screen and frame of a pedestrian signal face must be made of either (1) plastic that is a flat black color or (2) anodized aluminum that is a flat black color or finished with lusterless, black, exterior-grade latex paint formulated for application to metal surfaces.

86-1.02T Accessible Pedestrian Signals

Accessible pedestrian signal must comply with the *California MUTCD*, chapter 4E, and have:

1. Audible speech message that plays when the push button is actuated. The accessible pedestrian signal must have at least 5 audible message options.
2. Push button locator tone that clicks or beeps.
3. Feature that activates the pedestrian phase during any failure without causing the pedestrian phase to be on RECALL.

An accessible pedestrian signal must function with the Department-furnished Model 170E/2070E controller assembly.

No part of the accessible pedestrian signal must be installed inside the controller cabinet.
Power for the accessible pedestrian signal must be from the pedestrian signal housing terminal block.

The housing for the signal assembly must be made of corrosion-resistant material. Theft-proof bolts used for mounting the housing to the standard must be stainless steel with a content of 17 percent chromium and 8 percent nickel. The housing must be shaped to fit the pole's curvature.

The color of a metallic housing must match color no. 33538 of FED-STD-595.

The color of a plastic housing must match color no. 17038, 27038, or 37038 of FED-STD-595.

Accessible pedestrian signal must:

1. Have electronic switches, a potentiometer, or an access port for a device for controlling and programming the volume level and messaging
2. Be weatherproof and shockproof

Enclosure for the accessible pedestrian signal must:

1. Weigh less than 7 lb
2. Measure less than 16 by 6 by 5 inches
3. Have a wiring hole with a diameter not exceeding 1-1/8 inches
4. Have a switch for a push button
5. Have a vibrotactile device on the push button or on the arrow
6. Have an internal weatherproof speaker and microphone that senses the ambient sound level

The separation between adjacent holes used for conductors and mounting must be at least twice the diameter of the larger hole.

The speaker grills must be located on the surface of the enclosure. The speakers must not interfere with the housing or its mounting hardware.

The cable between the accessible pedestrian signal assembly and the pedestrian signal head must have a:

1. Minimum four no. 18 stranded or larger tinned copper conductors with a minimum insulation thickness of 15 mils
2. Cable jacket with a minimum thickness of 20 mils and rated for a minimum:
   2.1. 300 V(ac)
   2.2. 80 degrees C
3. Nominal outside diameter less than 350 mils
4. Conductor color code of black, white, red and green

86-1.02U Push Button Assemblies

The housing for a push button assembly must be made of die-cast aluminum, permanent mold-cast aluminum, or UV-stabilized self-extinguishing structural plastic. The plastic housing must have a color throughout that matches color no. 17038, 27038, or 37038 of FED-STD-595.

If the push button is to be attached to a pole, the housing must be shaped to fit the pole's curvature.

The assembly must be waterproof and shockproof.

The push button's switch must be a single-pole, double-throw switching unit with screw-type terminals rated 15 A at 125 V(ac).

Switch for the push button must have:

1. Plunger actuator and a U frame to allow recessed mounting in the push button housing
2. Operating force of 3.5 lb
3. Maximum pretravel of 5/64 inch
4. Minimum overtravel of 1/32 inch
5. Differential travel from 0.002 to 0.04 inch
6. Minimum 2-inch diameter actuator

86-1.02V Reserved

86-1.02W Loop Detector Sealants

86-1.02W(1) General

Sealant for filling loop detector slots must be one of the following:

1. Asphaltic emulsion
2. Elastomeric sealant
3. Epoxy sealant for inductive loops
4. Hot-melt rubberized asphalt

86-1.02W(2) Asphaltic Emulsion Sealant

Asphaltic emulsion sealant must comply with the State Specification 8040-41A-15.

86-1.02W(3) Elastomeric Sealant

Elastomeric sealant must be a polyurethane material that cures only in the presence of moisture if used within the stated shelf life. The sealant must be suitable for use in both asphalt concrete and concrete pavement.

The cured elastomeric sealant must comply with the requirements shown in the following table:

Cured Elastomeric Sealant Requirements

Quality characteristic	Test method	Requirement
Hardness	ASTM D2240[a]	65–85
Tensile strength (min, MPa)	ASTM D412[b]	3.45
Elongation (min, %)		400
Flex at -40 °C[c]	--	No cracks
Weathering resistance	ASTM D822[d]	Slight chalking
Salt spray resistance:	ASTM B117[e]	
Tensile strength (min, MPa)		3.45
Elongation (min, %)		400
Dielectric constant (%)	ASTM D150[f]	<25

[a]Indentation at 25 °C and 50% relative humidity (Rex. Type A, Model 1700 only)
[b]Die C pulled at 508 mm/minute
[c]0.6-mm free film bend (180°) over 13-mm mandrel
[d]Weatherometer 350 h, cured 7 days at 25 °C and 50% relative humidity
[e]28 days at 38 °C with 5% NaCl, Die C, and pulled at 508 mm/minute)
[f]Change over a temperature range from -30 to 50 °C

86-1.02W(4) Hot-Melt Rubberized Asphalt Sealant

Hot-melt rubberized asphalt sealant must:

1. Be in solid form at room temperature and fluid at an application temperature range from 190 to 205 degrees C
2. Not produce toxic fumes
3. Be suitable for use in both asphalt concrete and concrete pavement
4. Be packaged in containers clearly marked *Detector Loop Sealant* with the manufacturer's batch and lot number

The cured hot-melt rubberized asphalt sealant must comply with the requirements shown in the following table:

Cured Hot-Melt Rubberized Asphalt Sealant Requirements

Quality characteristic	Test method	Requirement
Cone penetration (max, 1/10 mm)	ASTM D5329, sec. 6[a]	35
Flow (max, mm)	ASTM D5329, sec. 8[b]	5
Resilience (min, %)	ASTM D5329, sec. 12[c]	25
Softening point (min, °C)	ASTM D36	82
Ductility (min, cm)	ASTM D113[d]	30
Flash point, Cleveland Open Cup (min, °C)	ASTM D92	288
Viscosity (Pa·s)	ASTM D4402[e]	2.5–3.5

[a]At 25 °C, 150 g, 5 s
[b]At 60 °C
[c]At 25 °C
[d]At 25 °C, 5 cm/minute
[e]Brookfield Thermosel, no. 27 spindle, 20 rpm, 190 °C

86-1.02X Electronic Markers and Locators

The electronic marker must be discrete or cast inside the pull box cover.

An electronic marker must:

1. Be passive
2. Be energized solely by electromagnetic energy received from the interrogating electronic marker locator
3. Operate over a temperature range from -4 to 122 degrees F
4. Operate at a frequency range between 30 kHz to 300 kHz and comply with FCC part 15
5. Have a watertight and moisture-resistant housing

In addition, a discrete electronic marker must:

1. Have a maximum diameter of 6 inches
2. Weigh a maximum of 2 lb
3. Be colored red for power and orange for communication circuits
4. Be self-leveling or omnidirectional

The electronic marker locator must:

1. Be compatible with the electronic marker
2. Detect the electronic marker in pull boxes buried under dirt, sand, or snow
3. Detect the electronic marker from a maximum distance of 5 feet vertically with a 6-inch offset
4. Have a headphone jack
5. Have a battery level indicator
6. Have a large character display
7. Have a numeric and audible signal strength indicator
8. Have a speaker volume adjustment

86-1.02Y Transformers

A transformer must be single-phase and may be a nonsubmersible or submersible type.

A transformer must be a dry type designed for operation on a 60 Hz supply. The transformer must have a decal showing a connection diagram. The diagram must show either color coding or wire tagging with primary (H1, H2) or secondary (X1, X2) markers and the primary and secondary voltage and volt-ampere rating. A transformer must comply with the electrical requirements shown in the following table:

Transformer Electrical Requirements

Quality characteristic	Requirement
Rating (V(ac))	120/480, 120/240, 240/480, or 480/120
Efficiency (%)	> 95
Secondary voltage regulation and tolerance from half load to full load (%)	±3

Secondary 240 and 480 V(ac) windings must be center tapped.

The transformer must withstand the application of 2,200 V(ac) from core to coils and from coil to coil for a 1-minute period when tested immediately after operation of the transformer at full load for 24 hours.

The external leads for the secondary connections must be no. 10 Type USE rated for 600 V(ac).

The transformer's leads must extend a minimum of 12 inches from the case.

The transformer's insulation must be NEMA 185 C or better.

Each transformer must:

1. Include metal half-shell coil protection
2. Have moisture-resistant, synthetic-varnish-impregnated windings
3. Be waterproof and suitable for outdoor operation

Each submersible transformer must:

1. Include a handle and a hanger.
2. Be securely encased in a rugged, corrosion-resistant, watertight case.
3. Have leads that extend out through 1 or more sealed hubs.
4. Be manufactured to withstand a 5-day test with 12-hour on and off periods submerged in 2 feet of salt water that is 2 percent salt by weight. The operating periods must be at full load.

86-1.02Z Batteries

Battery must:

1. Be deep-cycle, sealed, prismatic, lead-calcium-based, absorbed-glass-mat, valve-regulated, lead-acid type
2. Be rated for 12 V
3. Be rated for a temperature range from -25 to 60 degrees C
4. Be group size 24
5. Be commercially available and stocked locally
6. Be marked with a date code, maximum recharge data, and recharge cycles
7. Be new and fully charged when furnished
8. Be free from damage or deformities
9. Have a carrying handle
10. Have 2 top-mounted, threaded-stud posts that include all washers and nuts
11. Include insulating rubber covers for protecting the lugs, posts, and wiring: red for the positive terminal and black for the negative terminal

If a battery is used for a battery backup system, it must accommodate 3/8-inch ring lugs of a Department-furnished battery harness.

86-1.03 CONSTRUCTION

Not Used

86-1.04 PAYMENT

Not Used

87 ELECTRICAL SYSTEMS

87-1 GENERAL

87-1.01 GENERAL

87-1.01A Summary

Section 87 includes general specifications for constructing and installing electrical systems.

The Department deducts the cost for maintenance performed by the Department on new or portions of existing systems modified under the Contract.

87-1.01B Definitions

Reserved

87-1.01C Submittals

Reserved

87-1.01D Quality Assurance

87-1.01D(1) General

Reserved

87-1.01D(2) Quality Control

87-1.01D(2)(a) General

Before shipping the material to the job site, submit to METS test samples of:

1. Accessible pedestrian signals
2. LED countdown pedestrian signal face modules
3. LED signal modules
4. LED luminaires

Submit a sample size as shown in the following table:

Electrical Material Sampling

Contract quantity	Test sample size
1–8	1
9–15	2
16–25	3
26–90	5
91–150	8
151–280	13
281–500	20
501–1200	32

Before starting operation of an electrical system, perform a conductor test in the presence of the Engineer.

Conductor test consists of testing each conductor and the conductors in cables for:

1. Continuity.
2. Grounds.

3. Insulation resistance at 500 V(dc) between the circuit and ground. A minimum insulation resistance of 100 MΩ on circuits must be attained.

Start the operational test of the system on any day except Friday or the day before a holiday. The operational test for signals must start from 9:00 a.m. to 2:00 p.m. Notify the Engineer 48 hours before starting the test.

An operational test consists of a minimum of 5 business days of continuous, satisfactory operation of the system. If the system fails, correct the problem and retest the system. A shutdown of the system caused by traffic, a power interruption, or unsatisfactory performance of Department-furnished materials does not constitute discontinuity of the test.

87-1.01D(2)(b) Electronic Markers

Electronic marker test consists of placing the electronic marker in the pull box, temporarily marking the pull box location with a utility flag, and using a compatible electronic marker locator to perform the following location test in the presence of the Engineer:

1. Within a 10 foot radius of the electronic marker, slowly move the locator toward the marker to determine the exact location of the pull box.
2. Repeat the test at four different points at 90 degree from each other on a horizontal plane, away from the marker location, as shown. Take the average of the four points to determine the detected location of the pull box.
3. Detected location of the pull box must be within 0.5 feet of the actual location.

87-1.01D(2)(c) Battery Backup System

Notify the Engineer 48 hours before testing the battery backup system.

Test the system in the presence of the Engineer by turning off the power to the signal system at the service equipment enclosure. The signal system must run continuously for 30 minutes. If the battery backup system fails, correct the problem and retest the system for another 30 minutes. After successful completion of the test, turn the power on for the signal system.

87-1.01D(2)(d) Piezoelectric Axle Sensors

Piezoelectric axle sensors consists of testing each piezoelectric axle sensor for each lane of data collection as follows:

1. Capacitance must be 20 percent of the sensor's data sheet as provided by the manufacturer
2. Dissipation factor must be less than 0.04 nF when measured in the 20 nF range
3. Resistance must be greater than 20 Megaohms
4. Minimum of 100 per-vehicle records must be collected for each lane. Collected data must have:
   4.1. Total volume of ±3 percent accuracy
   4.2. Vehicle classification of 95 percent accuracy by type

Collect data files from the on-site equipment using the central office host computer to verify the communication link is working.

87-1.02 MATERIALS

Not Used

87-1.03 CONSTRUCTION

87-1.03A General

The Engineer determines the final locations of electrical systems.

Verify the locations of electrical systems and the depths of existing detectors, conduits, and pull boxes.

Notify the Engineer before performing work on the existing system.

You may shut down the system for alteration or removal.

Where an existing Department underground facility is shown within 10 feet of any excavation, locate and field mark the facility before performing work that could damage or interfere with the existing facility.

If an existing facility is within 2 feet of an excavation, determine the exact location of the facility by excavating with hand tools before using any power-operated or power-driven excavating or boring equipment. A vacuum excavator may be used if authorized.

Notify the Engineer immediately if an existing facility is damaged by your activities.

If existing underground conduit is to be incorporated into a new system, clean it with a mandrel or cylindrical wire brush and blow it clean with compressed air.

Limit the shutdown of traffic signal systems to normal working hours. Notify the local traffic enforcement agency before shutting down the signal.

Place temporary W3-1 and R1-1 signs in each direction to direct traffic through the intersection during shutdown of the signal. Place two R1-1 signs for 2-lane approaches. The signs must comply with part 2 of the *California MUTCD*.

Cover signal faces when the system is shut down overnight. Cover temporary W3-1 and R1-1 signs when the system is turned on.

If you work on an existing lighting system and the roadway is to remain open to traffic, ensure the system is in operation by nightfall.

Replace detectors you damage within 72 hours, or the Department replaces them and deducts the cost.

Work performed on an existing system not described is change order work.

Do not use electrical power from existing highway facilities unless authorized.

Maintain a minimum 48-inch clearance for a pedestrian pathway when placing equipment.

Except for service installation or work on service equipment enclosures, do not work above ground until all materials are on hand to complete the electrical work at each location.

Bond all metal components to form a continuous grounded system as specified in NEC.

Ground metallic equipment mounted less than 8 feet above the ground surface on a wood pole.

If you damage any portion of a concrete curb, sidewalk, curb ramp, driveway, or gutter depression, replace the entire section between contraction or expansion joints under section 73.

Apply equipment identification characters.

Orient louvers, visors, and signal faces such that they are clearly visible to approaching traffic from the direction being controlled.

Test loops and the detector lead-in cable circuit for continuity, ground, and insulation resistance at the controller cabinet before connecting detector lead-in cable to the terminal block.

Perform an operational test of the systems.

Before starting the operational test for systems that impact traffic, the system must be ready for operation, and all signs, pavement delineation, and pavement markings must be in place at that location.

87-1.03B Conduit Installation

87-1.03B(1) General

The installation of conduit includes installing caps, bushings, and pull tape and terminating the conduit in pull boxes, foundations, poles, or a structure.

Notify the Engineer at least 4 business days before starting horizontal directional drilling method or jack and drill activities.

Limit the number of bends in a conduit run to no more than 360 degrees between pull points.

Use conduit to enclose conductors except where they are installed overhead or inside standards or posts.

You may use a larger size conduit than specified for the entire length between termination points. Do not use a reducing coupling.

Extend an existing conduit using the same material. Terminate conduits of different materials in a pull box.

Install 2 conduits between a controller cabinet and the adjacent pull box.

Use a minimum trade size of conduit of:

1. 1-1/2 inches from an electrolier to the adjacent pull box
2. 1 inch from a pedestrian push button post to the adjacent pull box
3. 2 inches from a signal standard to the adjacent pull box
4. 3 inches from a controller cabinet to the adjacent pull box
5. 2 inches from an overhead sign to the adjacent pull box
6. 2 inches from a service equipment enclosure to the adjacent pull box
7. 1-1/2 inches if unspecified

Use Type 1 conduit:

1. On all exposed surfaces
2. In concrete structures
3. Between a structure and the nearest pull box

Ream the ends of shop-cut and field-cut conduit to remove burrs and rough edges. Make the cuts square and true. Do not use slip joints and running threads to couple conduit. If a standard coupling cannot be used for metal-type conduit, use a threaded union coupling. Tighten the couplings for metal conduit to maintain a good electrical connection.

Cap the ends of conduit to prevent debris from entering before installing the conductors or cables. Use a plastic cap for Type 1, 2, and 5 conduits and a standard pipe cap for all other types of conduit or bell.

For Type 1, 2, and 5 conduits, use threaded bushings and bond them using a jumper. For other types of conduit, use nonmetallic bushings.

Do not install new conduit through foundations.

Cut Type 2 conduit with pipe cutters; do not use hacksaws. Use standard conduit-threading dies for threading conduit. Tighten conduit into couplings or fittings using strap wrenches or approved groove joint pliers.

Cut Type 3 conduit with tools that do not deform the conduit. Use a solvent weld for connections.

Protect shop-cut threads from corrosion under the standards shown in the following table:

Shop-Cut Thread Corrosion Protection

Conduit	Standard
Types 1 and 2	ANSI C80.1
Type 5	ANSI C80.6

Apply 2 coats of unthinned, organic zinc-rich primer to metal conduit before painting. Use a primer on the Authorized Material List for organic zinc-rich primers. Do not use aerosol cans. Do not remove shop-installed conduit couplings.

For conduits, paint:

1. All exposed threads
2. Field-cut threads, before installing conduit couplings to metal conduit
3. Damaged surfaces on metal conduit

If a Type 2 conduit or conduit coupling coating is damaged:

1. Clean the conduit or fitting and paint it with 1 coat of rubber-resin-based adhesive under the manufacturer's instructions
2. Wrap the damaged coating with at least 1 layer of 2-inch-wide, 20 mils-minimum-thickness, PVC tape under ASTM D1000 with a minimum tape overlap of 1/2 inch

You may repair damaged spots of 1/4 inch or less in diameter in the thermoplastic coating by painting with a brushing-type compound supplied by the conduit manufacturer.

If factory bends are not used, bend the conduit to a radius no less than 6 times its inside diameter without crimping or flattening it. Comply with the bending requirements shown in the following table:

Conduit-Bending Requirements

Type	Requirement
1	Use equipment and methods under the conduit manufacturer's instructions.
2	Use a standard bending tool designed for use on thermoplastic-coated conduit. The conduit must be free of burrs and pits.
3	Use equipment and methods under the conduit manufacturer's instructions. Do not expose the conduit to a direct flame.
5	Use equipment and methods under the conduit manufacturer's instructions.

Install pull tape with at least 2 feet of slack in each end of the conduit that will remain empty. Attach the tape's ends to the conduit.

Install conduit terminating in a standard or pedestal from 2 to 3 inches above the foundation. Slope the conduit toward the handhole opening.

Terminate conduit installed through the bottom of a nonmetallic pull box 2 inches above the bottom and 2 inches from the wall closest to the direction of the run.

87-1.03B(2) Conduit Installation for Structures

87-1.03B(2)(a) General

Paint exposed Type 1 conduit the same color as the structure.

Install galvanized steel hangers, steel brackets, and other fittings to support conduit in or on a wall or bridge.

87-1.03B(2)(b) New Structures

Seal and make watertight the conduits which lead to soffits, wall-mounted luminaires, other lights, and fixtures located below the pull box grade.

If you place a conduit through the side of a nonmetallic pull box, terminate the conduit 2 inches from the wall and 2 inches above the bottom. Slope the conduit toward the top of the box to facilitate pulling conductors.

For ease of installation and if authorized, you may use Type 4 conduit instead of Type 1 conduit for the final 2 feet of conduit entering a pull box in a reinforced concrete structure.

Install an expansion fitting where a conduit crosses an expansion joint in a structure. Each expansion fitting for metal conduit must include a copper bonding jumper having the ampacity as specified in NEC.

Install an expansion-deflection fitting for an expansion joint with a 1-1/2-inch movement rating. The fitting must be watertight and include a molded neoprene sleeve, a bonding jumper, and 2 silicon bronze or zinc-plated iron hubs.

For an expansion joint with a movement rating greater than 1-1/2 inches, install the expansion-deflection fitting as shown.

For conduit installed inside of bridge structures, you must:

1. Install precast concrete cradles made of minor concrete and commercial-quality welded wire fabric. The minor concrete must contain a minimum of 590 lb of cementitious material per cubic yard. The cradles must be moist cured for a minimum of 3 days.
2. Bond precast concrete cradles to a wall or bridge superstructure with one of the following:
   2.1. Epoxy adhesive for bonding freshly-mixed concrete to hardened concrete.
   2.2. Rapid-set epoxy adhesive for pavement markers.
   2.3. Standard-set epoxy adhesive for pavement markers.
3. Use a pipe sleeve or form an opening for a conduit through a bridge superstructure. The sleeve or opening through a prestressed member or conventionally reinforced precast member must be:
   3.1. Oriented transverse to the member.
   3.2. Located through the web.
   3.3. No more than 4 inches in size.
4. Wrap the conduit with 2 layers of asphalt felt building paper and securely tape or wire the paper in place for a conduit passing through a bridge abutment wall. Fill the space around the conduit with mortar under section 51-1, except the proportion of cementitious material to sand must be 1 to 3. Fill the space around the conduits after prestressing is completed.

Thread and cap a conduit installed for future use in structures. Mark the location of the conduit's end in a structure, curb, or wall directly above the conduit with a *Y* that is 3 inches tall.

87-1.03B(2)(c) Existing Structures

Run surface-mounted conduit straight and true, horizontal or vertical on the wall, and parallel to walls on ceilings or similar surfaces. Support the conduit at a maximum of 5-foot intervals where needed to prevent vibration or deflection. Support the conduit using galvanized, malleable-iron, conduit clamps, and clamp backs secured with expansion anchorage devices complying with section 75-3.02C. Use the largest diameter of galvanized, threaded studs that will pass through the mounting hole in the conduit clamp.

87-1.03B(3) Conduit Installation Underground

87-1.03B(3)(a) General

Install conduit to a depth of:

1. 14 inches for the trench-in-pavement method
2. 18 inches, minimum, under sidewalk and curbed paved median areas
3. 42 inches, minimum, below the bottom of the rail of railroad tracks
4. 30 inches, minimum, everywhere else below grade

Place conduit couplings at a minimum of 6 inches from the face of a foundation.

Place a minimum of 2 inches of sand bedding in a trench before installing Type 2 or Type 3 conduit and 4 inches of sand bedding over the conduit before placing additional backfill material.

If installing conduit within the limits of hazardous locations as specified in NEC for Class I, division 1, install and seal Type 1 or Type 2 conduit with explosion-proof sealing fittings.

87-1.03B(3)(b) Conduit Installation under Paved Surfaces

You may lay conduit on existing pavement within a new curbed median constructed on top.

Install conduit under existing pavement by either the horizontal directional drill method or jack and drill method. You may use the trench-in-pavement method for either of the following conditions:

1. If conduit is to be installed behind the curb under the sidewalk
2. If the delay to vehicles will be less than 5 minutes

Do not use the trench-in-pavement method for conduit installations under freeway lanes or freeway-to-freeway connector ramps.

87-1.03B(3)(c) High Density Polyethylene Conduit Installation

For sweeps, maintain a conduit bend radius of a minimum 10 times the outside diameter of the conduit.

Conduits must not protrude more than 2 inches inside the pull box and vaults, and must enter at an angle less than 20 degrees from either the vertical or horizontal axis.

Demonstrate a minimum of 2 test fusions to the Engineer prior to performing fusion operations on HDPE conduit to be installed.

Join HDPE conduit using the electro fusion method recommended by the conduit manufacturer. Do not expose conduit to direct flame. The electro-fusion must be performed by a person certified by the conduit manufacturer.

Place warning tape in the trench 6 inches below finished grade.

Backfill trench with slurry concrete pigmented matching FED-STD-595 under 19-3.02E. The size of the aggregate must be no larger than 3/8 inch. Provide adequate spacers, tie-downs and bracing to maintain conduits in place during backfill.

For trenches in paved areas, only the top 4 inch of concrete backfill must be pigmented.

Blow out all conduits with compressed air until all foreign material is removed, before installing innerducts.

Install innerducts in accordance with the manufacturer's installation procedures. Innerducts must be one continuous unit between splice vaults. Innerducts may be interrupted inside pull boxes located between splice vaults and cabinets.

Lubricate innerducts per manufacturer's instructions during installation.

Install a pull tape in conduits and innerducts to remain empty.

Seal the ends of conduit after cables or pull tape are installed.

87-1.03B(3)(d) Conduit Installation under Railroad Tracks

Install Type 1 or Type 2 conduit with a minimum diameter of 1-1/2 inches under railroad tracks. If you use the jacking or drilling method to install the conduit, construct the jacking pit a minimum of 13 feet from the tracks' centerline at the near side of the pit. Cover the jacking pit with planking if left overnight.

87-1.03B(4) Conduit Installation by Horizontal Directional Drilling Method

Install a conduit to a minimum depth of 4 feetand maximum depth of 6 feet. If you must install a conduit less than 4 feet in depth or greater than 6 feet in depth, the installation must be authorized.

The diameter of the bore hole must be no larger than 1.5 times the outside diameter of the conduit.

Water-based mineral slurry or wetting solution may be used to lubricate the boring tool and stabilize the soil surrounding the boring path.

Disposal of residue must comply with section 13-4.03D.

The horizontal directional drilling equipment must have directional control of the boring tool and have an electronic boring tool location detection system. During operation, the equipment must be able to determine the location of the tool both horizontally and vertically.

Do not use slurry cement backfill.

Use a mandrel to prove the conduit is free and clear of dirt, rocks, and other debris after installation.

87-1.03B(5) Conduit Installation by the Jack and Drill Method

Keep the jacking or drilling pit 2 feet away from the pavement's edge. Do not weaken the pavement or soften the subgrade with excessive use of water.

If an obstruction is encountered, obtain authorization to cut small holes in the pavement to locate or remove the obstruction.

You may install Type 2 or Type 3 conduit under the pavement if a hole larger than the conduit's diameter is predrilled. The predrilled hole must be less than one and half the conduit's diameter.

Remove the conduit used for drilling or jacking and install new conduit for the completed work.

87-1.03B(6) Conduit Installation by the Trenching-In-Pavement Method

Install conduit by the trenching-in-pavement method using a trench approximately 2 inches wider than the conduit's outside diameter but not exceeding 6 inches in width.

Where additional pavement is to be placed, you must complete the trenching before the final pavement layer is applied.

If the conduit shown is to be installed under the sidewalk, you may install it in the street within 3 feet of and parallel to the face of the curb. Install pull boxes behind the curb.

Cut the trench using a rock-cutting excavator. Minimize the shatter outside the removal area of the trench.

Dig the trench by hand to the required depth at pull boxes.

Place conduit in the trench.

Backfill the trench with minor concrete to the pavement's surface by the end of each work day. If the trench is in asphalt concrete pavement and no additional pavement is to be placed, backfill the top 0.10 foot of the trench with minor HMA within 3 days after trenching.

87-1.03C Installation of Pull Boxes

87-1.03C(1) General

Install pull boxes no more than 200 feet apart.

You may install larger pull boxes than specified or shown and additional pull boxes to facilitate the work except in structures.

Install a pull box on a bed of crushed rock and grout it before installing conductors. The grout must be from 0.5 to 1 inch thick and sloped toward the drain hole. Place a layer of roofing paper between the grout and the crushed rock sump. Make a 1-inch drain hole through the grout at the center of the pull box.

Set the pull box such that the top is 1-1/4 inches above the surrounding grade in unpaved areas and leveled with the finished grade in sidewalks and other paved areas.

Place the cover on the box when not working in it.

Grout around conduits that are installed through the sides of the pull box.

Bond and ground the metallic conduit before installing conductors and cables in the conduit.

Bond metallic conduits in a nonmetallic pull box using bonding bushings and bonding jumpers.

Do not install pull boxes in concrete pads, curb ramps, or driveways.

Reconstruct the sump of a pull box if disturbed by your activities. If the sump was grouted, remove and replace the grout.

87-1.03C(2) Nontraffic Pull Boxes

For buried pull boxes, install the electronic marker.

If you bury a nontraffic pull box, set the box such that the top is 6 to 8 inches below the surrounding grade. Place a 20-mil-thick plastic sheet made of HDPE or PVC virgin compounds to prevent water from entering the box.

Place mortar between a nontraffic pull box and a pull box extension.

Where a nontraffic pull box is in the vicinity of curb in an unpaved area, place the box adjacent to the back of the curb if practical.

Where a nontraffic pull box is adjacent to a post or standard, place the box within 5 feet downstream from traffic if practical.

If you replace the cover on a nontraffic pull box, anchor it to the box.

Perform the electronic marker test.

87-1.03C(3) Traffic Pull Boxes

Place minor concrete around and under a traffic pull box.

Bolt the steel cover to the box when not working in it.

Bond the steel cover to the conduit with a jumper and bolt it down after installing the conductors and cables.

87-1.03C(4) Structure Pull Boxes

Bond metallic conduit in a metal pull box in a structure using locknuts, inside and outside of the box, bonding bushings, and bonding jumpers connected to bonding wire running in the conduit system.

87-1.03C(5) Tamper-Resistant Pull Boxes

Install the tamper-resistant pull boxes under the manufacturer's instructions.

87-1.03D Battery Backup System Cabinets

Install the battery backup system cabinet to the right of the Model 332L cabinet.

If installation on the right side is not feasible, obtain authorization for installation on the left side.

Provide access for power conductors between the cabinets using:

1. 2-inch nylon-insulated, steel chase nipple
2. 2-inch steel sealing locknut
3. 2-inch nylon-insulated, steel bushing

Remove the jumper between the terminals labeled *BBS-1* and *BBS-2* in the 5 position terminal block in the controller cabinet before connecting the Department-furnished electronics assembly.

87-1.03E Excavating and Backfilling for Electrical Systems

87-1.03E(1) General

Notify the Engineer at least 72 hours before starting excavation activities.

Dispose of surplus excavated material.

Restrict closures for excavation on a street or highway to 1 lane at a time unless otherwise specified.

87-1.03E(2) Trenching

Dig a trench for the electrical conduits. Do not excavate until the installation of the conduit.

Place excavated material in a location that will not interfere with traffic or surface drainage.

After placing the conduit, backfill the trench with the excavated material.

Compact the backfill placed within the hinge points and in areas where pavement is to be constructed to a minimum relative compaction of 95 percent.

Restore the sidewalks, pavement, and landscaping at a location before starting excavation at another location.

87-1.03E(3) Concrete Pads, Foundations, and Pedestals

Construct foundations for standards, poles, metal pedestals, and posts under section 56-3.

Construct concrete pads, foundations, and pedestals for controller cabinets, telephone demarcation cabinets, and service equipment enclosures on firm ground.

Install anchor bolts using a template to provide proper spacing and alignment. Moisten the forms and ground before placing the concrete. Keep the forms in place until the concrete sets for at least 24 hours to prevent damage to the surface.

Use minor concrete for pads, foundations, and pedestals.

In unpaved areas, place the top of the foundation 6 inches above the surrounding grade, except place the top:

1. 1 foot 6 inches above the grade for Type M and 336L cabinets
2. 1 foot 8 inches above the grade for Type C telephone demarcation cabinets
3. 2 inches above the grade for Type G and Type A cabinets and Type III service equipment enclosures

The pad must be 2 inches above the surrounding grade.

In and adjacent to the sidewalk and other paved areas, place the top of the foundation 4 inches above the surrounding grade, except place the top:

1. 1 foot 6 inches above the grade for Type M and 336L cabinets
2. 1 foot 8 inches above the grade for Type C telephone demarcation cabinets
3. Level with the finished grade for Type G and Type A cabinets and Type III service equipment enclosures

The pad must be level with the finished grade.

Apply an ordinary surface finish under section 51-1.03F.

Allow the foundation to cure for at least 7 days before installing any equipment.

87-1.03F Conductors and Cable Installations

87-1.03F(1) General

The installation of conductors and cables includes splicing conductors and attaching the terminals and connectors to the conductors.

Clean the conduit and pull all conductors and cables as a unit.

If new conductors or cables are to be added in an existing conduit:

1 Remove the content
2. Clean the conduit
3. Pull both old and new conductors and cables as a unit

Wrap conductors and secure cables to the end of the conduit in a pull box.

Seal the ends of conduits with a sealing compound after installing conductors or cables.

Neatly arrange conductors and cables inside pull boxes and cabinets. Tie the conductors and cables together with self-clinching nylon cable ties or enclose them in a plastic tubing or raceway.

Identify conductors and cables by direct labeling, tags, or bands fastened in such a way that they will not move. Use mechanical methods for labeling.

Provide band symbol identification on each conductor or each group of conductors comprising a signal phase in each pull box and near the end of terminated conductors.

Tape the ends of unused conductors and cables in pull boxes to form a watertight seal.

Do not connect the push-button or accessible pedestrian signal neutral conductor to the signal neutral conductor.

Install a continuous tracer throughout the length of the trench.

87-1.03F(2) Cables

87-1.03F(2)(a) General

Reserved

87-1.03F(2)(b) Communication Cables

87-1.03F(2)(b)(i) General

Terminate the ends of the communication cables as shown.

87-1.03F(2)(b)(ii) Category 5E and 6 Cables

Do not splice category 5E and 6 cables between components.

Provide a minimum of 3 feet of slack at each pull box and vault and minimum of 6 feet of slack at the cabinet.

87-1.03F(2)(b)(iii) Telephone Cables

Do not splice telephone cables between the telephone demarcation point and the controller cabinet.

Provide a minimum of 6 feet of slack at each cabinet, including the telephone demarcation cabinet.

87-1.03F(2)(c) Copper Cables

87-1.03F(2)(c)(i) General

Reserved

87-1.03F(2)(c)(ii) Detector Lead-in Cables

Install a Type B or C detector lead-in cable in conduit.

Waterproof the ends of the lead-in cable before installing it in the conduit to prevent moisture from entering the cable.

Splice loop conductors for each direction of travel for the same phase, terminating in the same pull box, to a separate lead-in cable running from the pull box adjacent to the loop detector to a sensor unit mounted in the controller cabinet. Install the lead-in cable without splices except at the pull box when connecting to loop wire.

Verify in the presence of the Engineer that the loops are operational before making the final splices between loop conductors and the lead-in cable.

Identify and tag each lead-in cable with the detector designation at the cabinet and pull box adjacent to the loops.

87-1.03F(2)(c)(iii) Conductors Signal Cables

Do not splice signal cables except for a 28-conductor cable.

Provide identification at the ends of terminated conductors in a cable as shown.

Provide identification for each cable in each pull box showing the signal standard to which it is connected except for the 28-conductor cable.

Connect conductors in a 12-conductor cable as shown in the following table:

12CSC Color Code and Functional Connection

Color code	Termination	Phase
Red	Red signal	2, 4, 6, or 8
Yellow	Yellow signal	2, 4, 6, or 8
Brown	Green signal	2, 4, 6, or 8
Red/black stripe	Red signal	1, 3, 5, or 7
Yellow/black stripe	Yellow signal	1, 3, 5, or 7
Brown/black stripe	Green signal	1, 3, 5, or 7
Black/red stripe	Spare or as required for red or *DONT WALK*	--
Black/white stripe	Spare or as required for yellow	--
Black	Spare or as required for green or *WALK*	--
Red/white stripe	Pedestrian signal *DONT WALK*	--
Brown/white stripe	Pedestrian signal *WALK*	--
White	Terminal block	Neutral

Provide identification for each 28-conductor cable C1 or C2 in each pull box. The cable labeled *C1* must be used for signal phases 1, 2, 3, and 4. The cable labeled *C2* must be used for signal phases 5, 6, 7, and 8.

Connect conductors in a 28-conductor cable as shown in the following table:

28CSC Color Code and Functional Connection

Color code	Termination	Phase
Red/black stripe	Red signal	2 or 6
Yellow/black stripe	Yellow signal	2 or 6
Brown/black stripe	Green signal	2 or 6
Red/orange stripe	Red signal	4 or 8
Yellow/orange stripe	Yellow signal	4 or 8
Brown/orange stripe	Green signal	4 or 8
Red/silver stripe	Red signal	1 or 5
Yellow/silver stripe	Yellow signal	1 or 5
Brown/silver stripe	Green signal	1 or 5
Red/purple stripe	Red signal	3 or 7
Yellow/purple stripe	Yellow signal	3 or 7
Brown/purple stripe	Green signal	3 or 7
Red/2 black stripes	Pedestrian signal *DONT WALK*	2 or 6
Brown/2 black stripes	Pedestrian signal *WALK*	2 or 6
Red/2 orange stripes	Pedestrian signal *DONT WALK*	4 or 8
Brown/2 orange stripes	Pedestrian signal *WALK*	4 or 8
Red/2 silver stripes	Overlap A, C	OLA[a], OLC[a]
Brown/2 silver stripes	Overlap A, C	OLA[c], OLC[c]
Red/2 purple stripes	Overlap B, D	OLB[a], OLD[a]
Brown/2 purple stripes	Overlap B, D	OLB[c], OLD[c]
Blue/black stripe	Pedestrian push button	2 or 6
Blue/orange stripe	Pedestrian push button	4 or 8
Blue/silver stripe	Overlap A, C	OLA[b], OLC[b]
Blue/purple stripe	Overlap B, D	OLB[b], OLD[b]
White/black stripe	Pedestrian push button common	--
Black/red stripe	Railroad preemption	--
Black	Spare	--
White	Terminal block	Neutral

OL = Overlap; A, B, C, and D = Overlapping phase designation
[a]For red phase designation
[b]For yellow phase designation
[c]For green phase designation

Use the neutral conductor only with the phases associated with that cable. Do not intermix neutral conductors from different cables except at the signal controller.

87-1.03F(2)(c)(iv) Signal Interconnect Cable

For a signal interconnect cable, provide a minimum of 6 feet of slack inside each controller cabinet.

Do not splice the cable unless authorized.

If splices are authorized, insulate the conductor splices with heat-shrink tubing and overlap the insulation at least 0.6 inch. Cover the splice area of the cable with heat-shrink tubing and overlap the cable jacket at least 1-1/2 inches. Provide a minimum of 3 feet of slack at each splice.

87-1.03F(3) Conductors

87-1.03F(3)(a) General

Do not run conductors to a terminal block on a standard unless they are to be connected to a signal head mounted on that standard.

Provide 3 spare conductors in all conduits containing ramp metering and traffic signal conductors.

Install a separate conductor for each terminal of a push button assembly and accessible pedestrian signal.

Provide conductor slack to comply with the requirements shown in the following table:

Conductor Slack Requirements

Location	Slack (feet)
Signal standard	1
Lighting standard	1
Signal and lighting standard	1
Pull box	3
Splice	3
Standards with slip base	0

87-1.03F(3)(b) Reserved

87-1.03F(3)(c) Copper Conductors

87-1.03F(3)(c)(i) General

Install a minimum no. 8 grounding copper conductor in conduit and connect it to all-metal components.

Where conductors from different service points occupy the same conduit or standard, enclose the conductors from one of the services in flexible or rigid metal conduit.

87-1.03F(3)(c)(ii) Inductive Loop Conductors

Install a Type 1 or 2 inductive loop conductor except use Type 2 for Type E loop detectors.

Install the conductor without splices except at the pull box.

87-1.03F(4) Manual Installation Method

Use an inert lubricant for placing conductors and cables in conduit.

Pull the conductors and cables into the conduit by hand using pull tape.

87-1.03F(5) Direct Burial Aluminum Cable Installation Method

Install direct burial aluminum cable at a minimum 30 inches below grade in unpaved areas or at a minimum 18 inches below finished grade in paved areas.

Do not splice the direct burial aluminum cable between pull boxes and enclosures.

Fill trench with slurry cement backfill to between 4 to 6 inches below finished grade under section 19-3.02E.

Fill the remaining trench to finished grade with native material. In paved area, fill the remaining trench to finished grade with the same material of the paved area.

87-1.03G Equipment Identification Characters

The Engineer provides you with a list of the equipment identification characters.

Stencil the characters or apply the reflective self-adhesive labels to a clean surface.

Treat the edges of self-adhesive characters with an edge sealant.

Place the characters on the side facing traffic on:

1. Front doors of cabinets and service equipment enclosures.
2. Wood poles, fastened with 1-1/4-inch aluminum nails, for pole mounted enclosures
3. Adjacent bent or abutment at approximately the same station as an illuminated sign or soffit luminaire
4. Underside of the structure adjacent to the illuminated sign or soffit luminaire if no bent or abutment exists nearby
5. Posts of overhead signs

6. Standards

Before placing new characters on existing or relocated equipment, remove the existing characters.

For luminaires, place equipment identification character labels outside the unit on the side facing the road. Equipment identification characters consist of:

1. R1 for Roadway 1, R2 for Roadway 2, R3 for Roadway 3, and R4 for Roadway 4
2. Rated wattage

87-1.03H Conductor and Cables Splices

87-1.03H(1) General

You may splice:

1. Grounded conductors in a pull box
2. Accessible pedestrian signal and push bottom conductors in a pull box
3. Ungrounded signal conductors in a pull box if signals are modified
4. Ungrounded signal conductors to a terminal compartment or a signal head on a standard with conductors of the same phase in the pull box adjacent to the standard
5. Ungrounded lighting circuit conductors in a pull box if lighting circuits are modified

Solder all copper conductor splices using the hot iron, pouring, or dipping method. Do not perform open-flame soldering.

Do not solder aluminum conductors.

87-1.03H(2) Splice Insulation Methods

Insulate splices in a multiconductor cable to form a watertight joint and to prevent moisture absorption by the cable.

Use heat-shrink tubing or Method B to insulate a splice.

Use heat-shrink tubing as follows:

1. Cover the splice area completely with an electrical insulating coating and allow it to dry.
2. Place mastic around each conductor before placing them inside the tubing. Use the type of mastic specified in the tubing manufacturer's instructions.
3. Heat the area under the manufacturer's instructions. Do not perform open-flame heating. After contraction, each end of the heat-shrink tubing or the open end of the tubing's end cap must overlap the conductor insulation at least 1-1/2 inches.
4. Cover the entire splice with an electrical insulating coating and allow it to dry.

Use Method B as follows:

1. Cover the splice area completely with an electrical insulating coating and allow it to dry
2. Apply 3 layers of half-lapped, minimum 60-mils, PVC tape
3. Apply 2 layers of 120-mils, butyl-rubber, stretchable tape with liner
4. Apply 3 layers of half-lapped, minimum 6-mils, PVC, pressure-sensitive, adhesive tape
5. Cover the entire splice with an electrical insulating coating and allow it to dry

87-1.03I Connectors and Terminals

Apply connectors and terminals to cables and conductors using a crimping compression tool under the manufacturer's instructions. The tool must prevent opening of the handles until the crimp is completed.

Install crimp-style terminal lugs on stranded conductors smaller than no. 14.

Solder no. 8 and smaller copper conductors to connectors and terminal lugs.

87-1.03J Standards, Poles, Pedestals, and Posts

Install standards, poles, pedestals, and posts under section 56-3.

Ground standards with a handhole by attaching a bonding jumper from the bolt or lug inside the standard to a metal conduit or to the grounding wire in the adjacent pull box. The bonding jumper must be visible when the handhole cover is removed.

Ground standards without a handhole or standards with a slip base by attaching a bonding jumper to all anchor bolts using ground clamps and connecting it to a metal conduit or to the grounding wire in the adjacent pull box. The bonding jumper must be visible after mortar has been placed on the foundation.

87-1.03K Piezoelectric Axle Sensors

Obtain authorization for exact locations for installation of the piezoelectric axle sensors.

Cut slots for axle sensors and screened transmission cables under section 87-1.03V(2).

Install the piezoelectric axle sensors in a channel under the manufacturer's instructions. Fill the channel with epoxy grout under section 95-1.02H. The grout must not exceed 165 degrees F while curing. Do not reopen the lane to traffic until the epoxy sets.

Perform the conductor test.

Connect the field wiring to the terminal blocks in the controller cabinet.

Perform the piezoelectric axle sensor test.

Perform the operational test. Failure of the system to record and store data as required for an accumulated time exceeding 3 hours during the 5-day period is cause for the operational test to be rejected and repeated.

87-1.03L Utility Service

87-1.03L(1) General

Install the service equipment early enough to allow the utility to complete its work before completion of the electrical work.

At least 15 days before permanent electrical and telecommunication service is required, request the service connections for permanent installations. The Department arranges with the utilities for completion of the connections and pays all costs and fees required by the utilities.

87-1.03L(2) Electric Service

87-1.03L(2)(a) General

If service equipment is to be installed on a utility-owned pole, furnish and install the conduit, conductors, pull boxes, and other necessary material to complete the service installation. The service utility decides the position of the riser and equipment on the pole.

87-1.03L(2)(b) Electric Service for Irrigation

Establishing electric service for irrigation includes installing conduit, conductors, and pull boxes and making connections from the service point to the irrigation controllers.

87-1.03L(2)(c) Electric Service for Booster Pumps

Establishing electric service for a booster pump includes installing conduit, conductors, and pull boxes and making connections from the service point to the booster pump enclosure.

87-1.03L(3) Telecommunications Service

Establishing telecommunication service includes installing conduit, conductors, and pull boxes and making connections from the service point to the telephone demarcation cabinet.

87-1.03M Photoelectric Controls

Mount the photoelectric unit on the top of the pole for Type I, II, and III photoelectric controls. Use mounting brackets where pole-top mounting is not possible. Orient the photoelectric unit to face north.

Mount the enclosure at a height of 6 feet above finished grade on the same standard as the photoelectric unit.

Install a minimum 100 VA, 480/120 V(ac) transformer in the contactor enclosure to provide 120 V(ac) for the photoelectric control unit when switching 480 V(ac), 60 Hz circuits.

87-1.03N Fused Splice Connectors

Install a fuse splice connector with a fuse:

1. In each ungrounded conductor for luminaires
2 On primary side of transformer when a transformer is installed

The connector must be located in the pull box adjacent to the standard.

Crimp the connector terminals onto the ungrounded conductors using a tool under the manufacturer's instructions. Insulate the terminals and make them watertight.

87-1.03O Grounding Electrodes

Install a grounding electrode for each cabinet, service equipment enclosure, and transformer.

Attach a grounding conductor from the electrode using either a ground clamp or exothermic weld. Connect the other end of the conductor to the cabinet, service equipment enclosure, and transformer.

87-1.03P Service Equipment Enclosures

Installing a service equipment enclosure includes constructing the foundation and pad and installing conduit, adjacent pull boxes, and grounding electrode.

Locate the foundation such that the minimum clearance around the front and back of the enclosure complies with NEC, article 110.26, "Spaces About Electrical Equipment, (600 V, nominal or less)."

Bond and ground metal conduit as specified in NEC and by the service utility except the grounding electrode conductor must be no. 6 or larger.

If circuit breakers and components do not have a description on engraved phenolic nameplates, install them using stainless steel rivets or screws under section 86-1.02P(2).

87-1.03Q Cabinets

87-1.03Q(1) General

Installing a cabinet includes constructing the foundation and pad and installing conduit, adjacent pull boxes, and grounding electrode.

Apply a mastic or caulking compound before installing the cabinet on the foundation to seal the openings.

Connect the field wiring to the terminal blocks in the cabinet. Neatly arrange and lace or enclose the conductors in plastic tubing or raceway. Terminate the conductors with properly sized captive or spring spade terminals. Apply a crimp-style connector and solder them.

Install and solder a spade-type terminal on no. 12 and smaller field conductors and a spade-type or ring-type terminal on conductors larger than no. 12.

87-1.03Q(2) Department-Furnished Controller Cabinets

Arrange for the delivery of Department-furnished controller cabinets.

87-1.03Q(3) Reserved

87-1.03Q(4) Telephone Demarcation Cabinets

Installing a telephone demarcation cabinet includes installing conduit, cable, and pull boxes to the controller cabinet.

Install the cabinet with the back toward the nearest lane of traffic.

87-1.03R Signal Heads

87-1.03R(1) General

Installing a signal head includes mounting the heads on standards and mast arms, installing backplates and visors, and wiring conductors to the terminal blocks.

Keep the heads covered or direct them away from traffic until the system is ready for operation.

87-1.03R(2) Signal Faces

Use the same brand and material for the signal faces at each location.

Program the programmable visibility signal faces under the manufacturer's instructions. The indication must be visible only in those areas or lanes to be controlled.

87-1.03R(3) Backplates

Install backplates using at least six 10-24 or 10-32 self-tapping and locking stainless steel machine screws and flat washers.

If a plastic backplate requires field assembly, attach each joint using at least four no.10 machine screws. Each machine screw must have an integral or captive flat washer, a hexagonal head slotted for a standard screwdriver, and either a locking nut with an integral or captive flat washer or a nut, flat washer, and lock washer. Machine screws, nuts, and washers must be stainless steel or steel with a zinc or black oxide finish.

If a metal backplate has 2 or more sections, fasten the sections with rivets or aluminum bolts peened after assembly to avoid loosening.

Install the backplate such that the background light is not visible between the backplate and the signal face or between sections.

87-1.03R(4) Signal Mounting Assemblies

Install a signal mounting assembly such that its members are arranged symmetrically and plumb or level. Orient each mounting assembly to allow maximum horizontal clearance to the adjacent roadway.

For a bracket-mounted assembly, bolt the terminal compartment or pole plate to the pole or standard.

In addition to the terminal compartment mounting, attach the upper pipe fitting of Type SV-1-T with 5 sections or a SV-2-TD to the standard or pole using the mounting detail for signal heads without a terminal compartment.

Use a 4-1/2-inch slip fitter and set screws to mount an assembly on a post top.

After installing the assembly, clean and paint the exposed threads of the galvanized conduit brackets and bracket areas damaged by the wrench or vise jaws. Use a wire brush to clean and apply 2 coats of unthinned, organic zinc-rich primer. Do not use an aerosol can to apply the primer.

Install the conductors in the terminal compartment and secure the cover.

87-1.03S Pedestrian Signal Heads

Installing a pedestrian signal head includes mounting the heads on standards and wiring conductors to the terminal blocks.

Install the pedestrian signal mounting assembly under section 87-1.03R(4).

Use the same brand and material for the pedestrian signal faces at each location.

Install a pedestrian signal face such that its members are arranged symmetrically and plumb or level.

87-1.03T Accessible Pedestrian Signals

Use the same brand for the accessible pedestrian signals at each location.

Install an accessible pedestrian signal and the R10 series sign on the crosswalk side of the standard.

Attach the accessible pedestrian signal to the standard with self-tapping screws.

Attach the sign to the standard using 2 straps and saddle brackets.

Point the arrow on the accessible pedestrian signal in the same direction as the corresponding crosswalk.

Furnish the equipment and hardware to set up and calibrate the accessible pedestrian signal.

Arrange to have a manufacturer's representative at the job site to program the accessible pedestrian signal with an audible message or tone.

87-1.03U Push Button Assemblies

Install the push button assembly and the R10 series sign on the crosswalk side of the standard.

Attach the sign to the assembly for Type B assemblies.

Attach the sign to the standard using 2 straps and saddle brackets for Type C assemblies.

You may use straps and saddle brackets to secure the push button to the standard.

Use a slip fitter to secure the assembly on top of a 2-1/2-inch-diameter post.

87-1.03V Detectors

87-1.03V(1) General

Installing a detector includes installing inductive loop conductors, sealant, conduit, and pull boxes.

Center the detectors in the traffic lanes.

Do not splice the detector conductor.

87-1.03V(2) Inductive Loop Detectors

Mark the location of the inductive loop detectors such that the distance between the side of the loop and a lead-in saw cut from an adjacent detector is at least 2 feet. The distance between lead-in saw cuts must be at least 6 inches.

Saw cut the slots under section 13-4.03E(7). The bottoms of the slots must be smooth with no sharp edges. For Type E detector loops, saw the slots such that the sides are vertical.

Wash the slots clean using water and blow dry them with compressed air to remove all moisture and debris.

Identify the start of the conductor.

Waterproof the ends of a Type 2 loop conductor before installing it in the conduit to prevent moisture from entering the cable.

Install the loop conductor in the slots and lead-in saw cuts using a 3/16- to 1/4-inch-thick wood paddle. Hold the conductors in place at the bottom of the slot with wood paddles during placement of the sealant.

Wind adjacent loops on the same sensor unit channel in opposite directions.

Twist the conductors for each loop into a pair consisting of a minimum of 2 turns per foot before placing them in the lead-in saw cut and the conduit leading to the pull box. Do not install more than 2 twisted pairs of conductors per lead-in saw cut.

Provide 5 feet of slack in the pull box.

Test each loop for continuity, circuit resistance, and insulation resistance before filling the slots with sealant.

Remove excess sealant from the adjacent road surface before it sets. Do not use solvents to remove the excess.

Identify the loop conductor pair in the pull box, marking the start with the letter *S* and the end with the letter *F*. Band conductors in pairs by lane in the pull box adjacent to the loops and in the cabinet. Identify each pair with the detector designation and loop number.

Install the conductors in a compacted layer of HMA immediately below the uppermost layer if more than one layer will be placed. Install the loop conductors before placing the uppermost layer of HMA. Fill the slot with a sealant flush to the surface.

Install the conductors in the existing pavement if one layer of HMA is to be placed. Install the loop conductors before placing the layer of HMA. Fill the slot with a sealant flush to the surface.

87-1.03V(3) Preformed Inductive Loop Detectors

Install a preformed inductive loop detector consisting of 4 turns in the loop and a lead-in conductor pair twisted at least 2 turns per foot all encased in conduit and sealed to prevent water penetration. The detector must be 6-foot square unless shown otherwise.

Construct the loop detector using a minimum 3/8-inch Schedule 40 or Schedule 80 PVC or polypropylene conduit and no. 16 or larger conductor with Type THWN insulation.

In new roadways, place the detector in the base course with the top of the conduit flush with the top of the base. Cover with HMA or concrete pavement. Protect the detector from damage before and during pavement placement.

In new reinforced concrete bridge decks, secure the detector to the top of the uppermost layer of reinforcing steel using nylon wire ties. Hold the detector parallel to the bridge deck using PVC or polypropylene spacers where necessary. Place conduit for lead-in conductors between the uppermost 2 layers of reinforcing steel.

Do not install detectors in existing bridge decks unless authorized.

Install a detector in existing pavement before placement of concrete or HMA as follows:

1. Saw cut slots at least 1-1/4 inches wide into the pavement.
2. Place the detector in the slots. The top of the conduit must be at least 2 inches below the top of the pavement.
3. Test each loop circuit for continuity, circuit resistance, and insulation resistance.
4. Fill saw cuts with elastomeric or hot melt rubberized asphalt sealant for asphalt concrete pavement and with epoxy sealant or hot melt rubberized asphalt sealant for concrete pavement.

87-1.03W Sealants

87-1.03W(1) General

Reserved

87-1.03W(2) Elastomeric Sealant

Apply an elastomeric sealant with a pressure feed applicator.

87-1.03W(3) Asphaltic Emulsion Sealant

Asphaltic emulsion sealant must:

1. Be used for filling slots in asphalt concrete pavement of a maximum width of 5/8 inch
2. Not be used on concrete pavement or where the slope causes the material to run from the slot
3. Be thinned under the manufacturer's instructions
4. Be placed when the air temperature is at least 45 degrees F

87-1.03W(4) Hot-Melt Rubberized Asphalt Sealant

Melt the sealant in a jacketed, double-boiler-type, melting unit. The temperature of the heat transfer medium must not exceed 475 degrees F.

Apply the sealant with a pressure feed applicator or a pour pot when the surface temperature of the pavement is greater than 40 degrees F.

87-1.03X Reserved

87-1.03Y Transformers

Installing a transformer includes placing the transformer inside a pull box, a cabinet, or an enclosure.

Wire the transformer for the appropriate voltage.

Ground the secondary circuit of the transformer as specified in the NEC.

87-1.03Z Reserved

87-1.04 PAYMENT

Not Used

87-2 LIGHTING SYSTEMS

87-2.01 GENERAL

87-2.01A Summary

Section 87-2 includes specifications for constructing lighting systems.

Lighting system includes:

1. Foundations
2. Pull boxes
3. Conduit
4. Conductors
5. Standards
6. Luminaires
7. Service equipment enclosure
8. Photoelectric control
9. Fuse splice connectors
10. High mast lighting assemblies

The components of a lighting system are shown on the project plans.

87-2.01B Definitions

Reserved

87-2.01C Submittals

Submit a certificate of compliance and test data for the high mast lighting luminaires.

87-2.01D Quality Assurance

Reserved

87-2.02 MATERIALS

87-2.02A General

Reserved

87-2.02B High Mast Lighting Assemblies

A high mast lighting assembly includes the foundation, pole, lowering device system, luminaires, and control pedestal.

Each luminaire in a high mast lighting assembly must include a housing, an optical system, and a ballast.

The housing must be made of aluminum.

A painted or powder-coated housing for a high mast lighting luminaire must be able to withstand a 1,000-hour salt spray test as specified in ASTM B117.

The optical system, consisting of the reflector, refractor or lens, lamp socket, and lamp, must be in a sealed chamber. The chamber must be sealed by a gasket between the reflector and refractor or lens and a gasket between the reflector and lamp socket. The chamber must have a separate filter or filtering gasket for flow of air.

An asymmetrical luminaire must have a refractor or reflector that is rotatable 360 degrees around a vertical axis to orient the distribution of light.

The luminaire must have a slip fitter for mounting on a 2-inch horizontal pipe tenon and must be adjustable ±3 degrees from the axis of the tenon.

The reflector must have a specular surface made of silvered glass or aluminum protected by either an anodized finish or a silicate film. The reflector must be shaped such that a minimum of light is reflected through the arc tube of the lamp.

The refractor and lens must be made of heat-resistant glass.

The lamp socket must be a porcelain-enclosed, mogul-multiple type. The shell must contain integral lamp grips to ensure electrical contact under conditions of normal vibrations. The socket must be rated for 1,500 W, 600 V(ac) and 4,000 V(ac) pulse for a 400 W lamp and 5,000 V(ac) pulse for a 1,000 W lamp.

The luminaire must have a dual fuse holder for 2 fuses rated at 5 A, 480 V(ac). The fuses must be 13/32 inch by 1-1/2 inches, standard midget ferrule type with a nontime-delay feature.

The lamps must be vertical burning, protected from undue vibration, and prevented from backing out of the socket by a stainless steel clamp attached to the luminaire.

A 1,000 W metal halide lamp must have an initial output of 100,000 lumens and an average rated life of 12,000 hours based on 10 hours per start.

A 400 W high-pressure sodium lamp must have an initial output of 50,000 lumens. A 1,000 W high-pressure sodium lamp must have an initial output of 140,000 lumens.

The ballast for the luminaire must be a regulator type and have a core and coils, capacitors, and starting aid.

Ballast must be:

1. Mounted within a weatherproof housing that integrally attaches to the top of a luminaire support bracket and lamp support assembly
2. Readily removable without removing the luminaire from the bracket arm
3. Electrically connected to the optical assembly by a prewired quick disconnect

The ballast for a metal halide luminaire must comply with luminaire manufacturer's specifications.

The wattage regulation spread at any lamp voltage, from nominal through the life of the lamp, must vary no more than 22 percent for a 1,000 W lamp and a ±10 percent input voltage variation. The ballast's starting line current must be less than its operating current.

87-2.02C Soffit and Wall-Mounted Luminaires

87-2.02C(1) General

Soffit and wall-mounted luminaires must be weatherproof and corrosion resistant.

Each luminaire must include a 70 W high-pressure sodium lamp with a minimum average rated life of 24,000 hours. The lamp socket must be positioned such that the light center of the lamp is located within 1/2 inch of the designed light center of the luminaire.

Luminaire wiring must be SFF-2.

Flush-mounted soffit luminaire must have:

1. Metal body with two 1-inch-minimum conduit hubs and a means of anchoring the body into the concrete
2. Prismatic refractor made of heat-resistant polycarbonate:
   2.1. Mounted in a door frame
   2.2. With the street side identified
3. Aluminum reflector with a specular anodized finish
4. Ballast located either within the housing or in a ceiling pull box if shown
5. Lamp socket

The door frame assembly must be hinged, gasketed, and secured to the luminaire body with at least 3 machine screws.

A pendant soffit luminaire must be enclosed and gasketed and have an aluminum finish. Luminaire must have:

1. Aluminum reflector with a specular anodized finish
2. Refractor made of heat-resistant polycarbonate
3. Optical assembly that is hinged and latched for lamp access and a device to prevent dropping
4. Ballast designed for operation in a raintight enclosure

5. Galvanized metal box with a gasketed cover, 2 captive screws, and 2 chains to prevent dropping and for luminaire mounting

Wall-mounted luminaire must have:

1. Cast metal body
2. Prismatic refractor:
   2.1. Made of glass
   2.2. Mounted in a door frame
3. Aluminum reflector with a specular anodized finish
4. Integral ballast
5. Lamp socket
6. Gasket between the refractor and the body
7. At least 2 mounting bolts of minimum 5/16-inch diameter

A cast aluminum body of a luminaire to be cast into or mounted against concrete must have a thick coat of alkali-resistant bituminous paint on all surfaces to be in contact with the concrete.

87-2.02C(2) High-Pressure Sodium Lamp Ballasts

87-2.02C(2)(a) General

A high-pressure sodium lamp ballast must operate the lamp for its rated wattage.

Starting aids for a ballast must be interchangeable between ballasts of the same wattage and manufacturer without adjustment.

The ballast must be provided with a heat-generating component to serve as a heat sink. The capacitor must be placed at the maximum practicable distance from the heat-generating components or thermally shielded to limit the case temperature to 75 degrees C.

The transformer and inductor must be resin impregnated for protection against moisture. Capacitors, except for those in starting aids, must be metal cased and hermetically sealed.

The ballast must have a power factor of 90 percent or greater.

For the nominal input voltage and lamp voltage, the ballast design center must not vary more than 7.5 percent from the rated lamp wattage.

87-2.02C(2)(b) Regulator-Type Ballasts

A regulator-type ballast must be designed such that a capacitance variance of ±6 percent does not cause more than ±8 percent variation in the lamp wattage regulation.

The ballast must have a current crest factor not exceeding 1.8 for an input voltage variation of ±10 percent.

The lamp wattage regulation spread for a lag-type ballast must not vary by more than 18 percent for ±10 percent input voltage variations. The primary and secondary windings must be electrically isolated.

The lamp wattage regulation spread for a constant-wattage, autoregulator, lead-type ballast must not vary by more than 30 percent for ±10 percent input voltage variations.

87-2.02C(2)(c) Nonregulator-Type Ballasts

A nonregulator-type ballast must have a current crest factor not exceeding 1.8 for an input voltage variation of ±5 percent.

The lamp wattage regulation spread for an autotransformer or high reactance type ballast must not vary by more than 25 percent for ±5 percent input voltage variations.

87-2.03 CONSTRUCTION

87-2.03A General

Set the foundations for standards such that the mast arm is perpendicular to the centerline of the roadway.

Tighten the cap screws of the luminaire's clamping bracket to 10 ft-lb for LED and low-pressure luminaires.

Label the month and year of the installation inside the luminaire housing's door.

Perform the conductor and operational tests for the system.

87-2.03B High Mast Lighting Assemblies

Mount and connect the luminaires to the accessory support ring. Aim the asymmetrical luminaire to orient the distribution of light.

87-2.03C Soffit and Wall-Mounted Luminaires

For a flush-mounted soffit luminaire:

1. Prevent concrete from getting into the housing during pouring of the concrete for the structure
2. Install the luminaire with the axis vertical and the street side of the refractor oriented as indicated
3. Locate the luminaire to provide a minimum 2-foot clearance from the inside surface of the girders and 1-foot clearance from the near face of the diaphragm
4. Install the bridge soffit and ceiling pull box over the same lane

For a pendant soffit luminaire:

1. Cast in place the inserts for the no. 8 pull box during concrete placement for a new structure
2. Drill holes for expansion anchors to support the no. 8 pull box on existing structures
3. Bond the suspension conduit and luminaire to the pull box

For a wall-mounted luminaire, provide:

1. Extension junction box or ring on a new structure
2. 4 external mounting taps on an existing structure

Place the soffits or wall-mounted luminaires in operation as soon as practicable after the falsework has been removed from the structure.

If the Engineer orders soffit or wall-mounted luminaires to be activated before permanent power service is available, installing and removing the temporary power service is change order work.

87-2.04 PAYMENT

Not Used

87-3 SIGN ILLUMINATION SYSTEMS

87-3.01 GENERAL

87-3.01A Summary

Section 87-3 includes specifications for constructing sign illumination systems.

Sign illumination system includes:

1. Foundations
2. Pull boxes
3. Conduit
4. Conductors
5. Sign lighting fixtures
6. Enclosure for the disconnect circuit breaker
7. Service equipment enclosure
8. Photoelectric control

The components of a sign illumination system are shown on the project plans.

87-3.01B Definitions

Reserved

87-3.01C Submittals

Submit the manufacturer's test data for the induction sign-lighting fixtures.

87-3.01D Quality Assurance

Reserved

87-3.02 MATERIALS

An induction sign-lighting fixture must include a housing with a door, reflector, refractor or lens, lamp, socket assembly, power coupler, high-frequency generator, fuse block, and fuses.

The fixture must comply with the isofootcandle curves as shown.

Fixture must weigh no more than 44 lb, be rated for 87 W at 120/240 V(ac), and have a mounting assembly made of one of the following materials:

1. Cast aluminum
2. Hot-dip galvanized steel plate
3. Galvanized steel plate finished with one of the following:
   3.1. Polymeric coating
   3.2. Same finish used for the housing

Housing must:

1. Be corrosion resistant and suitable for wet locations
2. Be above the top of the mounting rails at a maximum height of 12 inches
3. Have weep holes

Door must:

1. Hold a refractor or lens
2. Open without the use of special tools
3. Have a locking position at 50 degrees minimum from the plane of the door opening
4. Be hinged to the housing on the side of the fixture away from the sign panel
5. Have 2 captive latch bolts or other latching device

When the door is opened, it must lock in the 50 degrees position when an 85 mph, 3-second wind-gust load strikes the door from either side.

The housing and door must be manufactured of sheet or cast aluminum and have a gray powder coat or polyester paint finish. The sheet aluminum must comply with ASTM B209 or B209M for 5052-H32 aluminum sheet. External bolts, screws, hinges, hinge pins, and door closure devices must be corrosion resistant.

The housing and door must be gasketed. The thickness of the gasket must be a minimum of 1/4 inch.

Reflector must not be attached to the outside of the housing and must be:

1. Made of a single piece of aluminum with a specular finish
2. Protected with an electrochemically applied anodized finish or a chemically applied silicate film
3. Designed to drain condensation away from it
4. Secured to the housing with a minimum of 2 screws
5. Removable without removing any fixture parts

Refractor or lens must have a smooth exterior and must be manufactured from the materials shown in the following table:

Refractor and Lens Material Requirements

Component	Material
Flat lens	Heat-resistant glass
Convex lens	Heat-resistant, high-impact-resistant tempered glass
Refractor	Borosilicate heat-resistant glass

The refractor and convex lens must be designed or shielded such that no luminance is visible if the fixture is approached directly from the rear and viewed from below. If a shield is used, it must be an integral part of the door casting.

Lamp must:

1. Be an 85 W induction type with a fluorescent, phosphor-coated, interior wall
2. Have a minimum 70 percent light output of its original lumen output after 60,000 hours of operation
3. Have a minimum color-rendering index of 80
4. Be rated at a color temperature of 4,000K
5. Be removable with common hand tools

The lamp socket must be rated for 1,500 W and 600 V(ac) and be a porcelain-enclosed mogul type with a shell that contains integral lamp grips to ensure electrical contact under normal vibration conditions. The shell and center contact must be made of nickel-plated brass. The center contact must be spring loaded.

The power coupler must be removable with common hand tools.

High-frequency generator must:

1. Start and operate lamps at an ambient temperature of -25 degrees C or greater for the rated life of the lamp
2. Operate continuously at ambient air temperatures from -25 to 55 degrees C without a reduction in the generator life
3. Have a design life of at least 100,000 hours at 55 degrees C
4. Have an output frequency of 2.65 MHz ± 10 percent
5. Have radio frequency interference that complies with 47 CFR 18 regulations regarding harmful interference
6. Have a power factor greater than 90 percent and total harmonic distortion less than 10 percent

The high frequency generator must be mounted such that the fixture can be used as a heat sink and be replaceable with common hand tools.

Each fixture must include a barrier-type fuse block for terminating field connections. Fuse block must:

1. Be rated 600 V(ac)
2. Have box terminals
3. Be secured to the housing and accessible without removal of any fixture parts
4. Be mounted to leave a minimum of 1/2 inch of air space from the sidewalls of the housing
5. Be designed for easy removal of fuses with a fuse puller

The fixture's fuses must be 13/32-inch-diameter, 1-1/2-inch-long ferrule type and UL listed or NRTL certified. For a 120 V(ac) fixture, only the ungrounded conductor must be fused and a solid connection must be provided between the grounded conductor and the high frequency generator.

The fixture must be permanently marked with the manufacturer's brand name, trademark, model number, serial number, and date of manufacture on the inside and outside on the housing. The same information must be marked on the package.

If a wire guard is used, it must be made of a minimum 1/4-inch-diameter galvanized steel wire. The wires must be spaced to prevent rocks larger than 1-1/2-inch diameter from passing through the guard. The guard must be either hot-dip galvanized or electroplated zinc-coated as specified in ASTM B633, service condition SC4, with a clear chromate dip treatment.

87-3.03 CONSTRUCTION

Perform the conductor and operational tests for the system.

87-3.04 PAYMENT

Not Used

87-4 SIGNAL AND LIGHTING SYSTEMS

87-4.01 GENERAL

87-4.01A Summary

Section 87-4 includes specifications for constructing signal and lighting systems.

Signal and lighting system includes:

1. Foundations
2. Pull boxes
3. Conduit
4. Conductors and cables
5. Standards
6. Signal heads
7. Internally illuminated street name signs
8. Service equipment enclosure
9. Department-furnished controller assembly
10. Detectors
11. Telephone demarcation cabinet
12. Accessible pedestrian signals
13. Push button assemblies
14. Pedestrian signal heads
15. Luminaires
16. Photoelectric control
17. Fuse splice connectors
18. Battery backup system
19. Flashing beacons
20. Flashing beacon control assembly

The components of a signal and lighting system are shown on the project plans.

87-4.01B Definitions

Reserved

87-4.01C Submittals

Submit shop drawings showing the message for each internally illuminated street sign, including the size of letters, symbols, and arrows.

87-4.01D Quality Assurance

87-4.01D(1) General

Reserved

87-4.01D(2) Quality Control

87-4.01D(2)(a) General

Reserved

87-4.02 MATERIALS

87-4.02A General

Reserved

87-4.02B Reserved

87-4.02C Internally Illuminated Street Name Signs

An internally illuminated street name sign includes housing, brackets, sign panels, gaskets, ballast, lampholder, terminal blocks, conductors, and fuses.

An internally illuminated street sign must be designed and constructed to prevent deformation or failure when subjected to an 85 mph, 3-second wind-gust load as specified in the AASHTO publication, "Standard Specifications for Structural Supports of Highway Signs, Luminaires and Traffic Signals."

Sign must:

1. Be Types A or B
2. Have galvanized or cadmium-plated ferrous parts
3. Have screened weep holes
4. Have fasteners, screws, and hardware made of passive stainless steel, Type 302 or 304, or aluminum Type 6060-T6
5. Operate at a temperature from -20 to 74 degrees C

Photoelectric unit sockets are not allowed.

The housing must be constructed to resist torsional twist and warp. The housing must be designed such that opening or removing the panels provides access to the interior of the sign for lamp, ballast, and fuse replacement.

The top and bottom of the sign must be manufactured from formed or extruded aluminum and attached to formed or cast aluminum end fittings. The top, bottom, and end fittings must form a sealed housing.

For a Type A sign, both sides of the sign must be hinged at the top to allow installation or removal of the sign panel.

For a Type B sign, the sign panel must be slide mounted into the housing.

The top of the housing must have 2 free-swinging mounting brackets. Each bracket must be vertically adjustable for leveling the sign to either a straight or curved mast arm. The bracket assembly must allow the lighting fixture to swing perpendicular to the sign panel.

The reflectors must be formed aluminum and have an acrylic, baked-white-enamel surface with a minimum reflectance of 0.85.

Sign panel must be translucent, high-impact-resistant, and made of one of the following plastic materials:

1. Glass-fiber-reinforced, acrylated resin
2. Polycarbonate resin
3. Cellulose acetate butyrate

The sign panel must be designed not to crack or shatter if a 1-inch-diameter steel ball weighing 2.4 ounces is dropped from a height of 8.5 feet above the sign panel to any point on the panel. For this test, the sign panel must be lying in a horizontal position and supported within its frame.

The sign panel's surface must be evenly illuminated. The brightness measurements for the letters must be a minimum of 150 foot-lamberts, average. The letter-to-background brightness ratio must be from 10:1 to 20:1. The background luminance must not vary by more than 40 percent from the average background brightness measurement. The luminance of letters, symbols, and arrows must not vary by more than 20 percent from their average brightness measurement.

The sign panel's white or green color must not fade or darken if exposed to an accelerated test of UV light equivalent to 2 years of outdoor exposure.

The sign panel's legend, symbols, arrows, and border on each face must be white on a green background. The background must comply with color no. 14109 of FED-STD-595.

The message must appear on both sides of the sign and be protected from UV radiation. The letters must be 8-inch upper case and 6-inch lower case, series E.

A Type A sign must have a closed-cell, sponge-neoprene gasket installed between the sign panel frame to prevent the entry of water. The gasket must be uniform and even textured.

The sign ballast must be a high-power-factor type for outdoor operation from 110 to 125 V(ac) and 60 Hz and must comply with ANSI C82.1 and C82.2.

The ballast for a Type A sign must be rated at 200 mA. The ballast for a Type B sign must be rated at 430 mA.

Sign lampholder must:

1. Be the spring-loaded type
2. Have silver-coated contacts and waterproofed entrance leads
3. Have a heat-resistant, circular cross section with a partially recessed neoprene ring

Removal of the lamp from the socket must de-energize the primary of the ballast.

The springs for the lampholders must not be a part of the current-carrying circuit.

The sign's wiring connections must terminate on a molded, phenolic, barrier-type, terminal block rated at 15 A, 1,000 V(ac). The connections must have a white, integral, waterproof marking strip. The terminal screws must not be smaller than a no. 10.

The terminal block must be insulated from the fixture to provide protection from the line-to-ground flashover voltage.

A sectionalized terminal block must have an integral barrier on each side and must allow rigid mounting and alignment.

Fixture's conductors must:

1. Be stranded copper wire with a minimum thermoplastic insulation of 28 mils
2. Be rated at 1,000 V(ac) and for use up to 90 degrees C
3. Be a minimum of no. 16
4. Match the color coding of the ballast leads
5. Be secured with spring cross straps, installed 12 inches apart or less in the chassis or fixture

Stranded copper conductors connected to screw-type terminals must terminate in crimp-type ring connectors.

No splicing is allowed within the fixture.

The sign's fuse must be the Type 3AG, miniature, slow-blow type.

The fuse holder must be a panel-mounting type with a threaded or bayonet knob that grips the fuse tightly for extraction. Each ballast must have a separate fuse.

87-4.03 CONSTRUCTION

87-4.03A General

Set the foundations for standards such that the mast arm is perpendicular to the centerline of the roadway.

Tighten the cap screws of the luminaire's clamping bracket to 10 ft-lb for LED and low-pressure luminaires.

Label the month and year of the installation inside the luminaire housing's door.

Perform the conductor and operational tests for the system.

87-4.03B Reserved

87-4.03C Internally Illuminated Street Name Signs

Mount the internally illuminated street name sign to the signal mast arm using the adjustable brackets. Connect the conductors to the terminal blocks in the signal head mounting terminal block.

87-4.04 PAYMENT

Not Used

87-5 RAMP METERING SYSTEMS

87-5.01 GENERAL

Section 87-5 includes specifications for constructing ramp metering systems.

Ramp metering system includes:

1. Foundations

2. Pull boxes
3. Conduit
4. Conductors
5. Standards
6. Signal heads
7. Service equipment enclosure
8. Department-furnished controller assembly
9. Detectors
10. Telephone demarcation cabinet

The components of a ramp metering system are shown on the project plans.

87-5.02 MATERIALS

Not Used

87-5.03 CONSTRUCTION

Connect the field wiring to the terminal blocks in the controller cabinet. The Engineer provides you a list of field conductor terminations for each controller cabinet.

Perform the conductor and operational tests for the system.

87-5.04 PAYMENT

Not Used

87-6 TRAFFIC MONITORING STATION SYSTEMS

87-6.01 GENERAL

Section 87-6 includes specifications for constructing traffic monitoring station systems.

Traffic monitoring station system includes:

1. Foundations
2. Pull boxes
3. Conduit
4. Cables
5. Conductors
6. Service equipment enclosure
7. Controller cabinet
8. Detectors
9. Telephone demarcation cabinet

The components of a traffic monitoring station system are shown on the project plans.

87-6.02 MATERIALS

Not Used

87-6.03 CONSTRUCTION

Connect the field wiring to the terminal blocks in the controller cabinet. The Engineer provides you a list of field conductor terminations for the controller cabinet.

Perform the conductor and operational tests for the system.

87-6.04 PAYMENT

Not Used

87-7 FLASHING BEACON SYSTEMS

87-7.01 GENERAL

Section 87-7 includes specifications for constructing flashing beacon systems.

Flashing beacon system includes:

1. Foundations

2. Pull boxes
3. Conduit
4. Conductors
5. Standards
6. Service equipment enclosure
7. Signal heads
8. Flashing beacon control assembly

The components of a flashing beacon system are shown on the project plans.

The flash rate for the flashing beacon must comply with chapter 4L, "Flashing Beacons," of the *California MUTCD*.

The flashing beacon must allow alternating flashing wig-wag operation.

The flashing beacon must have a separate flasher unit installed in the flashing beacon control assembly.

87-7.02 MATERIALS

Flashing beacon control assembly must:

1. Have a NEMA 3R enclosure with a dead front panel and a hasp with a 7/16-inch hole for a padlock. The enclosure must have one of the following finishes:
   1.1. Powder coating.
   1.2. Hot-dip galvanized coating.
   1.3. Factory-applied, rust-resistant prime coat and finish coat.
2. Have barrier-type terminal blocks rated for 25 A, 600 V(ac), made of molded phenolic or nylon material and have plated-brass screw terminals and integral marking strips.
3. Include a solid state flasher complying with section 8 of NEMA standards publication no. TS 1 for 10 A, dual circuits.

87-7.03 CONSTRUCTION

Perform the conductor and operational tests for the system.

87-7.04 PAYMENT

Not Used

87-8 PEDESTRIAN HYBRID BEACON SYSTEMS

87-8.01 GENERAL

87-8.01A Summary

Section 87-8 includes specifications for constructing pedestrian hybrid beacon systems.

A pedestrian hybrid beacon system includes:

1. Foundations
2. Pull boxes
3. Conduit
4. Conductors and cables
5. Standards
6. Pedestrian hybrid beacon face
7. Pedestrian signal heads
8. Service equipment enclosure
9. Department-furnished controller assembly
10. Accessible pedestrian signals
11. Push button assemblies
12 Luminaires
13 Fuse splice connectors
14. Battery backup system

87-8.01B Definitions

Reserved

87-8.01C Submittals

Reserved

87-8.01D Quality Assurance

87-8.01D(1) General

Reserved

87-8.01D(2) Quality Control

Verify the sequence for the pedestrian hybrid beacon system per California Chapter 4F, Figure 3F-3 "Sequence for a Pedestrian Hybrid Beacon" during the operational test.

87-8.02 MATERIALS

87-8.02A General

The system must comply with California *MUTCD*, Chapter 4F.

87-8.02B Pedestrian Hybrid Beacon Face

A pedestrian hybrid beacon face consists of 3 12-inch signal heads.

87-8.03 CONSTRUCTION

Install pedestrian hybrid beacon system under sections 87-4.03A and 87-4.03B.

87-8.04 PAYMENT

Not Used

87-9–87-11 RESERVED

87-12 CHANGEABLE MESSAGE SIGN SYSTEMS

87-12.01 GENERAL

Section 87-12 includes specifications for constructing changeable message sign systems.

Changeable message sign system includes:

1. Foundations
2. Pull boxes
3. Conduit
4. Conductors and cables
5. Service equipment enclosure
6. Department-furnished controller cabinet
7. Department-furnished changeable message sign
8. Department-furnished wiring harness
9. Sign disconnect

The components of a changeable message sign system are shown on the project plans.

87-12.02 MATERIALS

Not Used

87-12.03 CONSTRUCTION

Install the changeable message sign.

Connect the field wiring to the terminal blocks in the sign assembly and controller cabinet.

The Engineer provides you a list of field conductor terminations for each sign cabinet and controller cabinet.

The Department maintains the sign assemblies.

87-12.04 PAYMENT

Not Used

87-13 RESERVED

87-14 RADAR SPEED FEEDBACK SIGN SYSTEMS

87-14.01 GENERAL

87-14.01A Summary

Section 87-14 includes specifications for installing radar speed feedback sign systems.

Radar speed feedback sign system includes:

1. Foundations
2. Pull boxes
3. Conduit
4. Conductors and cables
5. Standards or wood posts
6 Vehicle speed feedback sign
7. Service equipment enclosure

The components of a radar speed feedback sign system are shown on the project plans.

87-14.01B Definitions

Not Used

87-14.01C Submittals

Submit 2 copies of:

1. Test data report complying with NEMA-TS-2 for the vehicle speed feedback sign
2. Shop drawings or installation manuals for the sign support, electrical connections, attachments, and mounting configurations

87-14.01D Quality Assurance

87-14.01D(1) General

Not Used

87-14.01D(2) Quality Control

Equipment setup must comply with the sign manufacturer's instructions.

Notify the Engineer at least 5 business days before performing the system test. Test the system in the presence of the Engineer.

Radar speed feedback sign system test consists of:

1. Turning on the radar speed feedback sign system
2. Driving a vehicle and recording the speeds displayed:
   2.1. By the vehicle speedometer
   2.2. On the vehicle speed feedback sign for the vehicles
3. Performing the test 5 times per lane detected
4. Ensuring that the 5 recorded speeds of the vehicle speed feedback sign are within ± 1 mph of the vehicle speeds recorded from the vehicle speedometer

After successful testing, present the recorded results to the Engineer.

87-14.01D(3) Training

Provide training to a maximum of 4 Department employees on the operation of the vehicle speed feedback sign. Training must be a minimum of 1 hour and include how to program, adjust, troubleshoot, and repair the sign.

87-14.02 MATERIALS

87-14.02A General

Not Used

87-14.02B Vehicle Speed Feedback Signs

Vehicle speed feedback sign consists of a housing, display window, and radar unit.

Sign must:

1. Comply with the California MUTCD, Chapter 2B
2. Have an operating voltage of 120 V(ac) for permanent installations
3. Have a maximum weight of 45 lb
4. Have a wind load rating of 90 mph
5. Have an operating temperature range from -34 to 165 degrees F
6. Have a retroreflective white sheeting background

87-14.02B(1) Housings

Housing must:

1. Be weather proof (NEMA 3R or better) and vandal resistant
2. Be made of 0.09-inch-gauge welded aluminum with the outer surfaces being UV resistant
3. Have the manufacturer's name, model number, serial number, date of manufacture, rated voltage and rated current marked inside
4. Have the internal components easily accessible for field repair without removal of the sign

87-14.02B(2) Display Windows

Display window consists of a cover, LED character display, and dimming control. Character display and cover must deflect together without damage to the internal electronics and speed detection components.

87-14.02B(2)(a) Covers

Cover must be:

1. Vandal resistant and shock absorbent
2. Field replaceable with the removal of external stainless-steel, tamper proof fasteners

Cover must be made of a minimum .25-inch-thick, shatter-resistant polycarbonate.

87-14.02B(2)(b) LED Character Displays

LED character display must:

1. Consist of two 7-segment, solid-state, numeric characters
2. Be capable of displaying the detected vehicle speed within 1 second
3. Remain blank when no vehicles are detected within the radar detection zone
4. Have the option to flash the pre-set speed limit when the detected vehicle speed is 5 miles higher than the pre-set speed
5. Be viewable only by the approaching traffic

Characters must:

1. Be a minimum 15 inches in height
2. Be visible and legible from a minimum distance of 1500 feet and legible from a minimum distance of 750 feet
3. Consist of a minimum 16 LEDs

LEDs must:

1. Be amber and have a wavelength from 590 to 600 nm andrated for minimum 100,000 hours
2. Must maintain a minimum 85 percent of the initial light output after 48 months of continuous use over the temperature range

87-14.02B(2)(c) Dimming Controls

Dimming control must:

1. Automatically adjust the character light intensity to provide optimum character visibility and legibility under all ambient lighting conditions
2. Have minimum 3 manual dimming modes of different intensities

87-14.02B(3) Radar Units

Radar unit must:

1. Be able to detect up to 3 lanes of approaching traffic
2. Operate with an internal, low power, 24.159 GHz (K-band)
3. Be FCC approved Part 15 certified
4. Have a speed accuracy of ±1 mph
5 Have a maximum 15W power consumption

87-14.03 CONSTRUCTION

Install the vehicle speed feedback sign under the manufacturer's instructions.

Perform the conductor test.

Configure the radar speed feedback sign system to detect only traffic in the approach direction of travel.

Perform the radar speed feedback sign system test.

Perform the operational test for the system.

87-14.04 PAYMENT

Not Used

87-15–87-17 RESERVED

87-18 INTERCONNECTION CONDUIT AND CABLE

87-18.01 GENERAL

Section 87-18 includes specifications for constructing interconnection conduit and cable.

Interconnection conduit and cable includes:

1. Pull boxes
2. Conduit
3. Signal interconnect cables

The components of an interconnection conduit and cable are shown.

87-18.02 MATERIALS

Not Used

87-18.03 CONSTRUCTION

Test the signal interconnect cable.

Connect the signal interconnect cable to the terminal block in the controller cabinets. The Engineer provides you a list of terminations for each controller cabinet.

87-18.04 PAYMENT

Not Used

87-19 FIBER OPTIC CABLE SYSTEMS

87-19.01 GENERAL

87-19.01A Summary

Section 87-19 includes specifications for constructing fiber optic cable systems.

A fiber optic cable system includes:

1. Conduit and accessories
2. Splice vaults

3. Warning tape
4. Fiber optic cables
5. Fiber optic splice enclosures
6. Fiber distribution units
7. Fiber optic markers
8. Fiber optic connectors and couplers

The components of a fiber optic system are shown on the project plans.

87-19.01B Definitions

Reserved

87-19.01C Submittals

At least 15 days before cable installation, submit:

1. Manufacturer's procedures for pulling fiber optic cable
2. Test reports from a laboratory accredited to International Standards Organization/International Electrotechnical Commission 17025 by the American Association for Laboratory Accreditation (A2LA) or the ANSI-ASQ National Accreditation Board (ANAB) for:
   2.1. Water penetration
   2.2. Cable temperature cycling
   2.3. Cable impact
   2.4. Cable tensile loading and fiber strain
   2.5. Cable compressive loading
   2.6. Compound flow
   2.7. Cyclic flexing
3. Proof of calibration for the test equipment including:
   3.1. Name of calibration facility
   3.2. Date of calibration
   3.3. Type of equipment, model number and serial number
   3.4. Calibration result

Submit the data file and software from the OTDR with the test results for all OTDR tests. The software must support Windows computer operating systems.

After performing the OTDR and the power meter and light source tests, submit within 4 business days:

1. Cable Verification Worksheet
2. Segment Verification Worksheet
3. Link Loss Budget Worksheet

The worksheets are available at the Division of Construction website and copies are included in the *Information Handout*. Submittals must be in Microsoft Excel format. Include hard copies and copies in an electronic format.

87-19.01D Quality Assurance

87-19.01D(1) General

Reserved

87-19.01D(2) Quality Control

Notify the Engineer 4 days before performing field tests. Include exact location of the system or components to be tested. Do not proceed with the testing until authorized. Perform each test in the presence of the Engineer.

The OTDR test consists of:

1. Inspecting the cable segment for physical damage.
2. Measuring the attenuation levels for wavelengths of 1310 nm and 1550 nm in both directions for each fiber using a light source at one end and OTDR at the other end.

3. Comparing the test results with the data sheet provided with the shipment. If there are attenuation deviations greater than 5 percent, the test will be considered unsatisfactory and the cable segment will be rejected. The failure of any single fiber is a cause for rejection of the entire segment. Replace any rejected cable segments and repeat the test.

The power meter and light source test consists of:

1. Testing each fiber in a link using a light source at one end of the link and a power meter at the other end
2. Measuring and recording the power loss for wavelengths of 1310 nm and 1550 nm in both directions

Index matching gel is not allowed in connectors during power meter and light source test.

Test results must be generated from test equipment software and recorded, compared and proven to be within the calculated link loss budget, and filed with the other recordings of the same link.

Installation and splicing of the fiber optic cable system must be performed by a certified fiber optic installer.

The OTDR test and the power meter and light source test must be performed by a certified fiber optic technician.

The certification for the fiber optic installer and fiber optic technician must be from an organization recognized by the International Certification Accreditations Council and must be current through the installation of the fiber optic system.

87-19.02 MATERIALS

87-19.02A General

All metal components of the fiber optic cable system must be corrosion resistant.

All connectors must be factory-installed and tested.

Patch cords, pigtails and connectors must comply with ANSI/TIA-568.

Pigtails must have a minimum 80 N pull out strength.

Each cable reel must be labeled as specified in ANSI/ICEA S-87-640 including:

1. Contractor's name
2. Contract number
3. Cable diameter
4. Number of fibers
5. Cable attenuation loss per fiber at 1310 nm and 1550 nm

The information must be on a weatherproof label or tag and in a shipping record in a weatherproof envelope. The envelope must be removed only by the Engineer.

87-19.02B Splice Vaults

A splice vault must:

1. Comply with section 86-1.02C, AASHTO HS 20-44, and AASHTO M 306.
2. Be a minimum of 4 feet wide by 4 feet high by 4 feet long nominal inside dimensions or a minimum of 4 feet outside diameter for round splice vaults.
3. Be precast either modular or monolithic.
4. Have cable racks installed on the interior sides. A rack must:
   - 4.1. Be fabricated from ASTM A36 steel plate.
   - 4.2. Support a minimum of 100 pounds per rack arm.
   - 4.3. Support a minimum of 4 splice enclosures and a minimum of 4 cables with a minimum slack of 50 feet each.
   - 4.4. Be hot-dip galvanized after manufacturing.
   - 4.5. Be bonded and grounded.

5. Have a minimum of 4 knockouts for cable entry points. Entry points must not cause the cable to exceed its maximum bend radius.
6. Have a minimum 2 inch diameter drain hole at the base.
7. Be weatherproof.
8. Have cable accesses with rubber grommets or similar material to prevent the cable from coming in contact with the bare metal.

The cover must:

1. Be in two-piece torsion-assisted sections for non-rounded enclosures
2. Be galvanized steel with a minimum of 30 inches diameter for round enclosures
3. Have inset lifting pull slots
4. Have markings "CALTRANS FIBER OPTIC" on each section

87-19.02C Fiber Optic Cable

The fiber optic cable must:

1. Comply with 7 CFR 1755.900 to 1755.902 and ANSI/ICEA S-87-640
2. Be a single mode, zero-dispersion, and have non-gel loose type buffer tubes
3. Have no splices, including factory splices
4. Have a Type H or Type M outer jacket

The fiber optic cable must:

1. Be shipped on a reel
2. Have 10 feet of length on each end of the cable accessible for testing

The fiber optic riser cable must:

1. Comply with ICEA S-104-696
2. Be rated for underground and riser application
3. Have a minimum of 4 fibers
4. Be singlemode and operate at wavelengths of 1310 and 1550 nanometers

Fiber optic cable must be identified as shown in the following table:

Cable Identification

No.	Description	Code
1	Fiber Type	**S:** Singlemode
2	Fiber Count	**048 (example):** Actual number of fibers
3	Begin Point	T: TMC H: Hub V: Video Node D: Data Node C: Cable Node TV: CCTV Camera CM: CMS E: Traffic Signal RM: Ramp Meter TM: Traffic Monitoring/ Count Station/Vehicle Count Station (VDS, TMS) HA: Highway Advisory Radio EM: Extinguishable Message Sign RW: Roadway Weather Information System WM: Weigh In Motion WS: Weigh-Station Bypass System SV: Splice Vault or Fiber Optic Vault SC: Splice Cabinet
4	Begin Point County Abbreviation	Examples: Orange (Ora), San Mateo (SM). County abbreviations are available Plans Preparation Manual at Division of Design website.
5	Begin Point Route Number	Examples 005, 082, 114
6	Begin Point Post Mile	02470 (example 024.70): Actual PM value to the 1/100 value
7	End Point	In the same manner as for Begin Point
8	End Point County Abbreviation	
9	End Point Route Number	
10	End Point Post Mile	

87-19.02D Fiber Optic Splice Enclosures

A fiber optic splice enclosure must:

1. Be a maximum of 36 by 8 inches
2. Be thermoplastic, weather proof, chemical and UV resistant, and resealable
3. Accommodate a minimum of 8 internal splice trays
4. Have 1/4 to 1 inch diameter cable entry ports to accommodate cables as shown
5. Have brackets, clips and cable ties
6. Have means to anchor the dielectric member of the fiber optic cable
7. Include grounding hardware

87-19.02E Fiber Distribution Units

The Fiber Distribution Unit (FDU) consists of a housing, a patch panel, a 12 multicolor pigtail, and a splice tray.

The FDU must be self-contained and pre-assembled.

The housing must:

1. Be a 19-inch rack mountable modular metal enclosure

2. Be a one rack unit
3. Have cable clamps to secure fiber optic cables to the chassis
4. Have cable accesses with rubber grommets or similar material to prevent the cable from coming in contact with the bare metal
5. Be weatherproof
6. Have a hinged top door with a latch or thumbscrew to hold it in the closed position

A patch panel must have a minimum of 12 single-fiber type connector sleeves.

A pigtail must:

1. Be a simplex single mode fiber in a 900 µm tight buffer with a 0.12 inch outer diameter PVC jacket
2. Have a fiber optic connector attached on one end and bare fiber on the other end
3. Be at least 3 feet in length
4. Have the manufacturer's part number on the jacket

Pigtails must be single-fiber or ribbon type.

Patch cords must:

1. Be a single mode fiber in a 900 µm tight buffer with a 0.12 inch outer diameter PVC jacket
2. Have fiber optic connectors attached on both ends
3. Be at least 6 feet in length
4. Have manufacturer's part number on the jacket

Duplex patch cords must be of round cable structure, and not have zip-cord structure.

Splice trays must:

1. Have brackets to spool incoming fibers a minimum of 2 turns.
2. Have means to secure and protect incoming buffer tubes, pigtails, and a minimum of 12 heat shrink fusion splices.
3. Be stackable.
4. Have a snap-on or hinged cover. The cover may be transparent.

A splice cassette may be used in place of a pigtail and a splice tray.

87-19.02F Fiber Optic Markers

Fiber optic markers must be:

1. Type K-2 (CA) object markers for splice vaults or pull boxes
2. Type G retroreflective pavement markers for paved areas and transition points from unpaved to paved areas
3. Non-reflective Class 1, Type F, flexible post delineators for unpaved areas

87-19.02G Fiber Optic Connectors and Couplers

Singlemode fiber optic connectors must have a yellow strain relief boot or a yellow base.

Connectors must be:

1. 0.1-inch ceramic ferrule pre-radiused type
2. Capped when not used

Couplers must be made of the same material as the connector's housing and have ceramic sleeves.

87-19.03 CONSTRUCTION

87-19.03A General

Perform the OTDR test:

1. On the fiber optic cable upon its arrival to the job site and before its installation. Complete the Cable Verification Worksheet. Do not install the fiber optic cable until the Engineer's written approval is received.

2. After the fiber optic cable segments have been pulled but before breakout and termination. Complete the Segment Verification Worksheet.
3. Once the passive cabling system has been installed and is ready for activation. If the measured individual fusion splice losses exceed -0.30 dB, re-splice and retest. At the conclusion of the OTDR test, perform the power meter and light source test. If the measured link loss exceeds the calculated link loss, replace the unsatisfactory cable segments or splices and retest. Complete the Link Loss Budget Worksheet.

87-19.03B Splice Vaults Installation

Install a splice vault as shown and with the side facing the roadway a minimum of 2 feet from the edge of pavement or back of dike, away from traffic.

Install the top of the vault flush with surrounding grade in paved areas and 2 inches above the surrounding grade in unpaved areas.

Place minor concrete around and under vaults. In unpaved areas, finish top of concrete at a 2 percent slope away from cover. In paved areas, finish top of concrete to match existing slope.

Bolt the steel cover to the vault when not working in it.

87-19.03C Fiber Optic Cable Installation

Install fiber optic cable under manufacturer's instructions. Fiber optic cable must be installed by a certified installer or a representative from the fiber optic cable manufacturer must be present during installation.

For installation of fiber optic cable using mechanical aids:

1. Maintain a cable bend radius at least twenty times the outside diameter of the cable
2. Cable grips have a ball bearing swivel
3. Pulling force on a cable must not exceed 500 pound-foot or manufacturer’s recommended pulling tension, whichever is less

Cable installed using the air blown method must withstand a static air pressure of 110 psi.

Lubricate the cable using a lubricant recommended by the cable manufacture.

Use only a non-abrasive pull tape.

Install fiber optic cable without splices except where shown or authorized.

Provide a minimum of 65 feet of slack for each fiber optic cable at each splice vault. Divide the slack equally on each side of the splice enclosure.

Install tracer wires in the fiber optic conduits and innerducts as shown. Provide a minimum 5 feet of slack tracer wire in each pull box and splice vault from each direction. You may splice tracer wire at intervals of not less than 500 feet and only inside splice vaults or pull boxes.

If a fiber optic cable and tracer wire is installed in an innerduct, pulling a separate fiber optic cable into a spare duct to replace damaged fiber will not be allowed.

Apply a flooding material to fiber optic cable openings.

Seal the ends of conduit after cables are installed.

Install strain relief for fiber optic cable entering a fiber optic enclosure.

Identify fibers and cables by direct labeling, metal tags, or bands fastened in such a way that they will not move. Use mechanical methods for labeling.

Provide identification on each fiber or each group of fibers in each splice vault and near the end of terminated fibers.

Place labels on the cables at the following points:

1. Fiber optic splice vault entrance and exit

2. Splice enclosures entrance and exit
3. FDU entrance

For fiber optic riser cable inside controller cabinets, lace and secure the cable to the cage.

Support the fiber optic riser cable within 6 inches from a termination and every 2 feet.

Secure fiber optic cables to the cable racks. Store excess cable in a figure 8 fashion.

87-19.03D Fiber Optic Cable Splices

Use fusion splicing for fiber optic cables.

Splice single-buffer tube cable to multi-buffer tube cable using the mid-span access method under manufacturer's instructions. Any mid-span access splice or FDU termination must involve only those fibers being spliced as shown.

Place fiber splices in the splice enclosures installed in the splice vaults.

87-19.03E Splice Enclosures Installation

Maintain an equal amount of slack on each side of the splice enclosure.

Secure the fiber optic splices in splice tray.

Secure the splice trays to the inner enclosure.

Label cables and buffer tubes.

Do not seal fiber splice enclosure until authorized and the power meter and light source test is performed. Seal the enclosure under manufacturer's recommendation.

Flash test the outer enclosure under manufacturer's instructions in the presence of the Engineer. Visually inspect the enclosure. If bubbles are present, identify the locations where the bubbles are present, take corrective actions and repeat the flash test until no bubbles are present.

Attach the splice enclosure to the side wall of a splice vault or hub with a minimum 2 feet distance between the ground and the bottom of the enclosure.

Secure fiber optic cables to the chassis using cable clamps for fiber optic units.

Connect a minimum of one bonding conductor to a grounding electrode after mounting the fiber optic enclosure to the wall. If there are multiple bonding conductors, organize the conductors in a neat manner.

87-19.03F Fiber Optic Distribution Unit Installation

Spool incoming buffer tubes 2 feet in the splice tray and expose 1 foot of individual fibers.

Maintain a minimum 2-inch-bend radius during and after installation in the splice tray.

Splice incoming fibers in the splice tray.

Restrain each fiber in the splice tray. Do not apply stress on the fiber when located in its final position.

Secure buffer tubes near the entrance of the splice tray.

Secure splice trays under manufacturer's instructions.

Label splice tray after splicing is completed.

Install patch cords in FDUs and patch panels. Permanently label each cord and each connector in the panel with the system as shown.

87-19.03G Fiber Optic Markers Installation

Install fiber optic markers at 12-inch offset on the side furthest away from the edge of travel way:

1. For fiber optic cable at 500 feet apart in areas where the distance between splice vaults or pull boxes is greater than 500 feet

2. Adjacent to pull boxes and splice vaults
3. For fiber optic cable turns at:
   3.1. Beginning of the turn
   3.2. Middle of the arc
   3.3. End of the turn

When a fiber optic cable crosses a roadway or ramp, install a Type G marker over the conduit on:

1. Every shoulder within 6 inches from the edge of pavement
2. Delineated median
3. Each side of the barrier

Install markers under section 81 except each retroreflective face must be parallel to the road centerline and facing away from traffic.

87-19.04 PAYMENT

Not Used

87-20 TEMPORARY ELECTRICAL SYSTEMS

87-20.01 GENERAL

Section 87-20 includes specifications for providing temporary electrical systems.

Obtain the Department's authorization for the type of temporary electrical system and its installation method.

A temporary system must operate on a continuous, 24-hour basis.

Temporary wood poles must comply with section 48-6.

87-20.02 MATERIALS

87-20.02A General

Material and equipment may be new or used.

The components of a temporary system are shown on the project plans.

If you use Type UF-B cable, the minimum conductor size must be no. 12.

87-20.02B Temporary Flashing Beacon Systems

A temporary flashing beacon system consists of a flashing beacon system, wood post, generator, and photovoltaic system.

The system must comply with the specifications for a flashing beacon system in section 87-7, except it may be mounted on a wood post or a trailer.

87-20.02C Temporary Lighting Systems

A temporary lighting system consists of a lighting system, generator, and wood poles.

The system must comply with the specifications for a lighting system in section 87-2, except it may be mounted on a wood pole or a trailer.

87-20.02D Temporary Signal Systems

A temporary signal system consists of a signal and lighting system, wood poles and posts, and a generator.

System must comply with the specifications for a signal and lighting system in section 87-4, except:

1. Signal heads may be mounted on a wood pole, mast arm, tether wire, or a trailer
2. Flashing beacons may be mounted on a wood post, or a trailer

87-20.03 CONSTRUCTION

87-20.03A General

Provide electrical and telecommunication services for temporary systems. Do not use existing services unless authorized.

Provide power for the temporary electrical systems under section 12-3.33, except you may use a photovoltaic system for the temporary flashing beacon system.

Install conductors and cables in a conduit, suspended from wood poles at least 25 feet above the roadway, or use direct burial conductors and cables.

You may saw slots across paved areas for burial conductors and cables.

Install conduit outside the paved area at a minimum of 12 inches below grade for Type 1 and 2 conduit and at a minimum of 18 inches below grade for Type 3 conduit.

Install direct burial conductors and cables outside the paved area at a minimum depth of 24 inches below grade.

Place the portions of the conductors installed on the face of wood poles in either Type 1, 2, or 3 conduit between the point 10 feet above grade at the pole and the pull box. The conduit between the pole and the pull box must be buried at a depth of at least 18 inches below grade.

Place conductors across structures in a Type 1, 2, or 3 conduit. Attach the conduit to the outside face of the railing.

Mount the photoelectric unit at the top of the standard or wood post.

You may abandon in place conductors and cables in sawed slots or in conduit installed below the ground surface.

87-20.03B Temporary Flashing Beacon Systems

Install a fused-splice connector in the pull box adjacent to each flashing beacon. Wherever conductors are run overhead, install the splice connector in the line side outside of the control assembly.

87-20.03C Temporary Lighting Systems

Wherever conductors are run overhead, install the fuse splice connectors in the line side before entering the mast arm.

87-20.03D Temporary Signal Systems

You may splice conductors that run to a terminal compartment or a signal head on a pole to the through conductors of the same phase in a pull box adjacent to the pole. Do not splice conductors or cables except in a pull box or in a NEMA 3R enclosure.

The Department provides the timing for the temporary signal.

Maintain the temporary signal except for the Department-furnished controller assembly.

87-20.04 PAYMENT

Not Used

87-21 EXISTING ELECTRICAL SYSTEMS

87-21.01 GENERAL

Section 87-21 includes general specifications for performing work on existing electrical systems.

87-21.02 MATERIALS

Not Used

87-21.03 CONSTRUCTION

87-21.03A General

You may abandon unused underground conduit after pulling out all conductors and removing conduit terminations from the pull boxes.

If standards are to be salvaged, remove:

1. All components
2. Mast arms from the standards
3. Luminaires, signal heads, and signal mounting assemblies from the standards and mast arms

If the existing material is unsatisfactory for reuse and the Engineer orders you to replace it with new material, replacing the existing material with new material is change order work.

If the removed electrical equipment is to be reinstalled, supply all materials and equipment, including signal mounting assemblies, anchor bolts, nuts, washers, and concrete, needed to complete the new installation.

87-21.03B Maintaining Existing Electrical Systems

87-21.03B(1) General

Maintain the existing electrical system in working order during the progress of the work. Conduct your operations to avoid damage to the elements of the systems.

87-21.03B(2) Maintaining Existing Traffic Management System Elements During Construction

Section 87-21.03B(2) applies if a bid item for maintaining existing traffic management system elements during construction is shown on the Bid Item List.

Traffic management system elements include:

1. Ramp metering system
2. Traffic monitoring stations
3. Microwave vehicle detection system
4. Changeable message sign system
5. Extinguishable message sign system
6. Highway advisory radio system
7. Closed circuit television camera system
8. Roadway weather information system

Obtain authorization at least 72 hours before interrupting communication between an existing system and the traffic management center.

If the Engineer notifies you that an existing system is not fully operational due to your activities, repair or replace the system within 72 hours. If the system cannot be fixed within 72 hours or it is located on a structure, provide a temporary system within 24 hours until the system can be fixed. Perform a functional test of the system in the presence of the Engineer. If you fail to perform the necessary repair or replacement work, the Department may perform the repair or replacement work and deduct the cost.

If you damage an existing fiber optic cable, install a new cable such that the length of cable slack is the same as before the damage, measured from an original splice point or termination. All splices must be made using the fusion method.

You may interrupt the operation of traffic monitoring stations:

1. For 60 days if another operational traffic monitoring station is located within 3 miles
2. For 15 days if another operational traffic monitoring station is located more than 3 miles away

If a traffic monitoring station must be interrupted for longer periods than specified, provide a temporary detection system. Obtain the Department's authorization for the type of temporary system and its installation method.

87-21.03C Modifying Existing Electrical Systems

Modify electrical systems as shown.

87-21.03D Removing Existing Electrical Systems

The components to be removed are shown on the project plans.

87-21.04 PAYMENT

Not Used

88 RESERVED

DIVISION XI MATERIALS

89 AGGREGATE

89-1 GENERAL

89-1.01 GENERAL

Section 89 includes general specifications for furnishing aggregate.

89-1.02 MATERIALS

Not Used

89-1.03 CONSTRUCTION

Not Used

89-1.04 PAYMENT

Not Used

89-2–89-4 RESERVED

90 CONCRETE

90-1 GENERAL

90-1.01 GENERAL

90-1.01A Summary

Section 90-1 includes general specifications for furnishing, curing, and protecting concrete.

Concrete must be composed of cementitious material, fine aggregate, coarse aggregate, admixtures if used, and water.

PCC must comply with the specifications for concrete.

90-1.01B Definitions

free water: Total water in the concrete mixture minus the water absorbed by the aggregates in reaching a saturated surface-dry condition.

reclaimed aggregate: Aggregate that has been recovered from plastic concrete by washing away the cementitious material.

90-1.01C Submittals

90-1.01C(1) General

Reserved

90-1.01C(2) Aggregate Gradation

Before starting concrete work, submit the gradation of the primary aggregate nominal sizes. If the aggregate source changes, submit the new gradation before using the aggregate.

If a primary coarse aggregate or the fine aggregate is separated into 2 or more sizes, submit the gradation and proposed proportions of each size combined mathematically to show 1 proposed gradation. Show the percentage passing for each applicable sieve size.

90-1.01C(3) Cementitious Materials

Submit a certificate of compliance for cementitious materials. Include the source name and location.

If the cementitious material is delivered directly to the job site, the certificate of compliance must be signed by the cementitious material supplier.

If the cementitious material is used in ready-mixed concrete, the certificate of compliance must be signed by the concrete manufacturer.

If blended cement is used, the certificate of compliance must include a statement signed by the blended cement supplier that shows the actual percentage of SCM, by weight, in the blend. Determine the weight of SCM by using a weighing device or by chemical analysis.

90-1.01C(4) Admixtures

If you propose to use an admixture from the Authorized Material List for chemical admixture for use in concrete, submit a certificate of compliance from the manufacturer certifying that the admixture furnished is the same as that previously authorized.

90-1.01C(5) Curing Compound

For each batch of curing compound delivered to the job site or casting site, submit:

1. Split curing compound test samples to METS. The test samples must be from the shipping containers at the manufacturer's source of supply.
2. Certificate of compliance to the Engineer and to METS. The certificate of compliance must include:
   2.1. Test results for the tests specified in section 90-1.01D(6).
   2.2. Certification that the material was tested within 1 year before use.

If the curing compound is shipped in tanks or tank trucks, submit a shipping invoice with each load. The invoice must show the same information specified for container labels in section 90-1.03B(3)(b).

90-1.01C(6) Mix Design

Submit the concrete mix design before using the concrete in the work and before changing the mix proportions or an aggregate source.

90-1.01C(7) Concrete Delivery

Submit a weighmaster certificate as an informational submittal with each load of concrete delivered to the job site.

The weighmaster certificate must show:

1. Mix identification number.
2. Nonrepeating load number.
3. Date and time the materials were batched.
4. Total quantity of water added to the load.
5. For transit-mixed concrete, the revolution counter reading at the time the truck mixer is charged with cement.
6. Actual scale weights in pounds for the ingredients batched. Do not substitute theoretical or target batch weights for actual scale weights.

Submit weighmaster certificates in printed form or, if authorized, in electronic media. Present electronic media in a tab-delimited format on a CD or DVD. Captured data for the ingredients represented by each batch must be a line-feed, carriage-return, and one line separated record with sufficient fields for the specified data.

You may submit a weighmaster certificate with a separate certificate that lists the actual batch weights or measurements for a load of concrete if both certificates are delivered to the job site and are imprinted with the same nonrepeating load number that is unique to the Contract.

90-1.01C(8) Testing

If the concrete is tested for shrinkage, submit the test data with the mix design.

If prequalification is specified, submit certified test data or trial batch test reports under section 90-1.01D(5)(b).

If 56 days are allowed for the concrete to attain the strength described, submit test results under section 90-1.01D(5)(a).

90-1.01C(9) Stationary Mixer Certification

If you weigh the SCM cumulatively with the cement for concrete completely mixed in a stationary mixer, submit certification of the stationary mixer under section 90-1.02F(4)(c).

90-1.01C(10) Protecting Concrete

If requested, submit a plan for protecting the concrete.

90-1.01D Quality Assurance

90-1.01D(1) General

If requested, furnish test samples of the freshly mixed concrete and provide satisfactory facilities for obtaining the test samples.

90-1.01D(2) Cementitious Material Content

Adjust the batch proportions as necessary to produce concrete having the specified cementitious material content.

The Engineer verifies compliance with the specified cementitious material content by testing under California Test 518 for cement content. For testing purposes, SCM is considered to be cement.

For all concrete except minor concrete, if the cementitious material, portland cement, or SCM content is less than the minimum required and is not within the batching tolerances allowed under section 90-1.02F(3), you must remove the concrete. If the Engineer determines that the concrete is structurally adequate, the concrete may remain in place and $0.25 is deducted for each pound of cementitious

material, portland cement, or SCM less than the minimum required. No deductions are made based on the results of California Test 518.

90-1.01D(3) Shrinkage

If shrinkage limitations are specified, test the concrete under AASHTO T 160, modified as follows:

1. Prepare specimens that have a 4 by 4-inch cross section.
2. Remove each specimen from the mold 23 ± 1 hours after mixing the concrete and place the specimen in lime water at 73 ± 3 degrees F until 7 days age.
3. Take a comparator reading at 7 days age and record it as the initial reading.
4. Store the specimens in a humidity-controlled room maintained at 73 ± 3 degrees F and 50 ± 4 percent relative humidity for the remainder of the test.
5. Take subsequent readings at 7, 14, 21, and 28 days drying.

Perform AASHTO T 160 testing at a laboratory that is accredited to perform AASHTO T 160 or that maintains a current rating of 3 or better for the Cement and Concrete Reference Laboratory concrete proficiency sample program.

Shrinkage test data authorized by the Department no more than 3 years before the 1st day of the Contract is authorized for the entire Contract. The test data must be for concrete with similar proportions and using the same materials and material sources to be used on the Contract. Concrete is considered to have similar proportions if no more than 2 mix design elements are varied and the variation is within the tolerances shown in the following table:

Mix design element	Tolerance (±)
Water to cementitious material ratio	0.03
Total water content (%)	5
Coarse aggregate content (%)	10
Fine aggregate content (%)	10
SCM content (%)	5
Admixture as originally dosed[a] (%)	25

[a]Admixtures must be the same brand.

90-1.01D(4) Concrete Uniformity

The Engineer determines the uniformity of concrete mixtures based on differences in test results between 2 test samples of mixed concrete from the same batch for the following tests:

1. California Test 533 if the mix design specifies a penetration value
2. ASTM C143 if the mix design specifies a slump value
3. California Test 529

90-1.01D(5) Compressive Strength

90-1.01D(5)(a) General

Section 90-1.01D(5) applies for either of the following cases:

1. Concrete is designated by compressive strength.
2. Attaining a minimum concrete compressive strength is specified as a prerequisite to applying loads or stresses to a concrete structure or member.

If the 28-day compressive strength described is 3,600 psi or greater, the concrete is designated by compressive strength.

If the concrete is designated by compressive strength, the strength of concrete that is not steam cured is determined from cylinders cured under Method 2 of California Test 540.

If attaining a minimum concrete compressive strength is specified as a prerequisite to applying loads or stresses to a concrete structure or member, cylinders for concrete that is not steam cured are cured under Method 2 of California Test 540 and the concrete compressive strength is evaluated based on individual tests.

For concrete with a described 28-day compressive strength greater than 3,600 psi, 42 days are allowed to attain the strength described.

Except for concrete specified to be in a freeze-thaw area, 56 days are allowed to attain the strength described if the cementitious material satisfies the following equation:

$$[(41 \times UF) + (19 \times F) + (11 \times SL)]/TC \geq 7.0$$

where:
F = natural pozzolan or fly ash complying with AASHTO M 295, Class F or N, including the quantity in blended cement, lb/cu yd. *F* is equivalent to the sum of *FA* and *FB* as defined in section 90-1.02B(3).
SL = GGBFS, including the quantity in blended cement, lb/cu yd
UF = silica fume, metakaolin, or UFFA, including the quantity in blended cement, lb/cu yd
TC = total quantity of cementitious material used, lb/cu yd

For concrete satisfying the equation above, test for the compressive strength at least once every 500 cu yd at 28, 42, and 56 days. Submit the test results to the Engineer and to METS, Attention: Office of Structural Materials, Concrete Materials Testing Branch.

The Engineer determines the concrete compressive strength from test cylinders:

1. Made from concrete sampled under California Test 539
2. Molded and initially field cured under California Test 540
3. Cured and tested under California Test 521

A compressive strength test represents no more than 300 cu yd of concrete and consists of the average compressive strength of 2 cylinders made from material taken from a single load of concrete. If a cylinder shows evidence of improper sampling, molding, or testing, the cylinder is discarded and the test consists of the compressive strength of the remaining cylinder.

If a single compressive strength test result is below the strength described at the maximum age specified or allowed, or if the compressive strength of concrete tested at 7 days indicates to the Engineer that the concrete will not attain the strength described at the maximum age specified or allowed, correct the mix design or concrete fabrication procedures and obtain authorization before you place additional concrete.

If a single compressive strength test result is below the strength described at the maximum age specified or allowed, the concrete represented by the test is subject to one of the following actions:

1. If the compressive strength is at least 95 percent of the strength described, $10 per cubic yard of concrete is deducted.
2. If the compressive strength is below 95 percent of the strength described but is at least 85 percent of the strength described, $15 per cubic yard of concrete is deducted.
3. If the compressive strength is below 85 percent of the strength described, you must remove the concrete.

If a strength test result at the maximum age specified or allowed is below the strength described but is at least 85 percent of the strength described, the deductions specified above apply unless you obtain and submit evidence that the strength of the concrete placed in the work is greater than or equal to the strength described and this evidence is accepted by the Engineer.

If a strength test result at the maximum age specified or allowed is below 85 percent of the strength described, you must remove the concrete represented by the test unless you obtain and submit evidence that the strength of the concrete placed in the work is at least 85 percent of the strength described and this evidence is accepted by the Engineer.

If the evidence consists of tests made on cores taken from the work, obtain and test the cores under ASTM C42.

90-1.01D(5)(b) Prequalification

If the concrete has a described 28-day compressive strength greater than 3,600 psi, or if prequalification is specified, prequalify the materials, mix proportions, mixing equipment, and procedures proposed for use in the work before placing the concrete.

Submit certified test data or trial batch test reports based on the same materials, mix proportions, mixing equipment, procedures, and batch size proposed for use in the work.

Certified test data must show that:

1. Results of 90 percent or more of at least 20 consecutive tests exceed the compressive strength described at the maximum number of days specified or allowed and none of the test results are less than 95 percent of the strength described
2. All tests are the most recent tests made on concrete of the proposed mix design and were made within 1 year of the proposed use of the concrete

Trial batch test reports must show that:

1. Average compressive strength for 5 consecutive concrete cylinders taken from a single batch and tested at not more than the maximum age specified or allowed is at least 600 psi greater than the 28-day compressive strength described
2. No individual cylinder has a strength less than the strength described at the maximum age specified or allowed
3. Data contained in the report is from trial batches produced within 1 year of the proposed use of the concrete

If air entrainment is specified, the air content of the trial batches must be greater than or equal to the air content specified for the concrete without reduction due to tolerances.

Perform tests under the appropriate California Test methods or comparable ASTM test methods. Use testing equipment that is in good condition and properly calibrated. If tests are performed during the Contract, notify the Engineer in advance so that the Engineer can witness the test procedures.

Certified test data and trial batch reports must include:

1. Date of mixing
2. Mixing equipment and procedures
3. Batch size in cubic yards
4. Weight, type, and source for each ingredient
5. Penetration or slump as specified in section 90-1.02G(6)
6 Air content if an air-entraining admixture is used
7. Concrete age at the time of testing
8. Compressive strength for each cylinder tested
9. Signature of an official of the testing firm

If authorized, you may use the concrete from trial batches in the work at locations where lower quality concrete is required.

Any change to the prequalified materials, mix proportions, mixing equipment, or procedures that could result in a concrete strength below that described requires additional prequalification by trial batch testing.

90-1.01D(6) Curing Compound

Test each batch of curing compound delivered to the job site or casting site for:

1. Water loss at 24 hours under California Test 534
2. Reflectance under ASTM E1347
3. Viscosity under ASTM D2196
4. Nonvolatile content under ASTM D2369
5. Pigment content under ASTM D3723

A batch must be no larger than 10,000 gal.

The Engineer samples the curing compound at any of the following:

1. Manufacturer's supply source
2. Job site or casting site

The curing compound sampled from shipping containers from the manufacturer's supply source or from the job site must match the test results for viscosity, nonvolatile content, and pigment content within the tolerances specified in the precision and bias statements for the test methods.

Additional testing of the curing compound may be required before its use if the compound has not been used within 1 year or if the Engineer believes that the compound may no longer be acceptable.

90-1.02 MATERIALS

90-1.02A General

Concrete for pavement, approach slabs, and bridge decks must comply with the shrinkage limitations shown in the following table when tested under section 90-1.01D(3):

Type of work	Maximum length change of laboratory cast specimens at 28 days drying (average of 3) (percent)
Paving and approach slab concrete	0.050
Bridge deck concrete	0.045

When tested for uniformity under section 90-1.01D(4), the differences in test results between the 2 concrete test samples must comply with the following:

1. When tested under California Test 533, the difference in penetration values must not exceed 1/2 inch.
2. When tested under ASTM C143, the difference in slump values must not exceed the values shown in the following table:

Average slump, S (in)	Maximum permissible difference (in)
$S < 4$	1
$4 \leq S \leq 6$	1-1/2
$6 < S \leq 9$	2

3. When tested under California Test 529, the difference in the proportion of coarse aggregate must not exceed 170 pounds of aggregate per cubic yard of concrete.

Unless a modulus of rupture is specified, the minimum required compressive strength for concrete must be the greater of either the strength described or 2,500 psi. Proportion the concrete to attain the minimum required compressive strength.

For concrete not designated by compressive strength, the concrete must attain at least 85 percent of the minimum required compressive strength when tested at 28 days.

90-1.02B Cementitious Materials

90-1.02B(1) General

The cementitious materials type and brand must be on the Authorized Material List for cementitious material for use in concrete when the mix design is submitted.

Unless otherwise specified, the cementitious material must be one of the following:

1. Combination of Type II or V portland cement and SCM
2. Blended cement

The cementitious materials used in CIP concrete for exposed surfaces of similar elements of a structure must be from the same sources and of the same proportions.

Protect cementitious materials from moisture until used.

Place sacked cementitious materials in a pile to allow access for tallying, inspecting, and identifying each shipment.

Provide facilities that ensure the cementitious materials to be used in the work are kept separate from each other and from other cementitious materials.

A storage silo containing a cementitious material must be emptied before using the silo for a different cementitious material. Blended cements with a percentage of SCM differing by more than 2 percent are considered different cementitious materials.

Sample cementitious materials under California Test 125.

90-1.02B(2) Cement

Portland cement must comply with ASTM C150, except the C_3S content of Type II cement must not exceed 65 percent.

Blended cement must comply with portland blast-furnace slag cement, Type IS (MS), or portland-pozzolan cement, Type IP (MS), specified in AASHTO M 240, except:

1. Maximum limits on pozzolan content do not apply
2. Blended cement must be composed of Type II or V cement and SCM produced by one of the following methods:
   2.1. Intergrinding of portland cement clinker and granulated blast furnace slag, GGBFS, or pozzolan
   2.2. Blending of portland cement and either GGBFS or finely divided pozzolan
   2.3. Combination of intergrinding and blending

Types II, III, and V portland cement must comply with the following:

1. Alkali content must not exceed 0.60 percent by mass of alkalies as $Na_2O + 0.658\ K_2O$ when determined under AASHTO T 105.
2. Autoclave expansion must not exceed 0.50 percent.

Type III portland cement may be used only if specified or authorized.

90-1.02B(3) Supplementary Cementitious Materials

Each SCM must be one of the following:

1. Fly ash complying with AASHTO M 295, Class F, and either of the following:
   1.1. Available alkali as $Na_2O + 0.658\ K_2O$ must not exceed 1.5 percent when tested under ASTM C311.
   1.2. Total alkali as $Na_2O + 0.658\ K_2O$ must not exceed 5.0 percent when tested under AASHTO T 105.
2. UFFA complying with AASHTO M 295, Class F, and the chemical and physical requirements shown in the following 2 tables:

Chemical quality characteristic	Requirement (percent)
Sulfur trioxide (SO_3) (max)	1.5
Loss on ignition (max)	1.2
Available alkalies as $Na_2O + 0.658\ K_2O$ (max)	1.5

Physical quality characteristic	Requirement (percent)
Particle size distribution	
Less than 3.5 microns (min)	50
Less than 9.0 microns (min)	90
Strength activity index with portland cement	
7 days (% of control, min)	95
28 days (%t of control, min)	110
Expansion at 16 days when testing project materials under ASTM C1567[a] (max)	0.10

[a]In the test mix, at least 12 percent, by weight, of the Type II or V portland cement must be replaced with UFFA.

3. Raw or calcined natural pozzolans complying with AASHTO M 295, Class N, and either of the following:
   3.1. Available alkali as Na_2O + 0.658 K_2O must not exceed 1.5 percent when tested under ASTM C311.
   3.2. Total alkali as Na_2O + 0.658 K_2O must not exceed 5.0 percent when tested under AASHTO T 105.
4. Metakaolin complying with AASHTO M 295, Class N, and the chemical and physical requirements for the quality characteristics shown in the following 2 tables:

Chemical quality characteristic	Requirement (percent)
Silicon dioxide (SiO_2) + aluminum oxide (Al_2O_3) (min)	92.0
Calcium oxide (CaO) (max)	1.0
Sulfur trioxide (SO_3) (max)	1.0
Loss on ignition (max)	1.2
Available alkalies as Na_2O + 0.658 K_2O (max)	1.0

Physical quality characteristic	Requirement (percent)
Particle size distribution less than 45 microns (min)	95
Strength activity index with portland cement	
7 days (% of control, min)	100
28 days (% of control, min)	100

5. GGBFS complying with AASHTO M 302, Grade 100 or 120.
6. Silica fume complying with AASHTO M 307, with a minimum reduction in mortar expansion of 80 percent when using the cement from the proposed mix design.

Fly ash from different sources may be commingled at uncontrolled ratios if:

1. Each source produces fly ash complying with AASHTO M 295, Class F
2. At the time of commingling, each fly ash has:
   2.1. Running average of relative density that does not differ from any other fly ash by more than 0.25
   2.2. Running average of loss on ignition that does not differ from any other fly ash by more than 1 percent
3. Final commingled fly ash complies with AASHTO M 295, Class F
4. Fly ash supplier is responsible for testing the commingled fly ash

The quantity of portland cement and SCM in concrete must comply with the minimum cementitious material content specified.

The SCM content in concrete must comply with one of the following:

1. Any combination of portland cement and at least 1 SCM, satisfying equations 1 and 2:

   Equation 1:

   $[(25 \times UF) + (12 \times FA) + (10 \times FB) + (6 \times SL)]/MC \geq X$

   where:
   UF = silica fume, metakaolin, or UFFA, including the quantity in blended cement, lb/cu yd
   FA = natural pozzolan or fly ash complying with AASHTO M 295, Class F or N, with a CaO content of up to 10 percent, including the quantity in blended cement, lb/cu yd
   FB = natural pozzolan or fly ash complying with AASHTO M 295, Class F or N, with a CaO content of greater than 10 percent and up to 15 percent, including the quantity in blended cement, lb/cu yd
   SL = GGBFS, including the quantity in blended cement, lb/cu yd
   MC = minimum quantity of cementitious material specified, lb/cu yd
   X = 1.8 for innocuous aggregate, 3.0 for all other aggregate

   Equation 2:

   $MC - MSCM - PC \geq 0$

   where:
   MC = minimum quantity of cementitious material specified, lb/cu yd
   MSCM = minimum sum of SCMs that satisfies equation 1, lb/cu yd
   PC = quantity of portland cement, including the quantity in blended cement, lb/cu yd

2. 15 percent Class F fly ash with at least 48 oz of $LiNO_3$ solution added per 100 lb of portland cement. The CaO content of the fly ash must not exceed 15 percent.

90-1.02C Aggregates

90-1.02C(1) General

Both the coarse and fine aggregate must be on the Authorized Material List for the aggregate used in concrete to be considered innocuous.

Aggregates must be free from deleterious coatings, clay balls, roots, bark, sticks, rags, and other extraneous material.

Provide safe and suitable facilities, including splitting devices, for obtaining aggregate test samples under California Test 125.

Aggregates must have:

1. Characteristics that enable the production of workable concrete within the limits of water content specified in section 90-1.02G(6).
2. No more than 10 percent loss when tested for soundness under California Test 214. The soundness requirement does not apply to fine aggregate if the durability index of the fine aggregate is 60 or greater when tested under California Test 229.

Each cleanness value, sand equivalent, or aggregate gradation test represents no more than 300 cu yd of concrete or 1 day's pour, whichever is smaller.

If the results of any 1 or more of the cleanness value, sand equivalent, or aggregate gradation tests do not comply with the requirements for operating range, but all comply with the requirements for contract compliance:

1. Suspend the concrete placement at the completion of the current pour
2. Do not restart the concrete placement until test results or other information show that the next material to be used in the work complies with the requirements for operating range

If the results of either or both of the cleanness value and coarse aggregate gradation tests do not comply with the requirements for contract compliance, you must remove the concrete represented by the tests. If the Engineer determines that the concrete is structurally adequate, the concrete may remain in place and $3.50 per cubic yard for paving concrete and $5.50 per cubic yard for other concrete is deducted for the concrete represented by these tests and left in place.

If the results of either or both of the sand equivalent and fine aggregate gradation tests do not comply with the requirements for contract compliance, you must remove the concrete represented by the tests. If the Engineer determines that the concrete is structurally adequate, the concrete may remain in place and $3.50 per cubic yard for paving concrete and $5.50 per cubic yard for other concrete is deducted for the concrete represented by these tests and left in place.

The 2 preceding paragraphs apply individually to the contract compliance requirements for coarse and fine aggregate. If both coarse and fine aggregate do not comply with the contract compliance requirements, both paragraphs apply. The deductions specified in those paragraphs are in addition to any deductions made under section 90-1.01D(2).

90-1.02C(2) Coarse Aggregate

Coarse aggregate must consist of gravel, crushed gravel, crushed rock, reclaimed aggregate, crushed air-cooled iron blast furnace slag, or a combination of these.

Do not use crushed air-cooled iron blast furnace slag in reinforced or PS concrete.

Reclaimed aggregate must comply with the specifications for aggregate.

Coarse aggregate must have the requirements for the quality characteristics shown in the following table:

Quality characteristic	Test method	Requirement
Loss in Los Angeles rattler after 500 revolutions (%, max)	California Test 211	45
Cleanness value		
Operating range (min)	California Test 227	75
Contract compliance (min)	California Test 227	71

For cleanness value, an operating range limit of 71 minimum and a contract compliance limit of 68 minimum apply if you submit a certificate of compliance certifying that:

1. Coarse aggregate sampled at the completion of processing at the aggregate production plant had a cleanness value of at least 82 when tested under California Test 227
2. Prequalification tests performed under California Test 549 showed that the aggregate would develop a relative strength of at least 95 percent and have a relative shrinkage of no more than 105 percent based on concrete

90-1.02C(3) Fine Aggregate

Fine aggregate must consist of natural sand, manufactured sand produced from larger aggregate, or a combination of these. Manufactured sand must be well graded.

Fine aggregate must have the requirements for the quality characteristics shown in the following table:

Quality characteristic	Test method	Requirement
Organic impurities	California Test 213	Satisfactory[a]
Sand equivalent:		
Operating range (min)	California Test 217	75
Contract compliance (min)	California Test 217	71

[a]Fine aggregate that develops a color darker than the reference standard color may be authorized if 95 percent relative mortar strength is achieved when tested under ASTM C87.

For sand equivalent, an operating range limit of 71 minimum and a contract compliance limit of 68 minimum apply if you submit a certificate of compliance certifying that:

1 Fine aggregate sampled at the completion of processing at the aggregate production plant had a sand equivalent value of at least 82 when tested under California Test 217
2. Prequalification tests performed under California Test 549 showed that the aggregate would develop a relative strength of at least 95 percent and have a relative shrinkage of no more than 105 percent based on concrete

90-1.02C(4) Aggregate Gradation

90-1.02C(4)(a) General

Proposed aggregate gradations must be within the percentage passing limits shown in the following table:

Primary aggregate nominal size	Sieve size	Limits of gradation (% passing)
1-1/2 x 3/4 inch	1 in	19–41
1 inch x No. 4	3/4 in	52–85
1 inch x No. 4	3/8 in	15–38
1/2 inch x No. 4	3/8 in	40–78
3/8 inch x No. 8	3/8 in	50–85
Fine aggregate	No. 16	55–75
Fine aggregate	No. 30	34–46
Fine aggregate	No. 50	16–29

The Engineer may waive, in writing, the specifications for gradation if in the Engineer's opinion furnishing the gradation is not necessary for the work.

90-1.02C(4)(b) Coarse Aggregate Gradation

Coarse aggregate must be graded within the limits shown in the following table for each size of coarse aggregate:

Sieve size	Primary aggregate nominal sizes							
	1-1/2 x 3/4 inch		1 inch x No. 4		1/2 inch x No. 4		3/8 inch x No. 8	
	Operating Range (% passing)	Contract Compliance (% passing)	Operating Range (% passing)	Contract Compliance (% passing)	Operating Range (% passing)	Contract Compliance (% passing)	Operating Range (% passing)	Contract Compliance (% passing)
2 inch	100	100	--	--	--	--	--	--
1-1/2 inch	88–100	85–100	100	100	--	--	--	--
1 inch	X ± 18	X ± 25	88–100	86–100	--	--	--	--
3/4 inch	0–17	0–20	X ± 15	X ±22	100	100	--	--
1/2 inch	--	--	--	--	82–100	80–100	100	100
3/8 inch	0–7	0–9	X ± 15	X ± 22	X ± 15	X ± 22	X ± 15	X ± 20
No. 4	--	--	0–16	0–18	0–15	0–18	0–25	0–28
No. 8	--	--	0–6	0–7	0–6	0–7	0–6	0–7

NOTE: "X" is the percent passing of the gradation that you propose to furnish for the specific sieve size under section 90-1.02C(4)(a).

Furnish coarse aggregate for the 1-1/2-inch maximum combined aggregate gradation under section 90-1.02C(4)(d) in 2 or more primary aggregate nominal sizes. You may separate each primary aggregate nominal size into 2 sizes and store them separately, provided that the combined material complies with the gradation specifications for the primary aggregate nominal size.

You may separate the coarse aggregate for the 1-inch maximum combined aggregate gradation under section 90-1.02C(4)(d) into 2 sizes and store them separately, provided that the combined material complies with the gradation specifications for the 1 inch x No. 4 primary aggregate nominal size.

90-1.02C(4)(c) Fine Aggregate Gradation

Fine aggregate must be graded within the limits shown in the following table:

Sieve size	Operating range (% passing)	Contract compliance (% passing)
3/8 inch	100	100
No. 4	95–100	93–100
No. 8	65–95	61–99
No. 16	X ± 10	X ± 13
No. 30	X ± 9	X ± 12
No. 50	X ± 6	X ± 9
No. 100	2–12	1–15
No. 200	0–8	0–10

NOTE: "X" is the percent passing of the gradation that you propose to furnish for the specific sieve size under section 90-1.02C(4)(a).

Fine aggregate sizes must be distributed such that the difference between the total percentage passing the No. 16 and No. 30 sieves is from 10 to 40, and the difference between the percentage passing the No. 30 and No. 50 sieves is from 10 to 40.

You may separate fine aggregate into 2 or more sizes and store them separately, provided that the combined material complies with the gradation specifications.

90-1.02C(4)(d) Combined Aggregate Gradation

Use combined aggregate gradation limits only for the design of concrete mixes. Design concrete mixes such that aggregates are combined in proportions that produce a mixture within the gradation limits for combined aggregate.

Use either the 1-1/2-inch maximum gradation or the 1-inch maximum gradation, unless otherwise specified.

Combined aggregate must be graded within the limits shown in the following table:

Sieve size	1-1/2 inch max (% passing)	1 inch max (% passing)	1/2 inch max (% passing)	3/8 inch max (% passing)
2 inch	100	--	--	--
1-1/2 inch	90–100	100	--	--
1 inch	50–86	90–100	--	--
3/4 inch	45–75	55–100	100	--
1/2 inch	--	--	90–100	100
3/8 inch	38–55	45–75	55–86	50–100
No. 4	30–45	35–60	45–63	45–63
No. 8	23–38	27–45	35–49	35–49
No. 16	17–33	20–35	25–37	25–37
No. 30	10–22	12–25	15–25	15–25
No. 50	4–10	5–15	5–15	5–15
No. 100	1–6	1–8	1–8	1–8
No. 200	0–3	0–4	0–4	0–4

Do not change from one aggregate gradation to another during the progress of the work.

90-1.02D Water

Water for washing aggregates, mixing concrete, and curing must not contain:

1. Oil
2. Impurities at concentrations that cause either of the following results when compared to the same test using distilled or deionized water:
   2.1. Change of more than 25 percent in the setting time of cement when tested under ASTM C191 or ASTM C266

2.2. Reduction by more than 5 percent in the mortar compressive strength at 14 days when tested under ASTM C109

3. Chlorides as Cl or sulfates as SO_4 in excess of the values shown in the following table:

	Type of concrete work		
Quality characteristic	Nonreinforced	Reinforced	PS
Chloride as Cl[a] (ppm, max)	2,000	1,000	650
Sulfate as SO_4[b] (ppm, max)	1,500	1,300	1,300

[a]When tested under California Test 422
[b]When tested under California Test 417

Water for curing concrete must not contain impurities at concentrations that cause discoloration or surface etching.

Water reclaimed from washing out the mixer may be used in mixing concrete. The water must not contain coloring agents or more than 300 ppm of alkalis as $Na_2O + 0.658\ K_2O$ as determined on the filtrate. The specific gravity of the water must not exceed 1.03 and must not vary more than ±0.010 during a day's activities.

90-1.02E Admixtures

90-1.02E(1) General

The admixture type and brand must be on the Authorized Material List at the time of mix design submittal.

Admixtures must comply with the following:

1. Chemical admixtures must comply with ASTM C494
2. Air-entraining admixtures must comply with ASTM C260
3. Lithium nitrate must be in an aqueous solution that complies with the following:
   3.1. Lithium nitrate as $LiNO_3$ must be 30 ± 0.5 percent by weight
   3.2. Sulfate as SO_4 must be less than 1,000 ppm
   3.3. Chloride as Cl must be less than 1,000 ppm
   3.4. Alkalis as $Na_2O + 0.658\ K_2O$ must be less than 1,000 ppm

Chemical or air-entraining admixtures must not contain more than 1 percent chlorides as Cl by weight of admixture when tested under California Test 415.

Store and dispense the admixtures in liquid form.

Admixture properties must be uniform throughout their use in the work.

If more than 1 admixture is used, the admixtures must be compatible with each other such that the desirable effects of all the admixtures used are realized.

Use chemical admixtures in compliance with the manufacturer's written instructions. The instructions must include a statement that the admixture is compatible with the types and quantities of SCM used.

If you are ordered to use admixtures in the concrete that are not specified, furnishing the admixtures and adding them to the concrete is change order work.

90-1.02E(2) Chemical Admixtures

If the use of chemical admixtures is specified, use the dosage specified. If the dosage is not specified, use the dosage recommended by the admixture manufacturer.

You may use any of the following admixture types to conserve cementitious material or to facilitate construction:

1. Type A or F, water-reducing
2. Type B, retarding
3. Type D or G, water-reducing and retarding

If you use a water-reducing admixture or a water-reducing and retarding admixture, you may reduce the specified cementitious material content by up to 5 percent by weight. The resulting concrete must contain at least 505 pounds of cementitious material per cubic yard. If you reduce the cementitious material content, use at least the admixture dosage used in authorizing the admixture as shown on the Authorized Material List for chemical admixture for use in concrete.

You may use a Type S admixture.

You may use a Type C accelerating admixture. Inclusion of the Type C admixture in the mix design is not required if it is added to counteract changing conditions that contribute to delayed setting of the concrete and if the use or change in dosage of the admixture is authorized.

90-1.02E(3) Air-Entraining Admixtures

If air entrainment is specified or ordered, use the quantity of air-entraining admixture that produces concrete having the specified air content when tested under California Test 504.

If air entrainment is not specified or ordered, you may use an air-entraining admixture to facilitate the use of a construction procedure or equipment. The average air content of 3 successive tests must not exceed 4 percent and each test value must be no more than 5.5 percent when tested under California Test 504.

90-1.02F Proportioning Concrete

90-1.02F(1) General

Reserved

90-1.02F(2) Storage of Aggregates

Store or stockpile aggregates such that the coarse and fine particles of each size do not separate and various sizes do not intermix before proportioning.

Prevent contamination by foreign materials while storing, stockpiling, and handling aggregates.

If you store the aggregates at a batching or mixing plant that is erected after the Contract is awarded and is used for furnishing concrete for the work:

1. Prevent intermingling of different aggregate sizes by using measures such as the physical separation of stockpiles or the construction of bulkheads of adequate length and height
2. Prevent contamination of the aggregates by contact with the ground through measures such as placing the aggregates on wooden platforms or on hardened surfaces made of concrete, asphalt concrete, or cement-treated material

When placing the aggregates in storage or moving the aggregates from storage to the weigh hopper of the batching plant, do not use methods that cause either of the following:

1. Segregation, degradation, or the combining of materials of different gradations and result in an aggregate size failing to comply with the gradation specifications at the weigh hopper
2. Excessive particle breakage

You may be required to use devices that reduce the impact of falling aggregates.

90-1.02F(3) Proportioning Devices

Automatic weighing systems must comply with section 90-1.02F(4)(c). For an automatic device, the single operation of a switch or starter must be the only manual operation required to proportion the aggregates, cement, and SCM for 1 batch of concrete.

Insulate the weighing equipment against the vibration or movement of other plant equipment.

The weight of each batch of material must not vary from the weight designated by the Engineer by more than the specified tolerances.

The weighing and measuring equipment must have the following zero tolerances:

1. For cumulative weighing of aggregates, ±0.5 percent of the designated total aggregate batch weight

2. For weighing each aggregate size separately, ±0.5 percent of the designated batch weight for each aggregate size
3. For cumulative weighing of cement and SCM, ±0.5 percent of the designated total batch weight of the cement and SCM
4. For weighing cement and SCM separately, ±0.5 percent of their designated individual batch weights
5. For measuring water, ±0.5 percent of its designated weight or volume

The weight indicated for a batch of material must not vary from the preselected scale setting by more than the following:

1. Aggregates weighed cumulatively must be within ±1.0 percent of the designated total aggregate batch weight.
2. Aggregates weighed separately must be within ±1.5 percent of the designated batch weight of each aggregate.
3. Cement weighed separately must be within +2 to -1 percent of the designated cement batch weight.
4. SCM weighed separately must be within +2 to -1 percent of the designated SCM batch weight.
5. For cement and SCM weighed cumulatively, the cement must be within +2 to -1 percent of the designated cement batch weight and the total for cement and SCM must be within +2 to -1 percent of the sum of the designated cement and SCM batch weights.
6. Water must be within ±1.5 percent of the designated weight or volume of water.

Each scale graduation must be no more than 0.001 of the total scale capacity. For each material being weighed, use a scale with single graduations that indicate a weight not exceeding the maximum permissible weight variation above, except that graduations less than 1 lb are not required.

90-1.02F(4) Proportioning

90-1.02F(4)(a) General

Proportioning consists of dividing the aggregates into the specified sizes, each stored in a separate bin, and combining the aggregates with cementitious material, admixtures if used, and water.

Proportion the aggregates by weight.

At the time of batching:

1. Aggregates must be dried and drained to a stable moisture content such that no visible separation of water from the aggregate occurs during transportation from the proportioning plant to the point of mixing
2. Free moisture content of the fine aggregate must not exceed 8 percent of its saturated surface-dry weight

If the proportioning plant has separate supplies of the same size group of aggregate with different moisture content, specific gravity, or surface characteristics affecting workability, exhaust one supply before using another supply.

Weigh bulk Type IP (MS) or Type IS (MS) cement in an individual hopper and keep it separate from the aggregates until the ingredients are released for discharge into the mixer.

Bulk cement and SCM may be weighed in separate weigh hoppers or in the same weigh hopper. Keep the cement and SCM separate from the aggregates until the ingredients are released for discharge into the mixer.

If the cement and SCM are weighed in the same weigh hopper, weigh the cement first. If the cement and SCM are weighed in separate weigh hoppers, the weigh systems for the proportioning of the aggregate, the cement, and the SCM must be individual and distinct from all other weigh systems. To constitute an individual and distinct material-weighing device, each weigh system must have a hopper, a lever system, and an indicator.

Discharge the cement and the SCM into the mixer simultaneously with the aggregate.

The scales and weigh hoppers for bulk weighing cement, SCM, or cement plus SCM must be separate and distinct from the aggregate weighing equipment.

For batches of 1 cu yd or more, the batching equipment must comply with one of the following combinations:

1. Separate boxes and separate scale and indicator for weighing each aggregate size
2. Single box and scale indicator for all aggregates
3. Single box or separate boxes and automatic weighing mechanism for all aggregates

If you are requested to check the accuracy of batch weights, determine the gross weight and tare weight of batch trucks, truck mixers, truck agitators, and nonagitating hauling equipment. Weigh the equipment using scales designated by the Engineer.

For proportioning pavement concrete, install and maintain in good operating condition an electronically actuated moisture meter that indicates, on a readily visible scale, changes in the moisture content of the fine aggregate as it is batched within a sensitivity of 0.5 percent by weight of the fine aggregate.

90-1.02F(4)(b) Proportioning and Dispensing Liquid Admixtures

Liquid admixture dispensers must:

1. Have enough capacity to measure at 1 time the total quantity of admixture required for each batch of concrete
2. Include a graduated measuring unit that is accurate to within ±5 percent of the required quantity for each batch of concrete
3. Be located and maintained such that the graduations can be read accurately from the point at which proportioning is controlled to allow a visual check of batching accuracy before discharge
4. Have measuring units that are clearly marked for the type and quantity of admixture

Each liquid admixture dispensing system must be equipped with a sampling device that consists of a valve located in a safe and readily accessible position such that the Engineer can slowly withdraw a test sample.

If more than 1 liquid admixture is used in the concrete mix, each admixture must have a separate measuring unit and must be dispensed by injecting equipment located such that the admixtures are not mixed at high concentrations and do not interfere with the effectiveness of each other.

If an air-entraining admixture is used with other liquid admixtures, incorporate the air-entraining admixture into the mix first, unless you demonstrate that a different sequence improves performance.

If automatic proportioning devices are used, the liquid admixture dispensers must operate automatically with the batching control equipment. The dispensers must have an automatic warning system in good operating condition that provides a visible or audible signal at the point at which proportioning is controlled. The signal must activate if the quantity of admixture measured varies from the preselected dosage by more than 5 percent or if the entire contents of the measuring unit are not emptied from the dispenser.

Add liquid admixtures to the premeasured batch water or discharge the admixtures into the stream of water such that they are well-dispersed throughout the batch.

You may dispense air-entraining admixtures directly into moist sand in the batching bins if you maintain adequate control of the concrete air content.

90-1.02F(4)(c) Automatic Proportioning

Automatic proportioning devices must be authorized by the Department.

The batching of the aggregate and the cement, SCM, or cement plus SCM must be interlocked such that a new batch cannot start until all weigh hoppers are empty, the proportioning devices are within zero tolerance, and the discharge gates are closed.

The interlock must not allow any part of the batch to be discharged until all aggregate hoppers and the cement and SCM hoppers or the cement plus SCM hopper are charged with weights that are within the tolerances specified in section 90-1.02F(3).

If interlocks are required for the cement and SCM charging mechanisms and the cement and SCM are weighed cumulatively, their charging mechanisms must be interlocked to prevent the introduction of SCM until the weight of cement in the cement weigh hopper is within the tolerances specified in section 90-1.02F(3).

If the concrete is mixed completely in a stationary mixer, weigh the SCM in a separate weigh hopper and introduce the SCM and cement simultaneously into the mixer proportionately with the aggregate. If you submit certification that the stationary mixer is capable of mixing the cement, SCM, aggregates, and water uniformly before discharge, you may weigh the SCM cumulatively with the cement. Certification must include:

1. Test results for 2 compressive strength test cylinders taken within the first 1/3, and 2 compressive strength test cylinders taken within the last 1/3, of a single batch of concrete discharged from the stationary mixer. Strength tests and cylinder preparation must comply with section 90-1.01D(5).
2. Calculations demonstrating that the average of the 2 compressive strengths taken within the first 1/3 of the batch do not differ by more than 7.5 percent from the average of the 2 compressive strengths taken within the last 1/3 of the batch.
3. Mixer rotation speed and time of mixing before discharge that are required to produce a mix that complies with the above requirements.

The discharge gate on the cement and SCM hoppers or the cement plus SCM hopper must be designed to allow the regulation of the flow of cement, SCM, or cement plus SCM into the aggregate.

If separate weigh boxes are used for each aggregate size, the discharge gates must allow the regulation of the flow of each aggregate size.

Material discharged from each bin must be controlled by gates or by mechanical conveyors.

The means of withdrawal from the bins and of discharge from the weigh box must be interlocked such that not more than 1 bin can discharge at a time and the weigh box cannot be tripped until the required quantity from each bin has been deposited into it.

If a separate weigh box is used for each aggregate size, all the weigh boxes may be operated and discharged simultaneously.

If the discharge from the bins is controlled by gates, each gate must be actuated automatically such that the required weight is discharged into the weigh box, after which the gate must automatically close and lock.

The automatic weighing system must be designed to allow all required proportions to be set on the weighing controller at the same time.

90-1.02G Mixing and Transporting Concrete

90-1.02G(1) General

Mix the concrete in a mechanically operated mixer, except, if authorized, you may mix batches not exceeding 1/3 cu yd by hand methods under section 90-1.02G(5).

Do not use equipment with components made of aluminum or magnesium alloys that could have contact with plastic concrete during mixing, transporting, or pumping.

Concrete must be thoroughly mixed, homogeneous, and free of lumps or evidence of undispersed cementitious material.

90-1.02G(2) Machine Mixing

Concrete mixers must be the revolving drum or revolving blade type. Operate the mixing drum or blades uniformly at the mixing speed recommended by the manufacturer. Do not use a mixer or agitator that has an accumulation of hard concrete or mortar.

Immediately before placing the concrete, the temperature of the mixed concrete must be from 50 to 90 degrees F. Cool or heat the aggregates and mixing water as necessary to produce concrete within these temperature limits. Do not heat the aggregates or water above 150 degrees F. Any ice used to cool the concrete must be melted before the concrete is discharged from the mixer.

Charge the batch into the mixer such that some water enters before the cementitious materials and aggregates. Add all the water to the drum by the end of the first 1/4 of the specified mixing time. If the concrete is delivered in a truck mixer, you may withhold a portion of the mixing water and, if authorized, add it at the delivery point as specified in section 90-1.02G(3).

Batch and charge the cementitious materials into the mixer by means that will not cause:

1. Loss of cementitious materials due to the effect of wind
2. Accumulation of cementitious materials on the surfaces of conveyors or hoppers
3. Other conditions that reduce or vary the required quantity of cementitious material in the concrete mixture

Operate stationary mixers with an automatic timing device. The timing device and discharge mechanism must be interlocked such that during normal operation no part of the batch is discharged before the specified mixing time has elapsed.

The total time from the intermingling of damp aggregates and all cementitious materials to the start of mixing must not exceed 30 minutes.

The batch size must not exceed the manufacturer's guaranteed capacity.

For pavement or base concrete, install and maintain suitable batch counters in good operating condition at job site batching plants and stationary mixers. The batch counters must indicate the exact number of batches proportioned and mixed.

Mix and deliver the concrete to the job site by one of the following methods:

1. Central-mixed concrete, in which the concrete is mixed completely in a stationary mixer and transported to the delivery point in a truck agitator or nonagitating hauling equipment.
2. Shrink-mixed concrete, in which the concrete is mixed partially in a stationary mixer and the mixing is completed in a truck mixer.
3. Transit-mixed concrete, in which the concrete is mixed completely in a truck mixer.

Agitators must be truck mixers operating at agitation speed or truck agitators. Each mixer and agitator must have a metal plate attached in a prominent place that clearly shows:

1. Various uses for which the equipment is designed
2. Manufacturer's guaranteed drum or container capacity in terms of the volume of mixed concrete
3. Rotation speed of the mixing drum or blades

Truck mixers must have an electrically or mechanically actuated revolution counter that readily allows verification of the number of revolutions of the drum or blades.

For shrink-mixed concrete, transfer concrete that has been partially mixed at a central plant into a truck mixer and comply with the specifications for transit-mixed concrete. Partial mixing in a central plant does not count toward the number of revolutions at mixing speed.

90-1.02G(3) Transporting Mixed Concrete

You must transport mixed concrete to the delivery point in one of the following:

1. Truck agitator operating at the manufacturer's designated agitating speed if it:
   1.1. Does not carry more than the manufacturer's guaranteed capacity
   1.2. Maintains the mixed concrete in a thoroughly mixed and uniform mass during hauling
2. Truck mixer operating at the manufacturer's designated agitating speed
3. Nonagitating hauling equipment with a body that does not allow leakage of any part of the concrete mix at any time

When discharged at the delivery point, the consistency and workability of the mixed concrete must be suitable for adequate placement and consolidation in place and the mixed concrete must comply with the specifications for uniformity in section 90-1.02A.

Protect concrete hauled in open-top vehicles from rain or from exposure to the sun for more than 20 minutes if the ambient temperature exceeds 75 degrees F.

Do not add water to the concrete in excess of that in the authorized mix design. At the delivery point, you may add water withheld during batching if authorized. Add the water in 1 operation before the discharge of more than 1/4 cu yd. The equipment for supplying the water must comply with section 90-1.02G(6). After adding the water, revolve the drum at least 30 revolutions at mixing speed before discharging the concrete.

Control the rate of discharge of mixed concrete from a truck mixer or agitator by the speed of rotation of the drum in the discharge direction with the discharge gate fully open.

If you use a truck mixer or agitator to transport the concrete to the delivery point, comply with the following limits:

1. Complete the discharge within 1.5 hours or before 250 revolutions of the drum or blades, whichever occurs first, after introducing the cementitious materials to the aggregates.
2. Under conditions contributing to quick stiffening of the concrete, or if the concrete temperature is 85 degrees F or above, the time allowed may be less than 1.5 hours.
3. If you use an admixture to retard the set time:
   3.1. Concrete temperature must not exceed 85 degrees F
   3.2. Time limit is 2 hours
   3.3. Revolution limit is 300

If you use nonagitating hauling equipment to transport the concrete to the delivery point:

1. Complete the discharge within 1 hour after introducing the cementitious materials to the aggregates
2. Under conditions contributing to quick stiffening of the concrete, or if the concrete temperature is 85 degrees F or above, complete the discharge within 45 minutes after introducing the cementitious materials to the aggregates

If you add a high-range water-reducing admixture to the concrete at the job site, the total number of revolutions must not exceed 300.

90-1.02G(4) Time or Quantity of Mixing

Mixing of the concrete in a stationary mixer must continue for the required mixing time after all ingredients, except water and admixture that is added with the water, are in the mixing compartment of the mixer before any part of the batch is released. The transfer time in multiple drum mixers must not be counted as part of the required mixing time.

For concrete used in concrete structures other than minor structures, the mixing time in a stationary mixer must be at least 90 seconds and no more than 5 minutes, except that if authorized the minimum mixing time may be reduced to 50 seconds. For all other concrete, the mixing time must be at least 50 seconds and no more than 5 minutes.

The minimum required revolutions at the mixing speed for transit-mixed concrete must be at least that recommended by the mixer manufacturer and must be enough to produce uniform concrete under section 90-1.02A.

90-1.02G(5) Hand Mixing

Hand-mixed concrete must be made in batches of 1/3 cu yd or less.

Use the following procedure to make hand-mixed concrete:

1. Measure the quantity of coarse aggregate in measuring boxes.
2. Spread the coarse aggregate on a watertight, level platform.
3. Spread the fine aggregate on the layer of coarse aggregate. The total depth of the 2 layers must be 1 foot or less.
4. Spread the dry cementitious materials on the aggregates.
5. Turn the whole dry mass at least 2 times.
6. Add and evenly distribute the water.
7. Turn the whole mass at least 3 more times, not including placement in the carriers or forms.

90-1.02G(6) Quantity of Water and Penetration or Slump

Regulate the quantity of water used in the concrete mix such that the penetration as tested under California Test 533, or the slump as tested under ASTM C143, complies with the nominal range shown in the following table:

Type of work	Nominal		Maximum	
	Penetration (in)	Slump (in)	Penetration (in)	Slump (in)
Concrete pavement	0–1	--	1.5	--
Nonreinforced concrete members	0–1.5	--	2	--
Reinforced concrete structures with:				
Sections over 12 inches thick	0–1.5	--	2.5	--
Sections 12 inches thick or less	0–2	--	3	--
Concrete placed under water	--	6–8	--	9
CIP concrete piles	2.5–3.5	5–7	4	8

If the penetration or slump exceeds the nominal range, adjust the mixture for subsequent batches to reduce the penetration or slump to a value within the nominal range.

Do not use a batch of concrete with a penetration or a slump that exceeds the maximum value shown in the table above.

If Type F or G chemical admixtures are used, the penetration requirements do not apply and the slump must not exceed 9 inches after adding the chemical admixtures.

The quantity of free water must not exceed 310 pounds per cubic yard of concrete plus 20 pounds of free water for each required 100 pounds of cementitious material in excess of 550 pounds of cementitious material per cubic yard of concrete.

When determining the total quantity of free water, consider liquid admixtures to be water if the dosage is more than 1/2 gallon of admixture per cubic yard of concrete.

If there are adverse or difficult conditions that affect concrete placement, you may exceed the specified penetration and free water content limitations if you:

1. Receive authorization to increase the cementitious material content per cubic yard of concrete
2. Increase the water and cementitious material at a ratio that does not exceed 30 pounds of water per added 100 pounds of cementitious material per cubic yard of concrete

The equipment for supplying water to the mixer must accurately measure to within 1.5 percent of the quantity of water required to be added to the mix for any position of the mixer.

The tanks used to measure the water must be designed such that water cannot enter while water is being discharged into the mixer. The water must be discharged into the mixer rapidly in 1 operation without dribbling.

Arrange the equipment to allow checking of the quantity of water delivered by discharging into measured containers.

90-1.02H Concrete in Corrosive Environments

Section 90-1.02H applies to concrete specified in the special provisions to be in a corrosive environment.

The cementitious material to be used in the concrete must be a combination of Type II or V portland cement and SCM.

The concrete must contain at least 675 pounds of cementitious material per cubic yard.

The reduction of cementitious material content as specified in section 90-1.02E(2) is not allowed.

The specifications for SCM content in section 90-1.02B(3) do not apply.

The cementitious material must be composed of one of the following, by weight:

1. 25 percent natural pozzolan or fly ash with a CaO content of up to 10 percent and 75 percent portland cement
2. 20 percent natural pozzolan or fly ash with a CaO content of up to 10 percent, 5 percent silica fume, and 75 percent portland cement
3. 12 percent silica fume, metakaolin, or UFFA, and 88 percent portland cement
4. 50 percent GGBFS and 50 percent portland cement

90-1.02I Concrete in Freeze-Thaw Areas

90-1.02I(1) General

Section 90-1.02I applies to concrete for projects specified in the special provisions to be in a freeze-thaw area.

90-1.02I(2) Materials

90-1.02I(2)(a) General

The concrete must contain at least 590 pounds of cementitious material per cubic yard unless a higher cementitious material content is specified.

Add an air-entraining admixture to the concrete at the rate required to produce an air content of 6.0 ± 1.5 percent in the freshly mixed concrete.

For concrete placed at least 2 feet below the adjacent undisturbed grade or at least 3 feet below compacted finished grade, an air-entraining admixture is not required unless the concrete will experience freezing conditions during construction.

The cementitious material must satisfy the following equation:

$$[(41 \times UF) + (19 \times F) + (11 \times SL)]/TC \leq 7.0$$

where:
UF = silica fume, metakaolin, or UFFA, including the quantity in blended cement, lb/cu yd
F = natural pozzolan or fly ash complying with AASHTO M 295, Class F or N, including the quantity in blended cement, lb/cu yd. *F* is equivalent to the sum of *FA* and *FB* as defined in section 90-1.02I(2)(b).
SL = GGBFS, including the quantity in blended cement, lb/cu yd
TC = total quantity of cementitious material used, lb/cu yd

90-1.02I(2)(b) Concrete Exposed to Deicing Chemicals

Section 90-1.02I(2)(b) applies to concrete specified in the special provisions to be exposed to deicing chemicals.

The specifications for SCM content in section 90-1.02B(3) and the equation in section 90-1.02I(2)(a) do not apply.

The cementitious material must be composed of any combination of portland cement and at least 1 SCM satisfying the following equation:

Equation 1:

$$[(25 \times UF) + (12 \times FA) + (10 \times FB) + (6 \times SL)]/TC \geq X$$

The SCM must satisfy the following equations:

Equation 2:

$$4 \times (FA + FB)/TC \leq 1.0$$

Equation 3:

(10 x *UF*)/*TC* ≤ 1.0

Equation 4:

2 x (*UF* + *FA* + *FB* + *SL*)/*TC* ≤ 1.0

The concrete mix design must satisfy the following equation:

Equation 5:

27 x (*TC* - *MC*)/*MC* ≤ 5.0

where:
UF = silica fume, metakaolin, or UFFA, including the quantity in blended cement, lb/cu yd. If UF is used, the quantity of UF must be at least 5 percent.
FA = natural pozzolan or fly ash complying with AASHTO M 295, Class F or N, with a CaO content of up to 10 percent, including the quantity in blended cement, lb/cu yd. If FA is used, the quantity of FA must be at least 15 percent.
FB = natural pozzolan or fly ash complying with AASHTO M 295, Class F or N, with a CaO content of greater than 10 percent and up to 15 percent, including the quantity in blended cement, lb/cu yd. If FB is used, the quantity of FB must be at least 15 percent.
SL = GGBFS, including the quantity in blended cement, lb/cu yd
TC = total quantity of cementitious material, lb/cu yd
X = 1.8 for innocuous aggregate, 3.0 for all other aggregate
MC = minimum quantity of cementitious material specified, lb/cu yd

90-1.02J Curing Compound

Curing compound water loss must not exceed 0.15 kg/m^2 in 24 hours when tested under California Test 534.

90-1.03 CONSTRUCTION

90-1.03A General

Reserved

90-1.03B Curing Concrete

90-1.03B(1) General

Unless otherwise specified, cure newly placed concrete by one of the method specified in this section.

Cure mortar and grout by keeping the surface damp for 3 days.

90-1.03B(2) Water Method

The water method must consist of keeping the concrete continuously wet by applying water for a curing period of at least 7 days after the concrete is placed.

You may use cotton mats, rugs, carpets, or earth or sand blankets as a curing medium to retain the moisture during the curing period.

For curing structures, you may use a curing medium consisting of white opaque polyethylene sheeting extruded onto burlap. The polyethylene sheeting must have a minimum thickness of 4 mils and must be extruded onto 10-ounce burlap.

For curing columns, you may use a curing medium consisting of polyethylene sheeting with a minimum thickness of 10 mils achieved in a single layer of material.

Keep the concrete surface damp by applying water with an atomizing nozzle that forms a mist and not a spray until the surface is covered with the curing medium. Do not apply the water under pressure directly on the concrete or allow the water to flow over or wash the concrete surface. At the end of the curing period, remove the curing medium.

If you use polyethylene sheeting or polyethylene sheeting on burlap as a curing medium:

1. Secure the sheeting and the sheeting joints as necessary to retain moisture
2. Keep the sheeting within 3 inches of the concrete at all points along the surface being cured
3. Monitor the concrete temperature during curing
4. Discontinue the use of these curing media if the concrete temperature cannot be maintained below 140 degrees F

90-1.03B(3) Curing Compound Method

90-1.03B(3)(a) General

The curing compound method must consist of uniformly spraying the concrete surfaces exposed to the air with a curing compound.

90-1.03B(3)(b) Materials

The curing compound must comply with the requirements shown in the following table for the curing compound number specified:

Curing compound no.	ASTM C309 classification
1	Pigmented, Type 2, Class B[a]
2	Pigmented, Type 2, Class B
3	Pigmented, Type 2, Class A
4	Nonpigmented, Type 1, Class B
5	Nonpigmented, Type 1, Class A
6	Nonpigmented with fugitive dye, Type 1-D, Class A

[a]The resin type must be poly-alpha-methylstyrene. The infrared scan for the dried vehicle must match the scan on file at METS.

If no curing compound number is specified, use any of the curing compounds shown in the table above.

The curing compound must be manufactured to:

1. Remain sprayable at temperatures above 40 degrees F
2. Control sagging, pigment settling, leveling, and de-emulsification
3. Maintain the specified properties for at least 1 year

Pigmented curing compounds must be manufactured such that the pigment does not settle badly, cake or thicken in the container, or become granular or curdled.

Settlement of pigment must be a thoroughly wetted, soft, mushy mass allowing the complete and easy vertical penetration of a paddle. Settled pigment must be easily predisposed, with minimum resistance to the sideways manual motion of the paddle across the bottom of the container, to form a smooth, uniform product of the proper consistency.

Do not dilute or alter the curing compound after manufacture.

The curing compound must be packaged in clean 274-gallon totes, 55-gallon barrels, or 5-gallon pails, or must be supplied from a suitable storage tank located at the job site or casting site. The containers must comply with 49 CFR 171–180. The 274-gallon totes and 55-gallon barrels must have removable lids and airtight fasteners. The 5-gallon pails must be round and have standard full open head and bail. Do not use lids with bungholes.

Containers must be filled in a way that prevents skinning.

Steel containers and lids must be lined with a coating that prevents destructive action by the compound or chemical agents in the air space above the compound. The coating must not come off the container or lid as skins.

Plastic containers and lids must not react with the curing compound.

Label each curing compound container with:

1. Manufacturer's name

2. ASTM C309 classification
3. Batch number
4. Volume
5. Date of manufacture
6. Volatile organic compound content
7. Warning that curing compound containing pigment must be well stirred before using
8. Precautions concerning the handling and application of curing compound in compliance with 8 CA Code of Regs §§ 1500–1938 and 3200–6184
9. Statement that the contents fully comply with State air pollution control rules and regulations

90-1.03B(3)(c) Mixing

Before using a curing compound, completely redisperse settled or separated solids in containers, except tanks, by mixing at low speed in compliance with these specifications and the manufacturer's instructions. Mix manually using a paddle or mix using a mixing blade driven by a drill motor at low speed. Mixing blades must be the type used for mixing paint.

Keep on-site storage tanks clean and free of contaminants. Each tank must have a permanent system that completely redisperses settled material without introducing air or other foreign substances.

At the time of use, compounds containing pigments must be thoroughly mixed. Use a paddle to loosen all settled pigment from the container bottom and use a power-driven agitator to disperse the pigment uniformly throughout the vehicle.

Agitation must not introduce air or other foreign substances into the curing compound.

90-1.03B(3)(d) Application

Apply the curing compound at a nominal rate of 150 sq ft/gal.

At any point, the application rate must be within ±50 sq ft/gal of the nominal rate. The average application rate must be within ±25 sq ft/gal of the nominal rate when tested under California Test 535. Apply the curing compound such that there are no runs, sags, thin areas, skips, or holidays.

Apply the curing compound using power-operated spraying equipment with an operational pressure gauge and a means of controlling the pressure. The Engineer may allow hand spraying for small and irregular areas that, in the Engineer's opinion, are not reasonably accessible to power-operated spraying equipment.

Apply the curing compound to the concrete after finishing the surface, immediately before the moisture sheen disappears from the concrete surface but before drying shrinkage or craze cracks start to appear.

If the concrete surface cracks or dries, immediately and continually apply water with an atomizing nozzle as specified in section 90-1.03B(2) until application of the curing compound is resumed or started. Do not apply the curing compound over freestanding water.

If the film of curing compound is damaged before the expiration of 7 days after the concrete is placed for structures and 72 hours for pavement, immediately repair it with additional compound.

90-1.03B(4) Waterproof Membrane Method

The waterproof membrane method must consist of:

1. Spraying the exposed finished concrete surfaces with water, using an atomizing nozzle that forms a mist and not a spray, until the concrete has set
2. Placing the waterproof curing membrane immediately after spraying
3. Keeping the membrane in place for at least 72 hours

The membrane must be sheeting material that complies with ASTM C171 for white reflective materials.

Use sheeting material of such a width as to completely cover the entire concrete surface. Cement the sheeting joints together securely such that the joints are waterproof. The joint seams must have at least a 4-inch lap.

Securely weigh down the sheets by placing an earth bank on the sheet edges or by other authorized means.

If any portion of the sheets are damaged within 72 hours after being placed, immediately repair the damaged portion by cementing new sheets into place.

Do not use a membrane that is no longer waterproof or has been damaged such that it is unfit for curing concrete.

90-1.03B(5) Forms-In-Place Method

The forms-in-place method must consist of curing formed concrete surfaces by keeping the forms in place.

Keep the forms in place for at least 7 days after the concrete is placed, except keep the forms in place for at least 5 days for concrete members over 20 inches in least dimension.

The joints in the forms and the joints between the end of the forms and the concrete must be kept moisture tight during the curing period. Reseal cracks in the forms and cracks between the forms and the concrete using authorized methods.

90-1.03C Protecting Concrete

Protect the concrete from damage due to any cause, including rain, heat, cold, wind, your actions, and the actions of others.

Do not place the concrete on frozen or ice-coated ground or subgrade or on ice-coated forms, reinforcing steel, structural steel, conduits, PC members, or construction joints.

If it is raining, you must provide adequate protection against damage or you must stop placing the concrete before the quantity of surface water is sufficient to damage the surface mortar or cause a flow or wash of the concrete surface.

90-1.04 PAYMENT

Not Used

90-2 MINOR CONCRETE

90-2.01 GENERAL

90-2.01A Summary

Section 90-2 includes specifications for furnishing and protecting minor concrete.

90-2.01B Definitions

Reserved

90-2.01C Submittals

If required by the following table, submit compressive strength test results with the mix design that verify the minimum required compressive strength:

SCM	Test submittal required
Fly ash used alone	If portland cement content < 350 lb/cu yd
GGBFS used alone	If portland cement content < 250 lb/cu yd
Natural pozzolan used alone	If portland cement content < 350 lb/cu yd
More than 1 SCM	Always

NOTE: Compressive strength tests must be performed by an ACI-certified technician.

Submit the concrete mix design before using the concrete in the work and before changing the mix proportions.

Submit a proposed combined aggregate gradation. After authorization of the gradation, the aggregate furnished for minor concrete must comply with that gradation.

If requested, submit periodic test reports of the aggregate gradation furnished.

The Engineer may waive the specifications for gradation if the Engineer determines that furnishing a gradation is not necessary for the type or quantity of concrete work to be constructed.

Before placing minor concrete from a source not previously used on the Contract, submit a certificate of compliance stating that the minor concrete to be furnished complies with the Contract requirements, including the specified minimum cementitious material content.

Submit a weighmaster certificate as an informational submittal with each load of ready-mixed concrete at the concrete discharge location. The weighmaster certificate must show the date and time the load left the batching plant and, if hauled in a truck mixer or agitator, the time the mixing cycle started.

90-2.01D Quality Assurance

Section 90-1.01D(5) and the specifications for uniformity in section 90-1.02A do not apply to minor concrete.

The Engineer may perform tests and inspect the facilities, materials, and methods for producing the minor concrete to ensure that it is of suitable quality for use in the work.

The Engineer verifies compliance with the specified cementitious material content by testing under California Test 518 for cement content. For testing purposes, SCM is considered to be cement. Adjust the batch proportions as necessary to produce concrete having the specified cementitious material content.

90-2.02 MATERIALS

90-2.02A General

Reserved

90-2.02B Cementitious Material

Minor concrete must contain at least 505 pounds of cementitious material per cubic yard.

You may use rice hull ash as an SCM. Rice hull ash must comply with AASHTO M 321 and the requirements for the quality characteristics shown in the following tables:

Chemical quality characteristic	Requirement (percent)
Silicon dioxide (SiO_2)[a] (min)	90
Loss on ignition (max)	5.0
Total alkalies as Na_2O equivalent (max)	3.0

[a]SiO_2 in crystalline form must not exceed 1.0 percent.

Physical quality characteristic	Requirement
Particle size distribution	
Less than 45 microns (min, %)	95
Less than 10 microns (min, %)	50
Strength activity index with portland cement[a]	
7 days (min, % of control)	95
28 days (min, % of control)	110
Expansion at 16 days when testing project materials under ASTM C1567[b] (max, %)	0.10
Surface area when testing by nitrogen adsorption under ASTM D5604 (min, m^2/g)	40.0

[a]When tested under AASHTO M 307 for strength activity testing of silica fume.
[b]In the test mix, Type II or V portland cement must be replaced with at least 12 percent rice hull ash by weight.

For the purpose of calculating the equations for the cementitious material specifications, consider rice hull ash to be represented by the variable *UF*.

90-2.02C Aggregate

Sections 90-1.01C(2) and 90-1.02C do not apply to minor concrete.

The aggregate must be clean and free from deleterious coatings, clay balls, roots, and other extraneous material.

The maximum aggregate size must not be larger than 1-1/2 inches or smaller than 3/4 inch.

You may use crushed concrete and reclaimed aggregate if they comply with the specifications for aggregate.

90-2.02D Water

Section 90-1.02D does not apply to minor concrete.

Water used for washing, mixing, and curing must be free from oil, salts, and other impurities that would discolor or etch the surface or have an adverse affect on the concrete quality.

90-2.02E Production

Sections 90-1.02F, 90-1.02G(1), 90-1.02G(2), 90-1.02G(3), and 90-1.02G(4) do not apply to minor concrete.

Store, proportion, mix, transport, and discharge the cementitious material, water, aggregate, and admixtures in compliance with recognized standards of good practice that result in thoroughly and uniformly mixed concrete suitable for the intended use. Recognized standards of good practice are outlined in various industry publications, such as those issued by ACI, AASHTO, or the Department.

Use a quantity of water that produces concrete with a consistency that complies with section 90-1.02G(6). Do not add water during hauling or after arrival at the delivery point unless allowed by the Engineer.

Discharge ready-mixed concrete from the transport vehicle while the concrete is still plastic and before stiffening occurs. Take whatever action is necessary to eliminate quick stiffening, except do not add water.

Conditions contributing to quick stiffening are:

1. Elapsed time of 1.5 hours in agitating hauling equipment or 1 hour in nonagitating hauling equipment
2. More than 250 revolutions of the drum or blades after introduction of the cementitious material to the aggregates
3. Concrete temperature over 90 degrees F

The mixing time in a stationary mixer must be at least 50 seconds and no more than 5 minutes.

The minimum required revolutions at mixing speed for transit-mixed concrete must be at least that recommended by the mixer manufacturer and must be increased as needed to produce thoroughly and uniformly mixed concrete.

If you add a high-range water-reducing admixture to the concrete at the job site, the total revolutions must not exceed 300.

90-2.03 CONSTRUCTION

Maintain a concrete temperature of at least 40 degrees F for 72 hours after placing.

90-2.04 PAYMENT

Not Used

90-3 RAPID STRENGTH CONCRETE

90-3.01 GENERAL

90-3.01A Summary

Section 90-3 includes specifications for furnishing and curing RSC.

Section 90-3 applies only where the specifications allow the use of RSC.

90-3.01B Definitions

Reserved

90-3.01C Submittals

90-3.01C(1) General

Reserved

90-3.01C(2) Volumetric Proportioning

For volumetric-proportioned RSC, submit:

1. Aggregate moisture test results
2. Log of production data
3. Test samples of freshly mixed concrete for uniformity testing

Sampling facilities must be safe, accessible, and clean, and must produce a test sample that is representative of production. The sampling devices and methods must comply with California Test 125.

90-3.01C(3) Certificate of Compliance

Submit a certificate of compliance with each delivery of aggregate, cementitious material, and admixtures used for calibration tests. Include certified copies of the weight of each delivery.

The certificate of compliance must state that the source of the materials used for the calibration tests is the same source as to be used for the planned work. The certificate must be signed by your assigned representative.

90-3.01C(4) Weighmaster Certificate

Submit weighmaster certificates for RSC. Regardless of the proportioning method used, the certificates must include all the information necessary to trace the manufacturer and manufacturer's lot number for the cement used.

The weighmaster certificate for the cement must include:

1. Date of proportioning
2. Location of proportioning
3. Actual net draft cement weight, if proportioned into fabric containers
4. Net draft cement weight used in the load, if proportioned at the pour site from a storage silo

90-3.01C(5) Production Data

For volumetric-proportioned RSC, submit the daily production data in electronic or printed media at the end of each production shift. Report the data, including data titles, in the following order:

1. Weight of cement per revolution count
2. Weight of each aggregate size per revolution count
3. Gate openings for each aggregate size
4. Weight of water added to the concrete per revolution count
5. Moisture content of each aggregate size
6. Individual volume of admixtures per revolution count
7. Time of day
8. Day of week
9. Production start and stop times
10. Volumetric mixer identification
11. Name of supplier
12. Specific type of concrete being produced
13. Source of the individual aggregate sizes
14. Source, brand, and type of cement
15. Source, brand, and type of individual admixtures
16. Name and signature of the operator

The device controlling the proportioning of cement, aggregate, and water must produce production data that is captured at 15-minute intervals throughout daily production. Each capture of production data must

represent the production activity at that time and must not be a summation of data. The quantity of material represented by each production capture is the quantity produced in the period from 7.5 minutes before to 7.5 minutes after the capture time.

Production data must be input by hand into a pre-printed form or captured and printed by the proportioning device. Present electronic media containing recorded production data in a tab-delimited format on a CD or DVD. Each capture of production data must be followed by a line feed carriage return with sufficient fields for the specified data.

90-3.01D Quality Assurance

90-3.01D(1) General

Reserved

90-3.01D(2) Penetration

The specifications for penetration in section 90-1.02G(6) do not apply to RSC.

90-3.01D(3) Aggregate Moisture

For volumetric-proportioned RSC, determine the aggregate moisture under California Test 223 at least every 2 hours during proportioning and mixing. Record the aggregate moisture determinations and submit them at the end of each production shift.

90-3.01D(4) Concrete Uniformity

For volumetric-proportioned RSC, the Engineer determines the uniformity of concrete mixtures based on differences in penetration measurements when tested under California Test 533. Differences in penetration are determined by comparing the penetration tests on 2 test samples of mixed concrete from the same batch or volumetric mixer load.

90-3.02 MATERIALS

90-3.02A General

RSC must be one of the following:

1. Concrete complying with section 90-1. You may use Type III portland cement.
2. Concrete complying with section 90-1, except:
   2.1. You may use any cement that complies with the definition of hydraulic cement or blended hydraulic cement in ASTM C219 and must have the requirements for the quality characteristics shown in the following table:

Quality characteristic	Test method	Requirement[b]
Contraction in air (%, max)	California Test 527, W/C ratio = 0.390 ± 0.010	0.053
Mortar expansion in water (%, max)	ASTM C1038	0.04
Soluble chloride[a] (%, max)	California Test 422	0.05
Soluble sulfate[a] (%, max)	California Test 417	0.30
Thermal stability (%, min)	California Test 553	90
Compressive strength at 3 days (psi, min)	ASTM C109	2,500

[a]Perform the test on a cube specimen fabricated in compliance with ASTM C109, cured for at least 14 days, and then pulverized such that 100 percent passes the no. 50 sieve.
[b]If you use chemical admixtures, include them when testing.

   2.2. You may use citric acid or borax if you submit a written request from the cement manufacturer and a test sample.

The requirement for air entrainment of concrete in freeze-thaw areas applies only when portland cement is used.

SCM is not required in RSC.

When tested for uniformity under section 90-3.01D(4), the difference in penetration between the 2 concrete test samples must not exceed 5/8 inch.

90-3.02B Volumetric Proportioning

90-3.02B(1) General

RSC may be proportioned and placed using a volumetric mixer.

90-3.02B(2) Proportioning

Volumetric mixers must proportion cement, water, aggregate, and additives by volume.

Proportion aggregate using a belt feeder that is operated with an adjustable cutoff gate delineated to the nearest quarter increment. The gate opening height must be readily determinable.

Proportion cement by any method that complies with the accuracy tolerance specifications in section 90-1.02F(3).

Proportion water with a meter.

Proportion liquid admixtures under section 90-1.02F(4)(b), except proportion liquid admixtures with a meter.

90-3.02B(3) Mixer Requirements

Mix volumetric-proportioned RSC in a mechanically operated mixer. You may use an auger-type mixer. Operate the mixer uniformly at the mixing speed recommended by the manufacturer. Do not use a mixer that has an accumulation of hard concrete or mortar.

Volumetric mixers must comply with the following:

1. Aggregate feeders must connect directly to the drive on the cement vane feeder.
2. Cement feed rate must be tied directly to the feed rate for the aggregate and other ingredients. The ratio of cement to aggregate must be changed only by changing the gate opening for the aggregate feed.
3. Drive shaft of the aggregate feeder must have a revolution counter reading to the nearest full or partial revolution of the aggregate delivery belt.

Do not use equipment with components made of aluminum or magnesium alloys that could have contact with plastic concrete during mixing or transporting of the RSC.

Cover the rotating and reciprocating equipment on volumetric mixers with metal guards.

The identifying numbers of volumetric mixers must be at least 3 inches in height and must be located on the front and rear of the vehicle.

Each mixer must have metal plates that state the designed usage, the manufacturer's guaranteed mixed concrete volumetric capacity, and the rotation speed.

Locate cement storage immediately before the cement feeder. Equip the system with a device that automatically shuts down power to the cement feeder and aggregate belt feeder if the cement storage level is less than 20 percent of the total volume.

Equip each aggregate bin with a device that automatically shuts down the power to the cement feeder and the aggregate belt feeder if the aggregate discharge rate is less than 95 percent of the scheduled discharge rate.

The proportioning device indicators must be in working order before starting proportioning or mixing and must be visible when standing near the volumetric mixer.

90-3.02B(4) Mixer Calibration

Calibrate the cutoff gate for each volumetric mixer used and for each aggregate source. Calibrate each volumetric mixer at 3 different aggregate gate settings that correspond to production needs. Perform at least 2 calibration runs for each aggregate gate.

Individual aggregate delivery rate check-runs must not vary by more than 1.0 percent from the mathematical average of all runs for the same gate and aggregate type. Each test run must be at least 1,000 lb.

Individual cement delivery rate check-runs must not vary by more than 1.0 percent from the mathematical average of 3 runs of at least 1,000 lb each.

When the water meter operates from 50 to 100 percent of production capacity, the indicated weight of water delivered must not differ from the actual weight delivered by more than 1.5 percent for each of 2 runs of 300 gal for pavement or 75 gal for structures.

Calibrate the water meter under California Test 109. The water meter must be equipped with a resettable totalizer and must display the operating rate.

Conduct the calibration tests for aggregate, cement, and water proportioning devices using a platform scale located at the calibration site. Platform scales for weighing test-run calibration material must have a maximum capacity of 2.75 tons with maximum graduations of 1 lb. Error test the platform scale within 8 hours of calibrating the volumetric mixer proportioning devices. Perform error testing with test weights under California Test 109. Furnish a witness scale that is within 2 graduations of the test weight load. The witness scale must be available for use at the production site throughout the production period. Equipment needed for the calibration of proportioning systems must remain available at the production site throughout the production period.

The volumetric mixer must be equipped such that accuracy checks can be made. After production starts, recalibrate the proportioning devices at least every 30 days for pavement or 90 days for structures or when you change the source or type of any ingredient.

Each time 55 tons of cement passes through the volumetric mixer, perform a 2-run spot calibration of only the cement proportioning system. If the spot calibration shows that the cement proportioning system does not comply with the specifications, complete a full calibration of the cement proportioning system before you resume production.

90-3.02B(5) Mixing Concrete

At the time of batching volumetric-proportioned RSC:

1. Aggregates must be dried and drained to a stable moisture content. Do not proportion aggregates with visible separation of water from the aggregate.
2. Free moisture content of the fine aggregate must not exceed 8 percent of its saturated surface-dry weight.

If the proportioning plant has separate supplies of the same size group of aggregate with different moisture content, specific gravity, or surface characteristics affecting workability, exhaust one supply before using another supply.

Do not use ice to cool volumetric-proportioned RSC directly. If ice is used to cool the water used in the mix, it must be melted before entering the mixer.

Proportion and charge the cement into the volumetric mixer such that there is no variance of the required quantity due to conditions such as wind or accumulation on equipment.

Do not mix more material in the volumetric mixer than will allow complete mixing. Reduce the volume of material in the mixer if complete mixing is not achieved. Continue mixing until a homogeneous mixture is produced at discharge. Do not add water to the RSC after discharge.

90-3.03 CONSTRUCTION

For RSC using a cement other than portland cement, cure the concrete as recommended by the cement manufacturer. The method of curing must be authorized before starting construction.

90-3.04 PAYMENT

If volumetric mixer calibration is performed more than 100 miles from the project limits, $1,000 per calibration session is deducted.

90-4 PRECAST CONCRETE

90-4.01 GENERAL

90-4.01A Summary

Section 90-4 includes specifications for furnishing and curing PC concrete members.

The specifications for shrinkage in section 90-1.02A do not apply.

90-4.01B Definitions

Reserved

90-4.01C Submittals

90-4.01C(1) General

For reports and logs, type or clearly print the name next to the signature of the person signing the report or log.

Submit expansion test data under section 90-4.02, if required.

Submit daily temperature data for internally monitored tier 1 PC concrete members each week as an informational submittal.

90-4.01C(2) Certificates of Compliance

Submit a certificate of compliance for the cementitious material used in PC concrete members. The certificate must be signed by the PC concrete product manufacturer.

Submit a certificate of compliance for each PC concrete member. The certificate of compliance for tier 1 and tier 2 members must be signed by the QC manager. The certificate of compliance for tier 3 members must be signed by the QC Inspector.

90-4.01C(3) Precast Concrete Quality Control Plan

Before performing any precasting activities for tier 1 and tier 2 PC concrete members, submit 3 copies of the project-specific QC plan for the PC plant. The QC plan must supplement the information from the authorized facility audit. Submit a separate QC plan for each plant. Allow 25 days for review.

Each project-specific QC plan must include:

1. Name of the precasting plant, concrete plants, and any testing laboratory to be used.
2. Manual prepared by the precasting plant that includes:
   2.1. Equipment description
   2.2. Testing procedures
   2.3. Safety plan
   2.4. Personnel names, qualifications, and copies of certifications
3. QC manager and QC inspector names, qualifications, and copies of certifications.
4. Organizational chart showing QC personnel and their assigned QC responsibilities.
5. Methods and frequencies for performing QC procedures including inspections, material testing, and any survey performed for all components of PC concrete members. Components include prestressing, concrete, grout, reinforcement, steel, miscellaneous metal, and formwork.
6. System for reporting noncompliant PC concrete members to the Engineer.
7. System for identification and tracking repairs and repair methods.
8. Procedure for the reinspection of repaired PC concrete members.
9. Forms for certificates of compliance, daily production logs, and daily reports.

For internally monitored tier 1 PC bridge components, include the following as part of the QC plan:

1. Authorized mix design
2. Duration and method of curing
3. Concrete temperature monitoring and recording system details
4. Temperature sensor types and locations
5. Measures to ensure compliance with maximum temperature and temperature gain requirements, including maximum concrete temperature at discharge and controlling enclosure temperature

Submit a revised QC plan for any changes to:

1. Concrete plants
2. Material sources
3. Material testing procedures
4. Testing laboratory
5. Procedures and equipment
6. Systems for tracking and identifying PC concrete members
7. QC personnel
8. Methods for controlling internal concrete temperature

After authorization, submit 7 copies of each authorized QC plan and make 1 copy available at each location where work is performed.

Allow 7 days for review of a revised QC plan.

90-4.01C(4) Daily Production Log

The QC inspector must provide reports to the QC manager for each day that precasting activities are performed.

The QC manager must maintain a daily production log of PC activities for each day's precasting. PC activities include setting forms, placing reinforcement, setting prestressing steel, casting, curing, post tensioning, and form release. This daily log must be available at the precasting plant. The daily log must include:

1. Plant location
2. Specific description of casting or related activities
3. Any problems or deficiencies discovered
4. Any testing or repair work performed
5. Names of QC inspectors and the specific QC inspections they performed that day
6. Reports for that day's precasting activities from each QC inspector including before, during, and after precast inspections
7. Daily temperature data for internally monitored tier 1 PC concrete members

Immediately notify the Engineer when any precasting problems or deficiencies are discovered, and submit the proposed repair or process changes necessary to correct them.

90-4.01C(5) Precast Concrete Report

Before shipping PC concrete members, submit a PC concrete report. The report must include:

1. Reports of all material tests and any survey checks
2. Documentation that:
   2.1. You have evaluated all tests
   2.2. You corrected all rejected deficiencies
   2.3. Repairs have been reexamined with the required tests and found acceptable
3. Daily production logs
4. Certificates of compliance
5. Documentation of inspections

Each person who performs a material test or survey check must sign the corresponding report and submit the report directly to the QC manager.

90-4.01D Quality Assurance

90-4.01D(1) General

Quality assurance for PC concrete includes:

1. Your QC program
2. Department's acceptance of PC concrete members

PC concrete members are categorized into the following 4 tiers:

1. Tier 1 consists of:
   1.1. Components of bridge structures, including girders, deck panels, bent caps, abutments, slabs, closure wall panels, and piling
   1.2. Prestressed pavement
2. Tier 2 consists of:
   2.1. Components of earth retaining systems
   2.2. Wingwalls
   2.3. Types A, B, and C pipe culvert headwalls, endwalls, and wingwalls
   2.4. Pavement
   2.5. Box culverts
   2.6. Sound wall panels and supports
3. Tier 3 consists of:
   3.1. Pipes
   3.2. Pipe drainage facilities
   3.3. Straight and "L" pipe culvert headwalls except those listed under tier 2
   3.4. Drainage Inlets
   3.5. Flared end sections
4. Tier 4 consists of any member not described as tier 1, tier 2, or tier 3

90-4.01D(2) Quality Control

90-4.01D(2)(a) General

For tier 1 and tier 2 PC concrete members:

1. Fabricate PC concrete members at a plant on the Authorized Facility Audit List
2. Assign a PC concrete QC manager to the plant
3. Assign a QC inspector who is either registered as a civil engineer in the State or:
   3.1. For tier 1, has a Plant Quality Personnel Level II certification from the Precast/Prestressed Concrete Institute
   3.2. For tier 2, has a Plant Quality Personnel Level I certification from the Precast/Prestressed Concrete Institute
4. Prepare a PC concrete QC plan
5. Perform PC concrete materials testing
6. Maintain a daily production log
7. Prepare a PC concrete report
8. Prepare a certificate of compliance

For tier 3 PC concrete members:

1. Assign a QC inspector who has one of the following qualifications:
   1.1. Registration as a civil engineer in the State.
   1.2. Plant Quality Personnel, Level I certification from the Precast/Prestressed Concrete Institute.
   1.3. Competency to perform inspection of PC operations. An inspector is competent if the individual has completed training or has experience in PC operations and inspection.
2. Prepare a certificate of compliance

For tier 4 PC concrete members, prepare a certificate of compliance.

For each ASTM test method specified in this section, the material's test result must comply with the requirement specified for the comparable test elsewhere in section 90 unless otherwise specified.

If curing compound is used, provide certificate of compliance as specified in section 90-1.01C(5).

If PC concrete is manufactured at an established PC concrete plant, a trial batch and prequalification of the materials, mix proportions, mixing equipment, and procedures under section 90-1.01D(5)(b) are not required.

90-4.01D(2)(b) Quality Control Meeting

After submitting the PC concrete QC plan, hold a meeting to discuss the requirements for PC concrete QC. The meeting attendees must include the Engineer, the PC concrete QC manager, and a representative from each plant performing PC concrete activities for the Contract.

90-4.01D(2)(c) Sampling, Testing, and Inspecting

The QC laboratory testing personnel or the QC inspector must witness sampling. The QC laboratory testing personnel must perform testing.

QC laboratory testing personnel must have the following certifications, as applicable:

1. ACI Strength Testing Technician
2. ACI Concrete Laboratory Testing Technician Level 1
3. ACI Aggregate Testing Technician Level 2

The QC Inspector must perform inspections before, during, and after casting is complete.

QC field testing and inspection personnel must have an ACI Concrete Field Testing Technician, Grade I certification.

For each mix design used for tier 1 and tier 2 PC concrete members, perform sampling and testing at the minimum frequencies shown in the following tables:

Aggregate QC Tests

Quality characteristic	Test method	Minimum testing frequency
Aggregate gradation	ASTM C136	Once per 400 cu yd of concrete cast or every 7 days, whichever is more frequent
Sand equivalent	ASTM D2419	
Percent fines under 75 microns[a]	ASTM C117	
Moisture content of fine aggregate	ASTM C566, or electronically actuated moisture meter[b]	1–2 times per each day of pour, depending on conditions

[a]Percent fines under 75 microns test replaces the cleanness test in section 90-1.02C with the requirements of 1.5 percent maximum for "Operating Range" and 2.0 percent maximum for "Contract Compliance." The 5th paragraph of section 90-1.02C(2) does not apply.
[b]Electronically actuated moisture meter must be calibrated every 7 days per ASTM C566.

Concrete QC Tests

Quality characteristic	Test method	Minimum testing frequency
Compressive strength[a]	ASTM C172/C172M, ASTM C31/C31M, and ASTM C39/C39M	Once per 100 cu yd of concrete cast, or every day of casting, whichever is more frequent
Slump	ASTM C143/C143M	
Temperature at time of mixing	ASTM C1064/C1064M	
Density	ASTM C138	Once per 600 cu yd of concrete cast or every 7 days of batching, whichever is more frequent
Air content	ASTM C231/C231M or ASTM C173/C173M[b]	If concrete is air entrained, once for each set of cylinders, and when conditions warrant

[a]Cylinders must be 6 by 12 inches.
[b]ASTM C173/C173M must be used for lightweight concrete.

If concrete is batched at more than 1 plant, perform the tests at each plant.

Cure test cylinders for determining time of prestressing loading in the same manner as the concrete in the member.

Cure test cylinders for determining compliance with 28-day strength requirements in the same manner as the member until completion of the steam curing process followed by a water bath or moist room at 60 to 80 degrees F until tested.

For PC concrete that is steam cured, concrete designated by compressive strength is acceptable if its compressive strength reaches the described 28-day compressive strength in no more than the maximum number of days specified or allowed after the concrete is cast.

90-4.01D(2)(d) Temperature Monitoring

90-4.01D(2)(d)(i) General

At a minimum, provide temperature monitoring devices as shown in the following table:

Temperature Monitoring Requirements

Component	Steam curing	Other curing methods
Tier 1 PC bridge components except piling and deck panels	1 internal temperature sensor for each individually cast member; 1 internal temperature sensor for every 100 feet of bed length for continuously cast elements[a]	1 internal temperature sensor for each individually cast member; 1 internal temperature sensor for every 100 feet of bed length for continuously cast elements[a]
PC piling, deck panels, and PS pavement	1 enclosure temperature sensor for every 200 feet of bed length for continuously cast elements	Not required
Other PC components	1 enclosure temperature sensor for every 200 feet of bed length for continuously cast elements	Not required

[a]Members not instrumented are represented by the nearest internal temperature probe.

Temperature monitoring devices must provide an accurate, continuous, permanent record of the temperature during curing activities.

90-4.01D(2)(d)(ii) Tier 1 Bridge Components

Except for piling and deck panels, provide a temperature monitoring and recording system during concrete placement and curing for tier 1 PC bridge components. The system must consist of temperature sensors connected to a data acquisition system. The system must be capable of recording, printing, and downloading temperature data to a computer. Temperature sensors must be accurate to within ±2 degrees F.

Position each internal concrete temperature sensor as shown in the following table:

Internal Concrete Sensor Locations

PC component	Sensor location
Wide flange, 'I', and bulb tee girders	6–8 inches below top surface along center line at midpoint
Other girder shapes	6–8 inches below top surface along center line of stem at midpoint
Deck slabs	Center of element at mid-depth
Other elements	Position sensor to provide maximum concrete cover

Record temperature readings automatically at least every 15 minutes. You may discontinue temperature recording (1) when the maximum internal concrete temperature is falling for a minimum of 1 hour, or (2) immediately before stress transfer to the concrete.

Do not allow the ends of temperature sensors to come into contact with concrete supports, forms, or reinforcement.

Correct equipment failures in temperature control and monitoring and recording systems immediately.

90-4.01D(3) Department Acceptance

For PC concrete that is steam cured, the Engineer evaluates the compressive strength based on individual tests representing specific portions of production.

For tier 1 PC bridge components that are monitored for internal temperature, the Engineer rejects components if at any temperature sensor (1) the maximum internal concrete temperature exceeds 165 degrees F, or (2) the internal temperature gain exceeds 40 degrees F per hour. If the maximum internal concrete temperature is from 161 to 165 degrees F, the Engineer reduces payment for furnish PC

concrete member by a percentage equal to 2 times the difference of the maximum measured temperature in degrees F minus 160.

90-4.02 MATERIALS

You may use Type III portland cement in PC concrete.

The specifications for SCM content in section 90-1.02B(3) do not apply to PC concrete.

For PC concrete, the SCM content must comply with one of the following:

1. Any combination of portland cement and SCM satisfying the following equation:

   Equation 1:

   $[(25 \times UF) + (12 \times FA) + (10 \times FB) + (6 \times SL)]/TC \geq X$

   where:
   UF = silica fume, metakaolin, or UFFA, including the quantity in blended cement, lb/cu yd
   FA = natural pozzolan or fly ash complying with AASHTO M 295, Class F or N, with a CaO content of up to 10 percent, including the quantity in blended cement, lb/cu yd
   FB = natural pozzolan or fly ash complying with AASHTO M 295, Class F or N, with a CaO content of greater than 10 percent and up to 15 percent, including the quantity in blended cement, lb/cu yd
   SL = GGBFS, including the quantity in blended cement, lb/cu yd
   TC = total quantity of cementitious material, lb/cu yd
   X = 0.0 for innocuous aggregate, 3.0 for all other aggregate

2. 15 percent Class F fly ash with at least 48 oz of $LiNO_3$ solution added per 100 lb of portland cement. The CaO content of the fly ash must not exceed 15 percent.
3. Any combination of SCM and portland cement for which the expansion of cementitious material and aggregate does not exceed 0.10 percent when tested under ASTM C1567. Submit test data with each mix design. Test data authorized by the Department no more than 3 years before the 1st day of the Contract is authorized for the entire Contract. The test data must be for the same concrete mix and must use the same materials and material sources to be used on the Contract.

For tier 1 PC concrete members with internal temperature monitoring:

1. Maximum internal concrete temperature must not exceed 165 degrees F at any temperature sensor
2. Maximum temperature gain must not exceed 40 degrees F per hour at any temperature sensor

If municipally supplied potable water is used for PC concrete, the testing specified in section 90-1.02D is waived unless requested.

Portland cement based repair material must be on the Authorized Material List for precast portland cement based repair material.

90-4.03 CONSTRUCTION

Cure PC concrete using steam curing or any of the methods specified in section 90-1.03B. Cure for the minimum time specified for each method or until the concrete reaches its design strength, whichever is less.

Steam curing must comply with the following:

1. After placing the concrete, hold it for a 4-hour minimum presteaming period. If the ambient air temperature is below 50 degrees F, apply steam during the presteaming period to hold the air surrounding the concrete at a temperature of 50 to 90 degrees F.
2. To prevent moisture loss on the exposed surfaces during the presteaming period, cover the concrete as soon as possible after casting or keep the exposed surfaces wet by fog spray, curing compound, or wet blankets.
3. Enclosures for steam curing must allow free circulation of steam around the concrete and must be constructed to contain the live steam with a minimum moisture loss. The use of tarpaulins or similar

flexible covers is allowed if they are kept in good repair and secured in such a way that prevents the loss of steam and moisture.

4. Steam at the jets must be at low pressure and in a saturated condition. Steam jets must not impinge directly on the concrete, test cylinders, or forms. During application of the steam, the temperature rise within the enclosure must not exceed 40 degrees F per hour. Except for internally monitored components, the curing temperature throughout the enclosure must not exceed 150 degrees F. Maintain the curing temperature at a constant level for the time necessary to develop the required transfer strength. Cover control cylinders to prevent moisture loss and place them in a location where the temperature is representative of the average enclosure temperature.
5. Detension the concrete in pretension beds immediately after the steam curing is completed while the concrete and forms are still warm, or maintain the temperature under the enclosure above 60 degrees F until the stress is transferred to the concrete.
6. Curing is complete at the end of the steam curing cycle.

For dimensional tolerances of PC concrete members, comply with the Precast/Prestressed Concrete Institute's *Tolerance Manual for Precast and Prestressed Concrete Construction, MNL 135-00*.

For tier 1 and tier 2 PC concrete members, apply curing compound using power-operated spraying equipment. You may request application by hand spraying for small quantities of PC concrete members. For tier 3 and tier 4 PC concrete members, the application of curing compound may be hand sprayed.

For internally monitored tier 1 PC bridge components with a maximum internal concrete temperature of 161 to 165 degrees F, the following apply:

1. Do not apply curing compound.
2. Cure an additional 7 days using the water cure method.
3. After 7 days apply a silane waterproofing treatment under the following conditions:
   - 3.1. Silane waterproofing treatment selected for use must be on the Authorized Material List for silane reactive penetrating sealers.
   - 3.2. Concrete surfaces must be completely dry when silane is applied.
   - 3.3. Apply a single application of undiluted silane under the manufacturer's application instructions until surfaces are saturated.

90-4.04 PAYMENT

Not Used

90-5 SELF-CONSOLIDATING CONCRETE

90-5.01 GENERAL

90-5.01A Summary

Section 90-5 includes specifications for furnishing SCC.

Section 90-5 applies only where the specifications allow the use of SCC.

You may use SCC for PC concrete.

90-5.01B Definitions

self-consolidating concrete (SCC): Flowing concrete that is capable of spreading to a level state without segregation and without the use of internal or external vibrators.

90-5.01C Submittals

Submit the following before placing SCC:

1. Mix design and placement procedures.
2. Trial batch test report, including test results for the tests specified in section 90-5.01D(2)(c).
3. If a mock-up is specified:
   - 3.1. Details and placement procedures for the mock-up
   - 3.2. Test samples and test results from the mock-up

Submit test results for slump flow and visual stability index.

If the Engineer rejects the SCC for slump flow and visual stability index, make corrective changes and resubmit the SCC mix design or placement procedures.

Submit the aggregate gradation as an informational submittal.

90-5.01D Quality Assurance

90-5.01D(1) General

Reserved

90-5.01D(2) Quality Control

90-5.01D(2)(a) General

Reserved

90-5.01D(2)(b) Compressive Strength

Prepare SCC specimens for compressive strength testing under California Test 540, except fabricate test specimens as follows:

1. Place the test molds on a firm, flat surface to prevent distortion of the bottom surface.
2. If more than 1 specimen is to be made from the same batch, make all the specimens simultaneously.
3. Fill the mold in 1 lift, pouring the concrete from a larger container.
4. Pat the sides of the mold lightly by hand or jig by rocking the mold from side to side.
5. Strike off the surface of the concrete even with the top edge of the mold.
6. Wipe the sides of the mold free of excess concrete and press the lid on.

90-5.01D(2)(c) Prequalification of Mix Design

Prequalify the SCC mix design with a trial batch using the same materials, mix proportions, mixing equipment, procedures, and batch size to be used in SCC production.

The SCC trial batch must comply with the requirements for the quality characteristics shown in the following table:

SCC Mix Design Requirements

Quality characteristic	Test method	Requirement
Slump flow (min, inches)	ASTM C1611	20
Flow rate, T_{50} (seconds)	ASTM C1611	2–7
Visual stability index (max)	ASTM C1611	1
J-Ring flow[a] (max, inches)	ASTM C1621	2
Column segregation, static (max, %)	ASTM C1610	15
Bleeding capacity (max, %)	ASTM C232	2.5
Compressive strength[b,c] (min, psi)	California Test 521	strength described
Compressive strength[c] (min, psi, average of 5 cylinders)	California Test 521	≥ 600 + strength described

[a]Difference between J-ring flow and slump flow
[b]For an individual test cylinder
[c]At the maximum age specified or allowed

90-5.01D(2)(d) Mock-up

If the construction of a mock-up is specified in the special provisions, construct a mock-up before placing the SCC.

The mock-up must demonstrate that the SCC will:

1. Flow for the distance required by the proposed construction procedure
2. Completely fill the forms
3. Encapsulate the reinforcement and embedments

Prequalify the SCC mix design before constructing the mock-up.

The mock-up forms must be similar to those used for the production elements. Include in the mock-up the concrete, reinforcement, and concrete embedments shown, except the reinforcement and embedments must stop 12 inches from both longitudinal ends of the mock-up.

The mock-up must simulate the flow of concrete for the maximum distance anticipated during production or for a minimum of 10 feet if the anticipated flow travel is less than 10 feet.

Place the SCC in the mock-up in the Engineer's presence.

Take a test sample of at least 100 lb of concrete from within the forms at the discharge point and at the point farthest from the discharge point. Determine the coarse aggregate content of each test sample under California Test 529. The coarse aggregate content of the test samples must not differ from each other by more than 8 pounds of aggregate per cubic foot of concrete.

Saw-cut the mock-up full-depth in the transverse direction approximately 2 feet from the end of the pour. Voids or honeycombing in the SCC or between the concrete and embedded elements are not acceptable.

If the Engineer rejects the SCC placed in the mock-up, construct additional mock-ups until the SCC is accepted by the Engineer.

Dispose of the mock-up.

90-5.01D(2)(e) Field Quality Control

90-5.01D(2)(e)(i) General

Reserved

90-5.01D(2)(e)(ii) Fine Aggregate Moisture Content

Determine the fine aggregate moisture content for each batch of SCC.

90-5.01D(2)(e)(iii) Slump Flow and Visual Stability Index

At the start of SCC placement and whenever a set of concrete cylinders is prepared, determine the slump flow and the visual stability index under ASTM C1611.

90-5.01D(3) Department Acceptance

Reserved

90-5.02 MATERIALS

Section 90-1.02C(4) does not apply to SCC.

The minimum allowable slump flow is 20 inches. The slump flow must not vary by more than 3 inches from the mix design slump flow.

The visual stability index must not exceed 1.

90-5.03 CONSTRUCTION

Not Used

90-5.04 PAYMENT

Not Used

90-6 LIGHTWEIGHT CONCRETE

90-6.01 GENERAL

90-6.01A Summary

Section 90-6 includes specifications for furnishing lightweight concrete.

Lightweight concrete must be composed of cementitious material, lightweight coarse aggregate, fine aggregate, admixtures if used, and water.

Section 90-6 applies only where the use of lightweight concrete is specified in the special provisions.

90-6.01B Definitions

Reserved

90-6.01C Submittals

90-6.01C(1) General

Submit the prequalification data or reports and the proposed mix design at least 45 days before placing the lightweight concrete.

Submit certified copies of the manufacturer's test reports showing the estimated fresh concrete unit weight that results in the selected air-dry unit weight.

90-6.01C(2) Mix Design

Submit the mix design. Include the type, brand, weight, and absolute volume of each ingredient for each concrete type and strength.

Report the weight for each aggregate for a surface-dry condition, including moisture absorbed in the aggregate; for an oven-dry condition; or for the condition proposed for use.

Include with the mix design written verification that arrangements have been made for the Engineer to obtain test samples. The test samples of lightweight aggregates will not exceed 500 lb for each separate gradation.

90-6.01D Quality Assurance

90-6.01D(1) General

Reserved

90-6.01D(2) Quality Control

90-6.01D(2)(a) General

Reserved

90-6.01D(2)(b) Prequalification

Prequalify the lightweight concrete by submitting certified test data or trial batch test reports under section 90-1.01D(5)(b), except for PC concrete you must prequalify by submitting trial batch test reports. Dispose of the trial batches.

90-6.01D(2)(c) Unit Weight of Fresh Concrete

Determine the unit weight of fresh concrete under California Test 518.

90-6.01D(2)(d) Air-Dry Unit Weight

Determine the air-dry unit weight as follows:

1. Test three 6-inch-diameter by 12-inch-tall cylinders.
2. Prepare the cylinders under ASTM C192/C192M or ASTM C31/C31M, whichever is applicable.
3. Cure the cylinders for 6 days.
4. On the 6th day, remove the cylinders from the molds or curing media and immerse them in water at 73.4 ± 3 degrees F for 24 hours.
5. Determine the suspended-immersed weights of the cylinders.
6. Remove the cylinders from the water and determine the saturated surface-dry weights.
7. Dry the cylinders for 90 days at 73.4 ± 3 degrees F and a relative humidity of 50 ± 5 percent.
8. Weigh the dried cylinders.
9. Use the following equation to calculate the air-dry unit weight:

$$W = (A \times 62.3)/(B - C)$$

where:
W = air-dry unit weight, pcf
A = 90-day dried weight of the cylinder, lb
B = saturated surface-dry weight of the cylinder, lb
C = suspended-immersed weight of the cylinder, lb

90-6.01D(3) Department Acceptance

90-6.01D(3)(a) General

Reserved

90-6.01D(3)(b) Penetration

The Engineer performs penetration testing under California Test 533.

90-6.01D(3)(c) Air Content

The Engineer determines the concrete air content under ASTM C173/C173M.

90-6.01D(3)(d) Compressive Strength

The Engineer determines the compressive strength under section 90-1.01D(5).

90-6.02 MATERIALS

90-6.02A General

The unit weight of the fresh concrete used in the work must not vary from the weight shown in the test report by more than 4 pcf.

The air-dry unit weight of lightweight concrete furnished for each mix design must be a single weight from 109 to 115 pcf for prestressed concrete and from 104 to 110 pcf for nonprestressed concrete.

The total air content of freshly mixed concrete must not exceed 6 percent.

Lightweight concrete must have a 28-day compressive strength of at least that shown.

90-6.02B Aggregate

The fine aggregate must consist of lightweight fine aggregate, natural sand or manufactured sand fine aggregate, or a combination of these, as required to comply with the air-dry unit weight requirements.

Lightweight aggregates must comply with ASTM C330/C330M, except the splitting tensile strength and drying shrinkage requirements do not apply.

Lightweight aggregates must be rotary kiln expanded shale or clay having a surface sealed by firing. Do not crush the coarse aggregate after firing, except aggregate that is 3/4 inch and smaller may be crushed as necessary to produce the required coarse aggregate gradation. The final coarse aggregate size must not exceed 3/4 inch.

The shrinkage characteristics of lightweight aggregates must be such that the drying shrinkage of the lightweight concrete produced does not exceed 0.040 percent after 14 days of drying when tested under California Test 537.

Lightweight aggregates must have no more than 5 percent loss when tested for soundness under California Test 214.

90-6.02C Proportioning

At the time of batching, adjust the authorized aggregate weight to compensate for surface moisture and absorbed moisture.

After authorization of the mix design, do not alter the materials and batch proportions during the work, except as required to maintain the authorized cementitious material content and unit weight. The cementitious material content of individual batches must not vary from the authorized cementitious material content by more than from -15 to +25 pounds of cementitious material per cubic yard of concrete.

Batch the lightweight fine aggregate and natural sand by weight. Batch the lightweight coarse aggregate by weight or volumetric methods. If volumetric methods are used, the batching equipment must allow the Engineer to check the weight of each aggregate size in the batch.

Limit the absolute volume of coarse aggregate such that no concrete segregation occurs during mixing, transporting, placing, consolidating, or finishing. For site-cast concrete, the absolute volume of coarse aggregate must not exceed 10 cubic feet per cubic yard of concrete.

Uniformly pre-wet or pre-saturate the aggregates such that uniform penetration of the concrete is maintained. For lightweight concrete that is to be pumped, pre-saturate the aggregates using thermal, vacuum, or equivalent methods.

Lightweight concrete must have adequate workability such that proper placement, consolidation, and finishing are attained.

90-6.03 CONSTRUCTION

Not Used

90-6.04 PAYMENT

Not Used

90-7–90-8 RESERVED

90-9 RETURNED PLASTIC CONCRETE

90-9.01 GENERAL

90-9.01A Summary

Section 90-9 includes specifications for incorporating returned plastic concrete (RPC) into concrete.

RPC must be used only where the specifications allow its use. Do not use RPC in pavement or structural concrete.

90-9.01B Definitions

returned plastic concrete (RPC): Excess concrete that is returned to a concrete plant in a plastic state and that has not attained initial set.

hydration stabilizing admixture (HSA): Extended set retarding admixture that controls and predictably reduces the hydration rate of the cementitious material.

90-9.01C Submittals

Submit the following with the weighmaster certificate:

1. Weight or volume of RPC
2. Type, brand, and dosage of HSA
3. Time of adding HSA
4. Copy of the original weighmaster certificate for the RPC
5. Temperature of RPC

When requested, submit the HSA manufacturer's instructions, including dosage tables.

90-9.01D Quality Assurance

The material plant producing concrete containing RPC must be authorized under the MPQP.

For volumetric proportioning of RPC:

1. The volumetric container must be imprinted with manufacturer’s name, model number, serial number, the as-calibrated volume and date of the last calibration. Cross sectional dimensions of the container must remain the same as those during its calibration.
2. The device must be re-calibrated monthly and at any time when the container shape has been deformed from its original condition or there is evidence of material build-up on the inside of the device.
3. The device must be held in a level condition during filling. Fill the device to the measure or strike-off line. Each measurement must be filled to within 1.0% of the device as-calibrated volume.
4. The device interior must be cleaned after each measurement to maintain a zero condition.

For weight proportioning, proportion RPC with a weigh hopper attached to the plant at a position which allows the addition of the RPC to the mixer truck with the conventional PCC ingredients. The plant process controller must control the proportioning of RPC to within 1.0% of its target weight.

90-9.02 MATERIALS

90-9.02A General

The quantity of RPC added to the concrete must not exceed 15 percent.

The cementitious material content of the RPC must be at least that specified for the concrete that allows the use of RPC.

Water must not be added to the RPC after batching, including in the truck mixer.

Use HSA for controlling and reducing the hydration rate of RPC.

Incorporate RPC by mixing into the concrete before arriving at the jobsite.

90-9.02B Returned Plastic Concrete

The RPC must not exceed 100 degrees F at any time.

If HSA is not used, RPC must be incorporated into the concrete before attaining initial set or within 4 hours after batching of RPC, whichever is earlier.

If HSA is used:

1. Add HSA to RPC within 4 hours after original batching.
2. Measure and record the time, dosage of HSA, and temperature of RPC when HSA is added.
3. Mix the RPC under the HSA manufacturer's instructions after adding HSA or at least 30 revolutions, whichever is greater.
4. Incorporate RPC into the concrete within 4 hours after adding HSA.

RPC must not contain:

1. Accelerating admixture
2. Fiber
3. Pigment
4. Lightweight aggregate
5. Previously returned RPC
6. Any ingredient incompatible with the resultant concrete

90-9.02C Hydration Stabilizing Admixture

HSA must comply with ASTM C494 admixture Type B or Type D.

HSA must have a proven history of specifically maintaining and extending both plasticity and set.

HSA dosage must comply with the manufacturer's instructions.

90-9.02D Production

Proportion concrete containing RPC under section 90-2.02E.

Proportion RPC by weight or by volume.

90-9.03 CONSTRUCTION

Not Used

90-9.04 PAYMENT

Not Used

90-10–90-16 RESERVED

91 PAINT

91-1 GENERAL

91-1.01 GENERAL

91-1.01A Summary

Section 91-1 includes general specifications for furnishing paint used for highway construction.

91-1.01B Definitions

Reserved

91-1.01C Submittals

Reserved

91-1.01D Quality Assurance

The Department tests samples of paint taken from the source. Do not use paint until authorized.

91-1.02 MATERIALS

Paint containers must be:

1. New
2. Round
3. No more than 6 gallons in capacity
4. Standard full open head with bails
5. Nonreactive with contents
6. Equipped with compatible gaskets
7. Free of bungholes in the lids
8. Labeled with:
   - 8.1. State Specification number if described
   - 8.2. Manufacturer's name, product number, and batch number
   - 8.3. Date of manufacture
   - 8.4. Precautions required by 8 CA Code of Regs §§ 1501–1756 and §§ 3200–3206 concerning the handling and application of paint

Paint must:

1. Be manufactured ready for application. Do not add materials such as thinners after manufacture.
2. Be homogenous and free of contaminants.
3. Be smooth. Settled pigment must be soft and easily dispersed before using.
4. Retain the properties that affect its application, adhesion, and curing for at least 1 year after the date of manufacture.

91-1.03 CONSTRUCTION

Not Used

91-1.04 PAYMENT

Not Used

91-2 PAINT FOR METAL

91-2.01 GENERAL

Section 91-2 includes specifications for furnishing paint for metal.

91-2.02 MATERIALS

91-2.02A General

Zinc-rich primer must be on the Authorized Material List for inorganic and organic zinc-rich primers.

91-2.02B Exterior-Grade Latex Paint

Exterior-grade latex paint must be recommended by the manufacturer of the zinc-rich primer.

Exterior-grade latex paint must comply with SSPC-Paint 24. No visible color change in the finish coat must occur when tested for 800 hours under ASTM D4587, test cycle 2. The vehicle must be an acrylic or modified acrylic copolymer with a minimum of necessary additives.

91-2.02C Moisture-Cured Polyurethane Coating

Reserved

91-2.03 CONSTRUCTION

Not Used

91-2.04 PAYMENT

Not Used

91-3 PAINT FOR TIMBER

91-3.01 GENERAL

Section 91-3 includes specifications for furnishing paint for timber.

91-3.02 MATERIALS

91-3.02A General

Reserved

91-3.02B Latex-Base Wood Primer

Wood primer must be latex-base paint suitable for priming unpainted wood or exterior woodwork. Wood primer must comply with the MPI detailed performance standards for exterior wood primers and be listed on the MPI approved product list no. 6 for primer, latex for exterior wood.

91-3.02C Latex-Base Paint for Exterior Wood

Latex-base paint for exterior wood must comply with the MPI detailed performance standards for exterior latex paint and must be listed on one of the MPI approved products lists shown in the following table:

MPI list no.	Category name
10	Latex, exterior flat (MPI gloss level 1)
11	Latex, exterior semi-gloss (MPI gloss level 5)
119	Latex, exterior gloss (MPI gloss level 6)

You may use recycled paint. Recycled paint must comply with the MPI detailed performance standards for exterior latex paint and must be listed on one of the following MPI approved products lists:

MPI list no.	Category name
10RR	Latex, recycled (remanufactured), exterior flat (G1)
10RC	Latex, recycled (consolidated), exterior flat (G1)
15RR	Latex, recycled (remanufactured), exterior low sheen (G 3-4)

91-3.03 CONSTRUCTION

Not Used

91-3.04 PAYMENT

Not Used

91-4 MISCELLANEOUS PAINT

91-4.01 GENERAL

Section 91-4 includes specifications for furnishing paint for materials other than metal or timber.

91-4.02 MATERIALS

91-4.02A General

Reserved

91-4.02B Acrylic Emulsion Paint for Exterior Masonry

Acrylic emulsion paint for exterior masonry must comply with the MPI detailed performance standards for exterior latex paint and must be listed on one of the following MPI approved products lists:

MPI list no.	Category name
10	Latex, exterior flat (MPI gloss level 1)
11	Latex, exterior semi-gloss (MPI gloss level 5)
119	Latex, exterior gloss (MPI gloss level 6)

Acrylic emulsion paint may be tinted by using universal or all-purpose concentrates.

91-4.02C–91-4.02F Reserved

91-4.03 CONSTRUCTION

Not Used

91-4.04 PAYMENT

Not Used

92 ASPHALT BINDERS

92-1.01 GENERAL

92-1.01A Summary

Section 92 includes specifications for furnishing asphalt binders.

92-1.01B Definitions

asphalt binder: Asphalt from refined petroleum or from a mixture of refined liquid asphalt and refined solid asphalt prepared from crude petroleum.

modified asphalt binder: Asphalt binder modified with polymers, crumb rubber, or both.

92-1.01C Submittals

Reserved

92-1.01D Quality Assurance

92-1.01D(1) General

Reserved

92-1.01D(2) Certification

Asphalt binder suppliers must comply with the Department's Certification Program for Suppliers of Asphalt. For a copy of the certification program, go to the METS website.

92-1.01D(3) Sampling

A sampling device must be located in the asphalt binder feed line connecting the plant storage tanks to the asphalt binder weighing system or spray bar. The sampling device must be accessible from 24 to 30 inches above the platform. Provide a receptacle for flushing the sampling device.

The valve for the sampling device must be 1/2 to 3/4 inch in diameter and must allow a 1-quart sample to be taken slowly at any time during plant activities.

In the Engineer's presence, take two 1-quart samples per day during plant activities for the project. Sample containers must be 1-quart capacity and include round friction-top lids.

92-1.02 MATERIALS

92-1.02A General

Asphalt binder must not include residues caused by artificial distillation of coal, coal tar, or paraffin. Asphalt binder must be homogeneous and free of water.

92-1.02B Performance Grade Asphalt Binders

PG asphalt binder must comply with the requirements shown in the following table:

PG Asphalt Binders

Quality characteristic	Test method	Requirement				
		PG 58-22[a]	PG 64-10	PG 64-16	PG 64-28	PG 70-10
Original Binder						
Flash point (min, °C)	AASHTO T 48	230	230	230	230	230
Solubility[b] (min, %)	AASHTO T 44	99	99	99	99	99
Viscosity at 135 °C[c] (max, Pa•s)	AASHTO T 316	3.0	3.0	3.0	3.0	3.0
Dynamic shear Test temperature at 10 rad/s (°C) G*/sin(delta) (min, kPa) G*/sin(delta) (max, kPa)	AASHTO T 315	 58 1.00 2.00	 64 1.00 2.00	 64 1.00 2.00	 64 1.00 2.00	 70 1.00 2.00
RTFO[f] test[e] mass loss (max, %)	AASHTO T 240	1.00	1.00	1.00	1.00	1.00
RTFO[f] Test Aged Binder						
Dynamic shear Test temperature at 10 rad/s (°C) G*/sin(delta) (min, kPa)	AASHTO T 315	 58 2.20	 64 2.20	 64 2.20	 64 2.20	 70 2.20
Ductility at 25 °C (min, cm)	AASHTO T 51	75	75	75	75	75
PAV[g] Test temperature (°C)	AASHTO R 28	100	100	100	100	110
RTFO[f] Test and PAV[g] Aged Binder						
Dynamic shear, Test temperature at 10 rad/s (°C) G*sin(delta) (max, kPa)	AASHTO T 315	 22[d] 5000	 31[d] 5000	 28[d] 5000	 22[d] 5000	 34[d] 5000
Creep stiffness, Test temperature, °C S-value (max, MPa) M-value (min)	AASHTO T 313	 -12 300 0.300	 0 300 0.300	 -6 300 0.300	 -18 300 0.300	 0 300 0.300

[a]Use as asphalt rubber base stock for high mountain and high desert area.
[b]The Engineer waives solubility requirements if the supplier is an authorized material source as defined by the Department's *Certification Program for Suppliers of Asphalt*.
[c]The Engineer waives this specification if the supplier provides written certification the asphalt binder can be adequately pumped and mixed at temperatures meeting applicable safety standards.
[d]Test the sample at 3 °C higher if it fails at the specified test temperature. G*sin(delta) remains 5000 kPa maximum.
[e]The residue from mass change determination may be used for other tests.
[f]RTFO means rolling thin film oven.
[g]PAV means Pressure Aging Vessel.

PG modified asphalt binder must comply with the requirements shown in the following table:

PG Modified Asphalt Binders

Quality characteristic	Test method	Requirement		
		PG 58-34 M	PG 64-28 M	PG 76-22 M
Original Binder				
Flash point (min, °C)	AASHTO T 48	230	230	230
Solubility (min, %)	AASHTO T 44[a]	97.5	97.5	97.5[b]
Viscosity at 135 °C[c] (max, Pa•s)	AASHTO T 316	3.0	3.0	3.0
Dynamic shear, Test temperature at 10 rad/s (°C) G*/sin(delta) (min, kPa)	AASHTO T 315	58 1.00	64 1.00	76 1.00
RTFO[g] test[d], Mass loss (max, %)	AASHTO T 240	1.00	1.00	1.00
RTFO[g] Test Aged Binder				
Dynamic shear, Test temperature at 10 rad/s (°C) G*/sin(delta) (min, kPa)	AASHTO T 315	58 2.20	64 2.20	76 2.20
Dynamic shear, Test temperature at 10 rad/s, °C Delta (max, degree)	AASHTO T 315	80[e]	80[e]	80[e]
Elastic recovery[f], Test temperature (°C) Recovery (min, %)	AASHTO T 301	25 75	25 75	25 65
PAV[h], Temperature (°C)	AASHTO R 28	100	100	110
RTFO[g] Test and PAV[h] Aged Binder				
Dynamic shear, Test temperature at 10 rad/s (°C) G*sin(delta) (max, kPa)	AASHTO T 315	16 5000	22 5000	31 5000
Creep stiffness, Test temperature (°C) S-value (max, Mpa) M-value (min)	AASHTO T 313	-24 300 0.300	-18 300 0.300	-12 300 0.300

[a]The Department allows ASTM D5546 or ASTM D7553 instead of AASHTO T 44. Particles recovered from ASTM D5546 or ASTM D7553 or AASHTO T 44 must be less than 250 µm.
[b]Report only for spray application.
[c]The Engineer waives the viscosity requirements if the supplier provides written certification the asphalt binder can be adequately pumped and mixed at temperatures meeting applicable safety standards.
[d]The residue from mass change determination may be used for other tests.
[e]Test temperature is the temperature at which G*/sin(delta) is 2.2 kPa. A graph of log G*/sin(delta) plotted against temperature may be used to determine the test temperature when G*/sin(delta) is 2.2 kPa. A graph of (delta) versus temperature may be used to determine delta at the temperature when G*/sin(delta) is 2.2 kPa. The graph must have at least 2 points that envelope G*/sin(delta) of 2.2 kPa, and the test temperature must not be more than 6 degree C apart. The Engineer also accepts direct measurement of delta at the temperature when G*/sin(delta) is 2.2 kPa.
[f]Tests without a force ductility clamp may be performed.
[g]RTFO means rolling thin film oven.
[h]PAV means Pressure Aging Vessel.

Do not modify PG modified asphalt binder using polyphosphoric acid.

Crumb rubber modifier used must be on the Authorized Materials List for crumb rubber modifier.

Production equipment for PG modified asphalt binder with crumb rubber modifier must be authorized under the Department's *MPQP*.

Crumb rubber must be derived from waste tires described in Pub Res Code § 42703 and must be free from contaminants including fabric, metal, minerals, and other nonrubber substances.

PG modified asphalt binder modified with crumb rubber must be homogeneous and must not contain visible particles of crumb rubber.

The supplier of PG modified asphalt binder modified with crumb rubber must:

1. Report the quantity of crumb rubber by weight of asphalt binder
2. Certify a minimum of 10 percent of crumb rubber by weight of asphalt binder

92-1.03 CONSTRUCTION

Not Used

92-1.04 PAYMENT

If asphalt binder is paid for as a bid item, the payment quantity for any type of asphalt binder is measured by weight.

If a partial load of asphalt binder is used and a scale is not available within 20 miles, the weight of asphalt binder remaining on the transporting vehicle may be determined from volumetric measurements provided that the asphalt binder is delivered in a calibrated tank with a measuring stick and calibration card or trucks equipped with a vehicle tank meter and a calibrated thermometer that determines the asphalt binder temperature at delivery.

Before converting the volume to weight, the volume measured must be reduced to what the asphalt binder would occupy at 60 degrees F. Use the following conversion table to convert asphalt binder volume to weight:

Conversion Table

t	A	B	t	A	B	t	A	B
-13	1.0257	1.0294	22	1.0133	1.0152	57	1.0010	1.0012
-12	1.0253	1.0290	23	1.0129	1.0148	58	1.0007	1.0008
-11	1.0250	1.0286	24	1.0126	1.0144	59	1.0003	1.0004
-10	1.0246	1.0282	25	1.0122	1.0140	60	1.0000	1.0000
-9	1.0243	1.0277	26	1.0119	1.0136	61	0.9996	0.9996
-8	1.0239	1.0273	27	1.0115	1.0132	62	0.9993	0.9992
-7	1.0236	1.0269	28	1.0112	1.0128	63	0.9989	0.9988
-6	1.0232	1.0265	29	1.0108	1.0124	64	0.9986	0.9984
-5	1.0228	1.0261	30	1.0105	1.0120	65	0.9982	0.9980
-4	1.0225	1.0257	31	1.0101	1.0116	66	0.9979	0.9976
-3	1.0221	1.0253	32	1.0098	1.0112	67	0.9975	0.9972
-2	1.0218	1.0249	33	1.0094	1.0108	68	0.9972	0.9968
-1	1.0214	1.0245	34	1.0091	1.0104	69	0.9968	0.9964
0	1.0211	1.0241	35	1.0087	1.0100	70	0.9965	0.9960
1	1.0207	1.0237	36	1.0084	1.0096	71	0.9961	0.9956
2	1.0204	1.0233	37	1.0080	1.0091	72	0.9958	0.9952
3	1.0200	1.0229	38	1.0077	1.0087	73	0.9954	0.9948
4	1.0197	1.0225	39	1.0073	1.0083	74	0.9951	0.9944
5	1.0193	1.0221	40	1.0070	1.0079	75	0.9947	0.9940
6	1.0189	1.0217	41	1.0066	1.0075	76	0.9944	0.9936
7	1.0186	1.0212	42	1.0063	1.0071	77	0.9940	0.9932
8	1.0182	1.0208	43	1.0059	1.0067	78	0.9937	0.9928
9	1.0179	1.0204	44	1.0056	1.0063	79	0.9933	0.9924
10	1.0175	1.0200	45	1.0052	1.0059	80	0.9930	0.9920
11	1.0172	1.0196	46	1.0049	1.0055	81	0.9926	0.9916
12	1.0168	1.0192	47	1.0045	1.0051	82	0.9923	0.9912
13	1.0165	1.0188	48	1.0042	1.0047	83	0.9919	0.9908
14	1.0161	1.0184	49	1.0038	1.0043	84	0.9916	0.9904
15	1.0158	1.0180	50	1.0035	1.0039	85	0.9913	0.9900
16	1.0154	1.0176	51	1.0031	1.0035	86	0.9909	0.9897
17	1.0151	1.0172	52	1.0028	1.0031	87	0.9906	0.9893
18	1.0147	1.0168	53	1.0024	1.0027	88	0.9902	0.9889
19	1.0144	1.0164	54	1.0021	1.0023	89	0.9899	0.9885
20	1.0140	1.0160	55	1.0017	1.0019	90	0.9895	0.9881
21	1.0136	1.0156	56	1.0014	1.0016	91	0.9892	0.9877

Notes:

t = observed temperature in degrees F

A = multiplier for reducing volumes to the basis of 60 °F, for asphalt binder with density at 60 °F of 60.3 pcf or higher

B = multiplier for reducing volumes to the basis of 60 °F, for asphalt binder with density at 60 °F of from 53.1 to 60.2 pcf

Conversion Table—Continued

t	A	B	t	A	B	t	A	B
92	0.9888	0.9873	127	0.9768	0.9736	162	0.9648	0.9601
93	0.9885	0.9869	128	0.9764	0.9732	163	0.9645	0.9597
94	0.9881	0.9865	129	0.9761	0.9728	164	0.9641	0.9593
95	0.9878	0.9861	130	0.9757	0.9724	165	0.9638	0.9589
96	0.9874	0.9857	131	0.9754	0.9720	166	0.9634	0.9585
97	0.9871	0.9853	132	0.9750	0.9716	167	0.9631	0.9581
98	0.9867	0.9849	133	0.9747	0.9713	168	0.9628	0.9578
99	0.9864	0.9845	134	0.9744	0.9709	169	0.9624	0.9574
100	0.9861	0.9841	135	0.9740	0.9705	170	0.9621	0.9570
101	0.9857	0.9837	136	0.9737	0.9701	171	0.9617	0.9566
102	0.9854	0.9834	137	0.9733	0.9697	172	0.9614	0.9562
103	0.9850	0.9830	138	0.9730	0.9693	173	0.9611	0.9558
104	0.9847	0.9826	139	0.9726	0.9689	174	0.9607	0.9555
105	0.9843	0.9822	140	0.9723	0.9685	175	0.9604	0.9551
106	0.9840	0.9818	141	0.9720	0.9682	176	0.9600	0.9547
107	0.9836	0.9814	142	0.9716	0.9678	177	0.9597	0.9543
108	0.9833	0.9810	143	0.9713	0.9674	178	0.9594	0.9539
109	0.9830	0.9806	144	0.9709	0.9670	179	0.9590	0.9535
110	0.9826	0.9802	145	0.9706	0.9666	180	0.9587	0.9532
111	0.9823	0.9798	146	0.9703	0.9662	181	0.9583	0.9528
112	0.9819	0.9794	147	0.9699	0.9658	182	0.9580	0.9524
113	0.9816	0.9790	148	0.9696	0.9654	183	0.9577	0.9520
114	0.9812	0.9787	149	0.9692	0.9651	184	0.9573	0.9516
115	0.9809	0.9783	150	0.9689	0.9647	185	0.9570	0.9513
116	0.9805	0.9779	151	0.9685	0.9643	186	0.9567	0.9509
117	0.9802	0.9775	152	0.9682	0.9639	187	0.9563	0.9505
118	0.9799	0.9771	153	0.9679	0.9635	188	0.9560	0.9501
119	0.9795	0.9767	154	0.9675	0.9631	189	0.9556	0.9497
120	0.9792	0.9763	155	0.9672	0.9627	190	0.9553	0.9493
121	0.9788	0.9759	156	0.9668	0.9624	191	0.9550	0.9490
122	0.9785	0.9755	157	0.9665	0.9620	192	0.9546	0.9486
123	0.9781	0.9751	158	0.9662	0.9616	193	0.9543	0.9482
124	0.9778	0.9748	159	0.9658	0.9612	194	0.9540	0.9478
125	0.9774	0.9744	160	0.9655	0.9608	195	0.9536	0.9474
126	0.9771	0.9740	161	0.9651	0.9604	196	0.9533	0.9471

Notes:
t = observed temperature in degrees F
A = multiplier for reducing volumes to the basis of 60 °F, for asphalt binder with density at 60 °F of 60.3 pcf or higher
B = multiplier for reducing volumes to the basis of 60 °F, for asphalt binder with density at 60 °F of from 53.1 to 60.2 pcf

Conversion Table—Continued

t	A	B	t	A	B	t	A	B
197	0.9529	0.9467	232	0.9412	0.9335	267	0.9296	0.9204
198	0.9526	0.9463	233	0.9409	0.9331	268	0.9292	0.9201
199	0.9523	0.9459	234	0.9405	0.9327	269	0.9289	0.9197
200	0.9519	0.9455	235	0.9402	0.9324	270	0.9286	0.9193
201	0.9516	0.9452	236	0.9399	0.9320	271	0.9282	0.9190
202	0.9513	0.9448	237	0.9395	0.9316	272	0.9279	0.9186
203	0.9509	0.9444	238	0.9392	0.9312	273	0.9276	0.9182
204	0.9506	0.9440	239	0.9389	0.9309	274	0.9273	0.9179
205	0.9503	0.9437	240	0.9385	0.9305	275	0.9269	0.9175
206	0.9499	0.9433	241	0.9382	0.9301	276	0.9266	0.9171
207	0.9496	0.9429	242	0.9379	0.9297	277	0.9263	0.9168
208	0.9492	0.9425	243	0.9375	0.9294	278	0.9259	0.9164
209	0.9489	0.9421	244	0.9372	0.9290	279	0.9256	0.9160
210	0.9486	0.9418	245	0.9369	0.9286	280	0.9253	0.9156
211	0.9482	0.9414	246	0.9365	0.9283	281	0.9249	0.9153
212	0.9479	0.9410	247	0.9362	0.9279	282	0.9246	0.9149
213	0.9476	0.9406	248	0.9359	0.9275	283	0.9243	0.9145
214	0.9472	0.9403	249	0.9355	0.9271	284	0.9240	0.9142
215	0.9469	0.9399	250	0.9352	0.9268	285	0.9236	0.9138
216	0.9466	0.9395	251	0.9349	0.9264	286	0.9233	0.9134
217	0.9462	0.9391	252	0.9345	0.9260	287	0.9230	0.9131
218	0.9459	0.9387	253	0.9342	0.9256	288	0.9226	0.9127
219	0.9456	0.9384	254	0.9339	0.9253	289	0.9223	0.9123
220	0.9452	0.9380	255	0.9335	0.9249	290	0.9220	0.9120
221	0.9449	0.9376	256	0.9332	0.9245	291	0.9217	0.9116
222	0.9445	0.9372	257	0.9329	0.9242	292	0.9213	0.9112
223	0.9442	0.9369	258	0.9325	0.9238	293	0.9210	0.9109
224	0.9439	0.9365	259	0.9322	0.9234	294	0.9207	0.9105
225	0.9435	0.9361	260	0.9319	0.9230	295	0.9203	0.9101
226	0.9432	0.9357	261	0.9316	0.9227	296	0.9200	0.9098
227	0.9429	0.9354	262	0.9312	0.9223	297	0.9197	0.9094
228	0.9425	0.9350	263	0.9309	0.9219	298	0.9194	0.9090
229	0.9422	0.9346	264	0.9306	0.9216	299	0.9190	0.9087
230	0.9419	0.9342	265	0.9302	0.9212	300	0.9187	0.9083
231	0.9415	0.9339	266	0.9299	0.9208	301	0.9184	0.9079

Notes:
t = observed temperature in degrees F
A = multiplier for reducing volumes to the basis of 60 °F, for asphalt binder with density at 60 °F of 60.3 pcf or higher
B = multiplier for reducing volumes to the basis of 60 °F, for asphalt binder with density at 60 °F of from 53.1 to 60.2 pcf

Conversion Table—Continued

t	A	B	t	A	B	t	A	B
302	0.9180	0.9076	337	0.9066	0.8949	372	0.8953	0.8823
303	0.9177	0.9072	338	0.9063	0.8945	373	0.8950	0.8820
304	0.9174	0.9068	339	0.9060	0.8942	374	0.8947	0.8816
305	0.9171	0.9065	340	0.9057	0.8938	375	0.8944	0.8813
306	0.9167	0.9061	341	0.9053	0.8934	376	0.8940	0.8809
307	0.9164	0.9058	342	0.9050	0.8931	377	0.8937	0.8806
308	0.9161	0.9054	343	0.9047	0.8927	378	0.8934	0.8802
309	0.9158	0.9050	344	0.9044	0.8924	379	0.8931	0.8798
310	0.9154	0.9047	345	0.9040	0.8920	380	0.8928	0.8795
311	0.9151	0.9043	346	0.9037	0.8916	381	0.8924	0.8791
312	0.9148	0.9039	347	0.9034	0.8913	382	0.8921	0.8788
313	0.9144	0.9036	348	0.9031	0.8909	383	0.8918	0.8784
314	0.9141	0.9032	349	0.9027	0.8906	384	0.8915	0.8781
315	0.9138	0.9028	350	0.9024	0.8902	385	0.8911	0.8777
316	0.9135	0.9025	351	0.9021	0.8898	386	0.8908	0.8774
317	0.9131	0.9021	352	0.9018	0.8895	387	0.8905	0.8770
318	0.9128	0.9018	353	0.9014	0.8891	388	0.8902	0.8767
319	0.9125	0.9014	354	0.9011	0.8888	389	0.8899	0.8763
320	0.9122	0.9010	355	0.9008	0.8884	390	0.8895	0.8760
321	0.9118	0.9007	356	0.9005	0.8880	391	0.8892	0.8756
322	0.9115	0.9003	357	0.9002	0.8877	392	0.8889	0.8752
323	0.9112	0.8999	358	0.8998	0.8873	393	0.8886	0.8749
324	0.9109	0.8996	359	0.8995	0.8870	394	0.8883	0.8745
325	0.9105	0.8992	360	0.8992	0.8866	395	0.8880	0.8742
326	0.9102	0.8988	361	0.8989	0.8863	396	0.8876	0.8738
327	0.9099	0.8985	362	0.8985	0.8859	397	0.8873	0.8735
328	0.9096	0.8981	363	0.8982	0.8855	398	0.8870	0.8731
329	0.9092	0.8978	364	0.8979	0.8852	399	0.8867	0.8728
330	0.9089	0.8974	365	0.8976	0.8848	400	0.8864	0.8724
331	0.9086	0.8970	366	0.8973	0.8845	401	0.8860	0.8721
332	0.9083	0.8967	367	0.8969	0.8841	402	0.8857	0.8717
333	0.9079	0.8963	368	0.8966	0.8838	403	0.8854	0.8714
334	0.9076	0.8960	369	0.8963	0.8834	404	0.8851	0.8710
335	0.9073	0.8956	370	0.8960	0.8830	405	0.8848	0.8707
336	0.9070	0.8952	371	0.8956	0.8827	406	0.8844	0.8703

Notes:
t = observed temperature in degrees F
A = multiplier for reducing volumes to the basis of 60 °F, for asphalt binder with density at 60 °F of 60.3 pcf or higher
B = multiplier for reducing volumes to the basis of 60 °F, for asphalt binder with density at 60 °F of from 53.1 to 60.2 pcf

Conversion Table—Continued

t	A	B	t	A	B	t	A	B
407	0.8841	0.8700	442	0.8730	0.8578	477	0.8621	0.8457
408	0.8838	0.8696	443	0.8727	0.8574	478	0.8617	0.8454
409	0.8835	0.8693	444	0.8724	0.8571	479	0.8614	0.8450
410	0.8832	0.8689	445	0.8721	0.8567	480	0.8611	0.8447
411	0.8829	0.8686	446	0.8718	0.8564	481	0.8608	0.8443
412	0.8825	0.8682	447	0.8715	0.8560	482	0.8605	0.8440
413	0.8822	0.8679	448	0.8711	0.8557	483	0.8602	0.8437
414	0.8819	0.8675	449	0.8708	0.8553	484	0.8599	0.8433
415	0.8816	0.8672	450	0.8705	0.8550	485	0.8596	0.8430
416	0.8813	0.8668	451	0.8702	0.8546	486	0.8593	0.8426
417	0.8809	0.8665	452	0.8699	0.8543	487	0.8589	0.8322
418	0.8806	0.8661	453	0.8696	0.8540	488	0.8586	0.8318
419	0.8803	0.8658	454	0.8693	0.8536	489	0.8583	0.8315
420	0.8800	0.8654	455	0.8689	0.8533	490	0.8580	0.8311
421	0.8797	0.8651	456	0.8686	0.8529	491	0.8577	0.8308
422	0.8794	0.8647	457	0.8683	0.8526	492	0.8574	0.8406
423	0.8790	0.8644	458	0.8680	0.8522	493	0.8571	0.8403
424	0.8787	0.8640	459	0.8677	0.8519	494	0.8568	0.8399
425	0.8784	0.8637	460	0.8674	0.8515	495	0.8565	0.8396
426	0.8781	0.8633	461	0.8671	0.8512	496	0.8561	0.8392
427	0.8778	0.8630	462	0.8667	0.8509	497	0.8558	0.8389
428	0.8775	0.8626	463	0.8664	0.8505	498	0.8555	0.8386
429	0.8771	0.8623	464	0.8661	0.8502	499	0.8552	0.8382
430	0.8768	0.8619	465	0.8658	0.8498	500	0.8549	0.8379
431	0.8765	0.8616	466	0.8655	0.8495	501	0.8546	0.8376
432	0.8762	0.8612	467	0.8652	0.8491	502	0.8543	0.8372
433	0.8759	0.8609	468	0.8649	0.8488	503	0.8540	0.8369
434	0.8756	0.8605	469	0.8646	0.8485	504	0.8537	0.8365
435	0.8752	0.8602	470	0.8642	0.8481	505	0.8534	0.8362
436	0.8749	0.8598	471	0.8639	0.8478	506	0.8530	0.8359
437	0.8746	0.8595	472	0.8636	0.8474	507	0.8527	0.8355
438	0.8743	0.8591	473	0.8633	0.8471	508	0.8524	0.8352
439	0.8740	0.8588	474	0.8630	0.8467	509	0.8521	0.8348
440	0.8737	0.8584	475	0.8627	0.8464	510	0.8518	0.8345
441	0.8734	0.8581	476	0.8624	0.8461	511	0.8515	0.8342

Notes:
t = observed temperature in degrees F
A = multiplier for reducing volumes to the basis of 60 °F, for asphalt binder with density at 60 °F of 60.3 pcf or higher
B = multiplier for reducing volumes to the basis of 60 °F, for asphalt binder with density at 60 °F of from 53.1 to 60.2 pcf

Conversion Table—Continued

t	A	B	t	A	B	t	A	B
512	0.8512	0.8338	537	0.8435	0.8255	562	0.8358	0.8172
513	0.8509	0.8335	538	0.8432	0.8251	563	0.8355	0.8168
514	0.8506	0.8332	539	0.8429	0.8248	564	0.8352	0.8165
515	0.8503	0.8328	540	0.8426	0.8245	565	0.8349	0.8162
516	0.8500	0.8325	541	0.8423	0.8241	566	0.8346	0.8158
517	0.8496	0.8322	542	0.8420	0.8238	567	0.8343	0.8155
518	0.8493	0.8318	543	0.8417	0.8235	568	0.8340	0.8152
519	0.8490	0.8315	544	0.8413	0.8231	569	0.8337	0.8149
520	0.8487	0.8311	545	0.8410	0.8228	570	0.8334	0.8145
521	0.8484	0.8308	546	0.8407	0.8225	571	0.8331	0.8142
522	0.8481	0.8305	547	0.8404	0.8221	572	0.8328	0.8139
523	0.8478	0.8301	548	0.8401	0.8218	573	0.8325	0.8135
524	0.8475	0.8298	549	0.8398	0.8215	574	0.8322	0.8132
525	0.8472	0.8295	550	0.8395	0.8211	575	0.8319	0.8129
526	0.8469	0.8291	551	0.8392	0.8208	576	0.8316	0.8126
527	0.8466	0.8288	552	0.8389	0.8205	577	0.8313	0.8122
528	0.8463	0.8285	553	0.8386	0.8201	578	0.8310	0.8119
529	0.8459	0.8281	554	0.8383	0.8198	579	0.8307	0.8116
530	0.8456	0.8278	555	0.8380	0.8195	580	0.8304	0.8112
531	0.8453	0.8275	556	0.8377	0.8191	581	0.8301	0.8109
532	0.8450	0.8271	557	0.8374	0.8188	582	0.8298	0.8106
533	0.8447	0.8268	558	0.8371	0.8185	583	0.8295	0.8103
534	0.8444	0.8265	559	0.8368	0.8182	584	0.8292	0.8099
535	0.8441	0.8261	560	0.8365	0.8178	585	0.8289	0.8096
536	0.8438	0.8258	561	0.8362	0.8175	586	0.8286	0.8093

Notes:
t = observed temperature in degrees
A = multiplier for reducing volumes to the basis of 60 °F, for asphalt binder with density at 60 °F of 60.3 pcf or higher
B = multiplier for reducing volumes to the basis of 60 °F, for asphalt binder with density at 60 °F of from 53.1 to 60.2 pcf

93 RESERVED

94 ASPHALTIC EMULSIONS

94-1.01 GENERAL

94-1.01A Summary

Section 94 includes specifications for furnishing asphaltic emulsions.

94-1.01B Definitions

Reserved

94-1.01C Submittals

Submit an SDS for each shipment of asphaltic emulsion to the job site.

If you use the asphaltic emulsion before the Department's sampling and testing is complete, submit a certificate of compliance for each shipment to the job site. The certificate of compliance must include:

1. Shipment number and shipment date
2. Source refinery, consignee, and destination
3. Type and description of material with specific gravity and quantity
4. Contract or purchase order number
5. Signature by the manufacturer of the material and a statement that the material complies with the Contract
6. Test results showing the material complies with section 94-1.02

If no certificate of compliance is submitted, do not use asphaltic emulsion until authorized.

94-1.01D Quality Assurance

Sample asphaltic emulsion under AASHTO T 40.

Store samples in clean and airtight sealed containers. Storage temperature must be at least 40 degrees F until tested.

The Engineer may waive the settlement test if the asphaltic emulsion is used in less than 5 days from the time the sample is taken.

94-1.02 MATERIALS

94-1.02A General

Asphaltic emulsions must be composed of a bituminous material uniformly emulsified with water and an emulsifying or a stabilizing agent. Polymer modified asphaltic emulsion must contain a polymer.

Asphaltic emulsion must be homogeneous. Within 30 days after delivery and if freezing has not caused separation, the asphaltic emulsion must be homogeneous after thorough mixing.

Asphaltic emulsion must be anionic, cationic, polymer modified, or quick setting.

94-1.02B Anionic Asphaltic Emulsions

Anionic asphaltic emulsion must be rapid setting, medium setting, or slow setting.

Rapid-setting anionic asphaltic emulsion must comply with the requirements shown in the following table:

Rapid-Setting Anionic Asphaltic Emulsion Requirements

Quality characteristic	Test method	Requirement	
		Grade RS1	Grade RS2
Saybolt Furol viscosity, @ 25 °C (Saybolt Furol seconds)	AASHTO T 59	20–100	--
Saybolt Furol viscosity, @ 50 °C (Saybolt Furol seconds)		--	75–400
Settlement, 5 days (max, %)		5	5
Storage stability test, 1 day (max, %)[a]		1	1
Demulsibility, 35 ml, 0.02 *N* $CaCl_2$ (min, %)[b]		60	60
Sieve test (max, %)		0.10	0.10
Residue by distillation (min, %)		55	63
Tests on residue from distillation test:			
Penetration, 25 °C		100[c]–200	100[c]–200
Ductility, 25 °C, 50 mm/minute (min, mm)		400	400
Solubility in trichloroethylene (min, %)		97.5	97.5

[a]The 24-hour storage stability test may be used instead of the 5-day settlement test.
[b]The demulsibility test must be made within 30 days from date of shipment.
[c]A harder base asphalt meeting current asphalt binder specifications may be specified if the test requirements on the residue from distillation are waived.

Medium-setting anionic asphaltic emulsion must comply with the requirements shown in the following table:

Medium-Setting Anionic Asphaltic Emulsion Requirements

Quality characteristic	Test method	Requirement		
		Grade MS1	Grade MS2	Grade MS2h
Saybolt Furol viscosity, @ 25 °C (Saybolt Furol seconds)	AASHTO T 59	20–100	100 min	100 min
Settlement, 5 days (max, %)		5	5	5
Storage stability test, 1 day (max, %)[a]		1	1	1
Coating ability and water resistance:				
Coating, dry aggregate		good	good	good
Coating, after spraying		fair	fair	fair
Coating, wet aggregate		fair	fair	fair
Coating, after spraying		fair	fair	fair
Sieve test (max, %)		0.10	0.10	0.10
Residue by distillation (min, %)		55	65	65
Tests on residue from distillation test:				
Penetration, 25 °C		100–200	100–200	40–90
Ductility, 25 °C, 50 mm/minute (min, mm)		400	400	400
Solubility in trichloroethylene (min, %)		97.5	97.5	97.5

[a]The 24-hour storage stability test may be used instead of the 5-day settlement test.

Slow-setting anionic asphaltic emulsion must comply with the requirements shown in the following table:

Slow-Setting Anionic Asphaltic Emulsion Requirements

Quality characteristic	Test method	Requirement	
		Grade SS1	Grade SS1h
Saybolt Furol viscosity, @ 25 °C (Saybolt Furol seconds)	AASHTO T 59	20–100	20–100
Settlement, 5 days (max, %)		5	5
Storage stability test, 1 day (max, %)[a]		1	1
Cement mixing test (max, %)		2.0	2.0
Sieve test (max, %)		0.10	0.10
Residue by distillation (min, %)		57	57
Tests on residue from distillation test:			
Penetration, 25 °C		100–200	40–90
Ductility, 25 °C, 50 mm/minute (min, mm)		400	400
Solubility in trichloroethylene (min, %)		97.5	97.5

[a]The 24-hour storage stability test may be used instead of the 5-day settlement test.

94-1.02C Cationic Asphaltic Emulsions

Cationic asphaltic emulsion must be rapid, medium, or slow setting.

Rapid-setting cationic asphaltic emulsion must comply with the requirements shown in the following table:

Rapid-Setting Cationic Asphaltic Emulsion Requirements

Quality characteristic	Test method	Requirement	
		Grade CRS1	Grade CRS2
Saybolt Furol viscosity, @ 50 °C (Saybolt Furol seconds)	AASHTO T 59	20–100	100–400
Settlement, 5 days (max, %)		5	5
Storage stability test, 1 day (max, %)[a]		1	1
Demulsibility, 35 ml, 0.8 % sodium dioctyl sulfosuccinate (min, %)[b]		40	40
Particle charge test		positive	positive
Sieve test (max, %)		0.10	0.10
Distillation:			
Oil distillate by volume of emulsion (max, %)		3	3
Residue (min, %)		60	65
Tests on residue		97.5	97.5
Tests on residue from distillation test:			
Penetration, 25 °C		100[c]–250	100[c]–250
Ductility, 25 °C, 50 mm/minute (min, mm)		400	400
Solubility in trichloroethylene (min, %)		97.5	97.5

[a]The 24-hour storage stability test may be used instead of the 5-day settlement test.
[b]The demulsibility test must be made within 30 days from date of shipment.
[c]A harder base asphalt meeting current asphalt binder specifications may be specified if the test requirements on the residue from distillation are waived.

Medium-setting cationic asphaltic emulsion must comply with the requirements shown in the following table:

Medium-Setting Cationic Asphaltic Emulsion Requirements

Quality characteristic	Test method	Requirement		
		Grade CMS2S	Grade CMS2	Grade CMS2h
Saybolt Furol viscosity, @ 50 °C (Saybolt Furol seconds)	AASHTO T 59	50–450	50–450	50–450
Settlement, 5 days (max, %)		5	5	5
Storage stability test, 1 day (max, %)[a]		1	1	1
Coating ability and water resistance:				
Coating, dry aggregate		good	good	good
Coating, after spraying		fair	fair	fair
Coating, wet aggregate		fair	fair	fair
Coating, after spraying		fair	fair	fair
Particle charge test		positive	positive	positive
Sieve test (max, %)		0.10	0.10	0.10
Distillation:				
Oil distillate by volume of emulsion (max, %)		20	12	12
Residue (min, %)		60	65	65
Tests on residue from distillation test:				
Penetration, 25 °C		100–250	100–250	40–90
Ductility, 25 °C, 50 mm/minute (min, mm)		400	400	400
Solubility in trichloroethylene (min, %)		97.5	97.5	97.5

[a]The 24-hour storage stability test may be used instead of the 5-day settlement test.

Slow-setting cationic asphaltic emulsion must comply with the requirements shown in the following table:

Slow-Setting Cationic Asphaltic Emulsion Requirements

Quality characteristic	Test method	Requirement	
		Grade CSS1	Grade CSS1h
Saybolt Furol viscosity, @ 25 °C (Saybolt Furol seconds)	AASHTO T 59	20–100	20–100
Settlement, 5 days (max, %)		5	5
Storage stability test, 1 day (max, %)[a]		1	1
Particle charge test		Positive[b]	Positive[b]
Sieve test (max, %)		0.10	0.10
Cement mixing test (max, %)		2.0	2.0
Residue by distillation (min, %)		57	57
Tests on residue from distillation test:			
Penetration, 25 °C		100–250	40–90
Ductility, 25 °C, 50 mm/minute (min, mm)		400	400
Solubility in trichloroethylene (min, %)		97.5	97.5

[a]The 24-hour storage stability test may be used instead of the 5-day settlement test.
[b]Must comply with a pH requirement of 6.7 maximum under ASTM E70 if the particle charge test result is inconclusive.

94-1.02D Polymer Modified Asphaltic Emulsions

Polymer modified asphaltic emulsion must comply with the requirements shown in the following table:

Polymer Modified Asphaltic Emulsion Requirements

Quality characteristic	Test method	Requirement			
		Anionic		Cationic	
		Grade PMRS2	Grade PMRS2h	Grade PMCRS2	Grade PMCRS2h
Saybolt Furol viscosity, @ 50 °C (Saybolt Furol seconds)	AASHTO T 59	75–300	75–300	75–350	75–350
Settlement, 5 days (max, %)		5	5	5	5
Storage stability test, 1 day (max, %)		1	1	1	1
Sieve test (max, %)		0.30	0.30	0.30	0.30
Demulsibility (min, %)		60[a]	60[a]	40[b]	40[b]
Particle charge		--	--	positive	positive
Ash content (max, %)	ASTM D3723	0.2	0.2	0.2	0.2
Residue by evaporation (min, %)	California Test 331	65	65	65	65
Tests on residue from evaporation test:					
Penetration, 25 °C	AASHTO T 49	100–200	40–90	100–200	40–90
Ductility, 25 °C, (min, mm)	AASHTO T 51	400	400	400	400
Torsional recovery (min, %)	California Test 332	18	18	18	18
or					
Polymer content at 5% by weight (min, %)	California Test 401	2.5	2.5	2.5	2.5

[a]Use 35 ml of 0.02 *N* $CaCl_2$ solution.
[b]Use 35 ml of 0.8% sodium dioctyl sulfosuccinate solution.

94-1.02E Quick-setting Asphaltic Emulsions

Quick-setting asphaltic emulsion must comply with the requirements shown in the following table:

Quick-setting Asphaltic Emulsion Requirements

Quality characteristic	Test method	Requirement			
		Anionic		Cationic	
		Grade QS1	Grade QS1h	Grade CQS1	Grade CQS1h
Saybolt Furol viscosity, @ 50 °C (Saybolt Furol seconds)	AASHTO T 59	15–90	15–90	15–90	15–90
Storage stability test, 1 day (max, %)		1	1	1	1
Sieve test (max, %)		0.30	0.30	0.30	0.30
Particle charge[a]		negative	negative	positive	positive
Residue by distillation (min, %)		57	57	57	57
Tests on residue from distillation test:					
Penetration, 25 °C	AASHTO T 49	100–200	40–90	100–200	40–90
Ductility, 25 °C, (min, mm)	AASHTO T 51	400	400	400	400
Solubility in trichloroethylene (min, %)	AASHTO T 44	97	97	97	97

[a]If the result of the particle charge test is inconclusive, the asphaltic emulsion must be tested for pH under ASTM E70. Grade QS1h asphaltic emulsion must have a minimum pH of 7.3. Grade CQS1h asphaltic emulsion must have a maximum pH of 6.7.

94-1.03 CONSTRUCTION

Not Used

94-1.04 PAYMENT

The quantity of asphaltic emulsion is the weight determined before the addition of any water.

The weight of asphaltic emulsion is determined from volumetric measurements if:

1. Partial loads are used
2. Scale is not available within 20 miles
3. Asphaltic emulsion is delivered in:
   3.1. Trucks with each tank calibrated and accompanied by its measuring stick and calibration card
   3.2. Trucks equipped with a vehicle tank meter and a calibrated thermometer that determines the asphalt temperature at delivery

For volumetric measurements, the measured volume of asphaltic emulsion is reduced to the volume the material would occupy at 60 degrees F. One ton of asphaltic emulsion at 60 degrees F equals 240 gal. One gallon of asphaltic emulsion at 60 degrees F equals 8.33 lb.

Convert volume to weight using the factors shown in the following table:

Conversion Table

t	M	t	M	t	M	t	M
60	1.00000	83	0.99425	106	0.98850	129	0.98275
61	0.99975	84	0.99400	107	0.98825	130	0.98250
62	0.99950	85	0.99375	108	0.98800	131	0.98225
63	0.99925	86	0.99350	109	0.98775	132	0.98200
64	0.99900	87	0.99325	110	0.98750	133	0.98175
65	0.99875	88	0.99300	111	0.98725	134	0.98150
66	0.99850	89	0.99275	112	0.98700	135	0.98125
67	0.99825	90	0.99250	113	0.98675	136	0.98100
68	0.99800	91	0.99225	114	0.98650	137	0.98075
69	0.99775	92	0.99200	115	0.98625	138	0.98050
70	0.99750	93	0.99175	116	0.98600	139	0.98025
71	0.99725	94	0.99150	117	0.98575	140	0.98000
72	0.99700	95	0.99125	118	0.98550	141	0.97975
73	0.99675	96	0.99100	119	0.98525	142	0.97950
74	0.99650	97	0.99075	120	0.98500	143	0.97925
75	0.99625	98	0.99050	121	0.98475	144	0.97900
76	0.99600	99	0.99025	122	0.98450	145	0.97875
77	0.99575	100	0.99000	123	0.98425	146	0.97850
78	0.99550	101	0.98975	124	0.98400	147	0.97825
79	0.99525	102	0.98950	125	0.98375	148	0.97800
80	0.99500	103	0.98925	126	0.98350	149	0.97775
81	0.99475	104	0.98900	127	0.98325	150	0.97750
82	0.99450	105	0.98875	128	0.98300	151	0.97725

t = observed temperature in degrees F
M = multiplier for reducing volumes to the basis of 60 °F

95 EPOXY

95-1 GENERAL

95-1.01 GENERAL

95-1.01A Summary

Section 95 includes specifications for mixing and applying epoxy.

95-1.01B Definitions

kit: Two proportioned epoxy components packaged together.

95-1.01C Submittals

Submit a certificate of compliance for epoxy.

95-1.01D Quality Assurance

Reserved

95-1.02 MATERIALS

95-1.02A General

Furnish epoxy as 2 components and mix them together at the job site.

95-1.02B Packaging, Labeling, and Storing

Each epoxy component must be packaged in containers of a size proportional to the amount of that component in the mix so that 1 container of each component is used in mixing 1 batch of epoxy.

The containers must be sealed to prevent leakage and must not react with the components. Each container must be clearly labeled by the epoxy manufacturer with:

1. ASTM C881/C881M class and type
2. Component designation (A or B)
3. Manufacturer's name
4. Manufacture date
5. Batch number
6. Expiration date
7. Directions for use
8. Warnings or precautions required by State and federal laws and regulations

Store epoxy components at temperatures greater than 35 degrees F.

95-1.02C Epoxy Binder

Epoxy binder must be a low-viscosity epoxy formulated primarily for use in:

1. Making HS epoxy concrete and epoxy mortar
2. Pressure grouting cracks in concrete

For load-bearing applications, the epoxy must comply with ASTM C881/C881M, Type IV, Grade 1, Class B or C.

For non-load-bearing applications, the epoxy must comply with ASTM C881/C881M, Type I, Grade 1, Class B or C.

Use Class B whenever the surface temperature is from 40 to 60 degrees F. Use Class C whenever the surface temperature is above 60 degrees F.

If epoxy binder is used for HS epoxy concrete or epoxy mortar, thoroughly mix the components before adding aggregate. The mix proportions must be 1 part epoxy to 4 parts aggregate by volume. Aggregate must be clean and have a moisture content of not more than 0.50 percent when tested under California Test 226.

95-1.02D Epoxy Adhesive for Bonding Freshly Mixed Concrete to Hardened Concrete

Epoxy adhesive for bonding freshly mixed concrete to hardened concrete must comply with ASTM C881/C881M, Type V, Grade 2, Class B or C.

Use Class B whenever the surface temperature is from 40 to 60 degrees F or if a faster cure is required. Use Class C whenever the surface temperature is above 60 degrees F.

95-1.02E Rapid Set Epoxy Adhesive for Pavement Markers

Rapid set epoxy adhesive for bonding pavement markers to concrete and HMA must comply with ASTM C881/C881M, Type IV, Grade 3, Class B or C. The gel time for rapid set epoxy adhesive may be less than 30 minutes.

Use Class B whenever the surface temperature is from 40 to 60 degrees F. Use Class C whenever the surface temperature is above 60 degrees F.

The epoxy adhesive must comply with the requirements shown in the following table:

Rapid Set Epoxy Adhesive For Pavement Markers

Quality characteristic	Test method	Requirement
Gel time (max, minutes, at 77 °F)	California Test 434	30
Bond strength to concrete (minutes, maximum to reach not less than 200 psi)		
at 77 ± 2 °F		35
at 50 ± 2 °F		45
Slant shear strength (min, psi)		
2 days at 77 ± 2 °F		1,000
14 days at 77 ± 2 °F, plus water soak		1,500
Tensile adhesion and cohesion (min, psi)		
Ceramic marker bottom		700
Ceramic marker bottom, including post cure		700
Retroreflective pavement marker bottom		500
Color of mixed epoxy		gray
Glass transition temperature[a] (Tg, minimum)		86 °F

[a]Before testing, samples must be conditioned at 77 °F for 24 hours under ASTM D4065

95-1.02F Standard Set Epoxy Adhesive for Pavement Markers

Standard set epoxy adhesive for bonding pavement markers to concrete and HMA must comply with ASTM C881/C881M, Type IV, Grade 3, Class B or C.

Use Class B whenever the surface temperature is from 40 to 60 degrees F. Use Class C whenever the surface temperature is above 60 degrees F.

The epoxy adhesive must comply with the requirements shown in the following table:

Standard Set Epoxy Adhesive For Pavement Markers

Quality characteristic	Test method	Requirement
Bond strength to concrete (hours, maximum to reach not less than 200 psi)	California Test 434	
at 77 ± 2 °F		3.5
at 55 ± 2 °F		24
Slant shear strength (min, psi)		
2 days at 77 ± 2 °F		1,000
14 days at 77 ± 2 °F, plus water soak		1,500
Tensile adhesion and cohesion (min, psi)		
Ceramic marker bottom		700
Ceramic marker bottom, including post cure		700
Reflective pavement marker bottom		500
Color of mixed components		gray
Glass transition temperature[a] (Tg, minimum)		86 °F

[a]Before testing, samples must be conditioned at 77 °F for 24 hours under ASTM D4065

95-1.02G Epoxy Sealant for Inductive Loops

The epoxy for sealing inductive loops and leads imbedded in HMA and concrete must comply with ASTM C881/C881M, Type I, Grade 2.

The epoxy sealant must comply with the requirements shown in the following table:

Epoxy Sealant for Inductive Loops

Quality characteristic	Test method	Requirement
Tensile strength[a] (min, psi)	California Test 434	400
Elongation[a] (min, %)		90
Shore D hardness[a] (minimum)		45

[a]Test on a 0.125-inch-thick cast sheet, cured 18 hours at 77 °F plus 5 hours at 160 °F

95-1.02H Epoxy Resin Adhesive for Pressure Injection Grouting of Concrete Pavement

The epoxy resin adhesive for injection grouting of concrete pavement must comply with the requirements shown in the following table:

Epoxy Resin Adhesive for Injection Grouting of Concrete Pavement

Quality characteristic	Test method	Requirement
Brookfield viscosity, No. 3 spindle at 20 rpm (max, poise, at 77 °F)	California Test 434	9
Gel time (minutes)		2–15
Slant shear strength on dry concrete[a] (min, psi, after 4 days of cure in air at 77 ± 2 °F)		3,000
Slant shear strength on wet concrete[a] (min, psi, after 4 days of cure in air at 77 ± 2 °F)		1,700
Tensile strength (min, psi, after 4 days of cure at 77 ± 2 °F)		4,500
Elongation (max, %, after 4 days of cure at 77 ± 2 °F)		10

[a]Test for slant shear strength as follows, except item 1 in the list does not apply for testing on dry concrete:

1. Soak blocks in water for 24 hours at 77 ± 2 °F. Remove and wipe off excess water.
2. Apply a coat of epoxy 0.010-inch-thick to each diagonal surface. Place 4 pieces of shim stock on 1 block to control final film thickness. Shim stock pieces must be 0.12 by 0.125 inch and 0.012 inch thick. Before pressing the coated surfaces together, leave the blocks such that the coated surfaces are horizontal until the epoxy reacts slightly to prevent excessive flow.

95-1.03 CONSTRUCTION

Mix and apply the epoxy under the manufacturer's instructions.

Do not use an epoxy component if any of the following occur:

1. Evidence of crystallization
2. Permanent increase in viscosity too thick to be adequately mixed
3. Settled pigments that cannot be readily dispersed with a paddle
4. Component is older than the manufacturer's recommended expiration date

Thoroughly stir each epoxy component before mixing them together. Do not mix partial kits. Do not add solvents.

Automatic mixing equipment must have positive displacement pumps and be capable of metering a 2-component mix in the specified ratio ± 5 percent by volume of either component.

Mix the 2 epoxy components until no trace of black or white streaks is present in the mixed epoxy.

Clean surfaces to receive the epoxy of rust, paint, grease, asphalt, loose, and deleterious material. Apply the epoxy and place materials to be bonded before the epoxy starts to thicken. Do not use epoxy that has exceeded its working life.

Prime surfaces with epoxy immediately before placing epoxy concrete or mortar.

When bonding freshly-mixed concrete to hardened concrete, coat the blast-cleaned concrete surface with epoxy using a brush or roller. Place freshly-mixed concrete while the epoxy is tacky. Apply new coat of epoxy if the epoxy sets.

95-1.04 PAYMENT

Not Used

95-2–95-8 RESERVED

96 GEOSYNTHETICS

96-1.01 GENERAL

96-1.01A Summary

Section 96 includes specifications for furnishing geosynthetics.

96-1.01B Definitions

Reserved

96-1.01C Submittals

96-1.01C(1) General

For each type of geosynthetic submit:

1. Certificate of compliance
2. Test sample representing each lot
3. Minimum average roll value

Label submittals with the manufacturer's name and product information.

96-1.01C(2) Geotechnical Subsurface Reinforcement

Submit the LTDS and its supporting calculations at least 15 days before placing geotechnical subsurface reinforcement. The calculations must be signed by an engineer registered as a civil engineer in the State.

96-1.01D Quality Assurance

Geosynthetics must be on the DataMine list for geotextiles and geosynthetics at the National Transportation Product Evaluation Program website. The manufacturing source code must be printed every 5 meters along the edge of the material except for:

1. Paving mat
2. Paving grid, Class 2 and 3
3. Biaxial geogrid

96-1.02 MATERIALS

96-1.02A General

Treat geosynthetics to resist degradation from exposure to sunlight. Furnish geosynthetics in covers to protect against damage from moisture, sunlight, and shipping and storage.

96-1.02B Filter Fabric

Geosynthetics used for filter fabric must be permeable and nonwoven. Filter fabric must be manufactured from one of the following:

1. Polyester
2. Polypropylene
3. Combined polyester and polypropylene

Filter fabric must comply with the requirements shown in the following table:

Filter Fabric

Quality characteristic	Test method	Requirement		
		Class A	Class B	Class C
Permittivity, (min, sec^{-1})	ASTM D4491	0.5	0.2	0.1
Apparent opening size, average roll value, (max, US standard sieve size)	ASTM D4751	40	60	70
Grab breaking load, 1-inch grip, in each direction, (min, lb)	ASTM D4632	157		
Apparent elongation, in each direction, (min, percent)	ASTM D4632	50		
Puncture strength, (min, lb)	ASTM D6241	310		
Trapezoid tearing strength, (min, lb)	ASTM D4533	56		
UV resistance, retained grab breaking load, 500 hours, (min, percent)	ASTM D4355	70		

96-1.02C Geocomposite Wall Drain

Geocomposite wall drain must consist of a polymeric core with filter fabric integrally bonded to one or both sides of the core creating a stable drainage void.

Filter fabric must comply with section 96-1.02B.

Geocomposite wall drain must be from 0.25 to 2 inches thick.

Geocomposite wall drain must comply with the requirements shown in the following table:

Geocomposite Wall Drain

Quality characteristic	Test method	Requirement
Transmissivity, (gal/min/ft) gradient = 1.0, Normal stress = 5,000 psf	ASTM D4716	4

96-1.02D Geotechnical Subsurface Reinforcement

96-1.02D(1) General

Geosynthetic reinforcement used for geotechnical subsurface reinforcement must be either geotextile or geogrid.

When tested under ASTM D4491, geotextile permittivity must be at least 0.05 sec^{-1}.

Geogrid must have a regular and defined open area. The open area must be from 50 to 90 percent of the total grid area.

96-1.02D(2) Long Term Design Strength

Determine the LTDS of geosynthetic reinforcement from the ultimate tensile strength in the primary strength direction divided by reduction factors. Calculate LTDS from the guidelines in Geosynthetic Research Institute Standard Practice GG4a, GRI GG4b, or GRI GT7.

The product of the reduction factors must be at least 1.30. Determine the reduction factor for creep using a 75 year design life for permanent applications. For temporary applications, use a 5 year design life to determine the reduction factor. Determine the installation damage reduction factor from the characteristics of backfill materials used.

If test data is not available, use default values of reduction factors in the Geosynthetic Research Institute Standard Practice to determine LTDS.

96-1.02E Silt Fence Fabric

Silt fence fabric must comply with the requirements shown in the following table:

Silt Fence Fabric

Quality characteristic	Test method	Requirement	
		Woven	Nonwoven
Grab breaking load, 1-inch grip in each direction, (min, lb)	ASTM D4632	120	120
Apparent elongation, in each direction (min, percent)	ASTM D4632	15	50
Water flow rate, average roll value, (min and max, gal per minute/sq ft)	ASTM D4491	10–100	100–150
Permittivity, (min, sec^{-1})	ASTM D4491	0.05	1.1
Apparent opening size, average roll value, (max, inches)	ASTM D4751	0.023	0.012
UV resistance, retained grab breaking load, 500 hours, (min, percent)	ASTM D4355	70	70

96-1.02F Gravel-Filled Bag

Gravel-filled bag must comply with the requirements shown in the following table:

Gravel-Filled Bag

Quality characteristic	Test method	Requirement
Grab breaking load, 1-inch grip in each direction, (min, lb)	ASTM D4632	205
Water flow rate, average roll value, (min and max, gal per minute/sq ft	ASTM D4491	80–150
Permittivity, (min, sec^{-1})	ASTM D4491	0.2
Apparent opening size, average roll value, (max, inches)	ASTM D4751	0.016
UV resistance, retained grab breaking load, 500 hours, (min, percent)	ASTM D4355	70

96-1.02G Sediment Filter Bag

The sediment filter bag must comply with the requirements shown in the following table:

Sediment Filter Bag

Quality characteristic	Test method	Requirement	
		Woven	Nonwoven
Grab breaking load, 1-inch grip in each direction,(min, lb)	ASTM D4632	200	250
Apparent elongation, in each direction, (min, percent)	ASTM D4632	10	50
Water flow rate, average roll value, (min and max, gal per minute/sq ft)	ASTM D4491	100-200	75-200
Permittivity, (min, sec^{-1})	ASTM D4491	1.0	1.0
Apparent opening size, average roll value, (max, inches)	ASTM D4751	0.023	0.012
UV resistance, retained grab breaking load, 500 hours, (min, percent)	ASTM D4355	70	70

96-1.02H Temporary Cover

Temporary cover must comply with the requirements shown in the following table:

Temporary Cover

Quality characteristic	Test method	Requirement	
		Woven	Nonwoven
Grab breaking load, 1-inch grip in each direction, (min, lb)	ASTM D4632	200	200
Apparent elongation in each direction, (min, percent)	ASTM D4632	15	50
Water flow rate, average roll value, (min and max, gal per minute/sq ft)	ASTM D4491	4-10	80-120
Permittivity, (min, sec^{-1})	ASTM D4491	0.05	1.0
Apparent opening size, average roll value,(max, inches)	ASTM D4751	0.023	0.012
UV resistance, retained grab breaking load, 500 hours, (min, percent)	ASTM D4355	70	70

96-1.02I Rock Slope Protection Fabric

RSP fabric must be a permeable, nonwoven, needle-punched geotextile. The fabric must be manufactured from one of the following:

1. Polyester
2. Polypropylene
3. Combined polyester and polypropylene

Polymers must be either virgin compounds or clean reworked material. Do not subject virgin compounds to use or processing other than required for initial manufacture. Clean reworked material must be previously processed material from the processor's own production that has been reground, pelletized, or solvated. The fabric must not contain more than 20 percent of clean reworked material by weight. Do not use recycled materials from either post-consumer or post-industrial sources.

RSP fabric must comply with the requirements shown in the following table:

RSP Fabric

Quality characteristic	Test method	Requirement	
		Class 8	Class 10
Mass,(min, oz/sq yd)	ASTM D5261	7.5	9.5
Grab breaking load, 1 inch grip in each direction, (min, lb)	ASTM D4632	200	250
Apparent elongation in each direction, (min, percent)	ASTM D4632	50	50
Permittivity, (min, sec^{-1})	ASTM D4491	1.0	0.70
Apparent opening size, (min and max, US Standard sieve size)	ASTM D4751	70–100	70–100
UV resistance, retained grab breaking load, 500 hours, (min, percent)	ASTM D4355	70	70

96-1.02J Paving Fabric

Geosynthetics used for paving fabric must be nonwoven.

Paving fabric must comply with the requirements shown in the following table:

Paving Fabric

Quality characteristic	Test method	Requirement
Mass per unit area, (min, oz/sq yd)	ASTM D5261	4.1
Grab breaking load, 1-inch grip in each direction, (min, lb)	ASTM D4632	100
Apparent elongation in each direction, (min, percent)	ASTM D4632	50
Hydraulic bursting strength, (min, psi)	ASTM D3786	200
Melting point, (min, °F)	ASTM D276	325
Asphalt retention, (min, gal/sq yd)	ASTM D6140	0.2

96-1.02K Paving Mat

Geosynthetics used for paving mat must be a nonwoven fiberglass and polyester hybrid material.

Paving mat must comply with the requirements shown in the following table:

Paving Mat

Quality characteristic	Test method	Requirement
Breaking force, (min, lb/2 inch cut strip)	ASTM D5035	45
Ultimate elongation, (max, percent)	ASTM D5035	5
Mass per unit area, (min, oz/sq yd)	ASTM D5261	3.7
Melting point, (min, °F)	ASTM D276	400
Asphalt retention, (min, gal/sq yd)	ASTM D6140	0.10

96-1.02L Paving Grid

Geosynthetics used for paving grid must be a geopolymer material formed into a grid of integrally connected elements with openings.

Paving grid must comply with the requirements shown in the following table:

Paving Grid

Quality characteristic	Test method	Requirement		
		Class I	Class II	Class III
Tensile strength at ultimate, (min, lb/in[a])	ASTM D6637	560 x 1,120	560	280
Aperture size, (min, inch)	Calipered	0.5	0.5	0.5
Elongation, (max, percent)	ASTM D6637	12	12	12
Mass per area, (min, oz/sq yd)	ASTM D5261	16	10	5.5
Melting point, (min, °F)	ASTM D276	325	325	325

[a] For Class I, machine direction x cross direction. For Class II and Class III, both directions.

96-1.02M Paving Geocomposite Grid

Paving geocomposite grid must consist of a paving grid specified in section 96-1.02L bonded or integrated with a paving fabric as specified in section 96-1.02J.

Paving geocomposite grid must have a peel strength of at least 10 lb/ft when tested under ASTM D413.

96-1.02N Geocomposite Strip Membrane

Geocomposite strip membrane must be various widths of strips manufactured from asphaltic rubber and geosynthetics.

Geocomposite strip membrane must comply with the requirements shown in the following table:

Geocomposite Strip Membrane

Quality characteristic	Test method	Requirement
Strip tensile strength, (min, lb/inch)	ASTM D882	50
Elongation at break, (min, percent)	ASTM D882	50
Resistance to puncture, (min, lb)	ASTM E154	200
Permeance, (max, perms)	ASTM E96/E96M	0.10
Pliability, 1/4 inch mandrel with sample conditioned at 25 °F	ASTM D146	No cracks in fabric or bitumen
Melting point, (°F)	ASTM D276	325

96-1.02O Subgrade Enhancement Geotextile

Subgrade enhancement geotextile must be either polyester or polypropylene.

Subgrade enhancement geotextile must comply with the requirements shown in the following table:

Subgrade Enhancement Geotextile

Quality characteristic	Test method	Requirement[a]				
		Class A1	Class A2	Class B1	Class B2	Class B3
Elongation at break, (percent)	ASTM D4632	<50	≥50	<50	<50	≥50
Grab breaking load, 1-inch grip in each direction, (min, lb)	ASTM D4632	250	160	--	320	200
Wide width tensile strength at 5 percent strain, (min, lb/ft)	ASTM D4595	--	--	2,000	--	--
Wide width tensile strength at ultimate strength, (min, lb/ft)	ASTM D4595	--	--	4,800	--	--
Tear strength, (min, lb)	ASTM D4533	90	60	--	120	80
Puncture strength, (min, lb)	ASTM D6241	500	310	620	620	430
Permittivity, (min, sec^{-1})	ASTM D4491	0.05	0.05	0.20	0.20	0.20
Apparent opening size, (max, inches)	ASTM D4751	0.012	0.012	0.024	0.012	0.012
UV resistance, retained grab breaking load, 500 hours, (min, percent)	ASTM D4355	70	70	70	70	70

[a]Values are based on minimum average roll value in the weaker principal direction except apparent opening size is based on maximum average roll value.

96-1.02P Biaxial Geogrid

Geosynthetics used for biaxial geogrid must be a punched and drawn polypropylene material formed into an integrally formed biaxial grid.

Biaxial geogrid must comply with the requirements shown in the following table:

Biaxial Geogrid

Quality characteristic	Test method	Requirement
Aperture size, (min and max, inch)[a]	Calipered	0.8-1.3 x 1.0-1.6
Rib thickness, (min, inch)	Calipered	0.04
Junction thickness, (min, inch)	Calipered	0.150
Tensile strength, 2% strain, (min, lb/ft)[a]	ASTM D6637	410 x 620
Tensile strength at ultimate, (min, lb/ft)[a]	ASTM D6637	1,310 x 1,970
UV resistance, retained tensile strength, 500 hours, (min, percent)	ASTM D4355	100
Junction strength, (min, lb/ft)[a]	ASTM D7737	1,220 x 1,830
Overall flexural rigidity, (min, mg-cm)	ASTM D7748	750,000
Torsional rigidity at 20 cm-kg, (min, mm-kg/deg)[b]	GRI GG9	0.65

[a]Machine direction x cross direction
[b]Geosynthetic Research Institute, Test Method GG9, Torsional Behavior of Bidirectional Geogrids When Subjected to In-Plane Rotation

96-1.02Q Geosynthetic Bond Breaker

Geosynthetic bond breaker must be nonwoven; needle punched; not heat treated; polypropylene, polyethylene material.

Geosynthetic bond breaker material must comply with the requirements shown in the following table:

Geosynthetic Bond Breaker

Quality characteristic	Test method	Requirement
Mass per unit area, (min, oz/sq yd)	ASTM D5261	14.7
Thickness at 29 psi, (min, mm)	ASTM D5199	1.0
Tensile strength at ultimate, (min, lb/ft)	ASTM D4595	685
Elongation, (max, percent)	ASTM D4595	130
Permittivity at 2.9 psi, (min, m/s)	ASTM D5493	0.0001
Hydraulic transmissivity at 29 psi, (min, m/s)	ASTM D6574	0.0002
UV resistance, retained grab breaking load, 500 hours, (min, percent)	ASTM D4355	60

96-1.02R Geomembrane

Geomembrane must be:

1. Polyethylene or polypropylene
2. Water resistant
3. Unreinforced or scrim reinforced

Cushion fabric must be nonwoven.

Geomembrane and cushion fabric must comply with the requirements shown in the following tables:

Unreinforced Geomembrane

Quality characteristic	Test method	Requirement		
		Class A	Class B	Class C
Thickness, smooth (min, mil)	ASTM D5199	20	20	20
Thickness, textured (min, mil)	ASTM D5994			
Tensile break strength (min, lb/in)	ASTM D6693 Type IV	75	65	55
Puncture resistance (min, lb)	ASTM D4833	45	40	35
Tear resistance (min, lb)	ASTM D1004	20	15	10
Carbon black content (%)	ASTM D4218	2–3		

Scrim Reinforced Geomembrane

Quality characteristic	Test method	Requirement		
		Class A	Class B	Class C
Thickness, smooth (min, mil)	ASTM D5199	20	20	20
Thickness, textured (min, mil)	ASTM D5994			
Tensile break strength (min, lb)	ASTM D7004	250	200	150
Puncture resistance (min, lb)	ASTM D4833	45	40	35
Tear resistance (min, lb)	ASTM D5884	55	55	55
Ply adhesion (min, lb)	ASTM D6636	20	20	20
Carbon black content (%)	ASTM D4218	2–3		

Cushion Fabric

Quality characteristic	Test method	Requirement					
Mass per unit area (oz/sq yd)	ASTM D5261	10	12	16	24	32	60
Grab tensile break strength (min, lb)	ASTM D4632	230	300	370	450	500	630
Grab tensile break elongation (min, %)	ASTM D4632	50					
Puncture strength (min, lb)	ASTM D6241	700	800	900	1100	1700	2400
Trapezoidal tear strength (min, lb)	ASTM D4533	95	115	145	200	215	290
UV resistance (min, %)	ASTM D7238	70					

96-1.02S–96-1.02Y Reserved

96-1.03 CONSTRUCTION

Not Used

96-1.04 PAYMENT

Not Used

97–98 RESERVED

DIVISION XII BUILDING CONSTRUCTION

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