STANDARD SPECIFICATIONS

STATE OF CALIFORNIA
BUSINESS, TRANSPORTATION AND HOUSING AGENCY
DEPARTMENT OF TRANSPORTATION

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DIVISION I GENERAL PROVISIONS

1 GENERAL

1-1.01 GENERAL

Section 1 includes general rules of interpretation.

The specifications are divided into 11 divisions.

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

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

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

Division X 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 X.

Division XI 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 2 first 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. Assignments
2. Notifications
3. Proposals
4. Reports
5. Requests, including RFIs, sequentially numbered
6. Subcontracts
7. 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.

SECTION 1 GENERAL

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 U.S. 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 current version in effect on the date of the *Notice to Bidders*.

A reference to a section includes the general specifications for 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.

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

A department not specified as a federal or local department is a California department.

1-1.06 ABBREVIATIONS

Interpret the meaning of an abbreviation used in the specifications and the Bid Item List as shown in the following table:

Abbreviations

Abbreviation	Meaning
AASHTO	American Association of State Highway and Transportation Officials
AB	aggregate base
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMA	archaeological monitoring area
ANSI	American National Standards Institute
API	American Petroleum Institute
AREMA	American Railway Engineering and Maintenance-of-Way Association
AS	aggregate subbase
ASME	American Society of Mechanical Engineers
ASQ	American Society for Quality
ATPB	asphalt treated permeable base
AWG	American Wire Gauge
AWPA	American Wood Protection Association
AWS	American Welding Society[a]
AWWA	American Water Works Association
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
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
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	Electronic Industries Alliance
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
GAAP	Generally Accepted Accounting Principles
GGBFS	ground granulated blast furnace slag; slag cement
GSP	galvanized steel pipe
HMA	hot mix asphalt

HMA-O	hot mix asphalt (open graded)
HS	high strength
ICC	International Code Council
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
LEED	Leadership in Energy and Environmental Design
LOTB	log of test boring
LTDS	long term design strength
MC	medium curing
METS	Department's Materials Engineering and Testing Services
MPI	Master Painters Institute
MR	movement rating
MSDS	material safety data sheet
MT	magnetic particle testing
MUTCD	*Manual on Uniform Traffic Control Devices*
NDT	nondestructive testing
NETA	International Electrical Testing Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NPDES	National Pollutant Discharge Elimination System
NPT	National Pipe Thread Taper
NRTL	Nationally Recognized Testing Laboratory
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
PG	performance grade
PI_0	zero blanking band profile index
PJP	partial joint penetration
PQR	procedure qualification record
PS	prestressed
PSF	pedestrian signal face
PV	programmed visibility
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
SSPC	The Society for Protective Coatings
SWPPP	storm water pollution prevention plan
TEES	Transportation Electrical Equipment Specifications
TIA	time impact analysis
TV	target value
UDBE	Underutilized Disadvantaged Business Enterprise
UFFA	ultra fine fly ash
UL	Underwriters Laboratories, Inc
USC	United States Code
USM	unidentified stock material
UT	ultrasonic testing
VECP	value engineering change proposal
VFD	Variable-frequency drive
VPM	volts per mil
WPCP	water pollution control program
WPS	welding procedure specification

[a]Interpret a reference to AWS as a reference to AWS, ANSI/AWS, or AASHTO/AWS

Bid Item List Abbreviations

Abbreviation	Meaning
ACRE	acre
CF	cubic foot
CY	cubic yard
EA	each
(F)	final pay item
GAL	gallon
H	hour
LB	pound
LF	linear foot
LS	lump sum
LNMI	lane mile
MFBM	thousand foot board measure
MI	mile
MSYD	thousand station yard
STA	station (100 feet)
SQFT	square foot
SQYD	square yard
TAB	tablet
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

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.

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

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 (e.g., tools and tool fragments, hearth and food remains, structural remains, and human remains).

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 excavation or embankment under the lowest layer to be placed.

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

Bid Item List: List of bid items 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 Web site 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.

bridge: Structure that:

1. Has a bridge number
2. Carries a utility or railroad or 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 Web site.

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.

commercial quality: Quality meeting the best general practices.

commercial source: Established business operating as a material source to 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 completion date: Current extended date for completion of the Contract shown on the *Weekly Statement of Working Days*.

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 delay: Delay that extends the scheduled completion date.

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 Saturday or holiday.
2. **working day:** Time measure unit for work progress. A working day is any day except:
   - 2.1. Saturday and holiday.
   - 2.2. Day when you cannot perform work on the controlling activity for at least 50 percent of the day with at least 50 percent of the normal labor and equipment due to any of the following:
     - 2.2.1. Adverse weather-related conditions that cause the Contractor to dismiss the crew.
     - 2.2.2. Maintaining traffic under the Contract.
     - 2.2.3. Engineer's direction to suspend the controlling activities for reasons unrelated to the Contractor's performance.
     - 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.

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

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.

dispose of: Remove from the job site.

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

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

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

excusable delay: Delay to a controlling activity beyond the Contractor's control and not reasonably foreseeable when the work began such as:

1. Change in the work
2. Department action that is not part of the Contract
3. Presence of an underground utility main not described in the Contract or in a location substantially different from that specified
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
5. Department's failure to obtain timely access to the right-of-way
6. Department's failure to review a submittal or provide notification in the time specified

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.

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.

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.

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.

listed species: Any species listed as threatened or endangered under (1) 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.

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

material shortage: 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. Shortage relates to a produced, nonstandard material
2. Supplier's and the Contractor's priority for filling an order differs
3. Event outside the U.S. for a material produced outside the U.S.

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).

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 no more than 10 working days of total float.

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 remains of (1) animals, (2) animal tracks, (3) plants, and (4) other organisms. Archaeological resources are not paleontological and fossils found within an archaeological resource are generally considered archaeological resources, not paleontological resources.

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

permitted biological activities: Monitoring, surveying, or other practices that require a take permit and project-specific permission from the U.S. Fish and Wildlife Service or NOAA Fisheries or a take permit or memorandum of understanding with the Department of Fish and Game.

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 days shown on the *Notice to Bidders* for plant establishment.

protective radius: Minimum distance between construction activities and a regulated species.

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

regulated species: Any species protected by one or any 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 that governs activities that affect species or their habitats

roadbed: Roadway portion extending from curb line to curb line or 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: That portion of the highway within the outside lines of curbs, sidewalks, slopes, ditches, channels, or waterways. Roadway includes structures and features necessary for safety, protection of facilities, and drainage.

routine biological activities: Biological monitoring, surveying, or other activity that does not require a take permit from the U.S. Fish and Wildlife Service or NOAA Fisheries or a take permit or memo of understanding with the Department of Fish and Game.

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 project completion date shown on the current schedule.

service-approved biologist: Biologist whose activities must be approved by a state or federal agency as provided in PLACs.

shoulder: Roadway portion contiguous with the traveled way for stopped vehicle accommodation, 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: The 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.

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.

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

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 U.S. Fish and Wildlife Service or by the NOAA Fisheries that allows take of federal-listed species under 16 USC § 1539 or by the Department of Fish and Game that allows take of state-listed species under Fish & Game Code § 2081.

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

traveled way: Roadway portion for the movement of vehicles except shoulders.

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 authority.

withhold: Money temporarily or permanently taken from 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	PO BOX 911 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 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 RESERVED

1-1.11 WEB SITES, ADDRESSES, AND TELEPHONE NUMBERS

Web Sites, Addresses, and Telephone Numbers

Reference or agency or department unit	Web site	Address	Telephone no.
Authorized Laboratory Lists Authorized Material Lists Authorized Material Source Lists	http://www.dot.ca.gov/hq/esc/approved_products_list	--	--
Bidders' Exchange	http://www.dot.ca.gov/hq/esc/oe/bidex	MSC 26 BIDDERS' EXCHANGE DEPARTMENT OF TRANSPORTATION 1727 30TH ST SACRAMENTO CA 95816-7005	(916) 227-6259
CA Unified Certification Program's list of certified DBEs	http://www.dot.ca.gov/hq/bep/find_certified.htm	--	--
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.pd.dgs.ca.gov/smbus/default.htm	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 AVENUE 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
Office Engineer	--	MSC 43 OFFICE ENGINEER DEPARTMENT OF TRANSPORTATION 1727 30TH ST SACRAMENTO CA 95816-7005	--
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 DRIVE SACRAMENTO CA 95815-3800	--

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

2-1.03–2-1.05 RESERVED

2-1.06 BID DOCUMENTS

2-1.06A General

Standard Specifications and *Standard Plans* may be viewed at the Bidders' Exchange Web site and may be purchased at the Publication Distribution Unit.

The *Notice to Bidders and Special Provisions* and project plans may be viewed at the Bidders' Exchange Web site and at the street address.

Bid books may be ordered at the Bidders' Exchange Web site.

For an informal-bid contract in addition to viewing and ordering them as specified above, the *Notice to Bidders and Special Provisions*, project plans, and *Bid* book may be obtained at the Bidders' Exchange street address.

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

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* is available:

1. You may view it at the Bidders' Exchange Web site
2. For an informal-bid contract, you may obtain it at the Bidders' Exchange street address

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 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 dimensions of the work to fit existing conditions.

2-1.06C–2-1.06D Reserved

2-1.07–2-1.11 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.

Take necessary and reasonable steps to ensure that DBEs have opportunity to participate in the Contract (49 CFR 26).

2-1.12B Underutilized Disadvantaged Business Enterprises

2-1.12B(1) General

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

To ensure equal participation of DBE groups provided in 49 CFR 26.5, the Department shows a goal for UDBEs. A UDBE is a firm that meets the definition of DBE and is a member of one of the following groups:

1. Black Americans
2. Native Americans
3. Asian-Pacific Americans
4. Women

References to DBEs include UDBEs, but references to UDBEs do not include all DBEs.

Make work available to UDBEs and select work parts consistent with available UDBE subcontractors and suppliers.

Meet the UDBE 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 that the at the bid opening date the UDBE firm is certified as DBE by the CA Unified Certification Program.

Only UDBE participation will count toward the UDBE goal. DBE participation will count toward the Department's federally-mandated statewide overall DBE goal.

Credit for materials or supplies you purchase from UDBEs counts toward the goal in the following manner:

1. 100 percent if the materials or supplies are obtained from a UDBE manufacturer.
2. 60 percent if the materials or supplies are obtained from a UDBE 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 UDBE that is neither a manufacturer nor regular dealer. 49 CFR 26.55 defines "manufacturer" and "regular dealer."

You receive credit toward the goal if you employ a UDBE trucking company that performs a commercially useful function as defined in 49 CFR 26.55(d)(1)–(4), (6).

2-1.12B(2) UDBE Commitment Submittal

Submit UDBE information on the *Caltrans Bidder - UDBE - Commitment* form (UDBE commitment form) included in the *Bid* book. If the form is not submitted with the bid, remove the form from the *Bid* book before submitting your bid.

If the UDBE commitment form is not submitted with the bid, the apparent low bidder, the 2nd low bidder, and the 3rd low bidder must complete and submit the form to the Office Engineer. The UDBE commitment form must be received by the Office Engineer no later than 4:00 p.m. on the 4th business day after bid opening.

Other bidders are not required to submit the UDBE commitment form unless the Department requests it. If the Department requests a UDBE commitment form from you, submit the completed form within 4 business days of the request.

Submit written confirmation from each UDBE shown on the form stating that it will be participating in the Contract. Include confirmation with the UDBE commitment form. A copy of a UDBE's quote will serve as written confirmation that the UDBE will be participating in the Contract.

If you do not submit the UDBE commitment form by the specified time, your bid is nonresponsive.

2-1.12B(3) Good Faith Efforts Submittal

If you have not met the UDBE goal, complete and submit the *Good Faith Efforts Documentation* form with the bid showing that you made adequate good faith efforts to meet the goal. Only good faith efforts directed toward obtaining participation by UDBEs are considered. If good faith efforts documentation is not submitted with the bid, it must be received by the Office Engineer no later than 4:00 p.m. on the 4th business day after bid opening.

If your UDBE commitment form shows that you have met the UDBE goal or if you are required to submit the UDBE commitment form, you must 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 UDBE goal has not been met. Good faith efforts documentation must include the following information and supporting documents, as necessary:

1. Items of work you have made available to UDBE firms. Identify those items of work you might otherwise perform with your own forces and those items that have been broken down into economically feasible units to facilitate UDBE participation. For each item listed, show the dollar value and percentage of the total bid. You are responsible to demonstrate that sufficient work to meet the goal was made available to UDBE firms.
2. Names of certified UDBEs and dates on which they were solicited to bid on the project. Include the items of work offered. Describe the methods used for following up initial solicitations to determine with certainty whether the UDBEs were interested and include the dates of the follow-up. Attach supporting documents such as copies of letters, memos, facsimiles sent, telephone logs, telephone billing statements, and other evidence of solicitation. You are reminded to solicit certified UDBEs through all reasonable and available means and provide enough time to allow UDBEs to respond.
3. Name of selected firm and its status as a UDBE for each item of work made available. Include name, address, and telephone number of each UDBE that provided a quote and its price quote. If the firm selected for the item is not a UDBE, provide the reasons for the selection.
4. Name and date of each publication in which you requested UDBE participation for the project. Attach copies of the published advertisements.
5. Names of agencies and dates on which they were contacted to provide assistance in contacting, recruiting, and using UDBE firms. If the agencies were contacted in writing, provide copies of supporting documents.
6. List of efforts made to provide interested UDBEs with adequate information about the plans, specifications, and requirements of the contract to assist them in responding to a solicitation. If you have provided information, identify the name of the UDBE assisted, the nature of the information provided, and date of contact. Provide copies of supporting documents, as appropriate.
7. List of efforts made to assist interested UDBEs in obtaining bonding, lines of credit, insurance, necessary equipment, supplies, and materials excluding supplies and equipment that the UDBE subcontractor purchases or leases from the prime contractor or its affiliate. If such assistance is provided by you, identify the name of the UDBE assisted, nature of the assistance offered, and date assistance was offered. Provide copies of supporting documents, as appropriate.

8. Any additional data to support demonstration of good faith efforts.

The Department may consider UDBE commitments of the 2nd and 3rd bidders in determining whether the low bidder made good faith efforts to meet the UDBE 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 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 available DVBE subcontractors and suppliers.

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

Complete and submit the *Certified DVBE Summary* form. List all DVBE participation on this form. For an informal-bid contract, submit the form with your bid. For a non-informal-bid contract, you may submit the form with your bid; if you do not, submit it such that it is received at the Office Engineer no later than 4:00 p.m. on the 4th business day after bid opening. If a DVBE joint venture is used, submit the joint venture agreement with the *Certified DVBE Summary* form.

List each 1st-tier DVBE subcontractor in the *Subcontractor List* form regardless of 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. List all DVBE participation on this form.
2. List each 1st tier DVBE subcontractor in the *Subcontractor List* form regardless of percentage of the total bid.

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. For an informal-bid contract, submit the form with your bid. For a non-informal-bid-contract, you may submit the form with your bid; if you do not and you are the low bidder or the 2nd or 3rd low bidder, submit it such that it is received at the Office Engineer no later than 4:00 p.m. on the 4th business day after bid opening. If a DVBE joint venture is used, submit the joint venture agreement with the *Certified DVBE Summary* form. Other bidders may be required to submit this form if bid ranking changes.

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 DVBE incentive.

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

1. Percentage of 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 DVBE incentive and determines whether bid ranking changes.

A non–small business bidder cannot displace a small business bidder. However, a small business bidder with 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 Web site.

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, subcontractors, 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 time and day 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. You may submit this information with your bid. If you do not, submit it such that it is received at the Office Engineer no later than 4:00 p.m. on the 2nd business day after bid opening.

Each listed subcontractor and supplier must be certified as a small business at the time and day 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

2-1.19–2-1.23 RESERVED

2-1.24 TIED BID RESOLUTION

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.

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.

After bid verification, the Department breaks a tie between 2 or more bidders with a coin toss.

2-1.25–2-1.26 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 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.

2-1.28–2-1.29 RESERVED

2-1.30 JOB SITE AND DOCUMENT EXAMINATION

Examine the job site and bid documents.

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

2-1.31–2-1.32 RESERVED

2-1.33 BID DOCUMENT COMPLETION

2-1.33A General

Complete forms in the *Bid* book. Submit the forms with your bid.

On the Subcontractor List you may either submit the percentage of each bid item subcontracted with your bid or fax the percentage to (916) 227-6282 within 24 hours after bid opening.

Except for the percentage of each bid item subcontracted, do not fax submittals.

2-1.33B Bid Item List and Bid Comparison

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

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.

2-1.33C Subcontractor List

On the *Subcontractor List*, list each subcontractor to 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.).

The *Subcontractor List* must show the name, address, and work portions to be performed by each subcontractor listed. Show work portions by bid item number, description, and percentage of each bid item subcontracted.

2-1.33D 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 with your bid.

2-1.33E Reserved

2-1.34 BIDDER'S SECURITY

Submit your bid with 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. Bidder's bond signed by a surety insurer who is licensed in California

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 SSPC QP CERTIFICATION PREAWARD QUALIFICATION

Submit the SSPC QP certification required under section 59-2.01D(1) with your bid. Failure to submit the certification results in a nonresponsive bid.

2-1.36 RESERVED

2-1.37 BID SUBMITTAL

Submit your bid:

1. Under sealed cover
2. Marked as a bid
3. Identifying the contract number and the bid opening date

If an agent other than the authorized corporation 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.

2-1.38–2-1.39 RESERVED

2-1.40 BID WITHDRAWAL

An authorized agent may withdraw a bid before the bid opening date and time by submitting a written bid withdrawal request at the location where the bid was submitted. Withdrawing a bid does not prevent you from submitting a new bid.

After the bid opening time, you cannot withdraw a bid.

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 BID REJECTION

The Department may reject:

1. All bids
2. A nonresponsive bid

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 Web site.

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 U.S. 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.

3-1.02–3-1.03 RESERVED

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.

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 furnishes the successful bidder with bond forms.

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. The 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 0001 or similar exclusions are allowed if not inconsistent with section 7-1.06. 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, shall set forth deductible amounts applicable to each policy and all exclusions that are added by endorsement to each policy. The evidence of insurance shall provide that no cancellation, lapse, or reduction of coverage will occur without 10 days prior written notice to the Department.
3. A declaration under the penalty of perjury by a CPA certifying the accountant has applied GAAP guidelines confirming the successful bidder has sufficient 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, it shall 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 sign the *Payee Data Record* form included in the contract documents.

3-1.12 CALTRANS BIDDER - DBE INFORMATION FORM

Section 3-1.12 applies to a federal-aid contract.

Complete and sign the *Caltrans Bidder - DBE Information* form included in the contract documents regardless of whether no DBE participation is reported.

Provide written confirmation from each DBE that the DBE is participating in the Contract. A copy of a DBE's quote serves as written confirmation. If a DBE is participating as a joint venture partner, the Department encourages you to submit a copy of the joint venture agreement.

3-1.13–3-1.17 RESERVED

3-1.18 CONTRACT EXECUTION

The successful bidder must sign the *Contract* form.

Deliver to the Office Engineer:

1. Signed *Contract* form
2. Contract bonds
3. Documents identified in section 3-1.07
4. *Payee Data Record*
5. *Small Business (SB) Participation Report* form
6. For a federal-aid contract, *Caltrans Bidder - DBE Information* form

For an informal-bid contract, the Office Engineer must receive these documents before the 5th business day after the bidder receives the contract.

For all other contracts, 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 excavated material replacement 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. An ordered plan or specification change materially changes the character of a work item from that on which the bid price was based
2. The unit cost of the changed item differs when compared to 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 the differing site condition claim 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 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 to 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 Web site.

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 pay 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

Do not remove warning, regulatory, or guide signs until Contract acceptance.

5 CONTROL OF WORK

5-1.01 GENERAL

Section 5 includes specifications regarding 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 QA. The Department's QA does 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 at the Department's Web site.

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. The 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. A detail drawing governs over a general drawing
4. A detail specification governs over a general specification
5. A 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, 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 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

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 reference. This guide provides structure, context, and clarity to the partnering process requirements. For the guide, go to the Department's Division of Construction Web site.

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
   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 Web site
2. Schedule initial partnering workshop
3. Determine initial workshop site and duration
4. Agree to other workshop administrative details

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

5-1.09C Training in Partnering Skills Development

For a contract with a total bid of $25 million or greater, training in partnering skills development is required.

For a contract with a total bid between $10 million and $25 million, training in partnering skills is optional.

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 at least 2 representatives 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 you for:

1. 1/2 of partnering workshops and sessions based on facilitator and workshop site cost
2. 1/2 of monthly partnering evaluation survey service cost
3. Partnering skills development trainer and training site cost

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 wages, travel expenses, or other costs associated with the partnering workshops and sessions, monthly partnering evaluation surveys, and training in partnering skills development.

5-1.10–5-1.11 RESERVED

5-1.12 ASSIGNMENT

No third-party agreement relieves you or your surety of the responsibility to complete the work. Do not sell, transfer, or otherwise dispose of any Contract part without prior written consent from the Department.

If you assign the right to receive Contract payments, the Department accepts the assignment upon the Engineer's receipt of a notice. Assigned payments remain subject to deductions and withholds described in the Contract. The Department may use withheld payments for work completion whether 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' Web site.

If you violate Pub Cont Code § 4100 et seq., the Department may exercise the remedies provided under 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 State contractor's license with a classification appropriate for the work to be performed (Bus & Prof Code § 7000 et seq.).

Submit copies of subcontracts upon request.

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

5-1.13B Disadvantaged Business Enterprises

5-1.13B(1) General

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

Use each DBE subcontractor as listed on the *Subcontractor List* form and the *Caltrans Bidder - DBE Information* form unless you receive authorization for a substitution.

Notify the Engineer of any changes to your anticipated DBE participation. Submit this notification before starting the affected work.

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, submit a *Monthly DBE Trucking Verification* form.

If a DBE subcontractor is decertified before completing subcontracted work, the subcontractor must notify you in writing of the decertification date. If a subcontractor becomes a certified DBE before completing subcontracted work, the subcontractor must notify you in writing of the certification date. Submit the notifications. On work completion, complete a *Disadvantaged Business Enterprises (DBE) Certification Status Change* form. Submit the form within 90 days of Contract acceptance.

Upon work completion, complete a *Final Report – Utilization of Disadvantaged Business Enterprises (DBE), First-Tier Subcontractors* form. Submit it within 90 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) Underutilized Disadvantaged Business Enterprises

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

UDBEs must perform work or supply materials as listed in the *Caltrans Bidder - UDBE - Commitment* form.

Do not terminate a UDBE listed subcontractor for convenience and perform the work with your own forces or obtain materials from other sources without written 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 UDBE 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 UDBE fails to meet your bond requirements.
3. Work requires a contractors license and the listed UDBE does not have a valid license under Contractors License Law.
4. Listed UDBE fails or refuses to perform the work or furnish the listed materials.
5. Listed UDBE's work is unsatisfactory and not in compliance with the Contract.
6. Listed UDBE delays or disrupts the progress of the work.
7. Listed UDBE becomes bankrupt or insolvent.

If a listed UDBE is terminated, you must make good faith efforts to find another UDBE to substitute for the original UDBE. The substitute UDBE must perform at least the same amount of work as the original UDBE under the Contract to the extent needed to meet the UDBE goal.

The substitute UDBE must be certified as a DBE at the time of request for substitution.

Unless the Department authorizes (1) a request to use other forces or sources of materials or (2) a good faith effort for a substitution of a terminated UDBE, the Department does not pay for work listed on the *Caltrans Bidder - UDBE - Commitment* form unless it is performed or supplied by the listed UDBE or an authorized substitute.

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 for a substitution.

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

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 Contract 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. The representative must submit contact information (name, 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 fees and costs associated with obtaining them. Submit copies of Contractor-obtained after-award PLACs for review.

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 property use
   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

Reserved

5-1.20D–5-1.20F 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.

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 any omission.

Convert foreign language documents to English and U.S. customary units.

5-1.23B Action Submittals

5-1.23B(1) General

Action submittals include:

1. Shop drawings
2. Product data
3. Samples
4. Test samples
5. Quality control plans
6. Work plans
7. Material sources
8. Test data, test results, and evaluation reports

Maintain a sequential list of 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.

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

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.

Do not change the scope of work on revised submittals.

The Department's authorization of a 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 minimum of 20 lb paper
3. Have text of 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 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 deficiencies
2. Stamps the drawings with the date that the review stopped
3. Returns the drawings

For complete resubmitted drawings, allow 20 days for the review. Show 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 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) Product Data

Reserved

5-1.23B(4) Samples

Reserved

5-1.23B(5) Test Samples

For test samples, comply with section 6-3.05G.

If requested, obtain the Department's authorization for the material before incorporating the material represented by the test sample into the work.

5-1.23B(6) Quality Control Plans

Submit 7 copies of each authorized QC plan and make 1 copy available at each location where work is performed.

5-1.23B(7) Work Plans

Reserved

5-1.23C Informational Submittals

Informational submittals include:

1. Assignments
2. Certificates of compliance
3. Manufacturer instructions not associated with drawing submittals
4. Notifications
5. PLACs
6. Subcontracts

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 staking area is ready for stakes
2. On a *Request for Construction Stakes* 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 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. 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 corresponding vendor's invoice copies
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 does not comply with the Contract, is unauthorized, or 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.

The Department may reduce payment for noncompliant work left in place.

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 weekly.
2. Furnish trash bins for debris from construction. Place debris in trash bins daily.
3. Stack forms for falsework to be reused 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

Clearly 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 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. Division of Measurement Standards Official

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

Group 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 property and facilities, including:

1. Adjacent property
2. Department's instrumentation
3. ESAs
4. Lands administered by other agencies
5. Railroads and railroad equipment
6. Roadside vegetation not to be removed
7. Temporary work
8. Utilities
9. Waterways

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

Maintain temporary facilities until they are no longer needed.

Dispose of temporary facilities when 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 surrounding materials and grade surface to match the existing grade and cross slope.

5-1.36B 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 period is specified, replace plants before the start of the plant establishment period; otherwise, replace plants at least 30 days before Contract acceptance.

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

5-1.36C 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 railroad facilities. Instead of the 15 days specified in section 5-1.23B, allow 65 days for the review of the plans.

5-1.36D Nonhighway Facilities

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.

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

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.

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 described, finding the infrastructure is change order work.

Underground infrastructure described in the Contract may be in different locations from 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.

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

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. The Department does not adjust time or payment for rearrangement different from that described the Contract
5. Pay the infrastructure owner any additional cost

Immediately notify the Engineer of a delay due to:

1. The presence of main line underground infrastructure not described in the Contract or in a substantially different location
2. Rearrangement different from that described the Contract

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.

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 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 in a way that prevents jolting and bouncing of the equipment while crossing the bridge.
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. At most 1 piece of equipment may be 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 on a completed work portion. The work portion must have been completed under the Contract and to the Engineer's satisfaction. Work parts eligible for relief include:

1. Completed 0.3 mi of roadway or 0.3 mi 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 portion of work. On a relieved portion of work, you are not responsible for damage, 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.

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 specified in the special provisions. Perform work specified in section 5-1.39C(2) as ordered.

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 days. Proceed with the work unless otherwise ordered. You may protest the Engineer's response by:

1. Submitting an *Initial Potential Claim Record* within 5 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 impacts of potentially claimed work or event.

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*
2. *Supplemental Potential Claim Record*
3. *Full and Final Potential Claim Record*

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

The Engineer responds within 5 days of receiving the *Initial Potential Claim Record*. Proceed with the potentially claimed work 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*, submit a *Supplemental Potential Claim Record* including:

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

The Engineer evaluates the *Supplemental Potential Claim Record* and furnishes you a response 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* 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* including:

1. A 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. The Contract documents supporting the potential claim and a statement of the reasons these parts support entitlement
3. If a payment adjustment is requested, an itemized cost breakdown. 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. 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, cancelled 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* that does not have the same nature, circumstances, and basis of claim as those specified on the *Initial Potential Claim Record* and *Supplemental Potential Claim Record*.

The Engineer evaluates the information presented in the *Full and Final Potential Claim Record* and furnishes you a response within 30 days of its receipt unless the *Full and Final Potential Claim Record* is submitted after Contract acceptance, in which case, a response may not be furnished. The Engineer's receipt of the *Full and Final Potential Claim Record* 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 working days.

"The parties" in section 5-1.43E means you and the Department.

"Dispute meeting" in section 5-1.43E refers to both the traditional and informal dispute meeting processes.

The alternative dispute resolution 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. You must comply with section 5-1.43E(2)(d). You may comply with section 5-1.43E(1)(d).

The alternative dispute resolution process is not a substitute for the submitting of an RFI or a potential claim record.

Do not use the alternative dispute resolution 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 potential claim.

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

You, the Department, and the DRA or DRB must complete and comply with the *Dispute Resolution Advisor Agreement* or *Dispute Resolution Board Agreement*. For these agreement forms, go to the Department's Division of Construction Web site.

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

5-1.43E(1)(b) 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)(c) Dispute Meetings

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

Either you or the Department may refer a dispute to the DRA or DRB. To request a dispute meeting, 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 discrete segments are differentiated. 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 provides the DRA or DRB with the Contract documents and provides conference facilities for meetings at no cost to you.

Neither you nor the Department may meet with or discuss Contract issues with the DRA or DRB members unless the other party is present.

Only the Engineer, the Department's area construction engineer, or the Department's structure representative and your superintendent or project manager may present information at a dispute meeting. If the dispute involves a subcontractor, the subcontractor's superintendent or project manager must be present at the dispute meeting and may present information.

Only persons who are directly involved with the Contract and who have direct knowledge of the dispute may participate in the dispute meeting. No participation of either party's attorney is allowed. However, you and the Department may agree to a request from the DRA or DRB for participation of a person not associated with the Contract to provide technical services if the services are necessary to help the DRA or DRB make a recommendation.

If the DRA or DRB needs outside technical services, you and the Department must agree to the services before they are acquired. If you, the Department, and the DRA or DRB agree, the technical services may be provided by technical staff who works for you or the Department.

During a dispute meeting, each party presents its position, makes rebuttals, provides 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 argument.

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

You and the Department may resolve small and uncomplicated disputes using an informal process. You and the Department may use this process only if you, the Department, 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.

You and the Department must each furnish 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.

You and the Department may ask for clarification of the DRA's or DRB's recommendation within 5 days of the dispute meeting.

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 settled using the informal dispute meeting process, continue to comply with section 5-1.43E(2)(d).

5-1.43E(1)(e) Recommendations

Recommendations resulting from the alternative dispute resolution process are nonbinding.

If you and the Department resolve the dispute with the aid of the DRA's or DRB's recommendation, implement the resolution.

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

All alternative dispute resolution activities must be completed before Contract acceptance. Accelerated timeframes may be used if you, the Department, and the DRA or DRB agree.

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

Neither you nor the Department 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.

You and the Department must jointly 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)(g) Payment

Pay the DRA or each DRB member $1,500 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 one Department DRA or DRB, the $1,500 must be divided evenly among the contracts:

On-site meetings include:

1. Meeting at the start of the project
2. Scheduled progress meetings for a project with a DRB
3. Dispute meetings

This payment includes full compensation for onsite 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 plans and specifications, evaluating positions, preparing recommendations, or performs any other off-site DRA- or DRB-related tasks, you and the Department must agree to pay for the tasks. Pay the DRA or DRB member $150 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 technical services agreed to. Submit a change order bill and associated invoices with original supporting documents in the form of a cancelled check or bank statement to receive reimbursement. Do not add mark-ups to the change order bill.

The Department does not pay for any DRA- or DRB-related work performed after Contract acceptance.

The Department does not pay your cost of preparing for and attending a dispute resolution meeting.

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.

The DRA is a single-member board you and the Department establish.

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

Within 30 days of Contract approval, you and the Department must select the DRA using the following procedure:

1. You and the Department each 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 Web site 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 this 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. You and the Department must request a disclosure statement from each nominated DRA candidate and must furnish the 3 statements 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. Parties involved in the Contract
      2.2.2. Parties' principals
      2.2.3. Parties' counsel
      2.2.4. Associated subcontractors and suppliers
3. You and the Department must select 1 of the 6 candidates to be the DRA. If you and the Department cannot agree on 1 candidate, you and the Department each 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 notice of at least 15 days if:

1. The DRA resigns.
2. Either you or the Department replaces the DRA for failing to fully comply at all times 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 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 days after receiving the Engineer's response to your *Supplemental Potential Claim Record*. The dispute meeting must be scheduled no later than 25 days after of the DRA receives the referral unless you and the Department 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 days after the dispute meeting, the party receiving the request must furnish this information within 5 days of receiving the request.

The DRA provides a written recommendation report within 10 days of the dispute meeting unless you and the Department agree to allow more time.

Within 5 days of receiving the DRA's recommendation report, either you or the Department may request clarification of any part of the report. Only one request for clarification from each party is allowed per dispute.

Within 10 days after receiving the DRA's recommendation report, 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 report. Only one reconsideration request from each party is allowed per dispute.

If both you and the Department accept the DRA's recommendation but cannot agree on the time or payment adjustment within 30 days of 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.

The DRB is a 3-member board that you and the Department establish.

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

Within 45 days of Contract approval, you and the Department must select DRB members and establish the DRB using the following procedure:

1. You and the Department each nominates a DRB member candidate who is on the Department's approved list. For the list of approved member candidates, go to the Department's Division of Construction Web site. If you or the Department nominates someone who is not on that list, the candidate 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 this 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. You and the Department must request a disclosure statement from each nominated DRB member candidate and must each furnish it to the other party. The 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. Parties involved in the Contract
     - 2.2.2. Parties' principals
     - 2.2.3. Parties' counsel
     - 2.2.4. Associated subcontractors and suppliers
3. You and the Department are allowed:
   - 3.1. A one-time objection to the other's candidate
   - 3.2. An objection to the other's candidate based on a specific breach of the candidate's responsibilities or qualifications under items 1 and 2 above.
4. If you or the Department objects to the other's candidate, the party who's 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. You and the Department each provide written notification to your selected DRB member.
7. Within 15 days of their notifications, the selected DRB members recommend to you and the Department the 3rd DRB member candidate and provide that candidate's disclosure statement.
8. Within 15 days of the recommendation, you and the Department must each notify the first 2 DRB members whether you approve or disapprove 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 you and the Department for final selection and approval.

10. If the 2 DRB members do not recommend a 3rd DRB candidate within 15 days of notification of their selections, or if you and the Department do not agree on the 3rd DRB member candidate within 15 days of the recommendation, or if you and the Department do not agree on any of the candidates on the list provided by the first 2 selected DRB members, you and the Department each 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 you and the Department 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 service of a DRB member may end at any time with notice of at least 15 days if:

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. You or the Department replace any member who fails to comply with specified employment or financial disclosure conditions of DRB membership

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

A DRB member replacement is selected the same way as the original DRB member selection. Selecting a replacement DRB member must start upon determination of the need for 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 Progress Meetings

You and the Department must periodically meet with the DRB and visit the job site so the DRB members can keep abreast of construction activities and develop familiarity with the work in progress.

The progress meetings must occur at the start of the project and at least once every 4 months after that.

Both parties must attend each progress meeting.

You and the Department may agree to waive scheduled progress meetings when the only work remaining is plant establishment.

5-1.43E(3)(e) 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 later than 60 days after the DRB receives the referral unless you and the Department otherwise agree.

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

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

The DRB provides a written recommendation report within 30 days of the dispute meeting unless you and the Department agree to allow more time.

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

Within 30 days after receiving the DRB's recommendation report, each party must furnish a written response to the DRB 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 30 days after receiving the DRB's recommendation report. Only one request for reconsideration from each party is allowed per dispute.

If both you and the Department accept the DRB's recommendation but cannot agree on the time or payment adjustment within 60 days of 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 6-3.06

5-1.47–5-1.50 RESERVED

6 CONTROL OF MATERIALS

6-1 GENERAL

6-1.01 GENERAL

Section 6 includes specifications related to control of materials.

6-2 MATERIAL SOURCE

6-2.01 GENERAL

Material incorporated into the work must be new.

6-2.02 MATERIAL SOURCE

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

6-2.03 DEPARTMENT-FURNISHED MATERIALS

Request Department-furnished material 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 Department-furnished material. The Department deducts replacement costs. Department-furnished material not used in the work remains the property of the Department.

6-2.04 LOCAL MATERIALS

Local material must be:

1. Mineral material, including rock, sand, or gravel, or earth
2. Selected material or material procured from an established commercial source and not local borrow
3. Procured or produced from a source in the work vicinity specifically for project use

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 test costs.

6-2.05 BUY AMERICA

6-2.05A General

Reserved

6-2.05B Crumb Rubber (Pub Res Code § 42703(D))

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

1. Produced in the U.S
2. Derived from waste tires taken from vehicles owned and operated in the U.S

6-2.05C Steel and Iron Materials (23 CFR 635.410)

Section 6-2.05C applies to a federal-aid contract.

Furnish steel and iron materials to be incorporated into the work with certificates of compliance. Steel and iron materials must be produced in the U.S. 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 [60 Fed Reg 15478 (03/24/1995)]

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 U.S. may be used

Production includes:

1. Processing steel and iron materials, including smelting or other processes that alter the physical form or shape (such as rolling, extruding, machining, bending, grinding, and drilling) or chemical composition
2. Coating application, including epoxy coating, galvanizing, and painting, that protects or enhances the value of steel and iron materials

6-3 QUALITY

6-3.01 GENERAL

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

6-3.02 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

6-3.03 AUTHORIZED LABORATORY LISTS

Section 6-3.03 applies where an authorized laboratory is specified to be on an Authorized Laboratory List.

For procedures to be included on an Authorized Laboratory List, go to the METS Web site.

6-3.04 QUALITY CONTROL

Material production and testing equipment must measure accurately and precisely.

Prepare and maintain QC records, including:

1. Inspection types, results, and dates
2. Testing types, results, and dates
3. Inspector names and certificates
4. Acceptance criteria
5. Corrective actions

6-3.05 QUALITY ASSURANCE

6-3.05A General

The Department may use multiple QA methods for a material.

Allow the Department to record, including photograph and video record, to ensure a material is produced to comply with the Contract.

You may examine the records and reports of tests the Department performs if they are available at the job site.

Schedule work to allow time for QA.

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.

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 property shown in the following table, the Department tests under the corresponding California Test shown:

California Tests

Property	California Test
Relative compaction	216 or 231
Sand equivalent	217
Resistance (R-value)	301
Grading (sieve analysis)	202
Durability index	229

6-3.05B Source Inspection Expense Deductions

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 Prestressing system Precast concrete members specified section 11-2 Epoxy-coated reinforcement Structural steel for sign structures Miscellaneous metal	> 300 > 3,000	$5,000 $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 > 3,000	The greater of: 1. $5,000 2. $0.02/lb The greater of: 1. $8,000 2. $0.036/lb
Structural steel paint	> 300 > 3,000	The greater of: 1. $2,000 2. $0.01/sq ft The greater of: 1. $5,000 2. $0.015/sq ft
Check samples	> 300	$2,000
High mast poles	> 300 > 3,000	$2,500 $5,000
PTFE bearings, ≤ 2 lots	> 300 > 3,000	$5,000 $15,000
PTFE bearings, > 2 lots	> 300 > 3,000	$10,000 $20,000

[a]Distance is air-line miles from both Sacramento and Los Angeles to the inspection source.

6-3.05C Material Source Inspection and Testing

Section 6-3.05C 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 U.S.
3. 50 days before the planned production start for a material source outside the U.S. 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 Web site. Notify the Engineer of each submittal.

6-3.05D Job Site Inspection and Testing

Section 6-3.05D 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.

6-3.05E Certificates of Compliance

Section 6-3.05E applies (1) where a certificate of compliance is specified and (2) if any material is produced outside the U.S.

Submit a certificate:

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.

6-3.05F Test Data, Test Reports, and Evaluation Reports

Reserved

6-3.05G Test Samples

Section 6-3.05G 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 Web site.

Restore work immediately after sampling.

6-3.05H Reserved

6-3.05I Authorized Facility Audit Lists

Section 6-3.05I 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 METS Web site.

6-3.05J Quality Control Plans

Reserved

6-3.05K Authorized Material Lists

Section 6-3.05K 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 METS Web site.

6-3.05L Authorized Material Source Lists

Section 6-3.05L 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 METS Web site.

6-3.06 GUARANTEE

Guarantee that work remains free from substantial defects for 1 year after Contract acceptance except for work portions for which you were relieved of maintenance and protection. Guarantee each of these relieved work portions 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 portion 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. Expiration of guarantee period
2. Completion of corrective work

If a warranty specification conflicts with section 6-3.06, 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 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 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 emergency repair work

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

7 LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

7-1.01 GENERAL

Section 7 includes specifications regarding 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 U.S. 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 Regs §§ 8107 and 8203:

1. During the performance of this contract, contractor and its subcontractors shall not unlawfully discriminate against any employee or applicant for employment because of race, religion, color, national origin, ancestry, physical handicap, medical condition, marital status, age (over 40) or sex. Contractors and subcontractors shall insure that the evaluation and treatment of their employees and applicants for employment are free of such discrimination. Contractors and subcontractors shall comply with the provisions of the Fair Employment and Housing Act (Gov. Code, Section 12900 et seq.) and the applicable regulations promulgated thereunder (Cal. Admin. Code, Tit. 2, Section 7285.0 et seq.). The applicable regulations of the Fair Employment and Housing Commission implementing Government Code, Section 12990, set forth in Chapter 5 of Division 4 of Title 2 of the California Administrative Code are incorporated into this contract by reference and made a part hereof as if set forth in full. 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.
2. This Contractor shall include the nondiscrimination and compliance provisions of this clause in all subcontracts to perform work under the contract.

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. "Administrator" means Administrator, Office of Compliance Programs, California Department of Fair Employment and Housing, or any person to whom the Administrator delegates authority;
   b. "Minority" includes:
      (i) Black (all persons having primary origins in any of the black racial groups of Africa, but not of Hispanic origin);
      (ii) Hispanic (all persons of primary culture or origin in Mexico, Puerto Rico, Cuba, Central or South America or other Spanish derived culture or origin regardless of race);
      (iii) Asian / Pacific Islander (all persons having primary origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent or the Pacific Islands); and
      (iv) American Indian / Alaskan Native (all persons having primary origins in any of the original peoples of North America and who maintain culture identification through tribal affiliation or community recognition).
2. Whenever the contractor or any subcontractor subcontracts a portion of the work, it shall physically 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 paragraph 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 either minorities or women 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.
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, where possible, will assign two or more women to each construction project. 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, with specific attention to minority or female individuals working at such sites or in such facilities.
   b. Provide written notification within seven days to the director of DFEH when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or woman sent by the Contractor, or when the Contractor has other information that the union referral process 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 which 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 the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and female workforce participation, and can provide access to documentation which 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 minority groups, both male and female, and all women, both minority and non-minority. Consequently, the Contractor may be in violation of the Fair Employment and Housing Act (Gov. Code, Section 12990 et seq.) if a particular group is employed in a substantially disparate manner.
9. Establishment and implementation of a bona fide affirmative action plan pursuant to Section 8104 (b) of this Chapter shall create a rebuttal presumption that a contractor is in compliance with the requirements of Section 12990 of the Government Code and its implementing regulations.
10. The Contractor shall not use the nondiscrimination standards to discriminate against any person because of race, color, religion, sex, national origin, ancestry, physical handicap, medical condition, marital status or age over 40.
11. The Contractor shall not enter into any subcontract with any person or firm decertified from state contracts pursuant to Government Code Section 12990.
12. 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.
13. 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, social security number, race, sex, 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 §§ 1727 and 1770–1815 and 8 CA Code of Regs § 16000 et seq. Work includes roadside production and processing of materials.

Payroll records include time cards, cancelled 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' Web site

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 $50 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. The prior record of the Contractor or subcontractor in meeting its prevailing wage obligations
3. The 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* signed under penalty of perjury that declares:

1. The information contained in the payroll record is true, correct, and complete
2. The 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. The 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.

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 format. 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 Web site.

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 $25 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 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.

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. 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

	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)–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 the submittal of a lead compliance plan is specified in the special provisions.

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. Signed and sealed by a CIH

Allow 7 days for the Engineer's 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–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) 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 Web site.

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–7-1.02Q Reserved

7-1.02R Environmental Stewardship

Comply with section 14.

7-1.02S–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 water or dust palliative for the prevention or alleviation of dust nuisance.

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.

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 operations 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. 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 in a manner which the illumination and the illumination equipment does 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 20 days and not more than 90 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 12-3.06 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.

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.

Where 2 or more lanes in the same direction are adjacent to the area where the work is being performed, including shoulders, the adjacent lane must be closed 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 miles per hour
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 miles per hour

Closure of the adjacent traffic lane is not required when performing any of the following:

1. Working behind a barrier

2. Paving, grinding, or grooving
3. Installing, maintaining, or removing traffic control devices except Type K temporary railing

Do not reduce an open traffic lane width to less than 10 feet. When 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.

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 lane 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.

7-1.06 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 § 337.15.

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 certification submittal.

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 U.S. 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 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.

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.

Form FHWA-1273 is included in the Contract in section 7-1.11B. Some Contract terms on the form are different from those used in other Contract parts as shown in the following table:

FHWA-1273 Terms and Department Equivalencies

FHWA-1273 term	Equivalent term used in other Contract parts
proposal	bid
SHA	Department
SHA contracting officer	Engineer
SHA resident engineer	Engineer
special provision	specification

7-1.11B FHWA-1273

FHWA-1273 Electronic version -- March 10, 1994
with revised Section VI

REQUIRED CONTRACT PROVISIONS
FEDERAL-AID CONSTRUCTION CONTRACTS

I. General
II. Nondiscrimination
III. Nonsegregated Facilities
IV. Payment of Predetermined Minimum Wage
V. Statements and Payrolls
VI. Record of Materials, Supplies, and Labor

VII. Subletting or Assigning the Contract
VIII. Safety: Accident Prevention
IX. False Statements Concerning Highway Projects
X. Implementation of Clean Air Act and Federal Water Pollution Control Act
XI. Certification Regarding Debarment, Suspension, Ineligibility, and Voluntary Exclusion
XII. Certification Regarding Use of Contract Funds for Lobbying

ATTACHMENTS

A. Employment Preference for Appalachian Contracts (included in Appalachian contracts only)

I. **GENERAL**

1. 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.
2. Except as otherwise provided for in each section, the contractor shall insert in each subcontract all of the stipulations contained in these Required Contract Provisions, and further require their inclusion in any lower tier subcontract or purchase order that may in turn be made. The Required Contract Provisions shall not be incorporated by reference in any case. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with these Required Contract Provisions.
3. A breach of any of the stipulations contained in these Required Contract Provisions shall be sufficient grounds for termination of the contract.
4. A breach of the following clauses of the Required Contract Provisions may also be grounds for debarment as provided in 29 CFR 5.12:
   Section I, paragraph 2;
   Section IV, paragraphs 1, 2, 3, 4, and 7;
   Section V, paragraphs 1 and 2a through 2g.
5. Disputes arising out of the labor standards provisions of Section IV (except paragraph 5) and Section V of these Required Contract Provisions shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the U.S. Department of Labor (DOL) as set forth in 29 CFR 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 DOL, or the contractor's employees or their representatives.
6. **Selection of Labor:** During the performance of this contract, the contractor shall not:
   a. discriminate against labor from any other State, possession, or territory of the United States (except for employment preference for Appalachian contracts, when applicable, as specified in Attachment A), or
   b. employ convict labor for any purpose within the limits of the project unless it is labor performed by convicts who are on parole, supervised release, or probation.

II. **NONDISCRIMINATION**

(Applicable to all Federal-aid construction contracts and to all related subcontracts of $10,000 or more.)

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 and 41 CFR 60) 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 Equal Opportunity Construction Contract Specifications set forth under 41 CFR 60-4.3 and the provisions of the American 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 State highway agency (SHA) and the Federal Government in carrying out EEO obligations and in their review of his/her activities under the contract.
   b. The contractor will accept as his 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, preapprenticeship, and/or on-the-job training."

2. **EEO Officer:** The contractor will designate and make known to the SHA contracting officers an EEO Officer who will have the responsibility for and must be capable of effectively administering and promoting an active contractor program of EEO 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 minority group employees.
    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 minority groups 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 minority group applicants. To meet this requirement, the contractor will identify sources of potential minority group employees, and establish with such identified sources procedures whereby minority group 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, he is expected to observe the provisions of that agreement to the extent that the system permits the contractor's compliance with EEO contract provisions. (The DOL has held that where implementation of such agreements have the effect of discriminating against minorities or women, or obligates the contractor to do the same, such implementation violates Executive Order 11246, as amended.)
    c. The contractor will encourage his present employees to refer minority group applicants for employment. Information and procedures with regard to referring minority group 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 his 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 his avenues of appeal.

6. **Training and Promotion:**
a. The contractor will assist in locating, qualifying, and increasing the skills of minority group and women employees, and applicants for employment.
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. Where feasible, 25 percent of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training. In the event a special provision for training is provided under this contract, this subparagraph will be superseded as indicated in the special provision.
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 minority group and women employees 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 his/her best efforts to obtain the cooperation of such unions to increase opportunities for minority groups and women within the unions, and to effect referrals by such unions of minority and female employees. 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 best efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minority group members and women for membership in the unions and increasing the skills of minority group employees and women so that they may qualify for higher paying employment.
b. The contractor will use best 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 SHA 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 minority and women 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 minority group persons and women. (The DOL has held that it shall be no excuse that the union with which the contractor has a collective bargaining agreement providing for exclusive referral failed to refer minority employees.) In the event the union referral practice prevents the contractor from meeting the obligations pursuant to Executive Order

11246, as amended, and these specifications, such contractor shall immediately notify the SHA.

8. **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.
   a. The contractor shall notify all potential subcontractors and suppliers of his/her EEO obligations under this contract.
   b. Disadvantaged business enterprises (DBE), as defined in 49 CFR 23, shall have equal opportunity to compete for and perform subcontracts which the contractor enters into pursuant to this contract. The contractor will use his best efforts to solicit bids from and to utilize DBE subcontractors or subcontractors with meaningful minority group and female representation among their employees. Contractors shall obtain lists of DBE construction firms from SHA personnel.
   c. The contractor will use his best efforts to ensure subcontractor compliance with their EEO obligations.
9. **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 completion of the contract work and shall be available at reasonable times and places for inspection by authorized representatives of the SHA and the FHWA.
   a. The records kept by the contractor shall document the following:
      1. The number 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;
      3. The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minority and female employees; and
      4. The progress and efforts being made in securing the services of DBE subcontractors or subcontractors with meaningful minority and female representation among their employees.
   b. The contractors will submit an annual report to the SHA 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. If on-the-job training is being required by special provision, the contractor will be required to collect and report training data.

III. **NONSEGREGATED FACILITIES**

(Applicable to all Federal-aid construction contracts and to all related subcontracts of $10,000 or more.)

a. By submission of this bid, the execution of this contract or subcontract, or the consummation of this material supply agreement or purchase order, as appropriate, the bidder, Federal-aid construction contractor, subcontractor, material supplier, or vendor, as appropriate, certifies that the firm does not maintain or provide for its employees any segregated facilities at any of its establishments, and that the firm does not permit its employees to perform their services at any location, under its control, where segregated facilities are maintained. The firm agrees that a breach of this certification is a violation of the EEO provisions of this contract. The firm further certifies that no employee will be denied access to adequate facilities on the basis of sex or disability.

b. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, restrooms and washrooms, restaurants and other eating areas, timeclocks, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive, or are, in fact, segregated on the basis of race, color, religion, national origin, age or disability, because of habit, local custom, or otherwise. The only exception will be for the disabled when the demands for accessibility override (e.g. disabled parking).

c. The contractor agrees that it has obtained or will obtain identical certification from proposed subcontractors or material suppliers prior to award of subcontracts or consummation of

material supply agreements of $10,000 or more and that it will retain such certifications in its files.

IV. **PAYMENT OF PREDETERMINED MINIMUM WAGE**

(Applicable to all Federal-aid construction contracts exceeding $2,000 and to all related subcontracts, except for projects located on roadways classified as local roads or rural minor collectors, which are exempt.)

1. **General:**

a. All mechanics and laborers 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 (29 CFR 3) issued by the Secretary of Labor under the Copeland Act (40 U.S.C. 276c)] the full amounts of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment. The payment shall be computed at wage rates not less than those contained in the wage determination of the Secretary of Labor (hereinafter "the wage determination") which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor or its subcontractors and such laborers and mechanics. The wage determination (including any additional classifications and wage rates conformed under paragraph 2 of this Section IV and the DOL poster (WH-1321) or Form FHWA-1495) 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. For the purpose of this Section, contributions made or costs reasonably anticipated for bona fide fringe benefits under Section 1(b) (2) of the Davis- Bacon Act (40 U.S.C. 276a) on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of Section IV, paragraph 3b, hereof. Also, for the purpose of this Section, 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 paragraphs 4 and 5 of this Section IV.

b. 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.

c. All rulings and interpretations of the Davis-Bacon Act and related acts contained in 29 CFR 1, 3, and 5 are herein incorporated by reference in this contract.

2. **Classification:**

a. The SHA contracting officer shall require that any class of laborers or mechanics employed under the contract, which is not listed in the wage determination, shall be classified in conformance with the wage determination.

b. The contracting officer shall approve an additional classification, wage rate and fringe benefits only when the following criteria have been met:

1. the work to be performed by the additional classification requested is not performed by a classification in the wage determination;
2. the additional classification is utilized in the area by the construction industry;
3. the proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination; and
4. with respect to helpers, when such a classification prevails in the area in which the work is performed.

c. If the contractor or subcontractors, as appropriate, the laborers and mechanics (if known) to be employed in the additional classification 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 DOL, Administrator of the Wage and Hour Division, Employment Standards Administration, Washington, D.C. 20210. The Wage and Hour 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.

d. In the event the contractor or subcontractors, as appropriate, the laborers or mechanics to be employed in the additional 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. Said 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.

e. The wage rate (including fringe benefits where appropriate) determined pursuant to paragraph 2c or 2d of this Section IV shall be paid to all workers performing work in the additional classification from the first day on which work is performed in the classification.

3. **Payment of Fringe Benefits:**

a. 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 or subcontractors, as appropriate, shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly case equivalent thereof.

b. If the contractor or subcontractor, as appropriate, does not make payments to a trustee or other third person, he/she may consider as a 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.

4. **Apprentices and Trainees (Programs of the U.S. DOL) and Helpers:**

a. Apprentices:

1. 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 DOL, Employment and Training Administration, Bureau of Apprenticeship and Training, or with a State apprenticeship agency recognized by the Bureau, or if a person is employed in his/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 Bureau of Apprenticeship and Training or a State apprenticeship agency (where appropriate) to be eligible for probationary employment as an apprentice.

2. The allowable ratio of apprentices to journeyman-level employees 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 employee 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 listed in 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 or subcontractor 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-level hourly rate) specified in the contractor's or subcontractor's registered program shall be observed.

3. 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 journeyman-level 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 for the Wage and Hour Division determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination.

4. In the event the Bureau of Apprenticeship and Training, or a State apprenticeship agency recognized by the Bureau, withdraws approval of an apprenticeship program, the contractor or subcontractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the comparable work performed by regular employees until an acceptable program is approved.

b. Trainees:

1. 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 DOL, Employment and Training Administration.

2. The ratio of trainees to journeyman-level employees on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. 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.

3. Every trainee must be paid at not less than the rate specified in the approved program for his/her level of progress, expressed as a percentage of the journeyman-level 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-level wage rate on the wage determination which provides for less than full fringe benefits for apprentices, in which case such trainees shall receive the same fringe benefits as apprentices.

4. In the event the Employment and Training Administration withdraws approval of a training program, the contractor or subcontractor 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. Helpers:

Helpers will be permitted to work on a project if the helper classification is specified and defined on the applicable wage determination or is approved

pursuant to the conformance procedure set forth in Section IV.2. Any worker listed on a payroll at a helper wage rate, who is not a helper under an approved definition, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed.

5. **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.

6. **Withholding:**

The SHA shall upon its own action or upon written request of an authorized representative of the DOL withhold, or cause to be withheld, from the contractor or subcontractor 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, as 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 SHA contracting officer 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.

7. **Overtime Requirements:**

No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers, mechanics, watchmen, or guards (including apprentices, trainees, and helpers described in paragraphs 4 and 5 above) shall require or permit any laborer, mechanic, watchman, or guard in any workweek in which he/she is employed on such work, to work in excess of 40 hours in such workweek unless such laborer, mechanic, watchman, or guard receives compensation at a rate not less than one-and-one-half times his/her basic rate of pay for all hours worked in excess of 40 hours in such workweek.

8. **Violation:**

Liability for Unpaid Wages; Liquidated Damages: In the event of any violation of the clause set forth in paragraph 7 above, the contractor and any subcontractor responsible thereof shall be liable to the affected employee for his/her 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, mechanic, watchman, or guard employed in violation of the clause set forth in paragraph 7, in the sum of $10 for each calendar day on which such employee was required or permitted to work in excess of the standard work week of 40 hours without payment of the overtime wages required by the clause set forth in paragraph 7.

9. **Withholding for Unpaid Wages and Liquidated Damages:**

The SHA shall upon its own action or upon written request of any authorized representative of the DOL withhold, or cause to be withheld, from any monies 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 8 above.

V. **STATEMENTS AND PAYROLLS**

(Applicable to all Federal-aid construction contracts exceeding $2,000 and to all related subcontracts, except for projects located on roadways classified as local roads or rural collectors, which are exempt.)

1. **Compliance with Copeland Regulations (29 CFR 3):**

The contractor shall comply with the Copeland Regulations of the Secretary of Labor which are herein incorporated by reference.

2. **Payrolls and Payroll Records:**

a. Payrolls and basic records relating thereto shall be maintained by the contractor and each subcontractor during the course of the work and preserved for a period of 3 years from the date of completion of the contract for all laborers, mechanics, apprentices, trainees, watchmen, helpers, and guards working at the site of the work.

b. The payroll records shall contain the name, social security number, and address of each such employee; his or her correct classification; hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalent thereof 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. In addition, for Appalachian contracts, the payroll records shall contain a notation indicating whether the employee does, or does not, normally reside in the labor area as defined in Attachment A, paragraph 1. Whenever the Secretary of Labor, pursuant to Section IV, paragraph 3b, has found 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 and each subcontractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, that the plan or program has been communicated in writing to the laborers or mechanics affected, and show the cost anticipated or the actual cost incurred in providing benefits. Contractors or subcontractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprentices and trainees, and ratios and wage rates prescribed in the applicable programs.

c. Each contractor and subcontractor shall furnish, each week in which any contract work is performed, to the SHA resident engineer a payroll of wages paid each of its employees (including apprentices, trainees, and helpers, described in Section IV, paragraphs 4 and 5, and watchmen and guards engaged on work during the preceding weekly payroll period). The payroll submitted shall set out accurately and completely all of the information required to be maintained under paragraph 2b of this Section V. This information may be submitted in any form desired. Optional Form WH-347 is available for this purpose and may be purchased from the Superintendent of Documents (Federal stock number 029- 005-0014-1), U.S. Government Printing Office, Washington, D.C. 20402. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors.

d. Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his/her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

1. that the payroll for the payroll period contains the information required to be maintained under paragraph 2b of this Section V and that such information is correct and complete;

2. that such 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 the Regulations, 29 CFR 3;

3. that each laborer or mechanic has been paid not less that the applicable wage rate and fringe benefits or cash equivalent for the classification of worked performed, as specified in the applicable wage determination incorporated into the contract.

e. 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 2d of this Section V.

f. The falsification of any of the above certifications may subject the contractor to civil or criminal prosecution under 18 U.S.C. 1001 and 31 U.S.C. 231.

g. The contractor or subcontractor shall make the records required under paragraph 2b of this Section V available for inspection, copying, or transcription by authorized representatives of the SHA, the FHWA, or the DOL, 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 SHA, the FHWA, the DOL, or all may, after written notice to the contractor, sponsor, applicant, or owner, take such actions 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.

VI. **RECORD OF MATERIALS, SUPPLIES, AND LABOR**

(As of May 22, 2007, Form FHWA-47 is no longer required.)

VII. **SUBLETTING OR ASSIGNING THE CONTRACT**

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 State. 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).
   a. "Its own organization" shall be construed to include only workers employed and paid directly 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, assignee, or agent of the prime contractor.
   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 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 VII 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 SHA 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 SHA 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 SHA has assured that each subcontract is evidenced in writing and that it contains all pertinent provisions and requirements of the prime contract.

VIII. **SAFETY: ACCIDENT PREVENTION**

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 SHA 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. 333).
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. 333).

IX. FALSE STATEMENTS CONCERNING HIGHWAY PROJECTS

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, the following notice 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:

NOTICE TO ALL PERSONNEL ENGAGED ON FEDERAL-AID HIGHWAY PROJECTS

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 not more that $10,000 or imprisoned not more than 5 years or both."

X. IMPLEMENTATION OF CLEAN AIR ACT AND FEDERAL WATER POLLUTION CONTROL ACT

(Applicable to all Federal-aid construction contracts and to all related subcontracts of $100,000 or more.)

By submission of this bid or the execution of this contract, or subcontract, as appropriate, the bidder, Federal-aid construction contractor, or subcontractor, as appropriate, will be deemed to have stipulated as follows:

1. That any facility that is or will be utilized in the performance of this contract, unless such contract is exempt under the Clean Air Act, as amended (42 U.S.C. 1857 et seq., as amended by Pub.L. 91-604), and under the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq., as amended by Pub.L. 92-500), Executive Order 11738, and regulations in implementation thereof (40 CFR 15) is not listed, on the date of contract award, on the U.S. Environmental Protection Agency (EPA) List of Violating Facilities pursuant to 40 CFR 15.20.

2. That the firm agrees to comply and remain in compliance with all the requirements of Section 114 of the Clean Air Act and Section 308 of the Federal Water Pollution Control Act and all regulations and guidelines listed thereunder.
3. That the firm shall promptly notify the SHA of the receipt of any communication from the Director, Office of Federal Activities, EPA, indicating that a facility that is or will be utilized for the contract is under consideration to be listed on the EPA List of Violating Facilities.
4. That the firm agrees to include or cause to be included the requirements of paragraph 1 through 4 of this Section X in every nonexempt subcontract, and further agrees to take such action as the government may direct as a means of enforcing such requirements.

XI. **CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION**

1. **Instructions for Certification - Primary Covered Transactions:**

(Applicable to all Federal-aid contracts - 49 CFR 29)

a. By signing and submitting this proposal, the prospective primary 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 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 primary 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 department or agency determined to enter into this transaction. If it is later determined that the prospective primary participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause of default.
d. The prospective primary participant shall provide immediate written notice to the department or agency to whom this proposal is submitted if any time the prospective primary 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," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of rules implementing Executive Order 12549. You may contact the department or agency to which this proposal is submitted for assistance in obtaining a copy of those regulations.
f. The prospective primary 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 primary 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 Transaction," provided by the department or agency entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.
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 may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the nonprocurement portion of the "Lists of Parties Excluded From

Federal Procurement or Nonprocurement Programs" (Nonprocurement List) which is compiled by the General Services Administration.

i. 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.

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.

* * * * *

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion--Primary Covered Transactions

1. The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:
   a. Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
   b. Have not within a 3-year period preceding this proposal been convicted of or had a civil judgement 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;
   c. 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 1b of this certification; and
   d. Have not within a 3-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

2. Where the prospective primary 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 Covered Transactions:**

(Applicable to all subcontracts, purchase orders and other lower tier transactions of $25,000 or more - 49 CFR 29)

   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," "primary covered transaction," "participant," "person," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of rules implementing Executive Order 12549. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations.

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.

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 may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the Nonprocurement List.

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 Covered Transactions:

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 participation in this transaction 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.

*** * * * ***

XII. **CERTIFICATION REGARDING USE OF CONTRACT FUNDS FOR LOBBYING**

(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 his or her bid or proposal that he or she 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 (Percent)
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 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 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 6000 Oxnard-Simi Valley-Ventura, CA CA Ventura 6780 Riverside-San Bernardino-Ontario, CA CA Riverside; CA San Bernardino 7480 Santa Barbara-Santa Maria-Lompoc, CA CA Santa Barbara Non-SMSA Counties CA Inyo; CA Mono; CA San Luis Obispo	 11.9 28.3 21.5 19.0 19.7 24.6
181	San Diego, CA: SMSA Counties 7320 San Diego, CA CA San Diego Non-SMSA Counties CA Imperial	 16.9 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 U.S. 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 is met:

1. It 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. It is registered with the U.S. 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 working days.

Before or at the preconstruction conference, submit a CPM baseline schedule.

For each schedule submittal:

1. Submit a plotted original, time-scaled network diagram on a sheet at least 8-1/2 by 11 inches with a title block and timeline
2. If a computer program is used to make the schedule, submit a read-only compact disc or other Engineer-authorized data-storage device containing the schedule data. Label the data storage 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 date 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 on 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 results in altering the critical path or extending 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 working days, (2) a total bid from $1 to $5 million, or (3) a total bid over $5 million and less than 100 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.

Submit compatible software for the Engineer's exclusive possession and use.

You are responsible for assuring that all activity sequences are logical and that each schedule shows a coordinated plan for complete performance 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. Changes to the schedule that change 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 the Engineer's 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 Contract.

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 the proposed schedule software to be used. After authorization of the proposed software, submit schedule software and original software instruction manuals.

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

The Engineer returns the schedule software to you before the final estimate. The Department pays you by force account for replacement of software or manuals damaged, lost, or stolen after submittal.

8-1.02C(3)(b) Computer Software Training

Instruct the Engineer in the use of the software and provide software support until Contract acceptance.

Within 15 days of Contract approval, provide a commercial training session for 2 Department employees in the use of the software at a location acceptable to the Engineer. For Primavera P6 software, the training session must be 8 hours. For other software, the training session must be 16 hours.

The Department recommends that you send at least 2 employees to the same training session to facilitate development of similar knowledge and skills in the use of the software.

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 the Engineer's 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 submittal is not complete until the computer software is installed for use.

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 Contract 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 working days.

Comply with section 8-1.02D(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 Contract 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 Contract completion date

A schedule submittal is complete only when all documents and data are submitted as specified in section 8-1.02D(4).

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 section 8-1.02D 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 the 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 Contract completion in less than 85 percent of the Contract 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 the Engineer 15 days after receipt to review 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 days from the date you receive the Engineer's response to your protest to submit an *Initial Potential Claim Record.*

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
   1.3. Submittal of schedule software
   1.4. Completion of required schedule-software training
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:

Topics	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*
Materials on hand	*Request for Payment for Materials on Hand*
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*
Subcontracting	*Subcontracting Request*
Surveying	*Survey Request*
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

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.

Submit a notice 72 hours before starting job site activities. If the project has more than 1 location of work, 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 72-hour notice
3. Obtain an encroachment permit from the Department
4. Are authorized by the Department 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 starting before the 1st working day.

8-1.04C Delayed Start

Reserved

8-1.04D Early Return-Early Start

Reserved

8-1.04E Next-Day Start

Reserved

8-1.04F–8-1.04J Reserved

8-1.05 TIME

Contract time starts on the day specified in section 8-1.04 or on the day you start job site activities, whichever occurs first.

Complete the work:

1. Within the number of working days shown on the *Notice to Bidders* for a non–cost plus time based bid
2. Within the number of working days bid for a cost plus time based bid

Meet each specified interim work completion date.

The Engineer issues a *Weekly Statement of Working Days* by the end of the following week unless the Contract is suspended for reasons unrelated to your performance.

The *Weekly Statement of Working Days* shows:

1. Working days and non–working days during the reporting week
2. Time adjustments
3. Work completion date computations, including working days remaining
4. Controlling activities

8-1.06 SUSPENSIONS

8-1.06A General

The Engineer may suspend work wholly or in part due to any of the following:

1. Conditions are unsuitable for work progress.
2. You fail to do any of the following:
   2.1. Fulfill the Engineer's orders.
   2.2. Fulfill a Contract part.
   2.3. Perform weather-dependent work when conditions are favorable so that weather-related unsuitable conditions are avoided or do not occur.

Upon the Engineer's order of suspension, suspend work immediately. Provide for public safety and a smooth and unobstructed passageway through the work zone during the suspension as under sections 7-1.03 and 7-1.04. Resume work when ordered.

8-1.06B Suspensions Unrelated to Contractor Performance

For a suspension unrelated to your performance, providing for a smooth and unobstructed passageway through the work during the suspension is force account work.

The days during a suspension unrelated to your performance are non–working days.

8-1.06C Suspensions Related to Contractor Performance

For a suspension related to your performance, the Department may provide for a smooth and unobstructed passageway through the work during the suspension and deduct the cost from payments.

The days during a suspension related to your performance are working days.

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

For an excusable critical delay, the Department may make a time adjustment. The Engineer uses information from the schedule to evaluate requests for time adjustments.

If requesting an adjustment, submit a revised schedule showing the delay's effect on the controlling activity. If the delay has:

1. Occurred, submit records of dates and what work was performed during the delayed activity
2. Not occurred, submit the expected dates or duration of the delayed activity

If the Engineer requests, update the schedule to the last working day before the start of the delay.

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 equipment moving or transporting 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 idle workers under section 9-1.04B, but does not add markups.

The Engineer includes costs due to necessary extra equipment moving or transporting.

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 8-1.08B and 8-1.08C.

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 are as shown in the following table:

Liquidated Damages

Total bid		Liquidated damages per day
From over	To	
$0	$50,000	$1,200
$50,000	$120,000	$1,500
$120,000	$1,000,000	$1,900
$1,000,000	$5,000,000	$3,000
$5,000,000	$10,000,000	$5,400
$10,000,000	$30,000,000	$8,300
$30,000,000	$100,000,000	$10,500
$100,000,000	$250,000,000	$28,500

If all work except plant 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 in completing a work part beyond 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 in completing a work part beyond the specified completion date for the work part.

Damages for untimely work part completion 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 work part completion 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 Director Days

If the work is not completed within the working days, the Director may grant director days if it serves the State's best interest.

By granting director days, the Director adds working days to the Contract. The Director may either grant enough days to eliminate the liquidated damages or fewer. In the latter case, the Department deducts liquidated damages for the remaining overrun in Contract time. The Director may deduct the Department's engineering, inspection, and overhead costs incurred during the period of extension granted as director days.

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 you and your surety notice 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 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 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 U.S. 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 in advance of 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 security seal manipulation occurs, stop material production. Do not resume production until the Engineer reinspects and reseals the device.

Measure material paid for by weight onsealed 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 cement 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 4000 lb/sq ft

In constructing a scale:

1. Furnish 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 hopper scale lever systems and mechanical indicating elements so 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

Weigh empty vehicles used to haul material paid for by weight daily. Each vehicle must have a legible identification mark. The Department may verify material weight by having an empty and loaded vehicle weighed on any scale the Engineer designates.

If imported topsoil, soil amendment, or mulch is measured by volume:

1. Each vehicle must allow for an accurate contents determination
2. Unless vehicles are of uniform capacity, each vehicle must have a legible identification mark showing its volume capacity
3. Load vehicles to at least the volume capacity
4. Level vehicle loads on arrival at the delivery point

If determining a quantity paid on a volume basis is impractical or if you request and the request is 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 actual quantity used unless dimensions are changed by the Engineer.

9-1.02D Quantities of Aggregate and Other Roadway Materials

The Engineer determines the weight 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, aggregate subbase	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
Aggregate base and aggregate for cement treated bases	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

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 specified by the description and measurement unit shown on the Bid Item List
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 X is included in the payment for the bid items 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 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 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 final payment, the Department invoices you for the difference, to be paid upon receipt.

Pay your subcontractors within 10 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 in 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.

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 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 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. A 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 rental 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 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 equipment business you do not own.
      1.3.2. The Labor Surcharge and Equipment Rental Rates hourly rate is $10.00 per hour or less.
2. Using 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 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 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 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 original-Contract work, the time paid is the time the equipment is operated to perform work paid by force account and the time to move the equipment to a location on the job site 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 4 hours or less 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	7.5

7.5	7.75
≥8.0	hours used

9-1.04D(4) Equipment Not On the Job Site 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 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 return the equipment to its source 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

9-1.04D(5) Non-Owner-Operated Dump Truck Rental

Submit the rental rate for non-owner-operated dump truck rental. The Engineer determines the payment rate. Payment for non-owner-operated dump truck rental 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 Department pays your costs incurred before the Engineer's elimination 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 structure 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, Huntington Beach, 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 Web site.

If the adjustment is a decrease in payment, the Department deducts the amount from the monthly progress payment.

The Department includes 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 public weighmaster's certificate separately 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:

$Qh = HMATT \times [Xa / (100 + Xa)]$

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 weight of dry aggregate

9-1.07B(3) Rubberized Hot Mix Asphalt

The Engineer calculates the quantity of asphalt in RHMA using the following formula:

$Qrh = RHMATT \times 0.80 \times [Xarb / (100 + Xarb)]$

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 weight of dry aggregate

9-1.07B(4) Modified Asphalt Binder in Hot Mix Asphalt

The Engineer calculates the quantity of asphalt in modified asphalt binder using the following formula:

$Qmh = MHMATT \times [(100 - Xam) / 100] \times [Xmab / (100 + Xmab)]$

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 weight of dry aggregate

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:

$Qrap = HMATT \times [Xaa / (100 + Xaa)]$

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 weight of dry aggregate
Xta = total asphalt content of HMA expressed as a percentage of the weight of dry aggregate
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 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

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 to a project with (1) an estimated cost over $5 million and (2) 100 or more working days not including any plant establishment period working days.

The 1st sentence of section 8-1.07C and "excusable delay" and its definition in section 1-1.07B do not apply.

Time-related overhead includes costs for field- and home-office overhead for the time required to complete the work. It does not include non-time-related costs such as mobilization, licenses, permits, and other charges incurred once during the Contract.

Time-related overhead does not apply to subcontractors of any tier, suppliers, fabricators, manufacturers, or other parties associated with you.

Costs for field office overhead are time-related costs associated with the normal and recurring construction activities not directly attributed to the Contract work such as:

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

Costs for home-office overhead are fixed general and administrative costs for operating your business such as:

1. General administration
2. Insurance
3. Personnel and subcontract administration
4. Purchasing
5. Accounting
6. Project engineering and estimating

Home-office overhead costs exclude expenses specifically related to:

1. Your other contracts or other businesses

2. Equipment coordination
3. Material deliveries
4. Consultant and legal fees

Each bid item price except time-related overhead must exclude time-related overhead costs.

The Department does not make the unit price adjustment resulting from a change of more than 25 percent in the bid item's quantity specified in section 4-1.05A for the time-related overhead bid item.

Section 9-1.17D(2)(b) does not apply.

9-1.11B Audit Examinations and Reports

If the total time-related overhead bid item exceeds 149 percent of the quantity at the time of bid and if ordered, submit an audit examination and report prepared by an independent CPA within 60 days of the order. The audit examination and report must show your actual overhead costs, including:

1. Project and company-wide financial records
2. Overall average daily rates for both field and home office overhead for the entire duration of the project and whether the costs have been properly allocated. The field and home office overhead rates must be:
   2.1. Allowable under 48 CFR 31
   2.2. Supported by reliable records
   2.3. Related solely to the project

The CPA's audit must be performed under the Attestation Standards published by the American Institute of Certified Public Accountants.

Within 20 days of receipt of the Engineer's order, make your financial records available for an audit by the State for the purpose of verifying the actual rate of time-related overhead described in your submitted audit. The Engineer may or may not accept the rate of time-related overhead submitted.

The Department pays the accepted actual rate for time-related overhead in excess of 149 percent of the quantity shown on the Bid Item List.

The Department pays 1/2 the cost of performing the examination and preparing the report; the Contractor pays the other 1/2. The cost is determined under section 9-1.05.

The Department does not pay for an audit performed for the purpose of verifying actual rates for:

1. Overhead costs incurred before the 1st working day
2. Overhead claims

9-1.11C Payment

Time for plant establishment is not included in the quantity for time-related overhead.

The Engineer increases the quantity of time-related overhead if:

1. A suspension is ordered not related to:
   1.1. Weather conditions unfavorable for the suitable prosecution of the controlling activity.
   1.2. Your failure to carry out orders given or perform the work under the Contract.
   1.3. Factors beyond your control not caused by either the Department or you.
   1.4. Conditions that mutually benefit the State and you.
2. An increase of Contract time for a compensable delay is granted. A compensable delay is caused solely by the fault, deficiency, error, omission, or change made by the Department. A time adjustment and payment adjustment for the actual cost without markup or profit are allowed. A TIA is used to determine the duration of the compensable delay.

The Engineer decreases the quantity of time-related overhead if a decrease in Contract time due to an approved *Change Order* is granted.

The Department does not adjust the quantity of time-related overhead for:

1. Early completion of the project.
2. Performing change order work that does not affect a controlling activity.
3. Non–working days.
4. Delays to the controlling activities that occur before the 1st working day.
5. Nonexcusable delay. A nonexcusable delay is caused by you or your subcontractors of any tier or suppliers for either nonperformance or deficiency of the work. Days during a nonexcusable delay are working days. No time or payment adjustment for a nonexcusable delay is allowed.
6. Excusable delay. An excusable delay is caused by factors beyond your or the Department's control. Days during an excusable delay are non–working days.
7. 2 or more concurrent delays that occur when a nonexcusable or excusable delay overlaps partially or entirely with an excusable or compensable delay.
8. Suspensions ordered due to:
   8.1. Weather conditions unfavorable for the suitable prosecution of the controlling activity.
   8.2. Failure to carry out orders given or perform the work under the Contract.
   8.3. Factors beyond your control not caused by either the Department or you.
9. Suspensions that mutually benefit you and the Department.

For a cost-plus-time contract, if the quantity of time-related overhead is adjusted, the lump sum price for time-related overhead is adjusted for each day by an amount equal to the lump sum price bid divided by the number of working days bid to complete the Contract.

The Department makes progress payments for time-related overhead based on the number of working days used during that estimate period, including compensable suspensions and delays. The amount paid per working day is the lesser of the following amounts:

1. Bid item price for a non-cost-plus-time contract
2. Bid item lump sum price divided by the number of working days bid for a cost-plus-time contract
3. 20 percent of the total bid divided by the Contract number of working days

Working days granted by an approved *Change Order* due to changes and extra work is paid for upon Contract completion.

Payment for time-related overhead includes full compensation for additional overhead costs incurred during days of inclement weather when the Contract is extended into any additional construction seasons due to delays caused by the Department.

Payment for time-related overhead does not include payment for additional overhead cost involved in:

1. Satisfying an internal milestone or multiple calendar requirements
2. Performing additional work not considered a controlling activity
3. Overhead costs incurred by your subcontractors of any tier, suppliers, fabricators, manufacturers, and other associates
4. Other non-time-related-overhead costs

For a project without plant establishment work, the Department pays you the remaining balance of time-related overhead as specified in section 9-1.17B.

For a project with plant establishment work, the Department pays you the remaining balance of time-related overhead in the 1st progress payment after the work except plant establishment work is completed.

For work you perform that is paid by force account, the Department pays you based on the markups shown in the following table instead of the markups specified in section 9-1.04:

Cost	Percent markup
Labor	30
Materials	10
Equipment rental	10

Note: The markups apply to work paid by force account, regardless of whether the work revises the current Contract completion date.

For subcontracted work paid by force account, the markups in section 9-1.04 apply.

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 of 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 progress payment if:

1. Listed in a special provision as eligible and is in compliance with other Contract parts
2. Purchased
3. An 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

Mobilization is eligible for partial payments if the Contract includes a bid item for mobilization. The Department makes the partial payments under Pub Cont Code § 10264. If the Contract does not include a mobilization bid item, mobilization is included in the payment for the various bid items.

The Department pays the item total for mobilization in excess of 10 percent of the total bid 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 correction of noncompliance.

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 revised Contract working days
2. Percent of working days elapsed exceeds the percent of value of work completed by more than 15 percent

The Engineer determines the percent of 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 of value of 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*.

When the percent of working days elapsed minus the percent of 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 submittal of a document as specified, the Department withholds a part of the progress payment. The 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.

9-1.16E(4) Stop Notice Withholds

The Department may withhold payments to cover claims filed under Civ Code § 3179 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, 2014.

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 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 final estimate acceptance or a claim statement no later than the 30th day after receiving the proposed final estimate. Evidence of the Contractor's receipt of the final estimate and the Engineer's receipt of the Contractor's written acceptance or claim statement is a delivery service's proof of delivery or Engineer's written receipt if hand delivered.

If you claim that the 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 furnishes the final estimate to you 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, 6-3.06, and 9-1.21.

If you submit a claim statement within 30 days of receiving the Engineer's proposed final estimate, the Engineer furnishes a semifinal estimate to the Contractor 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 the claims or as specified in sections 5-1.27, 6-3.06, 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* and the final amount of additional payment requested except:

1. If the final amount of requested payment differs from the amount requested in the *Full and Final Potential Claim Record*
2. For a claim for quantities, withholds, deductions, liquidated damages, or change order bills
3. For an overhead claim

If the final amount of requested payment differs from the amount requested in the *Full and Final Potential Claim Record*, submit:

1. Identification number that corresponds to the *Full and Final Potential Claim Record*
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 the 15 days, the Engineer assigns a new number.

For a claim for quantities, withholds, deductions, or change order bills submit:

1. Final amount of 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 receipt of 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 from 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 receipt of the proposed final estimate, submit an audit report prepared by an independent CPA
    - 4.1. The audit report must show calculations with supporting documentation of actual home office and project field overhead costs
    - 4.2. The calculations must specify the actual daily rates for both field and home office overhead for the entire duration of the project expressed as a rate per working day
    - 4.3. The start and end dates of the actual project performance period, number of working days, overhead cost pools, and all allocation bases must be disclosed in the calculations of your actual field and home office overhead daily rates
    - 4.4. Neither daily rate may include a markup for profit
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 under the Attestation Standards published by the American Institute of Certified Public Accountants. The CPA's audit report must express an opinion 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 U.S. 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* identification number
2. Claim does not have the same nature, circumstances, and basis of claim as the corresponding *Full and Final Potential Claim Record*
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 claim supporting data 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 board of review meeting. Meet with the board of review and make a presentation supporting the claim.

After claim review completion by the Engineer or board of review, the Department makes the final determination of claims and furnishes it to the Contractor.

After the determination, the Engineer furnishes a final estimate to the Contractor 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, 6-3.06, and 9-1.21.

The Contractor's 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 the Department or the Contractor 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

Reserved

10-2 SUSTAINABLE DESIGN REQUIREMENTS

10-2.01 GENERAL

Reserved

10-2.02 LEED

10-2.02A–10-2.02H Reserved

10-2.03–10-2.10 RESERVED

10-3–10-10 RESERVED

11 QUALITY CONTROL AND ASSURANCE

11-1 GENERAL

11-1.01 GENERAL

Section 11 includes specifications relating to quality control and assurance.

11-1.02 QUALITY CONTROL MANAGER

Where a QC manager is specified, assign a QC manager before starting construction activities. 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 QC plans
3. Implementing QC plans
4. Maintaining QC records

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.

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.

11-2 PRECAST CONCRETE MEMBERS

11-2.01 GENERAL

Section 11-2 applies to PC concrete members fabricated under sections 49 or 51 excluding PC concrete members fabricated with minor concrete.

Fabricate PC concrete members at a plant on the Authorized Facility Audit List.

11-2.02 PRECAST CONCRETE QUALITY CONTROL MANAGER

Assign a PC concrete QC manager for each precasting plant.

11-2.03 QUALITY CONTROL INSPECTOR

The QC inspector must witness all PC concrete activities.

The QC inspector must either (1) be registered as a civil engineer in the State or (2) have a current Plant Quality Personnel Certification, Level II from the Precast/Prestressed Concrete Institute.

The QC inspector must perform inspection and testing before precasting, during precasting, and after precasting, as specified and as necessary to ensure that materials and workmanship comply with the Contract.

Regardless of your acceptance of a PC concrete member, the Engineer inspects PC concrete members and rejects any members that do not comply with the Contract.

11-2.04 SUBMITTALS

11-2.04A General

Before 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.

11-2.04B Precast Concrete Quality Control Plan

Before performing any precasting activities, submit 3 copies of a PC concrete QC plan for each member to be precast. Submit a separate QC plan for each plant. Allow 25 days for the Engineer's review.

Each QC plan must include:

1. Name of the precasting plant, concrete plant to be used, and any concrete testing laboratory to be used.
2. Manual prepared by the precasting plant that includes equipment, testing procedures, safety plan, and the names, qualifications, and documentation of certifications for all personnel to be used.
3. Name of the QC manager and the names, qualifications, and documentation of certifications for all QC inspectors.
4. Organizational chart showing all QC personnel and their assigned QC responsibilities.
5. Methods and frequencies for performing all required QC procedures, including all inspections, material testing, and any required survey procedures for all components of the PC concrete members including prestressing systems, concrete, grout, reinforcement, steel components embedded or attached to the PC concrete member, miscellaneous metal, and formwork.
6. System for reporting noncompliant PC concrete members to the Engineer.
7. System for identification and tracking of any required repairs, how they were repaired, and a procedure for the reinspection of any repaired PC concrete members.
8. Forms to be used for certificates of compliance, daily production logs, and daily reports.

A QC plan that was previously authorized no more than 1 year before the start of job site activities on the Contract is acceptable for the entire period of the Contract, if the Engineer determines the QC plan is for the same type of work that is to be performed on the Contract.

Submit an amended QC plan or an addendum to the QC plan for any changes to:

1. Concrete plants or source materials
2. Material testing procedures and testing labs
3. Procedures and equipment
4. Updated systems for tracking and identifying PC concrete members
5. QC personnel

Submit 7 copies of each authorized QC plan and make 1 copy available at each location where work is performed.

11-2.04C Daily Production Log

The QC inspector must provide reports to the QC manager on a daily basis for each day that precasting activities are performed.

The QC manager must maintain a daily production log for precasting for each day that precasting activities are performed, including setting forms, placing reinforcement, setting prestressing steel, casting, curing, post tensioning, and form release. This daily log must be available for viewing by the Engineer 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 all QC inspectors and the specific QC inspections they performed that day
6. Reports for that day's precasting activities from each QC inspector

Notify the Engineer immediately when any precasting problems or deficiencies are discovered and submit the proposed repair or process changes required to correct them. Allow 25 days for the Engineer 's review.

11-2.04D Precast Concrete Report

Submit a PC concrete report within 15 days following the completion of any PC concrete member. The report must include:

1. Reports of all material tests and any required survey checks.
2. Documentation that you have evaluated all tests and corrected all rejected deficiencies, and all repairs have been re-examined with the required tests and found acceptable.
3. Daily production logs.

4. Certificate of compliance signed by the 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 as described in the Contract.

The person who performed the material tests and required survey checks must sign all reports regarding these tests and survey checks and furnish these reports directly to the QC manager for review and signature before submittal to the Engineer. Corresponding names must be clearly printed or typed next to all signatures.

11-3 WELDING

11-3.01 GENERAL

11-3.01A General

Section 11-3.01 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 shown in the following table:

AWS code	Year of adoption
D1.1	2008
D1.3	2008
D1.4	2005
D1.5	2008
D1.6	2007
D1.8	2009

11-3.01B Definitions

continuous inspection: QC Inspector must be within close proximity of all welders or welding operators so that inspections by the QC Inspector of each welding activity at each welding location does not lapse for a period exceeding 30 minutes.

gross nonconformance: Sum of planar type rejectable indications in more than 20 percent of the tested length.

11-3.01C Quality Control Inspector

Replace clause 6.1.3 of AWS D1.1, the 1st paragraph of section 7.1.2 of AWS D1.4, and clause 6.1.1.2 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.
> Quality assurance is the prerogative of the Engineer. The QA Inspector is the duly designated person 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, 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 AWS welding codes and the specifications on all welded joints before welding, during welding, and after the completion of each weld.

11-3.01D 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. The period of effectiveness for a welder's or welding operator's qualification must be a maximum of 3 years for the same weld process, welding position, and weld type. If welding will be performed without gas shielding, then qualification must also include welding without gas shielding. Excluding welding of fracture critical members, a valid qualification at the start of job site activities on a contract is acceptable for the entire period of the Contract, as long as the welder's or welding operator's work remains satisfactory.

Replace clause 6.14.6 of AWS D1.1, section 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 who hold a current ASNT Level III certificate in that discipline and are certified to perform the work of Level II technicians

11-3.01E Joint Weld Details

If joint weld 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 joint weld details, including their intended locations, welding parameters, and essential variables.

Upon authorization of the proposed joint detail locations and qualification of the proposed joint details, welders and welding operators using these details must weld a qualification test plate using the WPS variables and the joint weld 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 nonstandard weld joint is to be made 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.

11-3.01F 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, remove the metal for the full length of the crack plus 2 inches on each side of the crack and reweld.

Clause 6.6.5 of AWS D1.1, section 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.

11-3.02 WELDING QUALITY CONTROL

11-3.02A General

Section 11-3.02 applies to work welded under sections 49, 52, 55, 75-1.03E, and 99-05120.

All welding requires inspection by the Engineer.

You must provide continuous inspection when any welding is being performed.

11-3.02B 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.

11-3.02C Submittals

11-3.02C(1) 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.

11-3.02C(2) 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. WPS
2. NDT firms
3. QC and QC personnel
4. NDT personnel or procedures
5. Systems for tracking and identifying welds
6. Welding personnel

Allow 7 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 make 1 copy available at each location where work is performed.

11-3.02C(3) Welding Report

Submit a welding report within 15 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

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 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 next to all signatures. Submit reports of all NDT performed, whether specified, additional, or informational.

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

11-3.02C(4) 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.

11-3.02D Personnel Qualifications and Certifications

Clauses 6.1.4.1 and 6.1.4.3 of AWS D1.1, the 2nd paragraph of section 7.1.2 of AWS D1.4, and clauses 6.1.3.2 through 6.1.3.3 of AWS D1.5 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 under AWS D1.5 and is performed at a permanent fabrication or manufacturing plant that is certified under the AISC Quality Certification Program, Category CBR, Major Steel Bridges, and Fracture Critical Endorsement F, if required
2. Structural steel for building work is welded under AWS D1.1 and 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

For welding performed at these facilities, the inspection personnel or NDT firms may be employed or compensated by the plant performing the welding if the plant maintains a QC program independent from production.

An authorized independent 3rd party must witness the qualification tests for welders or welding operators. The independent 3rd 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 3rd party.

11-3.02E 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 gages. 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.

11-3.02F Welding Procedures Qualification

Welding procedures qualification for work welded under AWS D1.5 must comply with clause 5.12 or 5.13 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 at least 2 WPS qualification tests. Conduct the tests using both figure 5.1 and figure 5.3. Conduct the test complying with figure 5.1 under clause 5.12 or 5.13 of AWS D1.5. Conduct the test complying with figure 5.3 using the welding electrical parameters that were established for the test conducted complying with figure 5.1. The ranges of welding electrical parameters established during welding under figure 5.1 in compliance with clause 5.12 of AWS D1.5 must be further restricted in compliance with the limits in table 5.3 during welding under figure 5.3.
3. You may qualify multiple zones within a weld joint. The travel speed, amperage, and voltage values that are used for tests conducted under clause 5.13 of AWS D1.5 must be consistent for each pass in a weld joint and must not vary by more than ±10 percent for travel speed, ±10 percent for amperage, and ±7 percent for voltage as measured from a predetermined target value or average within each

weld pass or zone. The travel speed must not vary by more than ±15 percent when using submerged arc welding.

4. For a WPS qualified under clause 5.13 of AWS D1.5, base the values to be used for calculating ranges for current and voltage on the average of all weld passes made in the test. Calculate heat input using the average of current and voltage of all weld passes made in the test for a WPS qualified under clause 5.12 or 5.13 of AWS D1.5.
5. Macroetch tests are required for WPS qualification tests, and acceptance must comply with clause 5.19.3 of AWS D1.5.
6. 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 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.
7. 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. Do not use test plates that do not comply with both tests.

11-3.02G Repair Work

Notify the Engineer immediately when 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

For requests to perform 3rd-time excavations or repairs of cracks, include an engineering evaluation of the proposed repair. 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

11-3.03 WELDING FOR OVERHEAD SIGN AND POLE STRUCTURES

11-3.03A General

Section 11-3.03 applies to work welded under sections 56-3 and 86-2.04.

Fabricate overhead sign and pole structures at a plant on the Authorized Facility Audit List.

11-3.03B 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 the Simple Steel Bridge Structures (SBR).

The AISC Certification category for pole structures is the Simple Steel Bridge Structures (SBR) or Standard for Steel Building Structures (STD).

11-3.03C Submittals

Submit a welding report under section 11-3.02C(3) 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 flagging, placing and installing temporary traffic-handling equipment and devices, maintaining traffic, placing and installing temporary traffic control systems, and placing temporary pavement delineation.

Temporary traffic control must comply with part 6, "Temporary Traffic Control," of the *California MUTCD*. For the *California MUTCD*, go to the Department's Web site.

12-1.02 FLAGGERS

Flagging apparel, traffic control devices, and equipment for flaggers must comply with part 6, "Temporary Traffic Control," of the *California MUTCD*. Assign flaggers to control traffic and to warn the public of any dangerous conditions resulting from work activities. Maintain flagging apparel, traffic control devices, and equipment for flaggers in good repair at all times.

12-1.03 FLAGGING COSTS

You and the State share the cost of furnishing all flaggers, including transporting flaggers and furnishing stands and towers for flaggers to provide for the passage of traffic through the work as specified in sections 7-1.03 and 7-1.04. The Department determines the cost under section 9-1.04 and pays you 1/2 of the cost. Furnishing and operating pilot cars if ordered is change order work.

12-2 CONSTRUCTION PROJECT FUNDING SIGNS

Reserved

12-3 TRAFFIC-HANDLING EQUIPMENT AND DEVICES

12-3.01 GENERAL

12-3.01A General

12-3.01A(1) Summary

Section 12-3 includes general specifications for placing, installing, maintaining, repairing, replacing, and removing traffic-handling equipment and devices.

Perform all layout work necessary to place channelizing devices:

1. On the proper alignment
2. Uniformly at the location and spacing shown
3. Straight on a tangent alignment
4. On a true arc in a curved alignment

Do not intermix different types of temporary traffic control devices on the same alignment. Types include plastic drums, portable delineators, channelizers, tubular markers, traffic cones, and Type I and Type II barricades.

Immediately replace or restore traffic-handling equipment and devices at their original location in an upright position whenever they are displaced or not in an upright position from any cause.

At your expense, repair or replace traffic-handling equipment and devices damaged from any cause during the Contract, including repainting if necessary.

Remove traffic-handling equipment and devices from the job site when they are no longer needed for controlling traffic.

12-3.01A(2) Definitions

Category 1 temporary traffic control devices: Small, lightweight devices weighing less than 100 pounds 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, lightweight devices weighing less than 100 pounds 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: Temporary traffic-handling equipment and devices weighing 100 pounds or more that are expected to produce significant changes in the vehicular velocity of impacting vehicles. Category 3 temporary traffic-handling equipment and devices include crash cushions, impact attenuator vehicles, temporary railing, temporary barrier, and end treatments for temporary railings and barriers.

hours of darkness: As defined under Veh Code § 280.

useable shoulder area: Any longitudinal paved or unpaved contiguous surface adjacent to the traveled way with:

1. Enough weight-bearing capacity to support traffic control vehicles and equipment, such as flashing arrow signs, portable changeable message signs, and impact attenuator vehicles
2. Slope not greater than 6:1 (horizontal:vertical)

12-3.01A(3) Submittals

Upon notification submit the following 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 notification 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 if applicable
   1.3. Contract number, district, county, route and post mile of project limits
   1.4. Company name of certifying vendor, street address, city, state and zip code
   1.5. Printed name, signature and title of 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 notification 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 on the project before placing portable delineators on the job site.

12-3.01A(4) Quality Control and Assurance

Category 2 temporary traffic control devices must be on the Authorized Material List for acceptable, crashworthy Category 2 hardware for work zones.

Category 2 temporary traffic control devices must be labeled with the FHWA acceptance letter number and the name of the manufacturer. The label must be legible and permanently affixed to the traffic control device by the manufacturer.

Category 3 temporary traffic control devices must be the type shown and on the Authorized Material List for highway safety features.

Retroreflectivity for the following materials must comply with Table 2A-3, "Minimum Retroreflectivity Requirements," 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-colored retroreflective stripes for plastic traffic drums.

The following traffic-handling devices must be visible from 1,000 feet during the hours of darkness under 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

12-3.01B Materials

Not Used

12-3.01C Construction

Furnishing, installing, maintaining, moving, removing traffic control equipment and devices, and performing lane closures ordered by the Engineer except for providing for public safety and convenience under section 7 is change order work.

12-3.01D Payment

Not Used

12-3.02 BARRICADES

12-3.02A General

Section 12-3.02 includes specifications for placing barricades.

Do not imprint owner identification on the retroreflective face of any rail.

12-3.02B 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 Federal Highway Administration's 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.

If a Type III barricade is used for a sign support, it must be successfully crash tested under *NCHRP Report 350* criteria as a single unit with an attached sign panel of the size and type used.

Sign panels for construction area signs and marker panels to be mounted on barricades must comply with section 12-3.06B(2).

12-3.02C Construction

Place barricades so that the stripes slope downward in the direction road users are to pass.

Place sand-filled bags near 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.

Install construction area signs and marker panels on barricades at the locations shown.

Do not remove barricades that are shown to be left in place at the time of project completion.

Moving the barricades from location to location is change order work if ordered after initial placement of the barricades.

12-3.02D Payment

Payment for barricades described for a traffic control system is not included in the payment for barricades.

12-3.03 FLASHING ARROW SIGNS

12-3.03A General

Section 12-3.03 includes specifications for placing and operating flashing arrow signs.

Flashing arrow signs must comply with the minimum legibility distance shown in the following table:

Legibility Requirements

Type	Min size	Min number of panel lights	Min legibility distance[a]
I	48" x 96"	15	1 mile
II	36" x 72"	13	3/4 mile

[a]The minimum 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.

12-3.03B Materials

Flashing arrow signs must be finished with commercial-quality, flat-black enamel and must be equipped with yellow or amber lamps that form arrows or arrowheads as required. Each lamp must be provided with a visor and the lamps must be controlled by an electronic circuit that provides between 30 and 45 complete operating cycles per minute in each of the displays and modes specified. The control must include provisions for 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.

Flashing arrow signs must be capable of being operated in the following display modes:

1. Pass Left Display
2. Pass Right Display
3. Simultaneous Display
4. Caution Display

Flashing arrow signs 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

The bottom of the flashing arrow sign must be a minimum of 7 feet above the roadway when mounted.

Flashing arrow sign trailers must be equipped with devices so that they can be leveled and plumbed.

Sign trailers must be equipped with a supply of electrical energy capable of operating the sign as specified in section 12-3.03.

12-3.03C Construction

Not Used

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.

Use only one type of portable delineator on the project.

12-3.04B Materials

Portable delineators, including the base, must be composed 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 shaped to prevent rolling after impact. The base must be anchored or weigh enough to keep the delineator in an upright position. Comply with the manufacturer's instructions for ballast for portable delineators.

The vertical portion of portable delineators must be fluorescent orange or predominantly orange. The posts must be not less than 3 inches in width or diameter. The minimum height must be 36 inches above the traveled way.

A minimum of 2 white retroreflective bands, each not less than 3 inches wide, must be mounted a minimum of 1-1/2 inches apart. The lower retroreflective band must be from 2.5 to 3 feet above the roadway surface.

12-3.04C Construction

Not Used

12-3.04D Payment

Not Used

12-3.05 PORTABLE FLASHING BEACONS

Reserved

12-3.06 CONSTRUCTION AREA SIGNS

12-3.06A General

12-3.06A(1) Summary

Section 12-3.06 includes specifications for placing, installing, maintaining, and removing 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.

If construction area signs are not shown as stationary-mounted signs or portable signs, you may use either type.

12-3.06A(2) Definitions

background: Dominant sign color.

legend: All letters, numerals, tildes, bars, arrows, route shields, symbols, logos, borders, artwork, and miscellaneous characters that are intended to convey specific meanings on traffic signs. The style, font, size, and spacing of the legend must comply with the *Standard Alphabets* published in the *FHWA's Standard Highway Signs Book*.

12-3.06A(3) Quality Control and Assurance

Construction area signs must be the product of a commercial sign manufacturer.

Construction area signs must be visible from 500 feet and legible from 300 feet at noon on a cloudless day and during the hours of darkness under illumination of legal low-beam headlights by persons with 20/20 vision or vision corrected to 20/20. Fabric sign panels on portable signs are not subject to the visibility and legibility requirements for headlight illumination during the hours of darkness.

Construction area signs may be new or used. Used signs must have the specified sheeting material and must comply with section 12-3.01A(4). A significant difference between day and nighttime retroreflective color is cause for rejecting signs.

12-3.06B Materials

12-3.06B(1) General

Unless the background and legend are shown differently, construction area warning and guide signs must have a black legend on a retroreflective, fluorescent orange background. W10-1 and W47(CA) advance warning signs for highway-rail grade crossings must have a black legend on a retroreflective yellow background.

Construction area signs must have Type III or higher grade retroreflective sheeting.

12-3.06B(2) Stationary-Mounted Signs

Materials for stationary-mounted signs must comply with section 56-2 for the type of panel involved.

Temporary sign supports of any type placed within 15 feet from the edge of the traveled way must comply with section 12-3.01 for Category 2 temporary traffic control devices.

Post size and number of posts must be as shown. The Engineer determines the post size and number of posts if the type of sign installation is not shown.

Sign posts must be good, sound wood posts. Wood posts must have the breakaway feature shown.

Fastening hardware and back braces must be commercial-quality materials.

12-3.06B(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.

Sign panels for portable signs must be one of the following:

1. Sign panels specified for stationary signs
2. Type VI, retroreflective, elastomeric roll-up fabric on the Authorized Material List for signing and delineation materials
3. Nonretroreflective cotton drill fabric
4. Nonretroreflective flexible industrial nylon fabric
5. Another type of fabric, if authorized

Do not use nonretroreflective portable signs during the hours of darkness. The size, color, and legend for portable signs must comply with section 12-3.06B(2).

The height above the edge of traveled way to the bottom of the portable sign panel must be at least 1 foot.

12-3.06B(4) Temporary Object Markers

Temporary object markers must be mounted on stationary wood or metal posts as shown and must comply with section 82.

Marker panels for Type N (CA), Type P (CA), and Type R (CA) object markers must comply with section 12-3.06B(2) for stationary sign panels.

Target plates, posts, and hardware for Type K (CA) and Type L (CA) temporary object markers must comply with section 82.

12-3.06C Construction

12-3.06C(1) General

Place all construction area signs outside of the traveled way. Do not block bicycle and pedestrian pathways with construction area signs.

Place, install, maintain, and remove temporary object markers shown as construction area signs in the same way 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. Check covered signs daily for damage and immediately replace covers if needed.

Covers for construction area signs must be of sufficient size and density to completely block out the message so that it is not visible. Securely fasten covers to prevent movement from wind.

Clean all construction area sign panels 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, on a daily basis, to furnish the items on short notice.

Replace any damaged construction area sign or repair the sign if authorized.

Remove sign panels that exhibit irregular luminance, shadowing, or dark blotches at nighttime under vehicular headlight illumination at your expense.

12-3.06C(2) Stationary-Mounted Signs

Install stationary-mounted signs as shown for the installation of roadside signs except as follows:

1. Back braces and blocks for sign panels are not required for signs that do not exceed 48 inches in width or diamond-shaped signs that are not larger than 48 by 48 inches.
2. The height above the edge of traveled way to the bottom of the sign panel must be at least 7 feet.
3. You may install construction area signs on above-ground, temporary platform sign supports or on existing lighting standards or other supports if authorized. Do not make holes in the standards to support the sign if installed on existing lighting standards.
4. Post embedment must be 2.5 feet if post holes are backfilled around the posts with PCC produced from commercial-quality aggregates. The concrete must contain at least 295 pounds of cementitious material per cubic yard.

Excavate post holes by hand methods without the use of power equipment. You may use power equipment at locations where you determine that subsurface utilities are not present in the area of the proposed post holes if authorized. The post hole diameter must be at least 4 inches greater than the longest cross-sectional dimension of the post if backfilled with PCC.

Furnishing, installing, maintaining, moving, and removing any additional construction area signs if ordered is change order work.

12-3.06D Payment

Payment for construction area signs described for a traffic control system is not included in the payment for construction area signs.

12-3.07 CHANNELIZERS

12-3.07A General

Section 12-3.07 includes specifications for placing channelizers.

12-3.07B Materials

Channelizers must be on the Authorized Material List for signing and delineation materials.

Channelizer posts must be orange.

Channelizers must be affixed with retroreflective white sheeting, 3 by 12 inches in size.

Channelizer bases must be cemented to the pavement under section 85-1.03 for cementing pavement markers to the pavement.

12-3.07C Construction

Install channelizers to clean, dry surfaces.

When no longer required for the work, remove the channelizers except those to be left in place and the underlying adhesive used to cement the channelizer bases to the pavement. Channelizers and adhesive that you remove become your property.

Do not remove channelizers that are shown to be left in place at the time of project completion.

12-3.07D Payment

Not Used

12-3.08 TYPE K TEMPORARY RAILING

12-3.08A General

12-3.08A(1) Summary

Section 12-3.08 includes specifications for placing, maintaining, repairing, replacing, and removing Type K temporary railing, including reinforcement, Type P marker panels, reflectors, excavation and backfill, drilling holes and bonding threaded rods or dowels if required, removing threaded rods or dowels and filling the drilled holes with mortar, and moving and replacing removable panels as required.

Type K temporary railing must consist of interconnected new or undamaged, used precast concrete barrier units as shown.

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.

12-3.08A(2) Submittals

Submit a certificate of compliance for new and used Type K temporary railing not cast at the job site.

12-3.08B Materials

12-3.08B(1) General

Paint exposed surfaces of new and used Type K temporary railing with white paint under section 91-4 before placing them on the job site. Repainting of units is change order work if ordered after the units are in place.

Concrete must comply with the specifications for minor concrete. Load tickets and a certificate of compliance are not required.

Reinforcing steel must comply with section 52.

Steel bars to receive bolts at ends of concrete panels must comply with ASTM A 36/A 36M. Bolts must comply with ASTM A 307.

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 A 36/A 36M
2. Have a minimum length of 26 inches
3. Have a 3-inch diameter by 3/8-inch thick plate welded on the upper end with a 3/16-inch fillet weld

The final surface finish of Type K temporary railing must comply with section 51-1.03F(2).

Cure the exposed surfaces of concrete elements by the water method, the forms-in-place method, or the curing compound method. Comply with section 90-1.03B(3) for curing compound no. 1 if the curing compound method is used.

12-3.08B(2) Type K Temporary Terminal Section

Reserved

12-3.08C Construction

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 structure 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 abutting ends of precast concrete units in alignment without substantial offset to each other.

Bond threaded rods or dowels in holes drilled in the existing concrete at the locations shown. Drilling of holes and bonding of threaded rods or dowels must comply with section 51-1 for bonding dowels. After you remove Type K temporary railing, 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 the mortar must be cured by the water method or by the curing compound method. Comply with section 83-2.02D(5) for curing concrete barrier if the curing compound method is used.

Install a reflector on top of the rail of each rail unit placed within 10 feet of a traffic lane. Reflectors must be on the Authorized Material List for signing and delineation materials. The adhesive for mounting the reflector must comply with the reflector manufacturer's instructions.

Install a Type P marker panel at each end of railing installed adjacent to a 2-lane, 2-way highway and at the end facing traffic for railing installed adjacent to a 1-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 you remove Type K temporary railing, restore any area to its previous condition or construct it to its planned condition where temporary excavation or embankment was used to accommodate the railing.

Whenever the Engineer orders a lateral move of Type K temporary railing and the repositioning is not shown, the lateral move is change order work and the railing is not measured in the new position.

12-3.08D Payment

Temporary railing (Type K) is measured along the top of the railing.

12-3.09 TELESCOPING FLAG TREES

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.

12-3.10 TRAFFIC CONES

Traffic cones must be flexible, fluorescent orange, and be 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 be of a highly pigmented, fluorescent orange, polyvinyl compound. The overall height of a traffic cone must be at least 28 inches and the bottom inside diameter must be at least 10.5 inches. The base must be anchored or have enough size and mass to keep the traffic cone in an upright position.

During the hours of darkness, traffic cones must have retroreflective cone sleeves.

Retroreflective cone sleeves must be one of the following types:

1. Removable flexible retroreflective cone sleeves fabricated from retroreflective sheeting at least 13 inches in height, placed a maximum of 3 inches from the top of the cone. Do not use the sleeves during daylight hours.

2. Permanently affixed, semitransparent, retroreflective cone sleeves fabricated from semitransparent, retroreflective sheeting at least 13 inches in height, placed a maximum of 3 inches from the top of the cone. You may use traffic cones with semitransparent retroreflective cone sleeves during daylight hours.
3. Permanently affixed double-band retroreflective cone sleeves consisting of 2 white retroreflective bands. The top band must be 6 inches in height, placed a maximum of 4 inches from the top of the cone. The lower band must be 4 inches in height, placed 2 inches below the bottom of the top band. You may use traffic cones with double-band retroreflective cone sleeves during daylight hours.

Use the same type of retroreflective cone sleeve for all cones used on the project.

12-3.11 PLASTIC TRAFFIC DRUMS

12-3.11A General

12-3.11A(1) Summary

Section 12-3.11 includes specifications for placing and removing plastic traffic drums.

Plastic traffic drums must comply with the manufacturer's instructions for weight and ballast.

12-3.11A(2) Definitions

orange-colored: The colors of orange, red-orange, fluorescent orange, or fluorescent red-orange.

12-3.11A(3) Submittals

Submit a certificate of compliance for plastic traffic drums.

12-3.11B Materials

Plastic traffic drums must:

1. Be orange-colored, low-density polyethylene
2. Be flexible and collapsible upon vehicle impact
3. Have a weighted base to maintain an upright position and prevent displacement by passing traffic

The weighted base must:

1. Be detachable
2. Be shaped to prevent rolling upon impact
3. Have a maximum outside diameter of 38 inches
4. Have a maximum height above the ground surface of 4 inches

Use the same type and brand of retroreflective sheeting for all plastic traffic drums used on the project.

12-3.11C Construction

Use one type of plastic traffic drum on the project.

Do not use sandbags or comparable ballast.

Plastic traffic drums must be a minimum of 36 inches in height above the traveled way.

Moving plastic traffic drums from location to location if ordered after initial placement is change order work.

Upon completion of work, plastic traffic drums become your property and must be removed from the job site.

12-3.11D Payment

Not Used

12-3.12 PORTABLE CHANGEABLE MESSAGE SIGNS

12-3.12A General

12-3.12A(1) Summary

Section 12-3.12 includes specifications for placing, operating, maintaining, repairing, replacing, transporting from location to location, and removing portable changeable message signs.

Each trailer-mounted portable changeable message sign must consist of a controller unit, a power supply, and a structural support system. The unit must be assembled to form a complete self-contained portable changeable message sign that can be delivered to the job site and placed into immediate operation. The sign unit must be capable of operating in an ambient air temperature from -4 to 158 degrees F and must be unaffected by unauthorized mobile-radio transmissions. The trailer must be equipped so that it can be leveled and plumbed.

12-3.12A(2) Submittals

Upon notification, submit a certificate of compliance for each portable changeable message sign.

12-3.12A(3) Quality Control and Assurance

Comply with the manufacturer's operating instructions for the portable changeable message sign.

Approaching drivers must be able to read the entire message at least 2 times before passing the portable changeable message sign at the posted speed limit. Use more than 1 portable changeable message sign to comply with this requirement if necessary.

12-3.12B Materials

The text displayed on a portable changeable message sign must not scroll or travel horizontally or vertically across the face of the message panel.

The sign face must be flat black. The sign face must be protected from the glare of the sun by a method that does not interfere with the clarity of the sign message. The sign must be raised and lowered by means of a power-driven lifting mechanism.

Matrix signs must provide complete alphanumeric selection.

Matrix-type signs utilizing lamps must be equipped with an automatic-dimming mode that automatically compensates for the influence of temporary light sources or other abnormal lighting conditions. The sign must have 3 or more manual dimming modes of different lamp intensities.

During the hours of darkness, matrix signs not utilizing lamps must be either internally or externally illuminated.

The controller must be an all solid-state unit containing all 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 contain nonvolatile memory that holds keyboard-created messages in memory during periods when the power is not activated. The controller must provide for a variable display rate that allows the operator to match the information display to the speed of approaching traffic. The operator must be able to adjust the flashing-off time from within the control cabinet.

12-3.12C Construction

Place a portable changeable message sign as far from the traveled way as practicable where it is legible to approaching traffic without encroaching on the traveled way. At locations where vertical roadway curvature restricts the sight distance of approaching traffic, place the portable changeable sign on or before the crest of the curvature where it is most visible to the approaching traffic. At locations where horizontal roadway curvature restricts the sight distance of approaching traffic, place the portable changeable message sign at or before the curve where it is most visible to approaching traffic. Where practicable, place a portable changeable message sign behind guardrail or Type K temporary railing.

Except where placed 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 portable changeable message sign.

When in full operation, the bottom of a portable changeable message sign must be at least 7 feet above the ground and the top must be no more than 14.5 feet above the ground.

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 must be legible from a distance of 750 feet at noon on a cloudless day by persons with 20/20 vision or vision corrected to 20/20.

Display only messages shown or ordered.

Repeat the entire message continuously in not more than 2 phases of at least 3 seconds per phase.

You must be available by cell phone during activities that require a portable changeable message sign. Before starting the activity, submit your cell phone number. Be prepared to change the displayed message immediately upon notification. You may operate the portable changeable message sign with a 24-hour timer control or remote control if authorized.

After initial placement, move portable changeable message signs from location to location as ordered.

Move unprotected portable changeable message signs to an area at least 15 feet from the edge of the traveled way or remove them from the job site away from traffic when not in use.

12-3.12D Payment

Not Used

12-3.13 IMPACT ATTENUATOR VEHICLE

Reserved

12-3.14 TEMPORARY TRAFFIC SCREEN

Reserved

12-3.15 TEMPORARY CRASH CUSHION MODULE

12-3.15A General

Section 12-3.15 includes specifications for installing and maintaining sand-filled temporary crash cushion modules in groupings or arrays. The grouping or array of sand-filled modules must form a complete sand-filled temporary crash cushion as described.

Whenever work activity exposes 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.

12-3.15B Materials

A sand-filled temporary crash cushion module must be manufactured after March 31, 1997 and be on the Authorized Material List for highway safety features.

Modules contained in the same grouping or array must be of the same type. The color of the modules must be standard yellow with black lids as furnished by the manufacturer. The modules must exhibit good workmanship, free from structural flaws and objectionable surface defects. The modules need not be new. You may use good, used, undamaged modules. For Fitch modules 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 the modules 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. At the time the sand is placed in the modules, the sand must contain not more than 7 percent water when tested under California Test 226.

12-3.15C Construction

Secure the sand-filled modules in place before commencing a work 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 sand-filled temporary crash cushions during the work period 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 period. Remove sand-filled temporary crash cushions when no longer required.

Immediately repair sand-filled temporary crash cushion modules damaged due to your activities. Remove and replace any module damaged beyond repair. Repair of temporary crash cushion modules damaged by traffic is 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.

Remove sand-filled temporary crash cushion modules, including sand, pallets or frames, and marker panels, at the time of Contract acceptance. Do not install sand-filled temporary crash cushion modules in the permanent work.

12-3.15D Payment

The Department does not pay for temporary crash cushion modules placed under section 7-1.04 or placed in excess of the number described.

A lateral move of temporary crash cushion module is change order work if ordered and the repositioning is not shown. The Department does not count repositioned modules in the count of temporary crash cushion modules.

12-3.16 TEMPORARY SIGNAL SYSTEM

Reserved

12-3.17 TEMPORARY FLASHING BEACON SYSTEM

Reserved

12-4 MAINTAINING TRAFFIC

12-4.01 GENERAL

Section 12-4 includes specifications for maintaining traffic through construction workzones.

Closures must comply with section 12-5.

A closure is defined as the closure of a traffic lane or lanes, including shoulder, ramp, or connector lanes, within a single traffic control system.

Wherever local authorities regulate traffic, notify the local authorities at least 5 business days before the start of work. Cooperate with the local authorities to handle traffic through the work area and to make arrangements to keep the work area clear of parked vehicles.

12-4.02 CLOSURE REQUIREMENTS

12-4.02A General

Limit work that interferes with traffic to the hours closures are allowed.

If complete ramp closure hours and ramp lane requirements are not included, you may close the ramp adjacent to the closed freeway lane.

Adjacent ramps in the same direction of travel servicing 2 consecutive local streets must not be closed simultaneously, unless directed by the Engineer.

Use the signs as shown in the following table:

Sign no.	Sign description	Condition
C43(CA)	Fresh Concrete	Use at the beginning of a pavement slab replacement work area and keep the sign in place throughout the curing period.
SC6-3(CA) SC6-4(CA)	Ramp Closed	Use to inform motorists that a connector, entrance ramp, or exit ramp will be closed for (1) 1 business day and use sign SC6-3(CA) or (2) more than 1 business day and use sign SC6-4(CA). Notify the Engineer at least 2 business days before installing the sign and install the sign 7 to 15 days before the closure.

Freeways may be closed only if signed for closing 7 days in advance. Notify the Engineer at least 5 business days before signing the freeway. If the freeway is not closed on the posted day, change the closure to allow a 3-business-day advance notice before closure.

If a minor deviation from the lane requirement charts is required, submit a request. If no significant increase in cost is accrued to the Department and the work can be expedited and better serve the traffic, the deviation may be authorized.

If pedestrian traffic is allowed to pass through construction areas, provide a pedestrian access facility through the construction areas within the highway. The walkway must:

1. Be surfaced with HMA, PCC, or timber.
2. Be skid resistant and free of irregularities.
3. Include hand railings on each side of the walkway as necessary to protect pedestrian traffic from hazards caused by construction activities or adjacent vehicular traffic. Railing must be made of wood, S4S, and painted white.
4. Include protective overhead covering as necessary to insure protection from falling objects and drips from overhead structures.

At locations where pedestrian openings through falsework are required, provide pedestrian access facilities during all bridge construction activities. If an activity requires a closure of a walkway, another walkway must be made available nearby off of the traveled way.

Maintain railings and walkways in good condition and keep walkways clear of obstructions.

Erect and remove falsework 1 location at a time. During falsework erection and removal, detour or stop traffic in the lanes over which falsework is erected or removed as specified. Falsework erection includes adjustments or removal of components that contribute to the horizontal stability of the falsework system. Falsework removal includes lowering the falsework, blowing sand from sand jacks, turning screws on screw jacks, and removing wedges.

If falsework pavement lighting or pedestrian openings through the falsework are required, falsework lighting must be installed under section 86-6.13.

Payment for providing pedestrian facilities is included in the payment for the bid items involved.

12-4.02B Seal Coats

On the days that lane closures are not allowed, moving lane closures are allowed to maintain the seal coat surface as specified in section 37-2.03I. Lane closures to maintain the seal coat surface must be restricted to daylight hours when traffic will be least inconvenienced and delayed as determined by the Engineer.

If traffic is routed over a surface where a seal coat application is intended, the seal coat 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.

Pilot cars used to convoy or control traffic must have radio contact with other pilot cars and personnel in the work area. The maximum speed of the pilot cars convoying or controlling traffic through the traffic control zone must be 15 mph on 2-lane, 2-way roadways and 25 mph on multilane divided and undivided roadways. Pilot cars must only use traffic lanes open to traffic.

On 2-lane, 2-way roadways, place W8-7, "Loose Gravel," and W13-1 (35) speed advisory signs at maximum 2,000-foot intervals along each side of the traveled way where screenings are spread on a traffic lane and at public roads or streets entering the seal coat area. Place the 1st W8-7 sign in each direction where traffic first encounters loose screenings, regardless of which lane the screenings are spread. A W13-1 (35) sign is not required where the posted speed limit is less than 40 mph.

On freeways, expressways, and multilane conventional highways, place W8-7, "Loose Gravel," and W13-1 (35) speed advisory signs at maximum 2,000-foot 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 seal coat area. Place the 1st W8-7 sign where the screenings start with respect to the direction of travel on that lane. A W13-1 (35) sign is not required where the posted speed limit is less than 40 mph.

Maintain signs in place at each location until the final brooming of the seal coat 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.

Payment for furnishing and using pilot cars to reduce the speed of traffic and convoy or control traffic, as specified, is included in the payment for the bid items involved unless a bid item for traffic control system is included in the Bid Item List.

12-4.02C Bridge Painting and Cleaning

In addition to the signs shown, furnish and place the signs shown in the following table:

Sign no.	Sign description	Requirements
W20-1	Road Work Ahead	Place a portable 30 by 30 inch sign at locations where traffic approaches a bridge with work underway. If the approach speed is greater than 50 mph, the size of the sign must be 48 by 48 inches. The sign panel base material must not be plywood. Attach an orange or fluorescent red-orange flag not less than a 16-inch square to each sign. The exact location of the signs will be determined by the Engineer. Signs must not be used until needed. Maintain signs in place while cleaning and painting operations are performed and remove at the end of each day's work.
	Cleaning and Painting Operations	Place a 48 by 48 inch square sign near each W20-1 sign. Use 4-inch high black lettering and include your name, address, and telephone number on an orange background. Maintain the sign in place while cleaning and painting operations are performed and remove at the end of each day's work.

At the end of each day's work, when activities are not in progress, remove obstructions and leave the roadway clear and unobstructed to allow 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.

12-4.02D Toll Bridges

Reserved

12-4.03 CLOSURE SCHEDULE AND CONDITIONS

Every Monday by noon, submit a schedule of planned closures for the next week period. The next week period is defined as Sunday noon through the following Sunday noon.

Submit a schedule not less than 25 days and not more than 125 days before the anticipated start of any activity that will:

1. Reduce the horizontal clearances of traveled ways, including shoulders, to 2 lanes or less due to operations such as temporary barrier placement and paving
2. Reduce the vertical clearances available to the public due to operations such as pavement overlay, overhead sign installation, or falsework or girder erection

Use the closure schedule request form from the Engineer and show the locations and times of the proposed closures. Closure schedules submitted with incomplete or inaccurate information will be rejected and returned for correction and resubmittal. You will be notified of unauthorized closures or closures that require coordination with other parties as a condition of approval.

Submit closure schedule amendments, including adding additional closures, by noon at least 3 business days before a planned closure. Approval of amendments will be at the discretion of the Engineer.

The Engineer must be notified of a cancelled closure 2 business days before the date of the closure.

The Engineer may reschedule a closure cancelled due to unsuitable weather.

A detailed contingency plan must be prepared for reopening closures to traffic. The contingency plan must be submitted within 1 business day of the Engineer's request.

If a closure is not reopened to traffic by the specified time, work must be suspended. No further closures are allowed until the Engineer has reviewed and accepted a work plan submitted by you that insures that future closures will be reopened to traffic at the specified time. Allow the Department 2 business days to review your proposed work plan. You are not entitled to compensation for the suspension of work resulting from the late reopening of closures.

Notify the Engineer of delays in your activities caused by:

1. Your proposed closure schedule being denied although your planned closures are within the time frame allowed for closures as specified in the special provisions. You will not be entitled to compensation for amendments to the closure schedule that are not authorized.
2. Your confirmed closure being denied.

If in the opinion of the Engineer your controlling activities are delayed or interfered with by reason of the conditions listed above and your loss due to that delay could not have been avoided by rescheduling the affected closure or by judicious handling of forces, equipment and plant, you will be compensated for the delay.

If you are directed to remove a closure before the time designated in the authorized closure schedule, you will be compensated for the delay.

12-4.04 LANE CLOSURE RESTRICTIONS FOR DESIGNATED HOLIDAYS AND SPECIAL DAYS

Reserved

12-4.05 LANE REQUIREMENT CHARTS

12-4.05A General

Reserved

12-4.05B Freeway and Expressway Lane Requirements

Reserved

12-4.05C Complete Freeway and Expressway Closure Hours

Reserved

12-4.05D Complete Connector Closure Hours and Connector Lane Requirements

Reserved

12-4.05E Complete Ramp Closure Hours and Ramp Lane Requirements

Reserved

12-4.05F Conventional Highway Lane Requirements

Reserved

12-4.05G Complete Conventional Highway Closure Hours

Reserved

12-4.05H Reserved

12-4.05I Reserved

12-5 TRAFFIC CONTROL SYSTEM FOR LANE CLOSURE

Reserved

12-6 TRAFFIC CONTROL SYSTEM FOR RAMP CLOSURE

12-6.01 GENERAL

Section 12-6 includes specifications for closing ramps. A traffic control system for a ramp closure must comply with the details shown.

12-6.02 MATERIALS

Use a SC6-3(CA) "Ramp Closed" sign to inform motorists of a temporary closing of a freeway or an expressway entrance or an exit ramp for 1 day or less.

Use a SC6-4(CA) "Ramp Closed" sign to inform motorists of a temporary closing of a freeway or an expressway entrance or an exit ramp for more than 1 day.

12-6.03 CONSTRUCTION

Close ramps at the times and locations specified in section 12-4.

Install a SC6-3(CA) or a SC6-4(CA) sign, whichever is applicable, at least 7 days before closing a ramp but not more than 14 days in advance of the ramp closure. Notify the Engineer at least 2 business days before installing a SC6-3(CA) or SC6-4(CA) sign. The SC6-3(CA) or SC6-4(CA) sign must be stationary-mounted at the locations shown and must remain in place and visible to motorists during the ramp closure.

Whenever components of the traffic control system are displaced or cease to operate or function as specified from any cause, immediately repair the components to the original condition or replace the components and restore the components to the original location.

For a ramp closure made only for the work period, remove the components of the traffic control system from the traveled way and shoulder, except for portable delineators placed along open trenches or excavation adjacent to the traveled way at the end of each work period. You may store the components at selected central locations designated by the Engineer within the limits of the highway.

Maintain accurate and timely information on the SC6-3(CA) or SC6-4(CA) sign. Immediately update the sign message when the information becomes outdated. Cover or remove a SC6-3(CA) or SC6-4(CA) sign when it is no longer required.

12-6.04 PAYMENT

Traffic control system for ramp closure is paid for as traffic control system.

12-7 TEMPORARY PEDESTRIAN WALKWAYS

12-7.01 GENERAL

Section 12-7 includes specifications for constructing temporary pedestrian walkways.

Provide temporary pedestrian access through work areas within the highway.

In addition to the required openings through falsework, provide temporary pedestrian access during pile driving, footing, wall, and other bridge work activities. At least 1 walkway must be available at all times. If work activities require the closure of the walkway, provide another walkway nearby, off the traveled way.

12-7.02 MATERIALS

Railings for a temporary pedestrian walkway must be S4S lumber and painted white.

The walkway must be surfaced with HMA, portland cement concrete, or wood. The surface must be skid resistant and free of irregularities.

Maintain railings and walkways in good condition. Keep walkways clear of obstructions.

12-7.03 CONSTRUCTION

Construct a hand railing on each side of a temporary pedestrian walkway as necessary to protect pedestrian traffic from hazards due to work activities or adjacent vehicular traffic.

Construct a protective overhead covering as necessary to protect pedestrians from falling objects and drippings from overhead structures.

12-7.04 PAYMENT

Not Used

12-8 TEMPORARY PAVEMENT DELINEATION

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 in streams, waterways, and other bodies of water.

Information on forms, reports, and other documents can be found in the following Department manuals:

1. *Field Guide for Construction Site Dewatering*
2. *Storm Water Pollution Prevention Plan (SWPPP) and Water Pollution Control Program (WPCP) Preparation Manual*
3. *Construction Site Best Management Practices (BMP) Manual*
4. *Construction Site Monitoring Program (CSMP) Guidance Manual*

For the above-referenced manuals, go to the Department's Web site for the Division of Construction, Storm Water and Water Pollution Control Information or the Department's publication distribution unit.

Do not start job site activities until:

1. The WPCP or SWPPP is authorized.
2. The waste discharge identification number is issued if the project requires a SWPPP.
3. WPCP or SWPPP review requirements have been fulfilled. If the RWQCB requires time for review, allow 30 days for the review. For projects in the Lake Tahoe Hydrologic Unit and the Mammoth Lakes Hydrologic Unit, the Lahontan RWQCB will review the WPCP or SWPPP.

If you operate a Contractor-support facility, protect stormwater systems or receiving waters from the discharge of potential pollutants by using water pollution control practices.

Contractor-support facilities include:

1. Staging areas
2. Storage yards for equipment and materials
3. Mobile operations
4. Batch plants for PCC and HMA
5. Crushing plants for rock and aggregate
6. Other facilities installed for your convenience, such as haul roads

Discharges from manufacturing facilities, such as batch plants and crushing plants, must comply with the general waste discharge requirements for *Order No. 97-03-DWQ, NPDES General Permit No. CAS000001*, issued by the State Water Resources Control Board for "*Discharge of Storm Water Associated with Industrial Activities Excluding Construction Activities*" and referred to herein as "General Industrial Permit." For the General Industrial Permit, go to the Web site for the State Water Resources Control Board.

If you operate a batch plant to manufacture PCC, HMA, or other material or a crushing plant to produce rock or aggregate, obtain coverage under the General Industrial Permit. You must be covered under the General Industrial Permit for batch plants and crushing plants located:

1. Outside of the job site
2. Within the job site that serve 1 or more contracts

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 therein.

The Department does not pay for water pollution control practices at Contractor-support facilities and noncommercially operated borrow or disposal sites.

13-1.01B Definitions

active area: Area where soil-disturbing work activities have occurred at least once within 15 days.

construction phase: Includes (1) highway construction phase for building roads and structures, (2) plant establishment and maintenance phase for placing vegetation for final stabilization, and (3) suspension phase for suspension of work activities or winter shutdown. The construction phase continues from the start of work activities to Contract acceptance.

inactive area: Area where soil-disturbing work activities have not occurred within 15 days.

normal working hours: Hours you normally work on the project.

qualifying rain event: Storm that produces at least 0.5 inch of precipitation with a 48-hour or greater period between rain events.

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

Within 48 hours after the conclusion of a storm event resulting in a discharge, after a nonstormwater discharge, or after receiving a written notice or an order from the RWQCB or another regulatory agency, the WPC manager must submit the following information:

1. Date, time, location, and nature of the activity and the cause of the notice or order
2. Type and quantity of discharge
3. Water pollution control practices in use before the discharge or before receiving the notice or order
4. Description of water pollution control practices and corrective actions taken to manage the discharge or cause of the notice

Submit water pollution control training records for all employees and subcontractors who will be working at the job site as an informational submittal. Include the training subjects, training dates, ongoing training, and tailgate meetings with your submittal. Submit records for:

1. Existing employees within 5 business days of obtaining SWPPP or WPCP authorization
2. New employees within 5 business days of receiving the training
3. Subcontractor's employees at least 5 business days before a subcontractor starts work

At least 5 business days before operating any Contractor-support facility, submit:

1. A plan showing the location and quantity of water pollution control practices associated with the Contractor-support facility
2. A 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 General Industrial Permit

13-1.01D Quality Control and Assurance

13-1.01D(1) General

Reserved

13-1.01D(2) Training

Employees must receive initial water pollution control training before starting work at the job site.

For your project managers, supervisory personnel, subcontractors, and employees involved in water pollution control work:

1. Provide stormwater training in the following subjects:
    1.1. Water pollution control rules and regulations
    1.2. Implementation and maintenance for:
        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 water pollution control practices
   2.2. Water pollution control 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. CSMP review
2. Health and safety review
3. Sampling simulations

13-1.01D(3) Water Pollution Control Manager

13-1.01D(3)(a) General

The WPC manager must be a QSP if the project requires a WPCP. The WPC manager must be a QSD if the project requires a SWPPP.

Assign 1 WPC manager to implement the WPCP or SWPPP, whichever is applicable for the project.

13-1.01D(3)(b) Qualifications

The QSD must:

1. Have completed the stormwater management training described in the Department's Web site for the Division of Construction, Storm Water and Water Pollution Control Information
2. Be registered or certified for at least one of the following:
   2.1. California registered civil engineer
   2.2. California registered professional geologist or engineering geologist
   2.3. California licensed landscape architect
   2.4. Professional hydrologist registered through the American Institute of Hydrology
   2.5. Certified Professional in Erosion and Sediment Control (CPESC)™ registered through Enviro Cert International, Inc.
   2.6. Certified Professional in Storm Water Quality (CPSWQ)™ registered through Enviro Cert International, Inc.
   2.7. Professional in erosion and sediment control registered through the National Institute for Certification in Engineering Technologies (NICET)

The QSP must comply with the qualifications for a QSD or must:

1. Have completed the storm water management training described in the Department's Web site for the Division of Construction, Storm Water and Water Pollution Control Information
2. Be certified for at least one of the following:
   2.1. Certified Erosion, Sediment and Storm Water Inspector (CESSWI)™ registered through Enviro Cert International, Inc.
   2.2. Certified Inspector of Sediment and Erosion Control (CISEC) registered through CISEC, Inc.

13-1.01D(3)(c) Responsibilities

The WPC manager must:

1. Be responsible for water pollution control work
2. Be the primary contact for water pollution control work
3. Oversee:
   3.1. Maintenance of water pollution control practices
   3.2. Inspections of water pollution control practices identified in the SWPPP or WPCP
   3.3. Inspections and reports for visual monitoring
   3.4. Preparation and implementation of REAPs
   3.5. Sampling and analysis
   3.6. Preparation and submittal of:
      3.6.1. NAL exceedance reports

3.6.2. NEL violation reports
3.6.3. SWPPP annual certification
3.6.4. Annual reports
3.6.5. BMP status reports

4. Oversee and enforce hazardous waste management practices under section 14-11, including spill prevention and control measures
5. Have authority to mobilize crews to make immediate repairs to water pollution control practices
6. Ensure that all employees have current water pollution control training
7. Implement the authorized SWPPP or WPCP
8. Amend the SWPPP or WPCP if required
9. Be at the job site within 2 hours of being contacted
10. Have the authority to stop construction activities damaging water pollution control practices or causing water pollution

13-1.01D(4)–13-1.01D(6) Reserved

13-1.02 MATERIALS

Not Used

13-1.03 CONSTRUCTION

13-1.03A General

Install facilities and devices used for water pollution control practices before performing work activities. Install soil stabilization materials for water pollution control practices in all work areas that are inactive or before storm events.

Repair or replace water pollution control practices within 24 hours of discovering any damage, unless a longer period is authorized.

The Department does not pay for the cleanup, repair, removal, disposal, or replacement of water pollution control practices due to improper installation or your negligence.

You may request changes to the water pollution control work or the Engineer may order changes to water pollution control work. Changes may include additional or new water pollution control practices. Additional water pollution control work is change order work.

Retain a printed copy of the authorized WPCP or SWPPP at the job site.

13-1.03B Monitoring

Monitor the National Weather Service's forecast on a daily basis. For the National Weather Service's forecast, go to the Web site for the National Weather Service.

13-1.03C Inspections

Use the *Stormwater Site Inspection Report* form for documenting site inspections.

The WPC manager must oversee:

1. Inspections of water pollution control practices identified in SWPPP or WPCP:
   1.1. Before a forecasted storm event
   1.2. After a qualifying rain event that produces site runoff
   1.3. At 24-hour intervals during extended storm events
   1.4. On a predetermined schedule of at least once a week
2. Daily inspections of:
   2.1. Storage areas for hazardous materials and waste under section 14-11
   2.2. Hazardous waste disposal and transporting activities under section 14-11
   2.3. Hazardous material delivery and storage activities
3. Inspections of:
   3.1. Vehicle and equipment cleaning facilities:
      3.1.1. Daily if vehicle and equipment cleaning occurs daily
      3.1.2. Weekly if vehicle and equipment cleaning does not occur daily
   3.2. Vehicle and equipment maintenance and fueling areas:
      3.2.1. Daily if vehicle and equipment maintenance and fueling occurs daily

3.2.2. Weekly if vehicle and equipment maintenance and fueling does not occur daily
3.3. Vehicles and equipment at the job site for leaks and spills on a daily schedule. Verify that operators are inspecting vehicles and equipment each day of use.
3.4. Demolition sites within 50 feet of storm drain systems and receiving waters daily.
3.5. Pile driving areas for leaks and spills:
3.5.1. Daily if pile driving occurs daily
3.5.2. Weekly if pile driving does not occur daily
3.6. Temporary concrete washouts:
3.6.1. Daily if concrete work occurs daily
3.6.2. Weekly if concrete work does not occur daily
3.7. Paved roads at job site access points for street sweeping:
3.7.1. Daily if earthwork and other sediment or debris-generating activities occur daily
3.7.2. Weekly if earthwork and other sediment or debris-generating activities do not occur daily
3.7.3. Within 24 hours of precipitation forecasted by the National Weather Service
3.8. Dewatering work:
3.8.1. Daily if dewatering work occurs daily
3.8.2. Weekly if dewatering work does not occur daily
3.9. Temporary active treatment system:
3.9.1. Daily if temporary active treatment system activities occur daily
3.9.2. Weekly if temporary active treatment system activities do not occur daily
3.10. Work over water:
3.10.1. Daily if work over water occurs daily
3.10.2. Weekly if work over water does not occur daily

13-1.03D Deficiencies

Whenever you or the Engineer identify a deficiency in the implementation of the authorized WPCP or SWPPP, correct the deficiency:

1. Immediately, unless a later date is authorized
2. Before precipitation occurs

The Department may correct the deficiency and deduct the cost of correcting the deficiency from payment if you fail to correct the deficiency by the agreed date or before the onset of precipitation.

13-1.03E–13-1.03G Reserved

13-1.04 PAYMENT

Not Used

13-2 WATER POLLUTION CONTROL PROGRAM

13-2.01 GENERAL

13-2.01A Summary

Section 13-2 includes specifications for developing and implementing a WPCP for projects where soil disturbance from work activities will be one of the following:

1. Less than 1 acre
2. Less than 5 acres if the project has an *Environmental Protection Agency Small Construction Project Erosivity Waiver* referred to herein as "Erosivity Waiver"

Prepare water pollution control program includes developing and implementing the WPCP, providing a WPC manager, conducting water pollution control training, and monitoring, inspecting and correcting water pollution control practices.

You may assign a QSP other than the WPC manager to develop the WPCP.

13-2.01B Submittals

Within 7 days after Contract approval:

1. Submit 2 copies of your WPCP for review. The Engineer provides comments and specifies the date when the review stopped if revisions are required.
2. Resubmit a revised WPCP within 7 days of receiving the Engineer's comments. The Department's review resumes when the complete WPCP has been resubmitted.
3. When the Engineer authorizes the WPCP, submit an electronic copy and 3 printed copies of the authorized WPCP.
4. If the RWQCB requires review of the authorized WPCP, the Engineer submits the authorized WPCP to the RWQCB for its review and comment.
5. If the Engineer orders changes to the WPCP based on the RWQCB's comments, amend the WPCP within 3 business days.

The WPCP must comply with the Department's *Storm Water Pollution Prevention Plan (SWPPP) and Water Pollution Control Plan (WPCP) Preparation Manual* and 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 water pollution control practices
3. Show the locations and types of water pollution control practices that will be used for:
    3.1. Stormwater and nonstormwater in areas 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
    3.3. Contractor-support facilities
4. Show the locations and types of temporary water pollution control practices that will be used in the work for each construction phase
5. Show the locations and types of water pollution control 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. Water pollution control practices associated with each construction phase will be implemented
    6.3. Soil stabilization and sediment control practices for disturbed soil areas will be implemented
7. Include a copy of permits obtained by the Department, including Fish & Game permits, US Army Corps of Engineers permits, RWQCB 401 certifications, aerially deposited lead variance from the Department of Toxic Substance Control, aerially deposited lead variance notification, and RWQCB waste discharge requirements for aerially deposited lead reuse

Amend the WPCP whenever:

1. Changes in work activities could affect the discharge of pollutants
2. Water pollution control practices are added by change order work
3. Water pollution control 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

Allow the same review time for amendments to the WPCP as for the original WPCP.

13-2.02 MATERIALS

Not Used

13-2.03 CONSTRUCTION

Manage work activities in a way that reduces the discharge of pollutants to surface waters, groundwater, and separate municipal storm sewer systems.

Monitor and inspect water pollution control practices at the job site.

Notify the Engineer within 6 hours whenever any of the following occurs:

1. You identify discharges into receiving waters or drainage systems that are causing or could cause water pollution
2. You 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 are responsible for delays and you must pay all costs associated with submitting a SWPPP due to your actions that result in one of the following:

1. 1 or more acres of soil disturbance on projects without an Erosivity Waiver
2. More than 5 acres of soil disturbance on projects with an Erosivity Waiver
3. Failure to comply with the schedule for soil disturbing activities for projects with an Erosivity Waiver if the delays void the Erosivity Waiver

13-2.04 PAYMENT

The Department pays you for prepare water pollution control program as follows:

1. A total of 75 percent of the item total upon authorization of the WPCP
2. A total of 100 percent of the item total upon Contract acceptance

13-3 STORM WATER POLLUTION PREVENTION PLAN

13-3.01 GENERAL

13-3.01A Summary

Section 13-3 includes specifications for developing and implementing a SWPPP for projects where soil disturbance from work activities will be 1 or more acres.

Prepare storm water pollution prevention plan includes developing and implementing the SWPPP, providing a WPC manager, conducting water pollution control training, and monitoring, inspecting, and correcting water pollution control practices.

You may assign a QSD other than the WPC manager to develop the SWPPP.

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."

Whenever a qualifying rain event produces runoff for a risk level 2 or risk level 3 project, sampling and analysis work must comply with the project's CSMP.

A storm water annual report must cover the preceding period from July 1st to June 30th.

13-3.01B Submittals

13-3.01B(1) General

Reserved

13-3.01B(2) Storm Water Pollution Prevention Plan

13-3.01B(2)(a) General

Within 20 days of Contract approval:

1. Submit 3 copies of your SWPPP for review. Allow 20 days for the Department's review. The Engineer provides comments and specifies the date when the review stopped if revisions are required.
2. Change and resubmit a revised SWPPP within 15 days of receiving the Engineer's comments. The Department's review resumes when a complete SWPPP has been resubmitted.
3. When the Engineer authorizes the SWPPP, submit an electronic copy and 4 printed copies of the authorized SWPPP.
4. If the RWQCB requires review of the authorized SWPPP, the Engineer submits the authorized SWPPP to the RWQCB for its review and comment.
5. If the Engineer requests changes to the SWPPP based on the RWQCB's comments, amend the SWPPP within 10 days.

The SWPPP must comply with the Department's *Storm Water Pollution Prevention Plan (SWPPP) and Water Pollution Control Plan (WPCP) Preparation Manual*. Include the following in the SWPPP:

1. Description of the work involved in the installation, maintenance, repair, and removal of temporary and permanent water pollution control practices.
2. Maps showing:
   2.1. Locations of disturbed soil areas
   2.2. Water bodies and conveyances
   2.3. Locations and types of water pollution control practices that will be used for each Contractor-support facility:
   2.4. Locations and types of temporary water pollution control practices that will be used in the work for each construction phase
   2.5. Locations and types of water pollution control practices that will be installed permanently under the Contract
   2.6. Pollutant sampling locations
   2.7. Locations planned for storage and use of potential nonvisible pollutants
   2.8. Receiving water sampling locations
3. CSMP
4. Copy of permits obtained by the Department, including Fish & Game permits, US Army Corps of Engineers permits, RWQCB 401 certifications, aerially deposited lead variance from the Department of Toxic Substance Control, aerially deposited lead variance notification, and RWQCB waste discharge requirements for aerially deposited lead reuse.

Include the following items in the SWPPP:

1. For all projects:
   1.1. Schedule
   1.2. CSMP
2. For risk level 2 projects add:
   2.1. Adherence to effluent standards for NALs
   2.2. REAP
3. For risk level 3 projects add:
   3.1. Adherence to effluent standards for NALs and NELs
   3.2. REAP

The SWPPP schedule must show when:

1. Work activities will be performed that could cause the discharge of pollutants into stormwater
2. Water pollution control practices associated with each construction phase will be implemented
3. Soil stabilization and sediment control practices for disturbed soil areas will be implemented

Amend and resubmit the SWPPP:

1. Annually before July 15th
2. Whenever:
   2.1. Changes in work activities could affect the discharge of pollutants
   2.2. Water pollution control practices are added by change order work
   2.3. Water pollution control practices are added at your discretion
   2.4. Changes in the quantity of disturbed soil are substantial
   2.5. Objectives for reducing or eliminating pollutants in stormwater discharges have not been achieved
   2.6. You receive a written notice of a permit violation for the project from the RWQCB or any other regulatory agency

Allow the same review time for amendments to the SWPPP as for the original SWPPP.

13-3.01B(2)(b) Construction Site Monitoring Program

A QSD must prepare the CSMP. Change the program to reflect current job site activities as needed. The CSMP must include the following:

1. For all projects:

1.1. Visual monitoring procedures
1.2. SAP for nonvisible pollutants
1.3. SAP for nonstormwater discharges
1.4. SAP for monitoring required by RWQCB
2. For risk level 2 projects add:
2.1. SAP for pH and turbidity
3. For risk level 3 projects add:
3.1. SAP for pH and turbidity
3.2. SAP for temporary active treatment systems

13-3.01B(2)(c) Sampling and Analysis Plan

The SAP must comply with the Department's *Construction Site Monitoring Program (CSMP) Guidance Manual*.

Describe the following water quality sampling procedures in the SAP:

1. Sampling equipment
2. Sample preparation
3. Collection
4. Field measurement methods
5. Analytical methods
6. Quality assurance and quality control
7. Sample preservation and labeling
8. Collection documentation
9. Sample shipping
10. Chain of custody
11. Data management and reporting
12. Precautions from the construction site health and safety plan
13. Laboratory selection and certifications

The SAP must identify the State-certified laboratory, sample containers, preservation requirements, holding times, and analytical method. For a list of State-certified laboratories go to the CDPH Web site.

Include procedures for sample collection during precipitation.

List conditions when you will not be required to physically collect samples such as:

1. Dangerous weather
2. Flooding or electrical storms
3. Times outside of normal working hours

Amend the SAP whenever discharges or sampling locations change because of changed work activities or knowledge of site conditions.

Include 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. Describe the collection of effluent samples at all locations where the stormwater is discharged off-site.

13-3.01B(2)(d) Sampling and Analysis Plan for Nonvisible Pollutants

The SAP for nonvisible pollutants must describe the sampling and analysis strategy for monitoring nonvisible pollutants.

The SAP for nonvisible pollutants 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 SAP for nonvisible pollutants must include sampling procedures for the following conditions when 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 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 historical usage of the site that could discharge pollutants to surface waters or drainage systems

The SAP for nonvisible pollutants must provide sampling procedures and a schedule for:

1. Sample collection during the first 2 hours of rain events that generate runoff
2. Sample collection during normal working hours
3. Each nonvisible pollutant source
4. Uncontaminated control sample

The SAP for nonvisible pollutants must identify locations for sampling downstream and 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.

13-3.01B(2)(e)–13-3.01B(2)(g) Reserved

13-3.01B(3) Annual Certification

Submit an annual certification of compliance as described in the Department's *Storm Water Pollution Prevention Plan (SWPPP) and Water Pollution Control Plan (WPCP) Preparation Manual* before July 15th of each year.

13-3.01B(4) Site Inspection Reports

The WPC manager must submit the following informational submittals within 24 hours of completing a weekly inspection:

1. Completed *Stormwater Site Inspection Report* form.
2. BMP status report. The WPC manager must oversee the preparation of the report. The report must include:
   - 2.1. Location and quantity of installed water pollution control practices
   - 2.2. Location and quantity of disturbed soil for active and inactive areas

13-3.01B(5) Visual Monitoring Reports

Submit visual monitoring reports for:

1. Each storm event. Include:
   - 1.1. Date, time, and rain gauge reading
   - 1.2. Visual observations:
     - 1.2.1. Within 2 business days before the storm for:
       - 1.2.1.1. Spills, leaks, or uncontrolled pollutants in drainage areas
       - 1.2.1.2. Proper implementation of water pollution control practices
       - 1.2.1.3. Leaks and adequate freeboard in storage areas
     - 1.2.2. Every 24 hours during the storm event for:
       - 1.2.2.1. Effective operation of water pollution control practices
       - 1.2.2.2. Water pollution control practices needing maintenance and repair
     - 1.2.3. Within 2 business days after the qualifying rain event for:

1.2.3.1. Stormwater discharge locations
1.2.3.2. Evaluation of design, implementation, effectiveness, and locations of water pollution control practices including locations where additional water pollution control practices may be needed

2. Nonstormwater discharges during each of the following periods:
   2.1. January through March
   2.2. April through June
   2.3. July through September
   2.4. October through December

Use the *Stormwater Site Inspection Report* form to document visual monitoring. A 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:
   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

Retain visual monitoring reports at the job site as part of the SWPPP.

13-3.01B(6) Sampling and Analysis Day

13-3.01B(6)(a) General

Submit a printed copy and electronic copy of water quality analysis results, and quality assurance and quality control reports within 48 hours of field sampling, and within 30 days of laboratory analysis. Electronic copies must be in one of the following formats: (1) xls, (2) .txt, (3) .cvs, (4) .dbs, or (5) .mdb. 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 identification number
2. Contract number
3. Constituent
4. Reported value
5. Analytical method
6. Method detection limit
7. Reported limit

13-3.01B(6)(b) Numeric Action Level Exceedance Reports

Whenever a NAL is exceeded, notify the Engineer and submit a NAL exceedance report within 48 hours after 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 BMPs and corrective actions taken to manage NAL exceedance

13-3.01B(6)(c) Numeric Effluent Limit Violation Reports

Whenever a NEL is exceeded, notify the Engineer and submit a NEL violation report within 6 hours. 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 observation and measurements
   1.3. Quantity of precipitation from the storm event
2. Description of BMPs and corrective actions taken to manage NEL exceedance

13-3.01B(6)(d)–13-3.01B(6)(f) Reserved

13-3.01B(7) Rain Event Action Plan

For a risk level 2 or risk level 3 project, submit a REAP whenever the National Weather Service is predicting a storm event with at least 50 percent probability of precipitation within 72 hours.

The WPC manager must submit the REAP at least 48 hours before a forecasted storm event.

The REAP 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 work 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 disturbed soil 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. BMPs for maintenance and repair
6. Flood contingency measures

13-3.01B(8) Storm Water Annual Report

Submit the storm water annual report before July 15th if construction occurs from July 1st through June 30th or within 15 days after Contract acceptance if construction ends before June 30th. Submit 2 copies of the report. Allow 10 days for the Engineer's review. The Engineer provides comments and specifies the date when the review stopped if revisions are required.

Obtain authorization for the format of the storm water annual report. The report must include:

1. Project information such as description 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 corrective actions taken
   - 2.4. Identification of corrective actions taken and compliance activities not implemented
   - 2.5. Summary of violations
   - 2.6. Names of 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. BMP installation, inspection, maintenance, and repair
   - 3.3. Preparing, revising, and amending the SWPPP

Submit a revised report within 5 business days of receiving the Engineer's comments. The Engineer's review resumes when a complete report has been resubmitted.

When the storm water annual report is authorized, submit 1 electronic copy and 2 printed copies of the report signed by the WPC manager.

13-3.01B(9)–13-3.01B(11) Reserved

13-3.01C Quality Control and Assurance

13-3.01C(1) General

Assign trained personnel to collect water quality samples. Document the personnel and training in the SAP.

Samples taken by assigned field personnel must comply with the equipment manufacturer's instructions for collection, 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*.

Whenever downstream samples show increased levels of pollutants, assess water pollution control practices, site conditions, and surrounding influences to determine the probable cause for the increase.

For a risk level 2 or risk level 3 project, obtain samples of pH and turbidity as shown in the following table:

Parameter	Test method	Detection limit (min)	Unit
Turbidity	Field test with calibrated portable instrument	1	NTU
pH	Field test with calibrated portable instrument	0.2	pH units

For a risk level 3 project, obtain samples and analyze the suspended sediment concentration whenever the turbidity NEL is exceeded as shown in the following table:

Parameter	Test method	Detection limit (min)	Unit
Suspended sediment concentration	ASTM D 3977	5	Mg/L

For a risk level 3 project, obtain samples of pH and turbidity from representative and accessible locations upstream of the discharge point and downstream of the discharge point.

For multiple discharge points, obtain samples from a single upstream and a single downstream location.

13-3.01C(2) Numeric Action Levels

For a risk level 2 or risk level 3 project, NALs must comply with the values shown in the following table:

Numeric Action Levels

Parameter	Test method	Detection limit (min)	Unit	Value
pH	Field test with calibrated portable instrument	0.2	pH	Lower NAL = 6.5 Upper NAL = 8.5
Turbidity	Field test with calibrated portable instrument	1	NTU	250 NTU max

13-3.01C(3) Numeric Effluent Limits

For a risk level 3 project, NELs must comply with the values shown in the following table:

Numeric Effluent Limits

Parameter	Test method	Detection limit (min)	Unit	Value
pH	Field test with calibrated portable instrument	0.2	pH	Lower NEL = 6.0 Upper NEL = 9.0
Turbidity	Field test with calibrated portable instrument	1	NTU	500 NTU max

The storm event daily average for storms up to the 5-year, 24-hour storm must not exceed the NEL for turbidity.

The daily average sampling results must not exceed the NEL for pH.

13-3.01C(4)–13-3.01C(6) Reserved

13-3.02 MATERIALS

Not Used

13-3.03 CONSTRUCTION

13-3.03A General

Obtain, install, and maintain a rain gauge at the job site. Observe and record daily precipitation.

Complete REAP activities, including crew mobilization, within 24 hours before precipitation occurs.

Continue SWPPP implementation during any suspension of work activities.

You may request or the Engineer may order laboratory analysis of stormwater samples. If ordered, laboratory analysis of stormwater samples is change order work.

The Department does not pay for the preparation, collection, laboratory analysis, and reporting of stormwater samples for nonvisible pollutants if water pollution control practices are not implemented before precipitation or if you fail to correct a water pollution control practice before precipitation.

13-3.03B Rain Event Action Plan

Have the REAP at the job site at least 24 hours before a forecasted storm event. The WPC manager must submit the REAP on the following forms:

1. *Rain Event Action Plan Highway Construction Phase*

2. *Rain Event Action Plan Plant Establishment Phase*
3. *Rain Event Action Plan For Inactive Project*

Retain a printed copy of each REAP at the job site as part of the SWPPP.

Implement the REAP, including mobilizing crews to complete activities, within 24 hours before precipitation occurs.

13-3.03C Sampling and Analysis Day

For a risk level 2 or risk level 3 project, collect 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 *Storm Event Sampling and Analyses Plan* form
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. At least 3 samples for each day of a qualifying rain event
   2.4. All locations identified on the *Qualifying Rain Event Sampling and Analyses Plan* form

Perform sample collection during:

1. Normal working hours
2. Each qualifying rain event
3. First 2 hours of each storm event

Collect receiving-water samples for a risk level 3 project and whenever a direct discharge to receiving waters occurs and NELs are violated.

Do not physically collect samples during dangerous weather conditions, such as flooding or electrical storms.

Whenever downstream samples show increased levels of turbidity, pH, and other constituents, assess water pollution control practices, site conditions, and surrounding influences to determine the probable cause for the increase.

Document sample collection during precipitation.

Retain documentation of water quality sampling and analysis results with the SWPPP at the job site.

13-3.03D Storm Water Annual Report

Document and summarize monitoring, sampling and analysis results, laboratory reports, and training.

13-3.03E–13-3.03G Reserved

13-3.04 PAYMENT

For projects with 60 working days or less, the Department pays you for prepare stormwater pollution prevention plan as follows:

1. A total of 75 percent of the item total upon authorization of the SWPPP
2. A total of 100 percent of the item total upon Contract acceptance

For projects with more than 60 working days, the Department pays you for prepare stormwater pollution prevention plan as follows:

1. A total of 50 percent of the item total upon authorization of the SWPPP
2. A total of 90 percent of the item total over the life of the Contract
3. A total of 100 percent of the item total upon Contract acceptance

The Department pays $500 for each rain event action plan submitted.

The Department does not adjust the unit price for an increase or decrease in the rain event action plan quantity.

The Department does not adjust the unit price for an increase or decrease in the storm water sampling and analysis day quantity.

The Department pays $2,000 for each storm water annual report submitted.

The Department does not adjust the unit price for an increase or decrease in the storm water annual report quantity.

For each failure to submit a completed storm water annual report, the Department withholds $10,000. This withhold is in addition to other performance failure withholds.

13-4 JOB SITE MANAGEMENT

13-4.01 GENERAL

13-4.01A Summary

Section 13-4 includes specifications for performing job site management, including spill prevention and control, material management, waste management, nonstormwater management, and dewatering activities.

Implement effective handling, storage, usage, and disposal practices to control material pollution and manage waste and nonstormwater at the job site before they come in contact with storm drain systems and receiving waters.

Linear sediment barriers must comply with section 13-10.

13-4.01B Submittals

Before you start dewatering, 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 locations, quantity of water, equipment, and discharge point
3. Estimated schedule for dewatering and 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 written approval to discharge into a sanitary sewer system at least 5 business days before starting discharge activities

Submit the following informational submittals:

1. MSDS at least 5 business days before material is used or stored
2. Monthly inventory records for material used or stored

Submit written 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.

13-4.02 MATERIALS

Not Used

13-4.03 CONSTRUCTION

13-4.03A General

Reserved

13-4.03B Spill Prevention and Control

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. Whenever you spill or leak chemicals or hazardous substances at the job site, you are responsible for all associated cleanup costs and related liability.

Report minor, semisignificant, and significant or hazardous spills to the WPC manager. The WPC manager must notify the Engineer immediately.

As soon as it is safe, contain and clean up spills of petroleum materials and sanitary and septic waste substances listed under 40 CFR, parts 110, 117, and 302. Comply with section 14-11 whenever spills or leaks produce hazardous waste.

13-4.03B(1) Minor Spills

Minor spills consist of quantities of oil, gasoline, paint, or other materials that are small enough to be controlled by a first responder upon discovery of the spill.

Clean up a minor spill using the following procedures:

1. Contain the spread of the spill
2. Recover the spilled material using absorption
3. Clean the contaminated area
4. Dispose of the contaminated material and absorbents promptly and properly

13-4.03B(2) Semisignificant Spills

Semisignificant spills consist of spills that can be controlled by a first responder with help from other personnel.

Clean up a semisignificant spill immediately using the following procedures:

1. Contain the spread of the spill.
2. On paved or impervious surfaces, encircle and recover the spilled material with absorbent materials. Do not allow the spill to spread widely.
3. If the spill occurs on soil, contain the spill by constructing an earthen dike and dig up the contaminated soil for disposal.
4. If the spill occurs during precipitation, cover the spill with 10-mil plastic sheeting or other material to prevent contamination of runoff.
5. Dispose of the contaminated material promptly and properly.

13-4.03B(3) Significant or Hazardous Spills

Significant or hazardous spills consist of spills that cannot be controlled by job site personnel.

Immediately notify qualified personnel of a significant or hazardous spill. Take the following steps:

1. Do not attempt to clean up the spill until qualified personnel have arrived
2. Notify the Engineer and follow up with a report
3. Obtain the immediate services of a spill contractor or hazardous material team
4. Notify local emergency response teams by dialing 911 and county officials by using the emergency phone numbers retained at the job site
5. Notify the California Emergency Management Agency State Warning Center at (916) 845-8911
6. Notify the National Response Center at (800) 424-8802 regarding spills of Federal reportable quantities under 40 CFR 110, 119, and 302
7. Notify other agencies as appropriate, including:
    - 7.1. Fire Department
    - 7.2. Public Works Department
    - 7.3. Coast Guard
    - 7.4. Highway Patrol
    - 7.5. City Police or County Sheriff's Department
    - 7.6. Department of Toxic Substances
    - 7.7. California Division of Oil and Gas
    - 7.8. Cal/OSHA
    - 7.9. Regional Water Resources Control Board

Prevent a spill from entering stormwater runoff before and during cleanup activities. Do not bury or wash the spill with water.

13-4.03B(4)–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.

Use less hazardous materials if practicable.

The following activities must be performed at least 100 feet from concentrated flows of stormwater, drainage courses, and inlets if within the floodplain and at least 50 feet if outside the floodplain, unless otherwise authorized:

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

If materials are stored:

1. Store liquids, petroleum materials, and substances listed in 40 CFR 110, 117, and 302 and place them in secondary containment facilities as specified by USDOT for storage of hazardous materials.
2. Secondary containment facilities must be impervious to the materials stored there for a minimum contact time of 72 hours.
3. Cover secondary containment facilities during nonworking days and whenever precipitation is forecasted. Secondary containment facilities must be adequately ventilated.
4. Keep secondary containment facilities free of accumulated rainwater or spills. After precipitation, or in the event of spills or leaks, collect accumulated liquid and place it into drums within 24 hours. Handle the liquid as hazardous waste under section 14-11 unless testing confirms that the liquid is nonhazardous.
5. Do not store incompatible materials, such as chlorine and ammonia, in the same secondary containment facility.
6. Store materials in their original containers with the original material labels maintained in legible condition. Immediately replace damaged or illegible labels.
7. Secondary containment facilities must have the capacity to contain precipitation from a 24-hour-long, 25-year storm, plus 10 percent of the aggregate volume of all containers or the entire volume of the largest container within the facility, whichever is greater.
8. Store bagged or boxed material on pallets. Protect bagged or boxed material from wind and rain during nonworking days and whenever precipitation is forecasted.
9. Provide sufficient separation between stored containers to allow for spill cleanup or emergency response access. Storage areas must be kept clean, well organized, and equipped with cleanup supplies appropriate for the materials being stored.
10. Repair or replace perimeter controls, containment structures, covers, and liners as necessary. Inspect storage areas before and after precipitation and at least weekly during other times.

13-4.03C(3) Stockpile Management

Minimize stockpiling of materials at the job site.

Implement water pollution control practices within 72 hours of stockpiling material or before a forecasted storm event, whichever occurs first. If stockpiles are being used, do not allow soil, sediment, or other debris to enter storm drains, open drainages, and watercourses.

Active and inactive soil stockpiles must be:

1. Covered with soil stabilization material or a temporary cover
2. Surrounded with a linear sediment barrier

Stockpiles of asphalt concrete and PCC rubble, HMA, aggregate base, or aggregate subbase must be:

1. Covered with a temporary cover
2. Surrounded with a linear sediment barrier

Stockpiles of pressure-treated wood must be:

1. Placed on pallets
2. Covered with impermeable material

Stockpiles of cold mix asphalt concrete must be:

1. Placed on an impervious surface
2. Covered with an impermeable material
3. Protected from stormwater run-on and runoff

Control wind erosion year round under section 14-9.03.

Repair or replace linear sediment barriers and covers as needed to keep them functioning properly. Whenever sediment accumulates to 1/3 of the linear sediment barrier 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 in a way that does not contaminate soil, receiving waters, or storm drain systems. Handle and dispose of the following as hazardous waste under section 14-11: paints, thinners, solvents, residues, and sludges that cannot be recycled or reused. When thoroughly dry, dispose of the following as solid waste under section 14-10: dry latex paint, paint cans, used brushes, rags, absorbent materials, and drop cloths.

13-4.03D(3) Concrete Waste

Use practices to prevent the discharge of asphalt concrete, PCC, and HMA waste into storm drain systems and receiving waters.

Collect and dispose of asphalt concrete, PCC, and HMA waste at locations where:

1. Concrete material, including grout, is used
2. Concrete dust and debris result from demolition
3. Sawcutting, coring, grinding, grooving, or hydro-concrete demolition creates a residue or slurry
4. Concrete trucks or other concrete-coated equipment is cleaned at the job site

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 provisions if using an on-site disposal system.

13-4.03D(5) Liquid Waste

Use practices that will prevent job-site liquid waste from entering storm drain systems and receiving waters. Liquid wastes include the following:

1. Drilling slurries or fluids
2. Grease-free 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 or rinse water
5. Other nonstormwater liquids not covered by separate permits

Hold liquid waste in structurally sound, leak-proof containers, such as roll-off bins or portable tanks.

Liquid waste containers must be of sufficient quantity and 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 the Engineer authorizes another method.

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) Water Control and Conservation

Manage water used for work activities in a way that will prevent erosion and the discharge of pollutants into storm drain systems and receiving waters. Obtain authorization before washing anything at the job site with water that could discharge into a storm drain system or receiving waters. Report discharges immediately.

Implement water conservation practices if water is used at the job site. Inspect irrigation areas. Adjust watering schedules to prevent erosion, excess watering, or runoff. Shut off the water source to broken lines, sprinklers, or valves and repair breaks within 24 hours. Reuse water from waterline flushing for landscape irrigation if practicable. Sweep and vacuum paved areas. Do not wash paved areas with water.

Direct runoff water, including water from water line repair, from the job site to areas where it can infiltrate into the ground. Do not allow runoff water to enter storm drain systems and receiving waters. Do not allow spilled water to escape filling areas for water trucks. Direct water from off-site sources around the job site if practicable. Minimize the contact of off-site water with job site water.

13-4.03E(2) Illicit Connection and Illegal Discharge Detection and Reporting

Before starting work, inspect the job site and the job site's perimeter for evidence of illicit connections, illegal discharges, and dumping. After starting work, inspect the job site and perimeter on a daily schedule for illicit connections and illegal dumping and discharges.

Whenever illegal connections, discharges, or dumping are discovered, notify the Engineer immediately. Do not take further action unless ordered. Assume that unlabeled or unidentifiable material is hazardous.

Look 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 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

13-4.03E(3) Vehicle and Equipment Cleaning

Limit vehicle and equipment cleaning or washing at the job site except what is necessary to control vehicle tracking or hazardous waste. 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 asphalt concrete, HMA, or PCC
2. Surrounded by a containment berm
3. Equipped with a sump to collect and dispose of wash water

Use as little water as practicable whenever washing vehicles and equipment with water. Hoses must be equipped with a positive shutoff valve.

Discharge 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 done at the job site, assign a site or sites, and obtain authorization before using them. Minimize mobile fueling and maintenance activities. Fueling and maintenance activities must be performed on level ground in areas protected from stormwater run-on and runoff.

Use containment berms or dikes around fueling and maintenance areas. Keep adequate quantities of absorbent spill-cleanup material and spill kits in the fueling or maintenance area and on fueling trucks. 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 an automatic shutoff control. Nozzles must be equipped with vapor-recovery fueling nozzles 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 an adequate supply of spill-cleanup material with vehicles and equipment. Place drip pans or plastic sheeting under vehicles and equipment on docks, barges, or other surfaces over water whenever vehicles or equipment will be idle for more than 1 hour.

Furnish watertight curbs or toe boards on barges, platforms, docks, or other surfaces over water to contain material, debris, and tools. Secure material to prevent spills or discharge into the water due to wind.

Report discharges to receiving waters immediately upon discovery. Submit a discharge notification.

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, Sawcutting, Grooving, and Grinding Activities

Prevent material from entering storm drain systems and receiving waters including:

1. Cementitious material
2. Asphaltic material
3. Aggregate or screenings
4. Sawcutting, grooving, and grinding residue
5. Pavement chunks
6. Shoulder backing
7. Methacrylate
8. Sandblasting residue

Cover drainage inlets and use linear sediment barriers to protect downhill receiving waters until paving, sealing, sawcutting, 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, sawcutting, and grinding to places where runoff can be captured.

Do not start seal coat, tack coat, slurry seal, or fog seal activities whenever precipitation is forecasted during the application and curing period. Do not excavate material from existing roadways during precipitation.

Use a vacuum to remove slurry immediately after slurry is produced. Do not allow the slurry to run onto lanes open to traffic or off the pavement.

Collect the residue from PCC grooving and grinding activities with a vacuum attachment on the grinding machine. Do not leave the residue on the pavement or allow the residue to flow across pavement.

You may stockpile material excavated 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.

Park paving equipment over drip pans or plastic sheeting with absorbent material to catch drips if the paving equipment is not in use.

13-4.03E(8) Thermoplastic Striping and Pavement Markers

Do not preheat, transfer, or load thermoplastic within 50 feet of drainage inlets and receiving waters.

Do not unload, transfer, or load bituminous material for pavement markers within 50 feet of drainage inlets and 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 on plywood and covering with plastic whenever 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 water and solid waste from high-pressure water blasting. Collect and dispose of sand and solid waste from sandblasting. Before sandblasting, cover drainage inlets within 50 feet of 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 it for hazardous materials and dispose of it properly.

Inspect containment structures for concrete finishing for damage before each day of use and before forecasted precipitation. Remove liquid and solid waste from 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 methods that use only 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 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 whenever sediment or debris is observed during activities that require sweeping
2. 24 hours whenever sediment or debris is observed during activities that do not require 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.

Remove and dispose of trash collected during sweeping.

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 temporary active treatment system or dewatering and discharge.

If dewatering and discharging activities are not specified under a work item and you perform dewatering activities:

1. Conduct dewatering activities under the Department's *Field Guide for Construction Site Dewatering*.

2. Ensure that 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. Notify the Engineer immediately upon discovering any such condition.

13-4.03H–13-4.03J Reserved

13-4.04 PAYMENT

Job site management is paid for as construction site management.

13-5 TEMPORARY SOIL STABILIZATION

13-5.01 GENERAL

Section 13-5 includes general specifications for applying temporary soil stabilization.

The Engineer designates the areas to receive soil stabilization materials by directing the placement of stakes or other suitable markers in increments of 1 acre or less. Furnish tools, labor, materials, and transportation for marking areas that will receive temporary soil stabilization.

Move-in/move-out temporary erosion control includes: (1) moving onto the project when the Engineer determines an area is ready to receive temporary soil stabilization materials, (2) setting up all required personnel and equipment, and (3) moving out all personnel and equipment when work in that area is complete.

13-5.02 MATERIALS

13-5.02A General

The following materials must comply with section 21-1.02:

1. Tackifier
2. Fiber
3. Seed
4. Straw

13-5.02B Erosion Control Blankets

Erosion control blankets must comply with section 21-1.02O for jute mesh, netting, and erosion control blanket.

An erosion control blanket classified as long-term and nondegradable must be rock slope protection fabric, Class 8.

13-5.02C Mulch

Temporary mulch must comply with section 20-7.02D(6).

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. Able to easily mix 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

Temporary cover must be geosynthetic fabric, plastic sheeting, or a combination.

Plastic sheeting must be single-ply geomembrane material, 10 mils thick, complying with ASTM D2103.

Use restrainers to secure the cover fabric or plastic sheeting to the surface of the slope or stockpile.

Restrainers must be one of the following:

1. Gravel-filled bags roped together and spaced not more than 6 feet apart.
2. Wooden lath and anchor restrainers as shown. Wooden lath must be 2 by 4 inches by 8 feet made from fir or pine. Anchor restrainers must be made from steel reinforcing bars and spaced not more than 4 feet apart along the wooden lath.
3. Another authorized method.

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.

Use a linear sediment barrier under section 13-10.

13-5.02G Gravel-Filled Bags

Gravel-filled bags must:

1. Be made of geosynthetic gravel-filled bag.
2. Have inside dimensions from 24 to 32 inches long and from 16 to 20 inches wide.
3. Have a bound opening to keep gravel. The opening must be 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 gravel-filled bags 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

Apply temporary soil stabilization materials within 24 hours after an area is ready to receive temporary soil stabilization or before a forecasted storm event. Do not use hydraulically-applied materials under the following conditions:

1. During precipitation
2. Whenever 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 by the tackifier manufacturer and authorized

13-5.03B Temporary Erosion Control Blankets

Apply temporary erosion control blanket under section 21-1.03O.

13-5.03C Temporary Mulch

Apply temporary mulch under section 20-7.03I(10).

If rates are not shown, spread mulch to a uniform thickness to form a 2-inch thick blanket.

13-5.03D Temporary Hydraulic Mulch

Apply temporary hydraulic mulch under section 21-1.03E.

If rates are not shown, apply temporary hydraulic mulch at the following rate:

1. Fiber at 2,000 lb/acre
2. Tackifier under the manufacturer's instructions for the slope, soil, and wind conditions

13-5.03E Temporary Hydraulic Mulch (Bonded Fiber Matrix)

Apply temporary hydraulic mulch (bonded fiber matrix) under section 21-1.03J.

If rates are not shown, apply temporary hydraulic mulch (bonded fiber matrix) at the rate of 3,500 lb/acre.

13-5.03F Temporary Hydraulic Mulch (Polymer-Stabilized Fiber Matrix)

Apply temporary hydraulic mulch (polymer-stabilized fiber matrix) under section 21-1.03I.

If rates are not shown, apply temporary hydraulic mulch (polymer-stabilized fiber matrix) at the following rate:

1. Fiber at 2,000 lb/acre
2. Tackifier at 8 gallons/acre

13-5.03G Temporary Hydraulic Mulch (Cementitious Binder)

Apply temporary hydraulic mulch (cementitious binder) under section 21-1.03E.

If rates are not shown, apply temporary hydraulic mulch (cementitious binder) at the following rate:

1. Fiber at 2,000 lb/acre
2. Cementitious binder at 4,000 lb/acre

Fiber for temporary hydraulic mulch (cementitious binder) must be at least 50 percent wood fiber. The remaining percentage must be cellulose fiber, alternate fiber, or a combination.

13-5.03H Temporary Tacked Straw

Apply temporary tacked straw under section 21-1.03H.

If rates are not shown, apply temporary tacked straw at the following rate:

1. Straw at 2.0 tons/acre
2. Fiber at 2,000 lb/acre
3. Tackifier under the manufacturer's instructions for the slope, soil, and wind conditions

Fiber for temporary tacked straw must be at least 50 percent wood fiber. The remaining percentage must be cellulose fiber, alternate fiber, or a combination.

13-5.03I Temporary Hydroseed

Apply temporary hydroseed under section 21-1.03E.

If rates are not shown for fiber and tackifier, apply temporary hydroseed at the following rate:

1. Seed as shown
2. Fiber at 2,000 lb/acre
3. Tackifier under the manufacturer's instructions for the slope, soil, and wind conditions

Fiber for temporary hydroseed must be at least 50 percent wood fiber. The remaining percentage must be cellulose fiber, alternate fiber, or a combination.

13-5.03J Temporary Soil Binder

Apply temporary soil binder under section 21-1.03E.

If rates are not shown, apply temporary soil binder under the manufacturer's instructions for the slope, soil, and wind conditions.

13-5.03K Temporary Covers

Install temporary cover fabric as follows:

1. Place fabric loosely on the slope or stockpile with the longitudinal edges perpendicular to the slope contours.
2. Place fabric on the upper portion of the slope to overlap the fabric on the lower portion of the slope.

3. Place fabric on the side facing the prevailing wind to overlap the fabric on the downwind side of the slope.
4. Anchor the perimeter edge of the fabric in key trenches.
5. Overlap edges of the fabric by at least 2 feet.
6. 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.
7. 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 or stockpile.

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.

Install a temporary linear sediment barrier to prevent run-on and concentrated flows of stormwater from touching stockpiled material. Surround the stockpile with the barrier. Add additional barrier within 24 hours of adding more material to the stockpile.

Whenever 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 exposure of slopes and stockpiles and prevent material movement beyond the linear sediment barrier.

Relocate and secure restrainers to keep erosion control blankets in place. Whenever a temporary cover breaks free, resecure it immediately.

Repair or replace a temporary cover whenever any of the following occur:

1. Covered area becomes exposed or exhibits visible erosion
2. Washouts occur 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

Bid items paid for by the area are measured parallel with the ground surface except overlaps.

Except for maintaining a temporary cover, you and the Department share the cost of maintaining soil stabilization measures. The Department determines the maintenance cost 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 constructing measures for temporary sediment control.

Temporary linear sediment barriers must comply with section 13-10.

13-6.02 MATERIALS

13-6.02A General

Erosion control blanket must comply with section 21-1.02O(4).

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 from 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 so that water does not flow between the units
8. Be secured to:
   8.1. Pavement with 1-inch concrete nails with 1-inch washers and solvent-free adhesive, gravel-filled bags, or a combination
   8.2. Soil with 6-inch nails with 1-inch washers and wood stakes
9. Comply with the values of the properties shown in the following table:

Property	Test method	Value
Grab tensile strength of outer jacket material, lb/sq in, min 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, 1/sec., min	ASTM D4491	0.38
Flow rate of filter core, gpm per sq ft	ASTM D4491	100 min 200 max
Filter core aperture size, max AOS, microns	--	425
UV stability (outer jacket & filter core), % tensile strength retained after 500 hours, min, xenon-arc lamp and water spray weathering method	ASTM D4355	90

[a]or appropriate test method for specific polymer

For a curb inlet without a grate, rigid plastic barriers must be sized to fit the catch basin or drainage inlet 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 catch basin without a curb inlet, rigid plastic barriers must be sized to fit the catch basin or drainage 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 curb inlet with a grate, rigid plastic barriers must be sized to fit the catch basin or drainage inlet and have:

1. Horizontal flap that covers the grate by at least 2 inches on the 3 sides that are away from the curb opening and must have an under-seal gasket to prevent underflows
2. High-flow bypass
3. Vertical section that covers the curb opening by at least 5 inches 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.

Sediment filter bags 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 whenever 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 whenever the volume has been reduced by approximately 1/2.

Remove sediment from a sediment filter bag whenever it becomes full or whenever the restraint cords are no longer visible. Empty a sediment filter bag without a metal frame by placing 1-inch steel reinforcing bars through the lifting loops and lifting the filled bag from the drainage inlet. Empty a sediment filter bag 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. Whenever rinsing a sediment filter bag, do not allow the rinse water to enter a drainage inlet or waterway.

Whenever 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.

A temporary check dam must be:

1. Placed approximately perpendicular to the centerline of the ditch or drainage line
2. Installed with sufficient spillway depth to prevent flanking of concentrated flow around the ends of the check dam
3. Type 2 if the ditch is lined with concrete or HMA
4. Type 1 or Type 2 if the ditch is unlined

For a Type 1 temporary check dam:

1. Secure the fiber rolls with rope and notched wood stakes as shown.
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. 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, as appropriate for conditions around the drainage inlet.

For drainage inlet protection at drainage inlets in paved and 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 so 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.

If a foam barrier is used for Type 4B temporary drainage inlet protection, secure the barrier to the pavement at the angle and spacing shown. 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 catch basin without a curb inlet, 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.

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

The Department does not pay for relocation of temporary drainage inlet protection during the course of work.

13-6.03D Temporary Sediment Basin

Reserved

13-6.03E Temporary Fiber Rolls

Install a temporary fiber roll under section 21-1.03P.

13-6.03F Temporary Gravel Bag Berms

Install a temporary gravel bag berm under section 13-10.03C.

13-6.03G Temporary Large Sediment Barriers

Install a temporary large sediment barrier under section 13-10.03D.

13-6.03H Temporary Reinforced Silt Fence

Install a temporary reinforced silt fence under section 13-10.03E.

13-6.03I Temporary Silt Fence

Install a temporary silt fence under section 13-10.03F.

13-6.03J Temporary Straw Bale Barrier

Install a temporary straw bale barrier under section 13-10.03D.

13-6.03K–13-6.03M Reserved

13-6.04 PAYMENT

Items paid for by length are measured along the centerline of the installed material.

Where temporary fiber rolls are joined and overlapped, the overlap is measured as a single installed check dam.

You and the Department share the maintenance cost of sediment control measures. The Department determines the maintenance cost 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 Summary

Section 13-7 includes specifications for limiting and removing sediment and debris tracked onto roadways.

13-7.01B Submittals

For a construction entrance, submit details for alternatives at least 5 business days before installation. You may propose alternatives for sump and corrugated steel panels. You may eliminate the sump if authorized.

At least 5 business days before starting clearing and grubbing, earthwork, or other activities with the potential for tracking sediment or debris, submit the number and type of street sweeper that will be used on the project.

13-7.01C Quality Control and Assurance

Retain and submit records of street sweeping activities, including sweeping times, sweeping locations, and the quantity of disposed sweeping waste.

13-7.02 MATERIALS

13-7.02A General

The street sweeper must be one of the following:

1. Mechanical sweeper followed by a vacuum-assisted sweeper
2. Vacuum-assisted dry, waterless, sweeper
3. Regenerative-air sweeper

Fabric for a temporary construction entrance must be rock slope protection fabric, Class 8.

Fabric for temporary construction roadway must be rock slope protection fabric, Class 10.

13-7.02B Rock

Type A rock must comply with:

1. Section 72-2.02
2. Sizes shown in the following table:

Square screen size (inch)	Percentage passing	Percentage retained
6	100	0
3	0	100

Type B rock must be railway ballast number 25. Do not use blast furnace slag. Railway ballast number 25 must comply with:

1. Description in *AREMA Manual for Railway Engineering*
2. Sizes shown in the following table:

Nominal size square opening	Percentage passing								
	3"	2-1/2"	2"	1-1/2"	1"	3/4"	1/2"	3/8"	No. 4
2-1/2"–3/8"	100	80–100	60–85	50–70	25–50	--	5–20	0–10	0–3

3. Values of the properties shown in the following table:

Property	Test method	Value
Percent material passing no. 200 sieve, max	ASTM C117	1.0
Bulk specific gravity, min	ASTM C127	2.60
Absorption, % min	ASTM C127	1.0
Clay lumps and friable particles, % max	ASTM C142	0.5
Degradation, % max	ASTM C535	30
Soundness (sodium sulfate), % max	ASTM C88	5.0
Flat, elongated particles, or both, % max	ASTM D4791	5.0

13-7.02C Corrugated Steel Panels

Corrugated steel panels must:

1. Be made of steel
2. Be pressed or shop welded
3. Have a slot or hook for connecting the panels together

13-7.02D–13-7.02F Reserved

13-7.03 CONSTRUCTION

13-7.03A General

Prepare the location for a temporary construction entrance or roadway as follows:

1. Remove vegetation to 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 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 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. Whenever dust or sediment tracking increases, place additional rock unless the Engineer authorizes another method.

Repair a temporary construction entrance or roadway if:

1. Fabric is exposed
2. Depressions in the surface develop
3. Rock is displaced

When the temporary construction entrance or roadway is being used, do not allow soil, sediment, and other debris that is tracked onto the pavement to enter storm drains, open drainage facilities, and watercourses. When material is tracked onto the pavement, remove it within 6 hours, unless the Engineer authorizes a longer period.

The Department does not pay the additional cost of relocating temporary construction entrances or roadways during the course of work.

13-7.03B Temporary Construction Entrance

If a Type 1 temporary construction entrance is shown, use Type A rock.

If a Type 2 temporary construction entrance is shown, use Type B 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.

13-7.03C Temporary Construction Roadway

Reserved

13-7.03D Street Sweeping

Street sweeping does not void specifications for main residue collection included in other work activities, such as grooving, grinding, or asphalt concrete planing.

Street sweeping must comply with section 13-4.03F except use a street sweeper.

At least 1 street sweeper must be kept at the job site at all times when street sweeping work is required. The street sweeper must be in good working order.

13-7.03E–13-7.03G Reserved

13-7.04 PAYMENT

You and the Department share the cost of maintaining a temporary construction entrance or roadway. The Department determines the maintenance cost under section 9-1.04 and pays you 1/2 of that cost.

13-8 TEMPORARY ACTIVE TREATMENT SYSTEM

13-8.01 GENERAL

13-8.01A Summary

Section 13-8 includes specifications for designing, installing, operating, monitoring, maintaining, and removing a temporary active treatment system for the treatment and discharge of uncontaminated groundwater and accumulated stormwater from excavations or other areas requiring dewatering.

Design, installation, operation, and monitoring of an 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*).

You may discharge into a publicly owned treatment works system instead of using an ATS. If uncontaminated groundwater, stormwater, or both are discharged to a publicly owned treatment works, obtain a municipal batch discharge permit. You are responsible for all costs and requirements related to obtaining the municipal batch discharge permit and discharging the water.

13-8.01B Submittals

13-8.01B(1) General

Reserved

13-8.01B(2) Active Treatment System Plan

Start the following process for the ATS plan within 20 days of Contract approval:

1. Submit 3 copies of the ATS plan. Allow 20 days for the Department's review. The Engineer provides comments and specify the date when the review stopped if revisions are required.
2. Change and resubmit a revised ATS plan within 15 days of receiving the Engineer's comments. The Engineer's review resumes when a complete ATS plan has been resubmitted.
3. When the Engineer authorizes the ATS plan, submit an electronic copy and 4 printed copies of the authorized ATS plan.
4. Allow 15 days for the Engineer to submit the authorized ATS plan to the State Water Resources Control Board and RWQCB.
5. If the Engineer requests changes to the ATS plan based on the State Water Resources Control Board's or RWQCB's comments, amend the ATS plan within 5 business days.

The ATS plan must include:

1. Title sheet.
2. Table of contents.
3. Certification and approval sheet described in the Department's *Storm Water Prevention Plan (SWPPP) and Water Pollution Control Plan (WPCP) Preparation Manual.*
4. Amendment log and format described in the Department's *Storm Water Prevention Plan (SWPPP) and Water Pollution Control Plan (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
    6.2. Percolation
    6.3. Storm sewers
    6.4. Surface waters
7. Treatment system description and components.
8. Anticipated flow rates.
9. Operation and maintenance manual for equipment.
10. Monitoring, sampling, and reporting plan, including quality assurance and quality control.
11. Health and safety plan.
12. Spill prevention plan.
13. Field-recorded data, visual inspection, calibration procedures, and examples of logs.
14. Measuring equipment descriptions.
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. The daily inspection report must include:
    16.1. Discharge volumes
    16.2. Water quality monitoring records
    16.3. Discharge point information that includes:
        16.3.1. Date and time
        16.3.2. Weather conditions, including wind direction and velocity
        16.3.3. Presence or absence of water fowl or aquatic wildlife
        16.3.4. Color and clarity of the effluent discharge
        16.3.5. Erosion or ponding downstream of the discharge site
        16.3.6. Photographs labeled with the time, date, and location
17. Municipal batch discharge permit from a publicly owned treatment works if required.
18. Coagulant prevention work plan if you use chemical coagulants, in-line flocculants, or both, in the treatment system. The coagulant prevention work plan must include:
    18.1. Description of BMPs 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 agents, including chemical and trade names
    18.4. Determination of acute and 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 established acute toxicity levels for freshwater and marine conditions for that agent

13-8.01B(3) Notice of Discharge Report

Whenever observations and measurements confirm that a residual chemical or water quality standard is exceeded:

1. Submit the notice of discharge within 48 hours after exceeding the limits

2. Document the reasons for exceeding the water quality standard and any corrective work performed to prevent a recurrence in the notice of discharge

13-8.01B(4) Numeric Effluent Limit Violation Report

Whenever the NEL is exceeded for a risk level 3 project, notify the Engineer and submit a NEL 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 BMPs and corrective actions taken to manage NEL exceedance

13-8.01B(5) Other Active Treatment System Submittals

If the ATS is discharging treated effluent, submit a daily inspection report within 24 hours.

Submit records of delivery and removal of ATS components.

13-8.01B(6)–13-8.01B(8) Reserved

13-8.01C Quality Control and Assurance

A residual chemical for the coagulant must be at less than 10 percent of the maximum allowable threshold concentration for the most sensitive species.

Discharges from an ATS must comply with the NEL values shown in the following table:

Numeric Effluent Limits

Parameter	Test method	Detection limit (min)	Unit	Values
Turbidity	EPA 0180.1 or field test with calibrated portable instrument	1	NTU	10 NTU for daily flow-weighted average and 20 NTU for any single sample
pH	Field test with calibrated portable instrument	0.2	pH	Lower NEL = 6.0 Upper NEL = 9.0

13-8.02 MATERIALS

13-8.02A General

Design and implement an appropriate active water treatment system for the site conditions and anticipated flow rate that includes (1) a treatment system, (2) a collection and conveyance system, and (3) a discharge method.

Design and implement an ATS to capture and treat, 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.

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 pH or dissolved oxygen by:

2.1. Addition of sulfuric, phosphoric, citric, or nitric acid under the supplier's specifications for 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 addition of sodium hydroxide for treatment of water with a low pH. You may use carbon dioxide diffusion that produces carbonic acid for pH adjustment.
2.3. Aeration for treatment of water with low dissolved oxygen.

13-8.02C Collection and Conveyance System

Provide 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.

Use a flow meter to measure all discharges from treatment activities.

13-8.02D Discharge Method

Provide a method for discharging treated water and include a discharge location. Do not discharge treated water in a way that impacts the natural bedding and aquatic life.

Discharge treated water:

1. To control dust in active work areas.
2. To land where the grade allows sheet flow and the soil allows infiltration.
3. In a way that does not cause erosion and scour. Whenever scour occurs, repair the damage and install a velocity dissipater.

13-8.02E–13-8.02G Reserved

13-8.03 CONSTRUCTION

13-8.03A General

Water quality must comply with limits for discharge effluents and the receiving waters. Whenever observations and measurements under section 13-8.03B determine the water quality limits are exceeded:

1. Stop the discharge immediately
2. Notify the Engineer
3. 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.

Maintain the ATS to provide proper function and prevent leaks. Whenever a component of the dewatering equipment is not functioning properly, discontinue the treatment activities and repair or replace the component.

Sediments removed from 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

Comply with the manufacturer's instructions for all calibrations of the flow meter. Perform calibrations in the presence of the Engineer.

While the ATS is being operated, monitor:

1. Influent turbidity
2. Effluent turbidity
3. Influent pH
4. Effluent pH
5. Residual chemical
6. Effluent flow rate
7. Effluent flow volume

Monitoring equipment for the ATS must record data at least once every 15 minutes. Cumulative flow data must be recorded daily. The recording system must have the capacity to record a minimum of 7 days of continuous data.

Monitoring equipment must be interfaced with the control system of the ATS to provide shutoff or recirculation whenever effluent readings exceed limits for turbidity and pH. The control system must default to recirculation or shutoff during a power failure or other catastrophic event.

The control system must control the dose of the coagulant, flocculant, or both to prevent overdosing.

Take water quality measurements to verify limit requirements for receiving waters and discharge effluent for:

1. Discharges of water that exceed 4 hours in duration occurring 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 start-up 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. Perform regular-phase sampling 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. Whenever the receiving body of water noticeably changes in color or clarity, take additional effluent, background, and downstream measurements.
    1.5. Whenever an initial measurement shows that the water quality limits are exceeded, take an additional measurement not less than 15 minutes and not more than 1 hour after the initial measurement.
    1.6. Whenever 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 for 4 hours or less in duration occurring 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 no 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. Whenever an initial measurement shows that the water quality limits are exceeded, take an additional measurement not more than 15 minutes after the initial measurement.
    2.4. Whenever 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 stormwater effluent turbidity and pH at the end of the outfall or in-line sampling port.
    3.2. Measure receiving water turbidity, pH, and dissolved oxygen at a point within the mixing zone.
    3.3. Measure receiving water turbidity, pH, and dissolved oxygen at a point within 15 feet downstream of the discharge point.
    3.4. Measure 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.
    3.5. 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.
4. Receiving water and natural background measurements as follows:
    4.1. If the receiving water is deeper than 3 feet, take depth-averaged measurements by taking samples from 3 points within the water column and averaging the following 3 measurements:
        4.1.1. 12 inches below the surface.
        4.1.2. Mid-depth.

4.1.3. 12 inches above the bottom.

4.2. If the receiving water is less than 3 feet in depth, take the measurement 12 inches below the surface.

Comply with the manufacturer's instructions for the use and calibration of meters and devices for taking water quality measurements. Perform calibrations in the presence of the Engineer.

13-8.03C–13-8.03E Reserved

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. Temporary concrete washouts include:

1. Temporary concrete washout facilities
2. Portable temporary concrete washouts
3. Temporary concrete washout bins

13-9.01B Submittals

At least 5 business days before concrete activities start, submit an informational submittal that includes:

1. Location of each concrete washout
2. Name and location of the off-site concrete waste disposal plant to receive the concrete waste
3. Copy of the permit issued by the RWQCB for the off-site commercial disposal plant
4. Copy of the permit issued by the state or local agency having jurisdiction over the disposal plant if the disposal site is located outside of the State

Retain and submit an informational submittal for records of disposed concrete waste, including weight tickets and receipts for delivery and removal of temporary concrete washouts.

Submit a certificate of compliance for:

1. Gravel-filled bag
2. Plastic liner

Submit a sample of your alternate attachment device for temporary sediment barriers if you propose not to use staples.

13-9.02 MATERIALS

13-9.02A General

The sign for a concrete washout must comply with section 12-3.06B(3), except the sign panel may be plywood if authorized. The sign panel must be at least 2 by 4 feet in size. The sign legend must read "Concrete Washout" in at least 3-inch high black letters on a white background.

13-9.02B Temporary Concrete Washout Facility

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. Single ply, new 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 Washout

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. Stencil "Concrete Waste Material" in 3-inch high black letters on white background where the top of stenciling is 12 inches from the top of the container.

13-9.02D Temporary Concrete Washout Bin

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 concrete placement activities start
2. In the immediate area of concrete work where authorized
3. No closer than 50 feet from storm drain inlets, open drainage facilities, ESAs, and watercourses
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 PCC or HMA from sawcutting, coring, grinding, grooving, and hydro-concrete demolition
3. Concrete waste from mortar mixing stations

Do not fill a concrete washout higher than 6 inches below the upper rim.

Remove and dispose of concrete waste within 2 business days after a concrete washout becomes filled. Dispose of concrete waste material 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 of concrete waste material whenever it is being relocated or transported within the job site. Whenever any spilled material is observed, 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 Submittals

Submit a certificate of compliance for:

1. Fiber roll
2. Safety cap for metal posts
3. Silt fence fabric
4. Sediment filter bag
5. Foam barrier
6. Gravel-filled bag fabric

If you substitute steel wire staples with an alternative attachment device, submit a sample of the device for approval at least 5 business days before installation.

13-10.02 MATERIALS

13-10.02A General

Fasteners and stakes must comply with section 21-1.02R.

13-10.02B Fiber Roll

Fiber rolls must comply with section 21-1.02P.

Fiber rolls for a large sediment barrier must be Type B, except the dimensions must be from 18 to 22 inches in diameter, at least 8 feet long, and weigh at least 6.5 pounds per linear foot.

13-10.02C Posts

Posts must be wood or metal.

Wood posts must be:

1. At least 2 by 2 inches in size and 4 feet long
2. Untreated fir, redwood, cedar, or pine, cut from sound timber
3. Straight and free of loose or unsound knots and other defects that could render the posts unfit for use
4. Pointed on the end to be driven into the ground

Metal posts must:

1. Be at least 4 feet long.
2. Be made of steel.
3. Have a U-shaped, T-shaped, L-shaped, or other cross-sectional shape that can resist failure from lateral loads.
4. Be pointed on the end to be driven into the ground.
5. Weigh at least 0.75 pound per foot.
6. Have a safety cap attached to the exposed end. The safety cap must be orange or red plastic and must fit snugly onto the metal post.

Do not use metal posts for a temporary large sediment barrier.

Posts for a temporary reinforced silt fence must be at least 6 feet in length for a Type 1 installation and 5 feet in length for a Type 2 installation.

Posts used as stakes for a temporary straw-bale barrier must be wood or metal.

13-10.02D High Visibility Fence

High visibility fabric must contain UV inhibitors and comply with the requirements in the following table:

Property	Specifications	Requirements
Width, inches, min	Measured	48
Opening size inches	Measured	1" x 1" (min) 2" x 4" (max)
Color	Observed	Orange
Roll weight, lb, min for 4’ x 100’ roll	Measured	12

Tensile strength, lb, min	ASTM D4595	320

13-10.02E Wire Mesh

Wire mesh for a temporary reinforced silt fence must comply with section 80-2.02E, be fabricated from at least 14-gage horizontal and vertical wires welded at each intersection, and have a maximum opening 2 inches wide by 4 inches high. The fence must 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-gage 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 straw bales must comply with section 21-1.02I.

Straw bales must be:

1. At least 14 inches wide, 18 inches high, 36 inches long, and weigh at least 50 pounds.
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 pounds of breaking strength.

13-10.02I Foam Barriers

Foam barriers 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. A length of at least 4 feet per unit
7. Ability to interlock separate units into a long barrier so that water will not flow between units

The geosynthetic fabric cover and flap for foam barriers must have the values of the properties shown in the following table:

Property	Test method	Value
Grab breaking load 1-inch grip, lb, min in each direction	ASTM D4632	200
Apparent elongation %, min in each direction	ASTM D4632	15
Water flow rate max average roll value, gpm/sq ft	ASTM D4491	100–150
Permittivity 1/sec, min	ASTM D4491	0.05
Apparent opening size max average roll value, U.S. standard sieve size	ASTM D4751	40
UV resistance, % min retained grab breaking load, 500 hr	ASTM D4355	70

Secure foam barriers to:

1. Pavement with 1-inch concrete nails, 1-inch washers, and solvent-free adhesive
2. Soil with 6-inch nails and 1-inch washers

13-10.02J Gravel-filled Bag Berms

Gravel-filled bags for the 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 whenever rills and other evidence of concentrated runoff are occurring 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.

Whenever a barrier becomes detached or dislodged from the pavement, reattach it.

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 whenever the sediment exceeds:

1. 1/3 of the height above ground behind a fence
2. 1 inch in depth behind a flexible sediment barrier

Whenever 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 under section 21-1.03P.

13-10.03C Temporary Gravel Bag Berms

Place the bags end-to-end to eliminate gaps. Place bags approximately parallel with the slope contour. Angle the last 6 feet upslope at the downhill end of the run. Stack the bags so that the upper row overlaps joints in the lower row.

If you need to increase the height of a temporary gravel bag berm, 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.

13-10.03D 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 so 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 of the silt fence to form reaches not more than 500 feet long. Each section must be a continuous run of silt fence from end-to-end or from an end to an opening, including joined panels.
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 by using 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 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 not more than 8 inches apart

Place 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 of the silt fence to form reaches not more than 500 feet long. Each section must be a continuous run from end-to-end or from an end to an opening, including joined panels.
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 the fabric.

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 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 keyed into the slope. Place the bales so that the binding wire or string does not come in contact with the soil.
3. Secure each straw bale with 2 stakes. The first stake in each bale must be driven toward the previously laid bale to force the bales together.
4. Drive the stakes into the soil so 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 temporary foam barriers to the pavement with nails and adhesive, gravel-filled bags, or a combination.

Install the foam barrier with the horizontal flap in a 3-inch deep trench and secure with nails and washers placed not more than 4 feet apart. Secure the barrier with 2 nails at the connection points where barriers overlap. Do not pierce the barrier's core with nails or stakes.

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 by hand or mechanical methods.

13-10.03J–13-10.03L Reserved

13-10.04 PAYMENT

Not Used

13-11–13-14 RESERVED

14 ENVIRONMENTAL STEWARDSHIP

14-1 GENERAL

14-1.01 GENERAL

Section 14-1 includes general specifications for environmental compliance and environmental resource management.

14-1.02 ENVIRONMENTALLY SENSITIVE AREA

14-1.02A General

Section 14-1.02 includes specifications for environmentally sensitive area requirements.

If an ESA is shown:

1. The boundaries shown are approximate; the Department marks the exact boundaries on the ground
2. Do not enter the ESA unless authorized
3. If the ESA is breached, immediately:
   3.1. Secure the area and stop all operations within 60 feet of the ESA boundary
   3.2. Notify the Engineer
4. If the ESA is damaged, the Department determines what efforts are necessary to remedy the damage and who performs the remedy; you are responsible for remedies and charges

14-1.02B Materials

Not Used

14-1.02C Construction

Not used

14-1.02D Payment

Not used

14-1.03 TYPE ESA TEMPORARY FENCE

14-1.03A General

14-1.03A(1) Summary

Section 14-1.03 includes specifications for installing, maintaining, and removing Type ESA temporary fence.

Type ESA temporary fence provides a visible boundary adjacent to protected areas such as an ESA.

Signs are required for Type ESA temporary fence.

14-1.03A(2) Submittals

Submit a certificate of compliance for high visibility fabric and safety caps for metal posts.

14-1.03B Materials

14-1.03B(1) High Visibility Fabric

High visibility fabric for Type ESA temporary fence must comply with section 13-10.02D and must:

1. Contain ultraviolet inhibitors
2. Comply with the ESA properties in the following table:

Property	Specifications	Requirements
Width, inches, min	Measured	48
Opening size, inches	Measured	1 by 1 inch (min) 2 by 4 inches (max)
Color	Observed	Orange
Roll weight, lb, min for 4 by 100 foot roll	Measured	12
Tensile strength, lb, min	ASTM D4595	320

14-1.03B(2) Posts

Posts for Type ESA temporary fence must be wood or steel.

Wood and metal posts for Type ESA temporary fence must comply with section 13-10.02.

Wood posts must be at least 2 by 2 inches in size and 6 feet long.

Metal posts must be at least 6 feet long.

14-1.03B(3) Signs

Signs for Type ESA temporary fence must be:

1. Weatherproof and fade-proof and may include plastic laminated printed paper affixed to an inflexible weatherproof backer board
2. Attached to the high visibility fabric with tie wire or locking plastic fasteners

14-1.03C Construction

14-1.03C(1) General

Install Type ESA temporary fence:

1. With high visibility fabric, posts, and fasteners as follows:
   1.1. If wood posts are used, fasteners must be staples or nails
   1.2. If steel posts are used, fasteners must be tie wires or locking plastic fasteners
   1.3. Spacing of the fasteners must be no more than 8 inches apart
2. Before clearing and grubbing activities
3. From outside of the protected area
4. With posts spaced 8 feet apart and embedded at least 16 inches in the soil

Signs must be attached with the top of the sign panel flush with the top of the high visibility fabric and placed 100 feet apart along the length and at each end of the fence.

If trees and other plants need protection, install the fence to enclose the drip line of the foliage canopy of protected plants and protect visible roots from encroachment.

14-1.03C(2) Maintenance

Maintain Type ESA temporary fence by:

1. Keeping posts in a vertical position
2. Reattaching fabric to posts
3. Replacing damaged sections of fabric
4. Replacing and securing signs

14-1.03D Payment

The fence payment quantity does not include the width of openings.

The fence is measured:

1. Parallel to the ground slope

2. Along the fence

14-1.04–14-1.10 RESERVED

14-2 CULTURAL RESOURCES

14-2.01 GENERAL

Section 14-2 includes specifications relating to cultural resources.

14-2.02 ARCHAEOLOGICAL RESOURCES

14-2.02A General

Section 14-2.02 applies if archaeological 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. Protect the discovery area
3. Notify the Engineer

The Department investigates. Do not move archaeological resources or take them from the job site. Do not resume work within the discovery area until authorized.

If ordered, furnish resources to assist in the investigation or recovery of archaeological resources. This work is change order work.

14-2.02B Materials

Not Used

14-2.02C Construction

Not used

14-2.02D Payment

Not used

14-2.03 ARCHAEOLOGICAL MONITORING AREA

14-2.03A General

Section 14-2.03 applies if an AMA is described in the Contract.

The Department assigns an archaeological monitor to monitor job site activities within the AMA. Do not work within the AMA unless the archeological monitor is present.

The Engineer and the Department's archaeological monitor conduct an AMA location field review with you at least 5 business days before start of work. The Department marks the exact boundaries of the AMA on the ground.

If Type ESA temporary fence or other enclosure for an AMA is described in the Contract, install Type ESA temporary fence or other enclosure to define the boundaries of the AMA during the AMA location field review.

At least 5 business days before starting work within an AMA, submit a schedule of days and hours to be worked for the Engineer's authorization. If you require changes in the schedule, submit an update for the Engineer's authorization at least 5 business days before any changed work day.

If archaeological resources are discovered within an AMA, comply with section 14-2.02.

14-2.03B Materials

Not Used

14-2.03C Construction

Not used

14-2.03D Payment

Not used

14-2.04–14-2.09 RESERVED

14-2.10 HISTORIC STRUCTURES

Reserved

14-2.11–14-2.16 RESERVED

14-3 COMMUNITY IMPACTS AND ENVIRONMENTAL JUSTICE

14-3.01–14-3.10 RESERVED

14-4 NATIVE AMERICAN CONCERNS

14-4.01–14-4.10 RESERVED

14-5 AESTHETICS

14-5.01–14-5.10 RESERVED

14-6 BIOLOGICAL RESOURCES

14-6.01 GENERAL

14-6.01A General

14-6.01A(1) Summary

Section 14-6 includes specifications relating to biological resources.

14-6.01A(2) Definitions

Nongame birds: Birds identified in the Fish and Game Code as nongame birds.

14-6.01B Materials

Not Used

14-6.01C Construction

Not Used

14-6.01D Payment

Not Used

14-6.02 SPECIES PROTECTION

Reserved

14-6.03 BIRD PROTECTION

14-6.03A General

Section 14-6.03 includes specifications relating to bird protection.

Protect migratory and nongame birds, their occupied nests, and their eggs.

The Department anticipates nesting or attempted nesting from February 15 to September 1.

The federal Migratory Bird Treaty Act, 16 USC § 703–711, and 50 CFR Pt 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 migratory or nongame bird nests are discovered that may be adversely affected by construction activities or an injured or killed bird is found, immediately:

1. Stop all work within a 100-foot radius of the discovery
2. Notify the Engineer

The Department investigates. Do not resume work within the specified radius of the discovery until authorized.

14-6.03B Materials

Not Used

14-6.03C Construction

If ordered, use exclusion devices, take nesting prevention measures, remove and dispose of partially constructed and unoccupied nests of migratory or nongame birds on a regular basis to prevent their occupation, or perform any combination of these. This work is change order work.

Prevent nest materials from falling into waterways.

14-6.03D Payment

Not used

14-6.04 FISH PROTECTION

Section 14-6.04 includes specifications relating to fish protection.

Protect all life stages of anadromous fish in streams and conduct work activities to allow free passage of anadromous migratory fish. Assure that construction work does not produce sound in water that results in unauthorized take of listed species.

14-6.05 CONTRACTOR-SUPPLIED BIOLOGIST

Reserved

14-6.06 SPECIES PROTECTION AREA

Reserved

14-6.07 NATURAL RESOURCES PROTECTION PLAN

Reserved

14-6.08 BIOLOGICAL RESOURCE INFORMATION PROGRAM

Reserved

14-6.09 TEMPORARY WETLAND PROTECTION MAT

Reserved

14-6.10–14-6.20 RESERVED

14-7 PALEONTOLOGICAL RESOURCES

14-7.01 GENERAL

Section 14-7 includes specifications relating to paleontological resources.

14-7.02 PALEONTOLOGICAL RESOURCE DISCOVERY

14-7.02A General

Section 14-7.02 includes specifications relating to paleontological resource discovery.

If paleontological resources are discovered at the job site, do not disturb the material and immediately:

1. Stop all work within a 60-foot radius of the discovery
2. Protect the area
3. Notify the Engineer

The Department investigates and modifies the dimensions of the protected area if necessary. Do not move paleontological resources or take them from the job site. Do not resume work within the specified radius of the discovery until authorized.

14-7.02B Materials

Not Used

14-7.02C Construction

Not Used

14-7.02D Payment

Not Used

14-7.03–14-7.10 RESERVED

14-8 NOISE AND VIBRATION

14-8.01 GENERAL

Section 14-8 includes specifications relating to controlling noise and vibration.

14-8.02 NOISE CONTROL

14-8.02A General

Section 14-8.02 includes specifications relating to noise control.

Do not exceed 86 dBA LMax at 50 feet from the job site activities from 9 p.m. to 6 a.m.

Equip an internal combustion engine with the manufacturer-recommended muffler. Do not operate an internal combustion engine on the job site without the appropriate muffler.

14-8.02B Materials

Not Used

14-8.02C Construction

Not Used

14-8.02D Payment

Not Used

14-8.03–14-8.10 RESERVED

14-9 AIR QUALITY

14-9.01 GENERAL

Section 14-9 includes specifications relating to air quality.

14-9.02 AIR POLLUTION CONTROL

14-9.02A General

Section 14-9.02 includes specifications relating to air pollution control.

Comply with air pollution control rules, regulations, ordinances, and statutes that apply to work performed under the Contract, including air pollution control rules, regulations, ordinances, and statutes provided in Govt Code § 11017 (Pub Cont Code § 10231).

Do not burn material to be disposed of.

14-9.02B Materials

Not Used

14-9.02C Construction

Not Used

14-9.02D Payment

Not Used

14-9.03 DUST CONTROL

14-9.03A General

Section 14-9.03 includes specifications relating to dust control.

Prevent and alleviate dust by applying water, dust palliative, or both under section 14-9.02 and by covering active and inactive stockpiles under sections 13-4.03C(3) and 14-9.02.

Apply water under section 17.

Apply dust palliative under section 18.

If ordered, apply water, dust palliative, or both to control dust caused by public traffic. This work is change order work.

14-9.03B Materials

Not Used

14-9.03C Construction

Not Used

14-9.03D Payment

Not Used

14-9.04 AIR MONITORING

Reserved

14-9.05–14-9.10 RESERVED

14-10 SOLID WASTE DISPOSAL AND RECYCLING

14-10.01 GENERAL

Section 14-10 includes general specifications relating to solid waste disposal and recycling.

Do not allow litter, trash, or debris to accumulate anywhere on the job 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. WPC manager must monitor solid waste storage and disposal procedures on the job site.

If practicable, recycle nonhazardous job site waste and excess material. If recycling is not practicable, dispose of it.

Furnish enough closed-lid dumpsters of sufficient size to contain the solid waste generated by work activities. When refuse 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 randomly by the public
12. Other trash and debris

Furnish and use trash receptacles 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

14-10.02A General

Section 14-10.02 includes specifications relating to the solid waste disposal and recycling report.

14-10.02A(1) Submittals

Submit an annual 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 through December 31 of the previous calendar year.

Submit a final annual 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 withholds $10,000.

14-10.02B Materials

Not Used

14-10.02C Construction

Not Used

14-10.02D Payment

Not Used

14-10.03–14-10.10 RESERVED

14-11 HAZARDOUS WASTE AND CONTAMINATION

14-11.01 GENERAL

14-11.01A Summary

Section 14-11 includes general specifications relating to hazardous waste and contamination

If hazardous waste is, or will be, generated on the job site, the WPC manager must be thoroughly familiar with proper hazardous waste handling and emergency procedures under 40 CFR § 262.34(d)(5)(iii) and must have successfully completed training under 22 CA Code of Regs § 66265.16.

The WPC manager must:

1. Oversee and enforce hazardous waste management practices
2. Inspect all hazardous waste storage areas daily, including all temporary containment facilities and satellite collection locations
3. Oversee all hazardous waste transportation activities on the job site

14-11.01B Submittals

14-11.01B(1) Disposal Documentation of Contractor-Generated Hazardous Waste

Submit a copy of uniform hazardous waste manifest forms within 24 hours of transporting hazardous waste.

14-11.01B(2) Disposal Documentation of Department Generated Hazardous Waste

Submit receiving landfill documentation of proper disposal within 5 business days of hazardous waste transport from the project.

14-11.02 CONSTRUCTION

14-11.02A Unanticipated Discovery of Asbestos and Hazardous Substances

Upon discovery, immediately stop working in and notify the Engineer of areas where asbestos or a hazardous substance is present if the:

1. Contractor reasonably believes 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. Presence is not described in the Contract
3. Substance has not been made harmless

14-11.02B Hazardous Waste Management Practices

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. For hazardous waste storage, use metal containers approved by the United States Department of Transportation (US DOT) 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 hazardous waste containers such that no spillage occurs.
5. Store hazardous waste away from storm drains, watercourses, moving vehicles, and equipment.
6. Furnish containers with adequate storage volume at convenient satellite locations for hazardous waste collection. Immediately move these containers to secure temporary containment facilities when no longer needed at the collection location or when full.
7. Store hazardous waste and potentially hazardous waste in secure temporary containment enclosures having secondary containment facilities impervious to the materials stored there for a minimum contact time of 72 hours. Temporary containment enclosures must be located away from public access. Acceptable secure enclosures include a locked chain link fenced area or a lockable shipping container located within the project limits until disposal as authorized.
8. Design and construct secondary containment facilities with the capacity to contain precipitation from a 24-hour-long, 25-year storm; and 10 percent of the aggregate volume of all containers, or the entire volume of the largest container within the facility, whichever is greater.
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 facility free of accumulated rainwater or spills. After a storm event, or in the event of spills or leaks, collect accumulated liquid and place into 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 sufficient separation between stored containers to allow for spill cleanup or emergency response access. Storage areas must be kept clean, well organized, and equipped with cleanup supplies appropriate for the wastes being stored.
13. Repair or replace perimeter controls, containment structures, covers, and liners as necessary. Inspect storage areas before and after a storm event, and at least weekly during other times.

Do not:

1. Overfill hazardous waste 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 and in compliance with the CA Highway Patrol Biennial Inspection of Terminals Program to transport hazardous waste to an appropriately permitted hazardous waste management facility.

14-11.02C Dust Control

Excavation, transportation, and handling of material containing hazardous waste or contamination must result in no visible dust migration. Have a water truck or tank on the job site at all times while clearing and grubbing and performing earthwork operations in work areas containing hazardous waste or contamination.

14-11.02D Stockpiling

Do not stockpile material containing hazardous waste or contamination unless ordered by the Engineer. Stockpiles of material containing hazardous waste or contamination must not be placed where affected by surface run-on or run-off. Cover stockpiles with 13 mils minimum thickness of plastic sheeting or 1 foot of nonhazardous material. Do not place stockpiles in environmentally sensitive areas. Stockpiled material must not enter storm drains, inlets, or waters of the State.

14-11.02D(1) Liner

Reserved

14-11.02E Contractor-Generated Hazardous Waste

14-11.02E(1) General

You are the generator of hazardous waste generated as a result of materials you bring to the job site. Use hazardous waste management practices under section 14-11.02B if you generate waste on the job site 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 hazardous waste constituent concentrations are unknown, use a laboratory certified by the Environmental Laboratory Accreditation Program under the California Department of Public Health (CDPH) to analyze a minimum of 4 discrete representative samples of the waste to determine whether it is a hazardous waste and to determine safe and lawful methods for storage and disposal. Perform sampling and analysis in compliance with US EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846) and under 22 CA Code of Regs, Div 4.5.

Use your own US EPA Generator Identification Number and sign hazardous waste manifests for the hazardous waste you generate.

14-11.02E(2) Contaminated Soil

Identify contaminated soil resulting from spills or leaks by noticing discoloration, or differences in soil properties. Immediately notify the Engineer of spills or leaks. Clean up spills and leaks under the Engineer's direction and to the satisfaction of the Engineer. Soil with evidence of contamination must be sampled and analysis performed by a laboratory certified by the ELAP.

If sampling and analysis of contaminated soil demonstrates that it is a hazardous waste, handle and dispose of the soil as hazardous waste. You are the generator of hazardous waste created as the result of spills or leaks for which you are responsible.

Prevent the flow of water, including ground water, 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 and analyze the water using a laboratory certified by the ELAP. If analysis results demonstrate that the water is a hazardous waste, manage and dispose of the water as hazardous waste.

14-11.02F Department-Generated Hazardous Waste

14-11.02F(1) General

If the Department is the generator of hazardous waste during the work performed on this project use hazardous waste management practices under section 14-11.02B.

14-11.02F(2) Hazardous Waste Storage

Labels must comply with the provisions of 22 CA Code of Regs § 66262.31 and § 66262.32. Mark labels with:

1. Date the hazardous waste is generated
2. The words "Hazardous Waste"
3. Composition and physical state of the hazardous waste (for example, asphalt grindings with thermoplastic or paint)
4. The word "Toxic"
5. Name, address, and telephone number of the Engineer
6. Contract number
7. Contractor or subcontractor name

Handle the containers such that no spillage occurs. You are the generator of any hazardous waste generated as the result of cleanup of spillage.

14-11.02F(3) Hazardous Waste Transport and Disposal

Dispose of hazardous waste within California at a disposal site operating under a permit issued by DTSC.

The Engineer will obtain the US EPA Generator Identification Number for hazardous waste disposal.

The Engineer will sign all hazardous waste manifests. Notify the Engineer 5 business days before the manifests are to be signed.

The Department will not consider you a generator of the hazardous waste and you will not be obligated for further cleanup, removal, or remedial action for such material handled or disposed of under these specifications and the appropriate State and federal laws and regulations and county and municipal ordinances and regulations regarding hazardous waste.

14-11.03 MATERIAL CONTAINING HAZARDOUS WASTE CONCENTRATIONS OF AERIALLY DEPOSITED LEAD

Reserved

14-11.04 MINIMAL DISTURBANCE OF MATERIAL CONTAINING HAZARDOUS WASTE CONCENTRATIONS OF AERIALLY DEPOSITED LEAD

Reserved

14-11.05 NATURALLY OCCURRING ASBESTOS

Reserved

14-11.06 DEPARTMENT GENERATED CONTAMINATED SOIL

Reserved

14-11.07 REMOVE YELLOW TRAFFIC STRIPE AND PAVEMENT MARKING WITH HAZARDOUS WASTE RESIDUE

Reserved

14-11.08 DISTURBANCE OF EXISTING PAINT SYSTEMS ON BRIDGES

Reserved

14-11.09 TREATED WOOD WASTE

Reserved

14-11.10 DISPOSAL OF ELECTRICAL EQUIPMENT REQUIRING SPECIAL HANDLING

Reserved

14-11.11–14-11.20 RESERVED

14-12 OTHER INTERAGENCY RELATIONS

14-12.01 GENERAL

Section 14-12 includes specifications relating to other interagency relations.

14-12.02 RESERVED

14-12.03 STATE PARKS

Reserved

14-12.04 STATE RECLAMATION BOARD

Reserved

14-12.05–14-12.15 RESERVED

15 EXISTING FACILITIES

15-1 GENERAL

15-1.01 GENERAL

Section 15-1 includes general specifications for performing work on existing facilities.

Wherever work requires removing materials, the work includes disposing of the materials unless salvaging or incorporating the materials into the final work is described.

Wherever work includes removing, salvaging, reconstructing, abandoning, destroying, modifying, resetting, relocating, or relaying, do not start such activities until the facility is no longer needed or not being used.

Portions of the existing facilities that are to remain in place must be protected, preserved, and maintained. If you damage a portion of the facility that is to remain in place, you must repair or replace the damaged facility. After the repair or replacement, the condition of the facility must be equal or better in quality than it was before beginning the work. Remove materials that are not repaired.

Drainage facilities include culverts, inlets, headwalls, endwalls, aprons, drains, pipes, catch basins, gutters, gutter depressions, junction structures, spillways, and check dams.

15-1.02 MATERIALS

Not Used

15-1.03 CONSTRUCTION

15-1.03A General

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 otherwise 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.

15-1.03B Residue Containing Lead from Paint and Thermoplastic

Reserved

15-1.03C Loop Detectors

Reserved

15-1.03D Highway Irrigation Facilities

Underground irrigation facilities are either shown or marked by the Engineer. If underground irrigation facilities are not shown or marked by the Engineer and you damage them, the repair or replacement is change order work.

Maintain the existing water supply under section 20-3.03B(3).

15-1.03E–15-1.03J Reserved

15-1.04 PAYMENT

Not Used

15-2 MISCELLANEOUS FACILITIES

15-2.01 GENERAL

15-2.01A General

Section 15-2 includes specifications for removing, salvaging, reconstructing, abandoning, destroying, modifying, resetting, relocating, relaying, remodeling, and adjusting miscellaneous highway facilities.

15-2.01B Materials

Unless described otherwise, use minor concrete.

Reinforcement must comply with section 52.

15-2.01C Construction

If a portion of the metal beam guard railing or thrie beam barrier is to remain in place, removing, salvaging, reconstructing, relocating, or resetting work includes:

1. Resetting end caps, return caps, terminal sections, and buried post anchors
2. Providing connections to existing and new facilities, including connections to concrete

15-2.01D Payment

Except for concrete barrier, remove, salvage, reconstruct, relocate, or reset railing or barrier is measured as specified for measuring new railing or barrier.

Remove, salvage, reconstruct, relocate, or reset fencing is measured parallel to the top of the fence. Gates are units. The fence payment quantity does not include the width of the gate.

Remove, salvage, reconstruct, relocate, or reset roadside signs are measured as a unit. Each individual sign installation is a unit regardless of the number of posts or sign panels involved.

15-2.02 REMOVE

15-2.02A General

Section 15-2.02 includes specifications for removing facilities or portions of facilities as described.

Remove bridges or portions of bridges under section 15-4 except removing surfacing on concrete bridges and approaches must comply with section 15-5.

15-2.02B Remove Pavement

15-2.02B(1) General

Removing pavement includes cold planing AC pavement and obliterating roads, detours, and surfacing.

Removing PCC pavement must comply with section 15-3.

15-2.02B(2) Obliterate Roads, Detours, and Surfacing

Where a portion of the surface is to remain in place, saw a neat line along the edge of the portion to remain in place before starting the obliteration operation.

Do not obliterate roads, detours, or surfacing until after they are no longer required for the passage of public traffic.

Obliterate by rooting, plowing, pulverizing, or scarifying to the greater depth of 6 inches or the bottom of the impermeable underlying base. Obliterate so that the material lumps are no larger than 4 inches in greatest dimension. Mix bituminous material with equal amounts of underlying permeable material. Grade the area so that it blends with the surrounding terrain and drains well.

You may obliterate by scarifying the existing base and surfacing for their full depth so that the material lumps are no larger than 12 inches in greatest dimension. Cover the area with at least 6 inches of earth cover. Grade the area so that it blends with the surrounding terrain and drains well.

15-2.02B(3) Cold Planing Asphalt Concrete Pavement

Reserved

15-2.02B(4) Remove Subbase, Base, and Bituminous Surfacing

15-2.02B(4)(a) General

Remove the subbase, base, and bituminous surfacing to a depth of at least 6 inches below the grade of the existing surfacing. Subbases and bases include the various types shown. Backfill the resulting holes and depressions with earth material from the excavation and to the lines and grades established by the Engineer.

15-2.02B(4)(b) Payment

For a given location if there is no bid item for cold plane or remove (1) various types of pavement, (2) various types of surfacing, (3) subbase, (4) base, or (5) bituminous surfacing, payment for remove is included in the payment for the type of excavation shown in the Bid Item List that corresponds to that given location.

15-2.02C Remove Traffic Stripes and Pavement Markings

15-2.02C(1) General

Remove traffic stripes before making any change to the traffic pattern.

Remove traffic stripes and pavement markings by methods that do not materially damage the pavement. Remove pavement marking images so that the old message cannot be identified. Wherever removing by grinding, make the grinding area rectangular. The minimum dimensions of the rectangle is the height and width of the pavement marking.

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.

If blast cleaning is used for removal and the work is performed within 10 feet of a traffic lane that is open to the public, remove the residue with a vacuum attachment that operates concurrently with the blast cleaning. The residue and dust must be removed immediately after contact between the sand and the surface.

15-2.02C(2) Remove Traffic Stripes and Pavement Markings Containing Lead

Reserved

15-2.02C(3) Payment

The payment quantities for traffic stripes are determined as follows:

1. For single traffic stripes that are 6-inches wide, the length is multiplied by 1.5
2. For single traffic stripes that are 8-inches wide, the length is multiplied by 2
3. For double traffic stripes, the length is multiplied by 2
4. For triple traffic stripes, the length is multiplied by 3

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 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.

15-2.02D Remove Pavement Markers

Remove pavement markers and the underlying adhesive by methods that cause the least possible damage to the pavement or surfacing.

During removal of ceramic-type pavement markers, use screens or other protective devices to contain fragments.

Fragments from the removal work must be removed before opening the lanes to public traffic.

15-2.02E Remove Contrast Treatment

Remove contrast treatment by methods that do not materially damage the pavement.

Sweep up or vacuum the removal residue before it can (1) be blown by traffic or wind, (2) migrate across lanes or shoulders, or (3) enter the drainage facility.

If blast cleaning is used for removal and the work is performed within 10 feet of a traffic lane that is open to the public, remove the residue with a vacuum attachment that operates concurrently with the blast cleaning. Residue and dust must be removed immediately after contact between the sand and the surface.

15-2.02F Remove Asphalt Concrete Dikes

Reserved

15-2.02G Remove Metal Beam Guard Railing

Where removing metal beam guard railing, remove any concrete anchors and steel foundation tubes.

15-2.02H Remove Cable Chain Link Barriers

Where removing cable-chain link barrier, remove any anchor blocks and post footings.

Where post footings do not conflict with the installation of the new barrier, the post footings may remain in place.

Where posts are in a bridge, remove the posts. Pipe post sleeves or other type of post anchorages must be cut off flush with the bridge deck. Clean the sleeve and fill with grout. Grout must consist of 1 part portland cement to 6 parts sand.

15-2.02I Remove Sign Structures

Reserved

15-2.02J Remove Roadside Signs

Do not remove roadside signs until the replacement signs are installed or until the existing signs are no longer required for public traffic.

15-2.02K Remove Drainage Facilities

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 one 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 15-3.

Reuse frames, grates, and covers at the locations shown. 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.

15-2.02L Remove Irrigation Facilities

Remove irrigation facilities as shown. Facilities 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.

15-2.02M–15-2.02R Reserved

15-2.03 SALVAGE

15-2.03A General

15-2.03A(1) General

Section 15-2.03 includes specifications removing, disassembling, cleaning, preparing, marking, bundling, packaging, tagging, hauling, and stockpiling facilities or portions of facilities as described.

Salvaged material and items remain the property of the Department.

Salvaging does not include preparation of existing material that is reused.

15-2.03A(2) Materials

15-2.03A(2)(a) General

Cleaning includes removing earth, foreign materials, and concrete.

Comply with the requirements for bundles and packages shown in the following table:

Material or item	Component	Bundle or package
Metal beam guard railing	Rail	25/bundle
	Wood posts, 6 by 8 inches	30/bundle
	Wood posts, 10 by 10 inches	20/bundle
	Steel posts	10/bundle
	Blocks	50/bundle
Fences	Chain link fabric	50 ft/pallet
	Corner posts and end posts	One assembly/bundle
Manholes or inlets or other facilities	Frames and covers	Match marked pairs
	Frames and grates	Match marked pairs
Single sheet aluminum signs	--	Banded on a pallet with a total weight of not more than 500 lb/pallet

Tag incomplete bundles or pallets and show the quantity contained.

Tag all material and items using Department-furnished tags, and show the following information as applicable:

1. Name or description of material or item
2. Type or model number
3. Dimensions
4. Quantity if more than one

Salvaged material and items must be hauled directly to the specified salvage storage location and stockpiled. If authorized, you may temporarily store salvaged materials at your location and later haul to and stockpile at the specified location. You must replace any material or items that are lost before they are stockpiled at the specified location. The Department does not pay for replacement of lost material or items.

15-2.03A(2)(b) Department Salvage Location

Reserved

15-2.03A(3) Construction

Segregate damaged from undamaged materials, and remove the damaged material or items.

If you damage material or items to be salvaged, repair, or replace them at your expense. Replacements for lost or damaged materials must be of the same kind and of the same or better quality and condition as the lost or damaged materials prior to removal. If authorized, the cost of replacement will be deducted in lieu of you providing a replacement.

15-2.03A(4) Payment

Reserved

15-2.03B Salvage Metal Beam Guard Railing

Reserved

15-2.03C Salvage Irrigation Facilities

Reserved

15-2.03D–15-2.03H Reserved

15-2.04 RECONSTRUCT

15-2.04A General

Section 15-2.04 includes specifications for removing, disassembling, and constructing facilities again at the original or new locations.

Furnish and install new parts and construct alterations as described.

Reconstructed facilities must conform to the design of the existing facility and be equal to the best portions of the existing facility.

Reconstruction work must comply with the applicable specifications for new work of similar character.

Clean the material to be reconstructed. Remove earth, foreign materials, and concrete.

Segregate damaged from undamaged material or items, and remove the damaged material or items.

If you damage material or items to be reconstructed, repair, or replace them at your expense. The replacement for the damaged material or item must be of the same kind and of the same or better quality and condition as the material or item before removal. If authorized, the cost of replacement will be deducted in lieu of you providing a replacement.

Before removal, if the Engineer determines that a portion of the existing facility cannot be reused in the reconstruction, remove that portion. Furnishing the replacement material or item for that portion of the existing facility is change order work.

15-2.04B Reconstruct Fences

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.

Gates to be reused must be installed in reconstructed fences at the locations designated by the Engineer.

Fence reconstruction includes necessary clearing. Clearing must comply with section 80-1.02.

If the amount of fence to be disassembled exceeds the amount needed for reconstruction, dispose of the excess fencing.

15-2.04C Reconstruct Sign Structures

Reserved

15-2.04D Reconstruct Metal Beam Guard Railing

Reserved

15-2.04E Reconstruct Metal Bridge Railing

Reserved

15-2.04F–15-2.04J Reserved

15-2.05 ABANDON

15-2.05A General

Section 15-2.05 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.

15-2.05B Abandon Manholes

Reserved

15-2.05C Abandon Culverts and Pipelines

Reserved

15-2.05D Abandon Inlets

Reserved

15-2.05E Abandon Pedestrian Undercrossings

Reserved

15-2.05F–15-2.05J Reserved

15-2.06 DESTROY

15-2.06A General

Section 15-2.06 includes specifications for rendering facilities unserviceable in place.

15-2.06B Destroy Wells

Reserved

15-2.06C–15-2.05F Reserved

15-2.07 MODIFY

15-2.07A General

Section 15-2.07 includes specifications for partially removing, adjusting, and adding to facilities.

15-2.07B Modify Sign Structures

Reserved

15-2.07C Modify Pipes

Modifying pipes includes extending pipes. Extending pipes must comply with the specifications for new pipe installation.

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.

15-2.07D Modify Inlets, Manholes, and Risers

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 lb/cu yd of cementitious material.

Backfill to match the grading plane.

15-2.07E–15-2.07J Reserved

15-2.08 RESET

15-2.08A General

Section 15-2.08 includes specifications for removing and reinstalling facilities at or near the original locations. The exact locations are as shown or as authorized.

15-2.08B Reset Mailboxes

15-2.08B(1) General

Mailboxes include newspaper boxes. Provide access for the mail and newspaper delivery at all times. Reset the mail box location as necessary during your work. Mount mailboxes on posts that are set in the ground. If authorized, temporary supports may be used. Do not use posts concreted in buckets for temporary supports.

Reset a newspaper box wherever the newspaper box is attached to the existing facility.

For the final location, install mailboxes on new redwood posts that comply with the specifications for sign posts under section 56.

Backfill the space around posts with earth material. Place the backfill in 4-inch thick layers. Moisten and thoroughly compact each layer.

Dispose of posts, mounts, and hardware that are no longer used.

15-2.08B(2) Payment

A mail box is one unit. A newspaper box is one unit.

Multiple boxes on a single post are counted as multiple units.

Payment for a unit includes resetting as many times as necessary during your work.

15-2.08C Reset Roadside Signs

Each roadside sign must be reset on the same day that the sign is removed.

Where shown, drill 2 holes in each post to provide the breakaway feature.

15-2.08D–15-2.08H Reserved

15-2.09 RELOCATE

15-2.09A General

Section 15-2.09 includes specifications for removing and installing facilities at new locations.

15-2.09B Relocate Sign Structures

Reserved

15-2.09C Relocate Roadside Signs

Each roadside sign must be relocated on the same day that the sign is removed.

Relocate using existing posts. If an existing post is deteriorated or broken, notify the Engineer. If ordered, use a new post and provide the breakaway feature shown.

If a new post is ordered for reasons other than damage caused by you, the post and installation is change order work.

15-2.09D Relocate Irrigation Facilities

Relocating irrigation facilities includes relocating valves, wye strainers, sprinklers, pull boxes, backflow preventer assemblies, irrigation controllers, and other facilities shown.

Valves and wye strainers include valve boxes and valve box covers. Install relocated valve boxes with new woven-wire cloth and gravel or crushed rock bedding as shown.

Sprinklers include risers, riser supports, check valves, and concrete protectors as shown.

Pull boxes include pull box covers. Install relocated pull boxes with new woven cloth and crushed rock bedding as shown for valve box installations.

Backflow preventer assemblies include backflow preventers, wye strainers, gate valves, unions, fittings, concrete pads, thrust blocks, pipe supports, backflow preventer assembly enclosures, and backflow preventer assembly blankets.

Install galvanized steel or copper pipe supply lines and fittings to the water meters or points of connections as shown.

Irrigation controllers include, controller enclosures, controller enclosure cabinets, concrete pads, anchor bolts, and electrical conduits. Electrical conduits include control conductors, neutral conductors, and electrical power conductors. Conduits for control and neutral conductors and electrical power conductors must terminate in separate new or relocated pull boxes located within 5 feet of the new concrete pads.

Where relocating 120-volt electrical power for irrigation facilities, comply with section 86-2.11B.

Irrigation facilities to be relocated and that are determined unsuitable by the Engineer must be replaced under section 15-2.04A.

After irrigation facilities have been relocated, demonstrate in the presence of the Engineer that the relocated facilities function properly.

15-2.09E–15-2.09H Reserved

15-2.10 ADJUST

15-2.10A General

Section 15-2.10 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.

15-2.10B Adjust 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, fabricate, and install raising devices. Raising devises 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.

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 involved.

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.

15-2.10C Adjust Inlet

Adjust inlets as shown.

Use minor concrete with at least 590 lb/cu yd of cementitious material.

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.

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.

15-2.10D Adjust Metal Beam Guard Railing

Reserved

15-2.10E–15-2.10H Reserved

15-2.11 RELAY

15-2.11A General

Section 15-2.11 includes specifications for removing and relaying facilities at the original or new locations.

15-2.11B–15-2.11F Reserved

15-2.12 REMODEL

15-2.12A General

Section 15-2.12 includes specifications for rebuilding facilities at the original location. Remodeling may require some removal.

15-2.12B–15-2.12F Reserved

15-2.13–15-2.15 RESERVED

15-3 CONCRETE REMOVAL

15-3.01 GENERAL

Section 15-3 includes specifications for removing all or a portion of a concrete facility.

Remove bridges or portions of bridges under section 15-4.

Remove concrete pipe under section 15-2.02K.

Types of concrete facilities to be removed may include curbs, gutters, gutter depressions, sidewalks, driveways, slope paving, island paving, barriers, retaining walls, minor structures, aprons, spillways, dams, and PCC pavement.

Where broken-concrete slope protection is shown, use broken PCC for the construction of the broken-concrete slope protection.

As an alternative to removing broken concrete from the job site, you may place broken concrete on the job site by:

1. Burial in embankments. Concrete must be broken into pieces that can be readily handled and incorporated into embankments and placed at a depth of at least 3 feet below the finished grade and slope lines. Concrete must not be buried in areas where piling is to be placed or within 10 feet of trees, pipelines, poles, buildings or other permanent objects or structures.
2. Placement at authorized locations. The broken concrete must not present an unsightly appearance from the highway.

15-3.02 MATERIALS

Concrete materials include PCC, masonry, and mortared rubble masonry.

15-3.03 CONSTRUCTION

Remove concrete to a depth of at least 3 feet below finished grade unless described otherwise.

Bar reinforcement or other steel may be encountered in portions of concrete to be removed.

Existing concrete must be cut to a true line where new concrete is joined to existing concrete.

Where no joint exists between the concrete facility to be removed and concrete to remain in place, use a power-driven saw to cut the concrete on a neat line to a minimum depth of 2 inches before removing the concrete.

Where no joint exists between PCC pavement to be removed and concrete pavement to remain in place, use a power-driven saw to cut the pavement on a neat line to a minimum depth of 2 inches before removing the pavement. If there is overlying material on the pavement, remove it with the pavement.

Where concrete has been removed outside the roadway prism, the backfilled areas must be graded to drain and blend in with the surrounding terrain.

The floors of concrete basements, pits, and structures that are not required to be removed and that are located within the roadway must be broken so that water will not be trapped.

Where shattering concrete is described, shatter the concrete into pieces that are equal to or less than 2 feet in greatest dimension.

15-3.04 PAYMENT

Concrete is measured before starting removal.

If there is an item for the removal of a concrete facility that has portions below ground, the payment quantity includes the below-ground portion.

Payment for removing reinforcement and removing steel is included in the payment for the remove concrete involved. If there is no item for remove concrete, removing reinforcement and removing steel is included in the type of removal work involved.

15-4 BRIDGE REMOVAL

15-4.01 GENERAL

15-4.01A General

15-4.01A(1) Summary

Section 15-4 includes specifications for removing and disposing of bridges or portions of bridges.

Design and construct temporary support shoring, temporary bracing, and protective covers under section 48.

15-4.01A(2) Submittals

If required, submit a daily inspection report.

Submit a bridge removal work plan for each structure. Include details for the following:

1. Removal sequence, including staging of removal operations 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 public 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. A stage is removal of (1) the deck, soffit, or girders in any span; or (2) walls, bent caps, or columns at support locations. Include dead and live loads used in the design of protective covers.

15-4.01A(3) Quality Control and Assurance

15-4.01A(3)(a) General

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.
3. Immediately submit a work plan for deviations from the authorized plan or unplanned events.

15-4.01A(3)(b) Design Criteria

For removal activities, 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.

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.

15-4.01B Materials

Not Used

15-4.01C Construction

15-4.01C(1) General

Type and limits of removal are described.

15-4.01C(2) Preparation

15-4.01C(2)(a) General

The Engineer may require you to perform additional exploratory work of bridge members for unforeseen damage. This is change order work.

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 public traffic.

15-4.01C(2)(b) 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 bridge removal, provide a vertical opening of 15 feet and a horizontal opening of 32 feet for public traffic.
5. Be cleaned of debris and fines before being removed.

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 at 5-foot centers.

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.

15-4.01C(3) Construction

15-4.01C(3)(a) General

Wherever complete bridges are removed, do not start removal activities until traffic is no longer carried on the bridge.

Before removing portions of monolithic concrete elements visible in the completed work, make a 1-inch deep saw cut along neat lines around the perimeter of the concrete to be removed.

Repair or replace materials to be used in the reconstructed work that are damaged during work activities.

Remove piling, piers, abutments, 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 it in new concrete.

You may use flame and saw cutting for removing, widening, or modifying bridges.

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 shields. Design protective shields as required by the equipment and activities being performed. Protective shields must be at least equal to 2-inch Douglas fir planking on posts at 5-foot centers.

Remove and stockpile salvaged materials under section 15-2.03.

You may dispose of broken concrete in embankments under section 15-3.

The Engineer may require you to remove existing footing concrete that is below ground and outside of the footing limits. This is change order work.

For bridge removal activities over or adjacent to roadways that are only closed to traffic when removal work is being performed, the following requirements apply:

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 operations 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.
6. Protective covers are not required.

15-4.01C(3)(b) 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 use protective covers to perform preliminary work if covers support all loads and prevent dust and fine material from falling onto the traveled way.

Protective covers must extend 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.

15-4.01D Payment

Not Used

15-4.02 ACCESS OPENINGS

15-4.02A General

Section 15-4.02 includes specifications for (1) removing portions of bridges to provide cell access and (2) closing access openings.

15-4.02B Materials

Concrete must be rapid-setting concrete complying with section 15-5.02.

Reinforcement must comply with section 52.

Steel plates, hardware, and thread locking compound must comply with section 75-1.03.

15-4.02C Construction

15-4.02C(1) General

Limits of removal shown are approximate. The Engineer authorizes removal limits before you start removal activities.

Saw cut concrete to a depth of 1 inch around removal limits before removing concrete.

Remove concrete and reinforcement to the limits shown. Paint exposed ends of the remaining reinforcement with 2 coats of organic zinc-rich coating under section 59-2.03C(2)(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.

15-4.02C(2) Deck Access Opening

Reserved

15-4.02C(3) Soffit Access Opening

Seal access openings with access doors when cell access is no longer required.

15-4.02C(4) Soffit Access Extension

For bridge soffit access extensions, remove and replace concrete within the limits shown. You may reduce removal limits if authorized.

Reconstruct soffit concrete to the original dimensions when cell access is no longer required.

15-4.02C(5) Close Deck Access Opening

Temporarily close deck access openings that are not completed before the traffic lane is opened.

Temporary deck cover plates must (1) be in place over access openings when lanes are not closed to traffic and (2) remain in place until the concrete overlay closing the opening is placed.

Use water to flush dust from areas to be filled with concrete. Remove all water by air blasting before placing concrete.

Do not allow public traffic on the new concrete until 1 hour after final set unless authorized.

15-4.02D Payment

Not Used

15-4.03–15-4.10 RESERVED

15-5 BRIDGE REHABILITATION

15-5.01 GENERAL

15-5.01A General

Section 15-5 includes specifications for rehabilitating concrete bridges.

15-5.01B Materials

Steel shot must comply with SSPC-AB 3. Recycled steel shot must comply with SSPC-AB 2.

15-5.01C Construction

15-5.01C(1) General

Before starting work, remove traffic stripes, pavement markings, and pavement markers under section 15-2.02.

Coarse aggregate remaining above the removal depth must be firmly embedded.

High-pressure water jet equipment must:

1. Have rotating or oscillating jets
2. Be rated at 30,000 psi minimum

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 the following features:

1. 3 or 4 riding tracks
2. Automatic grade control system with electronic averaging having 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

Provide personnel on each side of the milling drum to monitor milling activities. Maintain constant radio communication with the operator during milling activities.

15-5.01C(2) Prepare Concrete Deck Surface

Prepare concrete bridge decks 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
2. Sweep the deck surface
3. Blow the deck surface clean using high-pressure air

Remove unsound concrete under section 15-5.01C(5) before abrasive blasting.

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 before placing the deck treatment or overlays, abrasive blast clean the contaminated area and sweep the deck clean.

15-5.01C(3) Remove Concrete Deck Surface

Remove concrete deck surface to the specified depth.

Before removing concrete (1) sweep the deck surface and (2) blow the deck clean with high-pressure air.

Remove deck surface by cold milling or high-pressure water jetting.

15-5.01C(4) Remove 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 asphalt concrete every 50 feet (1) on each shoulder, (2) in the traveled way, and (3) at the roadway crown if a crown is shown.

Remove asphalt concrete surfacing and concrete expansion dams by cold milling. At least 1/2 inch of asphalt concrete surfacing must remain after milling activities.

Remove remaining asphalt surfacing using other authorized means. Do not damage the concrete slab.

15-5.01C(5) Remove 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 in conformance with section 52.

Replace or repair reinforcing steel damaged and rendered useless during removal.

15-5.01C(6) Remove Chip Seal

Where shown, remove bituminous chip seals, bituminous slurry seals, and polymer chip seals from bridge decks by grinding.

Remove the seal from the deck under section 42-3. Remove no more than 1/4 inch of concrete deck surface.

15-5.01D Payment

Wherever rapid setting concrete is used to fill voids from unsound concrete, the pay quantity for remove unsound concrete is the same as the pay quantity for rapid setting concrete (patch). No deduction is made for concrete used to fill spalls that existed before work began.

15-5.02 RAPID SETTING CONCRETE PATCH

15-5.02A General

Section 15-5.02 includes specifications for cleaning deck surfaces and placing rapid setting concrete patches up to 4 inches in depth.

15-5.02B Materials

Rapid setting concrete must comply with the specifications for bonding materials in section 51-1.02C.

You may extend concrete using a clean, uniform, rounded aggregate filler with a moisture content of no more than 0.5 percent. Aggregate grading 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.

15-5.02C Construction

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, reclean surfaces by sweeping and pressure jetting or other authorized means to remove debris.

The surface temperature of the existing concrete must be at least 40 degrees F during placement. Contact surfaces to receive magnesium phosphate concrete must be dry. Contact surfaces to receive modified high-alumina concrete or portland cement 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 over 5 percent.

Cure modified high-alumina based concrete and portland cement based concrete using the curing compound method. Do not cure magnesium phosphate concrete.

15-5.02D Payment

Pay quantities of rapid setting concrete (patch) are determined from the pounds of concrete used as measured by scale weights divided by a plastic density of 135 lb/cu ft.

15-5.03 REPAIR SPALLED SURFACE AREA

15-5.03A General

15-5.03A(1) Summary

Section 15-5.03 includes specifications for removing and patching spalled concrete surfaces other than bridge decks.

15-5.03A(2) Submittals

Submit a test sample of at least 1 complete unit of filler material. Allow 45 days for testing.

For contracts of less than 60 working days, submit certificates of compliance for the filler material and bonding agents.

15-5.03B Materials

Mortar must comply with section 51-1.02C.

Shotcrete must comply with section 53.

Alternative filler materials and bonding agents must have the values for the material properties shown in the following table:

Property	Test method	Value
Abrasion resistance, 28 days	California Test 550	25 grams, maximum
Modulus of elasticity, 28 days	California Test 551	10.3 to 24.1 GPa
Water soluble chlorides	California Test 422	500 mg/kg, maximum
Water soluble sulfates	California Test 417	2,500 mg/kg, maximum

For projects of less than 60 days, alternative materials must be authorized before use.

15-5.03C Construction

Remove unsound concrete under section 15-5.01C(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 alternative filler material and bonding agent.

If using an alternative filler material, apply 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.

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.

15-5.03D Payment

Repair spalled surface area is measured by the square foot of completed, repaired surface. Measured areas are recorded daily by the Engineer and agreed upon by you.

15-5.04 REFINISH BRIDGE DECK

15-5.04A General

Section 15-5.04 includes specifications for refinishing surfaces of bridge decks exposed when railings, curbs, or sidewalks are removed.

The Engineer determines the exact area to be refinished.

15-5.04B Materials

Use 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 between 50 and 55 percent fine aggregate. The remaining portion must be pea gravel. Grade pea gravel so that 100 percent passes the 1/2-inch sieve and at most 5 percent passes the no. 16 sieve.
4. The Engineer may request admixtures be used.

Rapid setting concrete must comply with section 15-5.02.

15-5.04C Construction

15-5.04C(1) General

For removal work performed within 10 feet of a traffic lane or over traffic, remove dust and residue using an authorized vacuum, water spray, or 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 brooming, abrasive blast cleaning, and using high-pressure air. Reblast contaminated areas before starting concrete placement activities.

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 15-5.02.

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 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 in the longitudinal direction.

15-5.04C(2) Placing Portland Cement Concrete

Abrasive blast clean surfaces to be refinished. Sweep blast-cleaned surfaces and blow them clean using high-pressure air.

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. Furnish and apply epoxy under section 95-2.03. 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 load concrete for 7 days after placement.

15-5.04C(3) Placing Rapid Setting Concrete

Blow surfaces to be refinished with high-pressure air immediately before placing concrete. Abrasive blast clean surfaces that are contaminated before the concrete is placed.

Do not allow public traffic on concrete until 24 hours after final set unless authorized.

15-5.04D Payment

Refinish bridge deck is measured from refinished areas measured horizontally, plus 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.

15-5.05 BRIDGE DECK METHACRYLATE RESIN TREATMENT

15-5.05A General

15-5.05A(1) Summary

Section 15-5.05 includes specifications for applying a high molecular weight methacrylate resin system with sand and absorbent material to bridge decks.

15-5.05A(2) Submittals

Submit a work plan for placement of the resin system. Include the following:

1. Schedule of work and testing for each bridge
2. Description of equipment for applying resin
3. Range of gel time and final cure time for resin
4. Description of absorbent material to be used
5. Description of equipment for applying and removing excess sand and absorbent material
6. Procedure for removing resin from the deck and equipment to be used
7. Procedure for storing and handling resin components and absorbent material
8. Procedure for disposing of excess resin and containers

Submit a material safety data sheet for each resin system component and diatomaceous earth shipment before use.

Submit test samples of methacrylate resin components 15 days before use.

15-5.05A(3) Quality Control and Assurance

The Engineer performs California Test 342 on treated deck surfaces. The coefficient of friction must be at least 0.35. The Engineer provides a 15-day notice for you to provide traffic control for testing at each bridge location.

Complete a test area before starting production treatment activities.

The test area must:

1. Be approximately 500 sq ft
2. Be placed within the project limits outside the traveled way at an authorized location
3. Be constructed using the same equipment as the production work
4. Replicate field conditions for the production work
5. Demonstrate that the proposed means and methods comply with the acceptance criteria
6. Demonstrate that the production work will be completed within the time allowed

The Engineer determines acceptability of the test area. The test area is acceptable if:

1. The treated deck surface is tack free and not oily
2. The sand cover adheres and resists brushing by hand
3. Excess sand and absorbent material has been removed
4. The coefficient of friction is at least 0.35

15-5.05B Materials

Notify the Engineer 15 days before delivery of methacrylate resin components in containers over 55 gallons to the job site.

A high-molecular-weight methacrylate resin system consists of resin, promoter, and initiator.

High-molecular-weight methacrylate resin must be low odor and have the values for the material properties shown in the following table:

Property	Test method	Value
Volatile content[a]	ASTM D 2369	30 percent maximum
Viscosity[a]	ASTM D 2196	25 cP maximum Brookfield RVT with UL adaptor, 50 RPM at 77 °F
Specific gravity[a]	ASTM D 1475	0.90 minimum at 77 °F
Flash point[a]	ASTM D 3278	180 °F, minimum
Vapor pressure[a]	ASTM D 323	1.0 mm Hg maximum at 77 °F
Tack-free time	Prepare specimens per California Test 551	400 minutes maximum at 25 °C
PCC-saturated surface-dry bond strength	California Test 551	3.5 MPa minimum at 24 hours and 21 ± 1 °C

[a]Test must be performed before adding initiator.

Sand for abrasive sand finish must be:

1. Commercial-quality, dry-blast sand
2. A grading having not less than 95 percent pass the no. 8 sieve and not less than 95 percent 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.

15-5.05C Construction

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.

Prepare the deck under sections 15-5.01C(2), 15-5.01C(5), and 15-5.02.

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.

Spread resin uniformly. 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, excess resin must be removed from the texture indentations.

Apply the abrasive sand finish no sooner than 20 minutes after applying resin. The sand application rate must at least 2 lb/sq yd or until saturation as determined by the Engineer. Apply absorbent material before opening lane to traffic. Remove excess sand and absorbent material by vacuuming or power sweeping.

Traffic or equipment is allowed on the overlay after the Engineer has determined:

1. The treated deck surface is tack free and not oily
2. The 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.

15-5.05D Payment

Furnish bridge deck treatment material is measured by the gallon of mixed high-molecular-weight methacrylate resin placed.

Place bridge deck methacrylate resin treatment is paid as treat bridge deck.

15-5.06 POLYESTER CONCRETE OVERLAY

15-5.06A General

15-5.06A(1) Summary

Section 15-5.06 includes specifications for placing a polyester concrete overlay with a prime coat of high-molecular-weight methacrylate resin to bridge decks.

15-5.06A(2) Submittals

Submit a work plan for overlay placement. Include the following:

1. Schedule of overlay work and testing for each bridge
2. Description of equipment for applying methacrylate resin
3. Description of equipment for measuring, mixing, placing, and finishing the polyester concrete overlay
4. Method for isolating expansion joints
5. Cure time for polyester concrete
6. Description of equipment for applying sand
7. Method for storage and handling of methacrylate resin and polyester concrete components
8. Method for disposal of excess methacrylate resin, polyester concrete, and containers

For each shipment of methacrylate and polyester concrete, submit a material safety data sheet for each component.

Submit test samples of methacrylate and polyester resins 15 days before use.

Submit aggregate and resin volumes recorded from the volumetric mixer at the end of each work shift.

15-5.06A(3) Quality Control and Assurance

Complete a trial overlay before starting production overlay activities.

The trial overlay must:

1. Be at least 12 feet wide by 6 feet long and the same thickness as the project overlay
2. Be constructed on a prepared concrete base
3. Be placed within the project limits at an authorized location
4. Be constructed using the same equipment as the production work
5. Replicate field conditions for the production work
6. Be used to determine the initial polyester-concrete set time
7. Demonstrate suitability of the proposed means and methods

The Engineer determines acceptability of the trial overlay.

Dispose of the trial overlay and concrete base after acceptance.

15-5.06B Materials

Notify the Engineer 15 days before delivery of resin in containers over 55 gallons to the job site.

Polyester concrete consists of polyester resin binder and aggregate.

Polyester resin binder must:

1. Be an unsaturated isophthalic polyester-styrene co-polymer
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. Have the values for the material properties shown in the following table:

Property	Test method	Value
Viscosity[a]	ASTM D 2196	75 to 200 cP RVT, no. 1 spindle, 20 RPM at 77 °F
Specific gravity[a]	ASTM D 1475	1.05 to 1.10 at 77 °F
Elongation	ASTM D 638 ASTM D 618	35 percent, minimum Type I specimen, 0.25 ± 0.03 inch thick Rate = 0.45 inch/minute Sample Conditioning: 18/25/50+5/70
Tensile strength	ASTM D 638 ASTM D 618	2,500 psi, minimum Type I specimen, 0.25 ± 0.03 inch thick Rate = 0.45 inch/minute Sample conditioning: 18/25/50+5/70
Styrene content[a]	ASTM D 2369	40 percent to 50 percent by weight
PCC saturated surface-dry bond strength	California Test 551	3.5 MPa minimum at 24 hours and 21 ± 1 °C
Static volatile emission[a]	SCAQMD Method 309-91	60 gram/sq m loss, maximum

[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)
2. Have not more than 45 percent crushed particles retained on the no. 8 sieve when tested under California Test 205
3. Have fine aggregate consisting of natural sand
4. Have a weighted-average aggregate absorption of no more than 1 percent when tested under California Tests 206 and 207
5. 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
6. Comply with the requirements for one of the aggregate gradings shown in the following table:

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 15-5.05B except the methacrylate resin must be free of wax and tack-free time requirements do not apply.

Sand for abrasive sand finish must:

1. Be commercial-quality blast sand
2. Have not less than 95 percent pass the no. 8 sieve and not less than 95 percent 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

15-5.06C Construction

15-5.06C(1) General

The Engineer determines the exact percentage of polyester resin binder at the time of placing.

The Engineer provides final grade and cross slope before the start of overlay work.

The Engineer tests existing deck surface smoothness under section 51-1.03F(5) and may require you to modify the existing deck smoothness under section 42-3. Modifying the existing deck smoothness is change order work.

Construction of approach slabs must be complete before placing polyester overlay.

New concrete deck surfaces must comply with section 51-1.03E(5) before starting overlay work.

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
2. Be used to consolidate the polyester concrete

Prepare the deck under sections 15-5.01C(2), 15-5.01C(5), and 15-5.02.

The deck must be dry before placing the methacrylate prime coat. The concrete surface must be from 50 to 100 degrees F. Relative humidity must be not more than 85 percent.

Sweep the deck. Blow the deck clean with compressed air.

Thoroughly mix all components of methacrylate resin. Apply methacrylate resin to the deck surface within 5 minutes of mixing. Apply methacrylate resin uniformly and spread to completely cover surfaces to be overlaid.

The rate of application for methacrylate resin must be approximately 55 sq ft/gal.

Place methacrylate prime coat on magnesium phosphate concrete no sooner than 72 hours after final set or on modified high-alumina based concrete no sooner than 30 minutes after final set.

For manual mixers, initiate the polyester resin binder and blend completely. Add aggregate and mix for not less than 2 minutes.

Place polyester concrete:

1. Immediately after applying the methacrylate prime coat
2. Before gelling
3. Within 15 minutes of adding 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 of from 30 to 120 minutes when tested using an initial-setting-time Gillmore needle under ASTM C 266.

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.

Apply a sand finish of not less than 0.8 lb/sq yd before gelling occurs.

Protect the overlay from moisture for not less than 4 hours after finishing. Do not allow traffic or equipment on the overlay for not less than 4 hours after final finishing.

Completed polyester-concrete deck surfaces must comply with section 51-1.03F(5).

Taper 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 edges that are transverse to the direction of traffic at a 20:1 (horizontal:vertical) slope. Taper 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.

15-5.06C(2) Expansion Dams

You may mix polyester concrete for expansion dams using mechanical mixers of not more than 9-yards capacity.

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.

Remove asphalt concrete and expansion dams. Do not damage the deck or asphalt concrete to remain in place.

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 not less than 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.

15-5.06D Payment

The Engineer determines the payment quantity of furnishing polyester concrete using the following:

1. Quantity of resin binder used
2. Percent by weight of resin binder in the polyester concrete
3. Unit weight of 135 lb/cu ft

Place polyester concrete overlay is measured by the square foot based on the dimensions shown.

Expansion dam is measured by the cubic foot based on the dimensions shown.

Payment for trial overlay and concrete base for the trial overlay is included in the payment for furnish polyester concrete.

15-5.07 CORE CONCRETE

15-5.07A General

15-5.07A(1) General

Section 15-5.07 includes specifications for coring holes through concrete bridge members.

15-5.07A(2) Materials

Water for coring activities must be from the local water supply or comply with the following:

1. Contain not more than 1,000 ppm chlorides as Cl
2. Contain not more than 1,300 ppm of sulfates as SO4
3. Contain no impurities that discolor the concrete or etch the surface

15-5.07A(3) Construction

Use coring methods that do not shatter or damage the concrete adjacent to the holes.

Do not allow water from coring activities to fall on public traffic, flow across shoulders or lanes occupied by public traffic, or flow into gutters or other drainage facilities.

15-5.07A(4) Payment

Coring concrete is measured by the linear foot measured along the centerline of the hole. No deduction is made for expansion joints.

15-5.07B Core and Pressure Grout Dowels

15-5.07B(1) General

Section 15-5.07B includes specifications for coring holes through reinforced concrete, placing dowels, and filling holes with pressurized grout.

15-5.07B(2) Materials

Grout must comply with ASTM C 1107 or ASTM C 845, 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 contain not 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.

15-5.07B(3) Construction

Clean loose and foreign material from concrete and steel surfaces that will contact grout. Flush holes with water and let dry to a surface-dry condition immediately before grouting.

Mix grout in conformance with the manufacturer's instructions. Fill cored holes with grout. Place dowels into grouted holes. Seal the ends of holes after placing dowels.

Place a vent tube at 1 end of the hole and an injection feed tube at the other end. For holes with only a single end, place vent and injection feed tubes in the same hole. Tubes must (1) vent air from holes and (2) completely fill holes with grout.

Pump grout into holes. Use sufficient pressure to eliminate voids. Continually waste grout until air and water eject from the vent tubes and there are no visible slugs.

15-5.07B(4) Payment

Dowels for pressure grouting are paid for as bar reinforcing steel (bridge).

15-5.08 EPOXY CRACK INJECTION

15-5.08A General

15-5.08A(1) Summary

Section 15-5.08 includes specifications for filling cracks in concrete structures with pressure-injected epoxy.

15-5.08A(2) Quality Control and Assurance

Take a 3-ounce sample of mixed epoxy from the injection gun (1) before starting injection activities and (2) at hourly intervals when requested by the Engineer. If samples show improper proportioning or mixing, stop injection activities and correct deficiencies.

15-5.08B Materials

Epoxy must comply with section 95-2.11. Multiple formulations may be required for cracks of varying widths.

15-5.08C Construction

The Engineer selects cracks having widths from 8 to 250 mils for 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 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 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 first port at the end of a crack. Pump epoxy into the port until epoxy runs substantially from the next adjacent port. Seal the first 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.

15-5.08D Payment

Inject crack (epoxy) is paid for as the total length of cracks designated by the Engineer to be injected and that are filled with epoxy.

For cracks extending around corners of members, the crack length is measured on both faces.

You are paid for cracks designated to be filled on opposite sides of a member if the cracks on both sides are completely filled after injection from only one side.

15-5.09–15-5.20 RESERVED

15-6 CULVERT REHABILITATION

15-6.01 GENERAL

15-6.01A General

15-6.01A(1) Summary

Section 15-6 includes specifications for cleaning and preparing, inspecting and evaluating, repairing, rehabilitating, and reinspecting culverts.

Wherever storm drains, pipes, conduit, risers, downdrains, median drainage inlets, and underdrains are attached to the culvert, they are included in the work under section 15-6.

Repair as described, and repairing may include:

1. Filling voids below and around the exterior of the culverts
2. Restoring culvert openings
3. Smoothing protrusions inside culverts

Rehabilitate as described, and rehabilitating may include:

1. Filling voids below and around culverts
2. Paving culvert inverts
3. Installing pipeliners inside culverts

For a given culvert, if only 1 type of pipeliner is shown, install that type of pipeliner. For a given culvert, if more than 1 type of pipeliner is shown, choose one of the types shown.

15-6.01A(2) Definitions

alternative pipeliner: Bid items used where more than 1 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.

15-6.01A(3) Submittals

15-6.01A(3)(a) General

For each culvert, submit a work plan in a 3-ring binder that has labeled dividers for each type of plan. The work plan must include:

1. Cleaning plan
2. Inspection plan
3. Contact grouting plan when this work is described
4. Annular-space grouting plan when this work is described
5. Inspection and evaluation report
6. Postrehabilitation inspection report

For each portion of the work plan, obtain the Department's authorization before you perform work based on that portion.

At the prerehabilitation meeting, submit the work plan. Include work plans for contact grouting and annular grouting when this work is described. Allow 7 days for the Department's review. If multiple binders are submitted simultaneously or a binder is submitted before the review of a previously submitted binder is complete, designate the sequence that the binders are to be reviewed. Allow review time specified plus 3 days for each additional binder.

Within 7 days of the inspection of a culvert, submit an inspection and evaluation report. Allow 7 days for the Department's review. If multiple reports are submitted simultaneously or a report is submitted before the review of a previously submitted report is complete, designate the sequence that the reports are to be reviewed. Allow the review time specified plus 3 days for each additional report.

Within 7 days of the completion of all culvert work, submit a postrehabilitation inspection report as an action submittal. Allow 5 days for the Department's review. If multiple reports are submitted simultaneously or an additional report is submitted before the review of a previously submitted report is complete, designate the sequence that the reports are to be reviewed. Allow the specified review time plus 3 days for each additional reinspection report. Obtain written approval of the reinspection report.

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

Retain a copy of the culvert inspection videos and records until the postrehabilitation inspection report is authorized.

15-6.01A(3)(b) Cleaning Plan

The cleaning plan must include methods for:

1. Cleaning
2. Controlling sediments dislodged during the cleaning
3. Controlling and diverting the existing stream or groundwater flow. The bypass system must have adequate capacity and size. Include:
    3.1. Your calculations for the existing flows and the capacity of the bypass system
    3.2. Your schedule for the required use of the bypass system

15-6.01A(3)(c) Inspection Plan

The inspection plan must include:

1. Sample of the printed CCTV video log. The printed log must include digital photographs of material not dislodged during cleaning operations, locations where invert repairs were necessary, culvert joints, lateral connection joints, protrusions, and other portions of the culvert.
2. Sample CCTV video recording from previous culvert inspection work. The video must have audio commentary stating operational and structural defects in pipes that are the same size as those for this Contract. Sample video recording must be taken with the same camera and lighting equipment proposed for this work. Describe the camera type, model. and transporter.

If human entry is possible, the plan must also include samples obtained from handheld video and still photographs. Include the following:

1. Sample of the printed video log. The printed log must include digital photographs of material not dislodged during cleaning operations, locations where invert repairs were necessary, culvert joints, lateral connection joints, protrusions, etc.
2. Sample video recording from previous culvert inspection work. The video must have audio commentary showing operational and structural defects in pipes that are the same size as those for this Contract. Sample video recording must be taken with the same camera and lighting equipment proposed for this work. Describe the camera type, model, and transporter.

15-6.01A(3)(d) Contact Grouting Plan

If contact grouting is described, ordered, or proposed as a repair method, submit a contact grouting plan.

The grouting plan must include:

1. Order of work
2. Maximum injection pressures
3. Details and data for drilling and grouting equipment
4. Plans for controlling groundwater and existing culvert stream flows
5. Pressure gage, recorder, and field equipment certifications, including calibrations by an independent testing agency
6. Sample printout of the form for recording grouting operations. Form must show the following tabulated information for each grout port:
   6.1. port location
   6.2. pressure
   6.3. volume
   6.4. start and end time
7. Schedule of grout port installations and method for obtaining probe depth dimensions at grout ports; tabulation of locations and dimensions
8. Culvert strut details as necessary
9. Method for monitoring deformation of culvert or concrete lining
10. Grout mix design, including:
    10.1. Densities and viscosity
    10.2. Initial set time
    10.3. Materials and the independent testing agency's test data as specified in section 41-1.01
    10.4. Grout working time before 15 percent change in density or viscosity occurs

15-6.01A(3)(e) Annular Space Grouting Plan

If a pipeliner with annular space grouting is described, submit an annular space grouting plan. Submit a separate plan for each kind of grout or variation in grouting procedure or pipeliner installation. For each plan, state the corresponding culvert location and applicable installation conditions. With authorization, you may change the grout mix or grouting procedure before starting grouting at the given culvert location. The grout plan must show grouting methods and procedures and include:

1. Grout mix design. Include details of and test results from an independent testing agency for the following:
   1.1. Components and proportions
   1.2. Densities and viscosity
   1.3. Initial set time of the grout
   1.4. 28-day minimum grout compressive strength
   1.5. Grout working time before a 15 percent change in density or viscosity occurs
2. Maximum injection pressures, including those for the stage at the crown of the culvert
3. Proposed grout lift heights and volumes (e.g., stage 1 to spring line; stage 2 is fully grouted)
4. Bulkhead designs and locations
5. Calculations of the buoyant forces during grouting and details for holding the pipeliner on the invert of the culvert for a period of time long enough to allow the first lift of grout to set before proceeding to the second lift
6. Details for re-establishing lateral connections and openings
7. Pressure gage, recorder, and field equipment calibration records from an independent testing agency
8. Proposed number and location of vents relative to pipeliner diameter, pipeliner stiffness, and depth of flow of grout in the pipe

9. Culvert strut details as necessary
10. Written confirmation that you have coordinated grouting procedures with the grout installer and pipeliner manufacturer
11. Calculations or other documentation verifying that pipeliner joints will not leak, separate, or deform under the proposed grouting pressure

15-6.01A(3)(f) Inspection and Evaluation Report

Report inspection findings and recommended repairs. CCTV or video recording and photography must comply with section 15-6.01(A)(4).

The inspection and evaluation report must include:

1. 2 copies of the CCTV or video recording and on the outside of each copy include:
    1.1. Recording number.
    1.2. Inspection date.
    1.3. Current distance along the culvert measured by a count meter.
    1.4. Encoded text description of location, culvert size, type and length.
    1.5. Printed labels with location and date on a hard copy of the video recording.
    1.6. Audio portion stating:
        1.6.1. Inspection date.
        1.6.2. Confirmation of the orientation and origin of the tape counter meter.
        1.6.3. Description of culvert size, type and length.
        1.6.4. Description and location of each defect.
        1.6.5. Description and location of each lateral pipe opening.
        1.6.6. Description of flow direction.
2. 1 set of the digital photographs.
3. Documentation of the condition of the culvert, including:
    3.1. Any condition that might prevent proper installation of pipeliner or invert paving.
    3.2. Protrusions.
    3.3. Collapsed or crushed areas.
    3.4. Reduced cross-sectional areas.
    3.5. Each lateral pipe opening, including:
        3.5.1. Drainage system identification.
        3.5.2. Distance into culvert.
        3.5.3. Exact position and orientation within culvert wall.
        3.5.4. Size or dimensions of opening.
        3.5.5. Connecting joint.
        3.5.6. Flow direction.
    3.6. Each culvert joint.
4. Either a recommendation for repairs or statement that no repairs are needed.
5. If repairs are recommended, describe the location and conditions, including any sharp or protruding appurtenances that might snag or tear the pipeliner. If possible, include a detailed evaluation by human entry of the areas where repairs are needed. Describe any corrective action proposed to re-establish lateral pipe and service openings.

If the Engineer determines that the inspection documentation is not adequate, your inspection and evaluation report will be rejected and you must reinspect and resubmit your report. Inadequate documentation may include poor camera head position, poor camera focus, poor illumination, rapid rate of progression, and incomplete records and logs. No payment is made for recleaning and reinspecting.

15-6.01A(3)(g) Postrehabilitation Inspection Report

After the completion of the postrehabilitation inspection, submit a postrehabilitation inspection report. The written logs, videos, and photographs must comply with section 15-6.01A(3)(f).

The report must document the repairs, rehabilitation, and any subsequent deficiencies, including:

1. Defects
2. Discoloration
3. Irregularities
4. Surface discontinuities

5. Anomalies
6. Constrictions
7. Deformities

If there are deficiencies and human entry is possible, the report must include more detailed documentation of human-entry inspection, concentrating on the areas with deficiencies.

If there are deficiencies, the inspection report must include recommendations to correct the deficiencies.

If the Engineer determines that the inspection report is not adequate, your report will be rejected and you must reinspect and resubmit your report. Inadequate documentation may include poor camera head position, lack of focus, poor illumination, rapid rate of progression, and incomplete records and logs. No payment is made for recleaning and reinspecting.

If there are deficiencies, do not start corrections until you have obtained authorization of the report.

15-6.01A(4) Quality Control and Assurance

15-6.01A(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.

15-6.01A(4)(b) 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. Select a date and time that is acceptable to the Engineer and so that all participants will attend.

15-6.01A(4)(c) 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. Select a date and time that is acceptable to the Engineer and so that all participants will attend.

15-6.01A(4)(d) CCTV

CCTV recordings must be made and submitted in high quality electronic media such as VHS, 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.

15-6.01A(4)(e) 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.

15-6.01A(4)(f) 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. Gages must comply with ANSI B40, Grade 2A. The pressure gages, recorder, and field equipment must be calibrated by an independent testing agency.

15-6.01A(4)(g) 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.

15-6.01A(4)(h) 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 and 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.

15-6.01B Materials

15-6.01B(1) General

Slurry cement backfill for culverts must comply with section 19-3.02D.

15-6.01B(2) Contact Grout

Grout for contact grouting must comply with section 41-1.02 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, sand must comply with section 90-1.02C(3) and the grading 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

15-6.01B(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 C 869.

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 compressive strength under ASTM C 495 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.

15-6.01C Construction

15-6.01C(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 postrehabilitation 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.

15-6.01C(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.

15-6.01C(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.

15-6.01C(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.

15-6.01C(5) Rehabilitation

15-6.01C(5)(a) General

Place slurry cement backfill around the culvert and below the culvert invert as shown.

15-6.01C(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 before starting grouting you determine 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.

For each batch of grout, perform density and viscosity tests under ASTM C138 and ASTM C 939 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 C 939 unless otherwise authorized.

For pipeliners with a stiffness 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 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 pumps's maximum allowable pressure.

Install a grout pressure gage 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 gage to a saddle-type diaphragm seal to prevent clogging with grout.

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 the maximum pressure at the point of grout injection must be reduced, or staged grouting must be employed.

15-6.01C(6) 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 either of the following:

1. Quick-set epoxy mortar
2. High viscosity epoxy
3. Hydrophilic vulcanized expansive rubber strip
4. Manufacturer's recommended mix

15-6.01C(7) Postrehabilitation Inspection

Postrehabilitation inspection must comply with section 15-6.01C(3).

15-6.01D 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. Repairing
6. 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:

1. Due to your negligence. If you cause damage, you are responsible.
2. 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 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.

15-6.02 FILL CULVERT VOIDS

Reserved

15-6.03 CONTACT GROUTING

Reserved

15-6.04 CONCRETE INVERT PAVING

Reserved

15-6.05–15-6.09 RESERVED

15-6.10 PLASTIC PIPELINERS

Reserved

15-6.11 CURED-IN-PLACE PIPELINERS

Reserved

15-6.12 DEFORMED AND REFORMED PIPELINERS

Reserved

15-6.13 MACHINE SPIRAL WOUND PVC PIPELINERS

15-6.13A General

15-6.13A(1) Summary

Section 15-6.13 includes specifications for fixed diameter and expandable diameter PVC pipeliner that is machine spiral wound and installed directly into the culvert.

Restore openings.

15-6.13A(2) Submittals

Submit a certificate of compliance for each reel of PVC strip and include:

1. Name of manufacturer
2. Plant location
3. Date of manufacture and shift
4. Cell classification
5. Unit mass
6. Average pipeliner stiffness and profile type

15-6.13A(3) Quality Control and Assurance

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 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.

15-6.13B Machine Spiral Wound PVC Pipeliners, Fixed Diameter

Reserved

15-6.13C Machine Spiral Wound PVC Pipeliners, Expandable Diameter

Reserved

15-6.14 CEMENTITIOUS PIPELINERS

Reserved

15-6.15–15-6.20 RESERVED

DIVISION III GRADING

16 CLEARING AND GRUBBING

16-1.01 GENERAL

Section 16 includes specifications for clearing and grubbing.

Clearing and grubbing consists of removing objectionable material from within the highway, bridge construction areas, road approaches, material sites within the right-of-way, areas through which ditches and channels are to be excavated, and other specified areas.

Work specified in section 20-3.03B(4) must be completed before clearing and grubbing.

16-1.02 MATERIALS

Not Used

16-1.03 CONSTRUCTION

16-1.03A General

Clear and grub before performing earthwork in an area.

Do not injure standing trees, plants, and improvements shown to be protected.

Clear and grub construction areas on the job site where facilities are shown to be constructed, including highways, structures, road approaches, frontage roads, accessory roads and connections, streets, ramps, ditches, and channels.

Clear and grub to:

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. 5 feet outside of slope lines for ditches and channels with a bottom width of 12 feet or more
5. 2 feet outside of slope lines for ditches and channels with a bottom width of less than 12 feet

Clear and grub material sites and construction areas enclosed by interchange loops and ramps.

If the construction area includes an orchard, vineyard, or other cultivated area, clear and grub the entire right-of-way.

16-1.03B Clearing

Clear the area above original ground of all objectionable material including trees, vines, logs, upturned stumps, downed trees, plants, brush, grass, weeds, concrete, and masonry.

Cut tree branches that extend over the roadway and hang within 20 feet of finished grade. Cut off branches close to the trunk under section 20-1.03D. Cut other branches to give each tree a balanced appearance.

16-1.03C Grubbing

In embankment areas where the grading plane is less than 2 feet above original ground, grub to a depth necessary to remove all stumps, roots, buried logs, and other objectionable material.

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.

Remove trees, stumps, and roots completely where work includes:

1. Roadway excavation
2. Earthwork slope construction
3. Structure construction
4. Pile construction
5. Trench, ditch, or channel excavation
6. Removal of unsuitable material

16-1.03D Disposal of Materials

Unless the Contract includes a bid item for duff as specified in section 21-1.02C, dispose of objectionable materials resulting from clearing and grubbing activities. Do not leave objectionable material in or under embankments, including dikes.

You may reduce combustible material to chips with a maximum thickness of 1/2 inch. Spread chips in areas enclosed by interchange loops and ramps or between slope lines and right-of-way lines. Either bury or distribute uniformly by mixing with underlying soil to prevent combustion.

Accumulation of flammable material is not allowed.

16-1.04 PAYMENT

Not Used

17 WATERING

17-1 GENERAL

17-1.01 GENERAL

17-1.01A General

Section 17-1 includes general specifications for watering.

If an available source of water is described in the *Information Handout*, verify the quality and quantity of water.

If water becomes unavailable in the quantities needed for the work, the unavailability of water is a material shortage.

17-1.01B Submittals

For recycled water, submit a copy of the waste water discharge permit or waiver from the appropriate RWQCB for each water source before using the water in the work.

17-1.01C Quality Control and Assurance

For recycled water, meet the CDPH and the appropriate RWQCB requirements. File a report with the appropriate RWQCB.

17-1.02 MATERIALS

Water may be potable or nonpotable. Nonpotable water must be either recycled water or nonpotable water developed from other sources.

17-1.03 CONSTRUCTION

Not Used

17-1.04 PAYMENT

Not Used

17-2 DEVELOP WATER SUPPLY

17-2.01 GENERAL

17-2.01A Summary

Section 17-2 includes specifications for developing a water supply.

17-2.01B Submittals

Submit PLACs for developing a water supply system.

17-2.01C Quality Control and Assurance

Do not convey nonpotable water in tanks or drain pipes that will be used to convey potable water.

Label nonpotable water supply, tanks, pipes, and any other conveyances of nonpotable water as follows:

NONPOTABLE WATER

DO NOT DRINK

17-2.02 MATERIALS

Furnish pipelines or other necessary equipment to supply water for the work, including change order work.

Each water storage tank and distribution system must be equipped with positive shut-off valves.

17-2.03 CONSTRUCTION

Not Used

17-2.04 PAYMENT

Not Used

17-3 APPLY WATER

17-3.01 GENERAL

Section 17-3 includes specifications for applying water.

17-3.02 MATERIALS

Not Used

17-3.03 CONSTRUCTION

Apply water in the quantity, at the location, and for the purpose described or ordered.

For compacting embankment material, subbase, base, and surfacing material and for dust control, apply water with the appropriate equipment to ensure the uniform application of water.

You may use a chemical additive in water for compaction if authorized.

Unless all water is applied by means of pipelines or unless otherwise authorized, you must have at least 1 mobile unit available at all times. The unit must have a capacity of at least 1,000 gal.

17-3.04 PAYMENT

Not Used

18 DUST PALLIATIVE

18-1.01 GENERAL

Section 18 includes general specifications for controlling dust using binder or dust palliative.

Monitor air quality and provide dust control measures to limit dust below nuisance levels under section 14-9.

18-1.02 MATERIALS

Dust control binders or dust palliative must be either miscible in water or a material that is directly applied to the surface without mixing with water.

Binders that are miscible in water must be one of the following types:

1. Resin emulsion composed from 57 to 63 percent of semiliquid petroleum resin and the remainder composed of water to which a suitable emulsifying agent has been added. Resin emulsion must comply with the following:
   1.1. Resin emulsion must be readily miscible with water and when diluted with any hard water in the proportions of 1 part emulsion to 10 parts water must show no signs of breakdown or separation of the petroleum resin base.
   1.2. Resin emulsion that has been stored in closed containers at temperatures above freezing for a period up to 3 months must show no signs of separation.
   1.3. Resin emulsion that has been stored for more than 3 months must not be used until tested and authorized.
2. Asphaltic emulsion complying with the material specifications for asphaltic emulsions, Grade SS1.
3. Binder materials composed of lignin sulfonate.
4. Binder material that is noncorrosive, effective as a dust palliative, and miscible in water in the proportions specified in section 18-1.03C.

Binders that are directly applied to the surface without mixing with water must be a product prepared from crude petroleum that is effective as a dust palliative.

18-1.03 CONSTRUCTION

18-1.03A General

Monitor conditions and apply dust palliative for dust control as described and as ordered. Dust control may be required at any time.

18-1.03B Mixing

Mix binders that are miscible in water with additional water at a rate of 4 to 19 parts water to 1 part binder. The exact rate must be authorized. Accomplish mixing by placing the binder and water in the spreading equipment simultaneously or by another mixing method that produces equivalent results.

18-1.03C Application

Apply binders that are miscible in water with pressure type water distributor trucks equipped with a spray system or pressure type asphalt distributors that comply with mixing and application specifications in section 93. Apply material at an approximate rate of 0.2 to 0.8 gal/sq yd.

Apply binders that are directly applied to the surface without mixing with water using authorized equipment. Apply binder at a rate of 0.10 to 0.25 gal/sq yd.

18-1.04 PAYMENT

Dust palliative weight is measured before adding water.

The Department does not adjust the unit price for an increase or decrease in the binder (dust palliative) or dust palliative (stabilizing emulsion).

19 EARTHWORK

19-1 GENERAL

19-1.01 GENERAL

19-1.01A Summary

Section 19-1 includes general specifications for performing earthwork activities including:

1. Excavating
2. Excavating and replacing unsuitable material
3. Removing slides and slipouts
4. Preparing basement material
5. Constructing embankments and shoulder backing
6. Backfilling
7. Grading

Work specified in section 20-3.03B(4) must be completed before starting earthwork activities.

19-1.01B Definitions

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

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

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 into the work. Excessive moisture alone is not sufficient cause for determining that the material is unsuitable.
3. Inappropriate for planned use.

19-1.02 MATERIALS

Not Used

19-1.03 CONSTRUCTION

19-1.03A General

Unless otherwise specified in section 14-11, use material resulting from any excavation to construct embankments and dikes or you may use it to backfill structures. If the quantity of excavated material is not sufficient to construct embankments, obtain material under section 19-7.

Apply water under section 17-3.

19-1.03B Unsuitable Material

Excavate unsuitable material.

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 19-6.

19-1.03C Grade Tolerance

Immediately before placing subsequent layers of material, prepare the grading plane to comply with the following:

1. Where HMA is to be placed, the grading plane must not vary more than 0.05 foot above or below the grade established by the Engineer.
2. Where PCC base or pavement is to be placed, the grading plane must not extend above the grade established by the Engineer.

3. Where structure approach slabs or the thickened portion of sleeper slabs are to be placed, the grading plane for the embankments beneath must not extend above the grade established by the Engineer.
4. If material to be placed on the grading plane is paid by the cubic yard, the grading plane at any point must be within 0.05 foot above the grade established by the Engineer.
5. If subbase or base material to be placed on the grading plane is paid by the ton, the grading plane at any point must be within 0.10 foot above the grade established by the Engineer.

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 and disposal as change order work

19-1.03E Ditch Excavation

Excavate ditches including channels for changing the course of streams.

The excavation required to construct a ditch or channel with a bottom width less than 12 feet is classified as ditch excavation.

The excavation required to construct a ditch or channel with a bottom width 12 feet or more is classified as roadway excavation.

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.

19-1.04 PAYMENT

If removal of unsuitable material is described, removing unsuitable material is paid for as the type of excavation involved.

If removal of unsuitable material is not described, removing unsuitable material is paid for as the type of excavation involved, unless before removal activities, (1) removing the material is ordered as change order work or (2) you request the removal to be change order work.

If removal of a buried man-made object is described, payment for removing the object encountered in an excavation is included in the type of excavation involved.

If removal of a buried man-made object is not described, payment for removing a buried man-made object is included in the type of excavation involved, unless before removal activities, (1) removing the object is ordered as change order work or (2) you request the removal to be change order work.

The payment quantity for ditch excavation is determined based on average areas and the distances between them.

19-2 ROADWAY EXCAVATION

19-2.01 GENERAL

19-2.01A Summary

Section 19-2 includes specifications for excavating and grading to construct the roadway.

Comply with section 19-5.

Roadway excavation does not include structure excavation, ditch excavation, or other excavation work paid for as a separate item.

19-2.01B Definitions

selected material: Specific material excavated from a described location on the job site. Selected material includes top soil.

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 authorized material and compact.

Where a portion of the existing pavement is to be removed, cut the outline of the area to be removed on a neat line with a power-driven saw to a depth of at least 0.17 foot before removing surfacing.

Construct embankments under section 19-6.

19-2.03B Surplus Material

If a quantity of surplus material is described, 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, you must replace it with authorized material. The Department does not pay for replacing the material.

If an ordered change increases the quantity of excavation or decreases the quantity of embankment so 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 the Contract does not include a bid item for imported borrow, obtaining imported borrow is change order work.

19-2.03D Selected Material

Use selected material as described.

If not used for topsoil or any other specified layer, place 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. This work is paid for as the type of roadway excavation involved.

Selected material must remain in place until it can be placed in its final position as provided above. The Department does not pay for any delay or inconvenience in excavation operations.

If stockpiling of selected material is ordered, payment for excavating and stockpiling the material is included in the payment for the type of roadway excavation involved.

If stockpiling of selected material is ordered, removing selected material from stockpiles and placing it in its final position in the roadway prism is again paid for as roadway excavation of the type involved, except quantities are determined from measurements of the stockpile before removal.

The Department does not pay for stockpiling selected material unless stockpiling is ordered.

Topsoil placed along the tops of slopes as erosion control is not considered stockpiled material.

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. 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.

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 finished work resulting from a slide or slipout as ordered. Repair work is paid for at the bid price for the item of work involved unless authorized as change order work.

If a slide or slipout is caused by your activities or negligence, the Department does not pay for removing slide or slipout material and restoring 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, except if the excavation is in rock, any point on the completed slope must be within 2 feet of the planned slope.

No portion of the slope may 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 true and smooth. The Department does not pay for repairing slope damage caused by erosion regardless of amount or extent.

19-2.04 PAYMENT

The payment quantity for roadway excavation is determined based on average end areas and the distances between them.

Whenever changed conditions or nature of a particular operation make it impractical to determine quantities of roadway excavation based on average end areas, the Engineer computes the quantities of material excavated by a method best suited to obtain an accurate determination.

When quantities of roadway excavation are determined based on average end areas and center line 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, correction is made for curvature if the centerline radius is 1,000 feet or less.

The Department does not pay for an excavation in excess of the limits shown or authorized. If removal of a slide or a slipout is described, removing the failed material is paid for as the type of roadway excavation involved.

If removal of a slide or a slipout is not described, removing the failed material is paid for as the type of roadway excavation involved, unless before removal activities, (1) removing the material is ordered as change order work or (2) you request the removal to be change order work.

19-3 STRUCTURE EXCAVATION AND BACKFILL

19-3.01 GENERAL

19-3.01A General

19-3.01A(1) Summary

Section 19-3 includes specifications for performing structure excavation and backfill.

19-3.01A(2) Submittals

19-3.01A(2)(a) General

Reserved

19-3.01A(2)(b) Cofferdams

Submit shop drawings for cofferdam construction. Include construction methods and calculations in 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 60 days for review.

19-3.01A(2)(c) 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.

19-3.01A(2)(d) 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 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 ground water during construction

Shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer in the State.

Submit 5 sets of shop drawings for initial review. Allow 30 days for review.

Submit from 6 to 12 sets of final shop drawings as requested by the Engineer for final authorization.

19-3.01A(2)(e) Test Results

Submit test results of any stability testing performed for ground anchor walls and soil nail walls.

19-3.01A(3) Quality Control and Assurance

19-3.01A(3)(a) General

Reserved

19-3.01A(3)(b) Stability Test for Ground Anchor and Soil Nail Walls

If you use an excavation lift height greater than 5 feet or an exposure duration longer than 1 work shift, perform stability testing. Stability testing must be performed 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 a height as 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 specified 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. For ground anchor walls, a wall zone is the entire wall.

If the Engineer determines the exposed excavated face is not maintaining its integrity, you must stabilize the excavated face immediately 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 Structure Backfill

Structure backfill must be free of organic or other unsatisfactory material.

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 grading 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 grading 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)
Under 10	C, D, or E	1
10–25	D or E	2
Over 25	E	4

Backfill material type	Grading		Sand equivalent	Relative compaction
	Sieve size	Percentage passing		
C	3"	100	None	90% min
D	3"	100	30 min	90% min
	No. 4	35–100		
E	3"	100	None	90% min
	No. 4	25–70		
	No. 50	5–20		
	No. 200	0–5		

19-3.02C 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 grading requirements shown in the following table:

Sieve sizes	Percentage passing
2"	100
No. 50	0–100
No. 100	0–8
No. 200	0–4

Grading for sacked pervious backfill material behind wall drain outlets must comply with the grading specified for 1-1/2 x 3/4 inch primary aggregate in section 90-1.02C(4)(b).

19-3.02D Slurry Cement Backfill

Slurry cement backfill must be a fluid workable mixture of aggregate, cement, and water.

Cement must comply with section 90-1.02B(2) except testing is not required.

Water must be free from 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 grading 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

Proportion slurry cement backfill by weight or volume. Use at least 188 pounds of cement per cubic yard. Use sufficient 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 for pipe culverts.

19-3.02E Culvert Beddings

19-3.02E(1) General

Culvert beddings consist of shaped bedding, sand bedding, or soil cement bedding.

If more than one type of bedding is allowed, use the same bedding for the entire length of the culvert.

19-3.02E(2) Sand Beddings

Sand bedding must consist of sand:

1. Free from clay or organic material
2. Suitable for the purpose intended
3. Complying with the grading requirements shown in the following table:

Sieve sizes	Percentage passing
No. 4	90–100
No. 200	0–5

19-3.02E(3) Soil Cement Beddings

Material and mixing requirements for soil cement bedding must comply with the specifications for slurry cement backfill in section 19-3.02D except:

1. Use at least 282 pounds of cement per cubic yard
2. Do not use commercial-quality concrete sand as aggregate

19-3.02F Controlled Low-Strength Material

You may request to use controlled low-strength material as structure backfill for pipe culverts except when pipe culverts have a diameter or span more than 20 feet.

Controlled low-strength material must be a fluid workable mixture of aggregate, cement, and water.

Cement must comply with one of the following:

1. ASTM C 150
2. Blended hydraulic cement complying with either of the following:
   2.1. ASTM C 595
   2.2. Physical requirements in ASTM C 1157

If you propose using controlled low-strength material, submit a mix design including test data before excavating the trench where controlled low-strength material is to be used. When tested under ASTM D 4832, the 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. At least 100 psi for pipe culverts with over 20 feet in height of cover

Water must be free from 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 grading 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

19-3.02G Concrete Backfill

Concrete backfill encasing steel soldier piles below the lagging must comply with section 90 and contain at least 505 pounds of cementitious material per cubic yard.

19-3.02H Lean Concrete Backfill

Lean concrete backfill must comply with the specifications for slurry cement backfill in section 19-3.02D except aggregate must be commercial-quality concrete sand.

19-3.03 CONSTRUCTION

19-3.03A General

Reserved

19-3.03B Structure Excavation

19-3.03B(1) General

Structure excavation includes:

1. Excavating foundations for structures, including trenches for culverts, pipes, rods, deadmen, cutoff walls, and other facilities
2. Control and removal of water
3. 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.

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.

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

19-3.03C Cofferdams

Cofferdams for foundation construction must be (1) carried below the bottom of footings and (2) braced and as watertight as practicable. Interior dimensions of cofferdams must provide sufficient space inside wales for form construction and pile driving and allow pumping of water from outside foundation forms.

You may construct the cofferdam large enough to provide clearance to perform the work. The Department does not pay for the increase in quantities greater than 1 foot outside the footing dimensions.

Cofferdams tilted or moved out of position during sinking must be righted or enlarged 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.

No shoring is allowed in cofferdams that would induce stress, shock, or vibration in the permanent structure.

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 concrete of the type specified for the surrounding concrete.

Remove cofferdams with all sheeting and bracing to at least 2 feet below the streambed after completing substructure construction. Do not disturb or mar the finished concrete or masonry.

19-3.03D 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 choose a seal course, (1) the 3rd paragraph of section 51-1.03D(3), does not apply for spread footings and (2) section 51-1.03D(3) does not apply for pile footings.

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, comply with the following:

1. Perform excavation without disturbing foundation material. Dewater the excavation if ground water is encountered and no seal course is used. Continue dewatering activities before or 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. For culverts, use Class 2 aggregate base that complies with section 26 to replace

damaged or removed foundation material. Compact Class 2 aggregate 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 as ordered. Corrective work is change order work.

When footing concrete or masonry is placed on rock, the rock must be fully uncovered and the surface removed to sound rock. Rock must be leveled or cut to steps and then roughened.

Pressure grout or treat seams in rock as ordered. This work is change order work.

Except for arch culverts, if you encounter solid rock or other unyielding material when excavating for a culvert at the elevation of the culvert bottom, remove the material below the bottom of the culvert to a depth of 1/24 the height of embankment above the top of culvert. This removal must be a minimum of 1 foot to a maximum of 5 feet. 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, complete excavation to the bottom of footings before driving or drilling 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.

19-3.03E 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 except when compaction is done by ponding and jetting, the thickness must be at most 4 feet.

Do not use compaction equipment or methods that may cause excessive displacement or damage structures.

Do not place structure backfill until footings or other portions 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 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 impounded. 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

Where ordered, place a compacted impervious backfill material instead of structure backfill at the following locations:

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

For the impervious backfill material, use an authorized earthy material. The sand equivalent requirement does not apply.

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 soil free of organic matter, trash, or other unsatisfactory material
3. Must be placed to the level of original ground or finished grade shown

If you excavate outside the designated pay limits, material placed in those excavation areas must comply with the material and compaction requirements of the adjacent structure backfill.

If the Contract includes an item for imported borrow, you may use imported borrow as structure backfill if it complies with the specifications for structure backfill. No deduction is made in the quantity of imported borrow paid if you provide replacement material for imported borrow placed as structure backfill.

Material from structure excavation not suitable for use as structure backfill may be used to replace imported borrow or other excavated material.

Material from structure excavation not used as structure backfill must be placed in roadway embankments under section 19-6 or disposed of under section 19-2.03B.

19-3.03E(2) Crib Walls

Backfill cells formed by crib members and the space between crib walls and limits for structure excavation. Include space from material removed outside excavation limits.

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 means.

19-3.03E(3) Soldier Pile Walls

Compact structure backfill behind lagging of soldier pile walls by hand tamping or mechanical compaction.

In fill areas behind the lagging, key structure backfill into the existing or excavated back slope.

Place and compact 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 drilled, stressed, and grouted.

19-3.03F Slurry Cement Backfill

Place slurry cement backfill within 1 hour of mixing. Place in a uniform manner without voids or segregation. Place in a manner that does not float or shift culverts. Remove foreign material that falls into trenches.

Do not backfill over or place material over slurry cement backfill until 4 hours after placement. Unless 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 so 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 or (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 embankment placed before excavating for culvert pipe. Where

necessary, compact earth plugs at each end of the pipe before placing 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 any one location must have approximately the same grading. Cover pervious backfill material at locations exposed to erosion with a 1-foot layer of authorized earthen material.

Where shown, you may use the *Weep Hole and Geocomposite Drain* alternative instead of pervious backfill material. The alternative must comply with section 68-7.

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 culvert backfill material. Shape beds using a template conforming to the outside shape of the culvert that is guided by headers set parallel to the culvert grade. Headers may be left in place.

Place soil cement bedding as specified in section 19-3.03F, except do not backfill over soil cement bedding until 8 hours after placing bedding.

19-3.03I Controlled Low-Strength Material

If a controlled low-strength material l is used as structure backfill, the excavation width may be reduced so 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 20 feet or less in height of cover or with 42 inches or less of diameter or span or (2) 1 foot for pipe culverts with over 20 feet in height of cover or over 42 inches in diameter or span.

Mix materials thoroughly by machine. Use a pugmill, rotary drum, or other authorized mixer. Mix until cement and water are thoroughly dispersed.

Place controlled low-strength material for that portion of structure backfill (1) below the original ground or grading plane or (2) below the top of embankment that is placed before excavating for the pipe. Compact earth plugs at each end of the pipe culvert before placing 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 permeable drainage layer. Where a drainage layer does not exist, place the material no higher than 1 inch below the bottom of the existing AC surfacing or no higher than the top of the base below existing PCC 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 0.5 times the pipe culvert height.

For flexible pipe culverts, the minimum height of controlled low-strength material must be 0.7 times the pipe culvert diameter or 0.7 times the pipe culvert height.

Whenever 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 as determined under ASTM D 6024 before covering and opening to traffic.

19-3.03J Soldier Pile Walls

Where necessary, remove lean concrete backfill from drilled holes and in front of pile flanges to install lagging.

19-3.03K Ground Anchor and Soil Nail Walls

Excavate in lifts from the top down.

Before you excavate for the installation of production or proof test soil nails in a wall zone:

1. Complete stability testing

2. Complete verification testing
3. Obtain authorization of test data

Clean the excavated face of loose materials, mud, rebound, and other materials that prevent or reduce shotcrete bond to the excavated face and soil nails.

Remove cobbles, boulders, portions of boulders, or debris at the final wall alignment that protrude more than 2 inches from the excavated face. Backfill the over excavation with shotcrete.

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.

Stabilize unstable areas immediately by buttressing the excavated face with an earth berm or other authorized methods. Stop construction in unstable areas until remedial measures are authorized.

Protect installed soil nails and ground anchors during construction. Replace damaged soil nails and ground anchors.

Do not excavate to the next underlying excavation lift until the following conditions have been attained for the portion of the wall in the current excavation lift:

1. Soil nails or ground anchors are installed and grouted
2. Reinforced shotcrete facing is constructed
3. Soil nail grout and shotcrete facing have cured for 72 hours
4. The soil nail facing anchorages are attached
5. Representative soil nail tests are complete for that portion of wall and the results are authorized

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 pay for:

1. Removal of material coming into an excavation from outside the described limits
2. Removal of material resulting from heave caused by the driving of piles in an excavation
3. Volume of backfill occupied by the new structure
4. Furnishing and placing backfill material in an excavation that is below or outside the described limits

Unless otherwise shown, quantities for structure excavation and backfill for structures other than culverts are computed as follows:

1. Horizontal limits are vertical planes 1 foot outside neat lines of footings or structures without footings.
2. Upper limit for structure excavation is the ground surface before starting construction activities. Where structure excavation is performed within roadway excavation or 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. In no case is the upper limit above the plane of the new embankment.
3. The upper limit for structure backfill is the finished grading plane or the finished slope lines. If the Engineer authorizes a higher limit, the limit for payment is the authorized higher limit.
4. The lower limit is a plane at the bottom of the completed footings or structures or the lower outside surface of rods or deadmen.

If the Engineer authorizes an increase in depth or width of structure excavation for structures except culverts, excavation to a depth of 2 feet below and for a width up to 3 times the outside width of the footing is paid for at the bid price for structure excavation. Excavation to greater depths or widths is paid for at the contract price for structure excavation unless before removal activities, (1) the Engineer authorizes this excavation to be paid for as change order work or (2) you request this excavation be paid

as change order work. Payment for structure backfill is similarly increased and paid for at the bid price for structure backfill.

Where a seal course is shown, structure excavation for footings is measured as structure excavation (Type A). If the depth of the structure excavation is reduced due to a reduction or elimination of the seal course, no decrease in the quantity of structure excavation (Type A) is made.

The volume of pervious backfill material within the limits of structure backfill is deducted from the quantities of structure backfill.

Structure excavation or structure backfill for bridges not designated by type is paid as structure excavation (bridge) and structure backfill (bridge).

The actual depth of structure excavation for culverts is the vertical distance between the ground line before excavating and the bottom of the culvert trench. If the structure excavation depth is more than 0.5 foot from the depth shown and an adjustment is requested or ordered, the Department makes a payment adjustment under section 4-1.05B. Increased depth due to unsuitable material, rock, other unyielding material below the planned grade is not considered in determining the depth of structure excavation for culverts.

Where compaction is not required, payment for structure backfill is included in payment for the type of structure excavation involved.

Payment for shotcrete used on ground anchor and soil nail walls to fill voids created by the removal of cobbles and boulders or other obstructions is included in the payment for shotcrete.

19-4 RESERVED

19-5 COMPACTION

19-5.01 GENERAL

19-5.01A Summary

Section 19-5 includes specifications for obtaining required compaction for 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 excavation or embankment.

The moisture content of material to be compacted to at least 95 percent must be such that the specified relative compaction is obtained 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)

Obtain 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.

Obtain a relative compaction of at least 95 percent for embankments under retaining wall footings without pile foundations:

1. For the full depth

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)

Obtain 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.

If you elect to excavate and replace basement material to facilitate compaction, before replacement begins and if ordered, compact a layer below the excavated material to the 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, then the replaced material is paid for at the bid price for the type of excavation or imported borrow involved.

19-6 EMBANKMENT CONSTRUCTION

19-6.01 GENERAL

Section 19-6 includes specifications for constructing embankments.

Embankment construction 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 on or off the job site

19-6.02 MATERIALS

19-6.02A General

Use material from excavations or from local or imported borrow.

In embankment areas where piles are to be placed or driven, do not use material containing rocks, broken concrete, or other solid materials larger than 4 inches in greatest dimension.

Whenever selection of material is possible, do not place borrow or excavation material having a sand equivalent value less than 10 within 2.5 feet of finished grade. Use this material to construct the lower portions of embankments.

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

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

Backfill must comply with the requirements in the following 2 tables:

Sieve size	Percent passing
1-1/2"	100
3/4"	75–100
No. 4	20–100
No. 40	0–60
No. 200	0–50

Property	Requirement	California Test
Plasticity index	20 max	204
pH	5–9	643

The Engineer may authorize the use of backfill with grading larger than the specified size up to a 4 inches maximum if you submit, with your LTDS calculations, test results for installation damage reduction factors for each type of geosynthetic reinforcement under FHWA-NHI-00-044, section 5.1.

19-6.03 CONSTRUCTION

19-6.03A General

Compact embankment under section 19-5.

Construct embankment slopes under section 19-2.03G.

When constructing an embankment on an existing roadway, scarify, water, grade, and roll the existing roadbed before placing new material.

When constructing an embankment against an existing slope or when constructing 1/2 the embankment width at a time, prepare the slope 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. If ordered to cut more than 6 feet, the excavated material in excess of 6 feet is paid for as roadway excavation.

For bridge footings to be constructed in 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

Reserved

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, except if material, such as hardpan or cemented gravel, cannot be broken readily:

1. Distribute 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 the following percentages by volume of rock larger than 8 inches in greatest dimension, before compaction, the loose thickness of each layer of embankment material below a plane 3 feet below finished grade must comply with the following table:

Percent by volume	Loose layer thickness
Over 50	Max. rock size
From 25 to 50	Max. rock size up to 3 feet
Less than 25	8 inches in areas between 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 embankment against existing slopes or 1/2 the embankment width at a time, then plow or cut the slopes of the original ground or embankment before end dumping starts.

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 equipment for placing subsequent layers.

Construct embankments such that each layer has a cross fall less than 5 percent.

At locations where it is impractical to use mobile power compacting equipment, compact embankment layers by any method that obtains the specified compaction.

19-6.03D Settlement Periods and Surcharges

Where 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 surcharge in uniform layers to the described height and limits. Compact the full width of the surcharge by routing the grading equipment.

Retain embankment and any specified surcharge from encroaching upon the traveled way or existing improvements.

The settlement period starts after the embankment and any specified surcharge 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 foundation piles or drill holes for CIP piles

If an ordered settlement period increases or decreases the Contract completion time, the Department makes a time adjustment.

Following removal of surcharge material above the grading plane and before placing subsequent layers of subbase or base, the embankment below the grading plane must comply with section 19-5.

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 layers of geosynthetic reinforcement, unless otherwise 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 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 geosynthetic reinforcement with backfill within the same work shift.

Place at least 6 inches of backfill on the geosynthetic reinforcement before operating or driving equipment or vehicles over it, except those used under the conditions specified below for spreading backfill.

You may drive equipment or vehicles for spreading backfill directly on the geosynthetic reinforcement if you:

1. Comply with manufacturer's instructions
2. Use rubber-tire vehicles
3. Minimize traffic repetitions
4. Maintain speed less than 5 mph
5. Avoid sudden braking and sharp turning

Where guard railing posts will be placed at the top crest of the geosynthetic reinforced embankment and the geosynthetic reinforcement interferes with placement of posts, you may precut affected layers of reinforcement into cross-shaped patterns. The precutting dimensions must not exceed post dimensions by more than 12 inches.

Do not extend geosynthetic reinforcement into the pavement structure.

Replace or repair any geogrid reinforcement damaged during construction. Repair by placing additional reinforcement to cover the damaged area and:

1. For reinforcement placed parallel to slope contours, overlapping 5 aperture openings or 8 inches whichever is greater
2. For reinforcement placed perpendicular to slope contours, splicing the edges as instructed by the manufacturer

Replace any geotextile reinforcement damaged during construction.

Grade and compact backfill to ensure the reinforcement remains taut.

Compact backfill under section 19-5.03C. 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

Removing surcharge material is paid for as roadway excavation.

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.

19-7.01B Definitions

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.

imported borrow: Material obtained from sources that comply with section 6-2.04 or from any other source you choose.

19-7.01C Submittals

Submit PLACs for each imported borrow site.

19-7.01D Quality Control and Assurance

Notify the Engineer sufficiently in advance of opening any imported borrow material site so that cross-section elevations and measurements of the ground surface after stripping may be taken and the material may be tested.

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. Portland cement 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. You are responsible for disposing of surplus material.

19-7.04 PAYMENT

Local borrow is paid for as roadway excavation.

The payment quantity of imported borrow is determined based on average areas and the distances between them.

Areas and distances are based on those from the material site before and after the imported borrow is excavated.

The Department does not pay for imported borrow that is not used in the work.

The Department does not pay for disposal of surplus imported borrow.

19-8 SUBGRADE ENHANCEMENT GEOTEXTILE

19-8.01 GENERAL

Section 19-8 includes specifications for placing subgrade enhancement geotextile between the subgrade and pavement structure.

19-8.02 MATERIALS

Subgrade enhancement geotextile must comply with section 88-1.02O.

19-8.03 CONSTRUCTION

Before placing subgrade enhancement geotextile, remove loose or extraneous material and sharp objects that may come in contact with the geotextile material.

Place subgrade enhancement geotextile:

1. Under manufacturer's instructions
2. Longitudinally along the roadway alignment
3. Without wrinkles

Do not use a polyester-type geotextile within 4 inches of recycled concrete.

Overlap adjacent edges of rolls at least 2 feet. Overlap the ends of rolls at least 2 feet in the direction you spread the material covering the geotextile.

You may fold or cut subgrade enhancement geotextile to conform to curves. If cut, overlap at least 1-1/2 feet. Hold the overlap in place with staples, pins, or small piles of material placed on the geotextile.

Do not:

1. Stockpile material on the geotextile
2. Operate equipment or vehicles directly on the geotextile
3. Place more geotextile than can be covered in 72 hours
4. Compact with a sheepsfoot or other non–smooth roller
5. Turn vehicles on material placed directly over geotextile

Before operating equipment on areas where geotextile has been placed, spread and compact 6 inches of material on the geotextile. Compact it with either (1) a smooth-wheeled roller with no vibrations or (2) a rubber-tired roller.

Repair or replace damaged subgrade enhancement geotextile. Make repairs by placing a new piece of geotextile with at least 3 feet of overlap from the edges of the damaged area.

19-8.04 PAYMENT

The Department does not pay for additional geotextile used for overlaps.

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. Reclaimed processed asphalt concrete, PCC, LCB, or CTB

Shoulder backing may be 100 percent reclaimed asphalt concrete.

Shoulder backing must comply with the grading requirements for the sieve sizes shown in the following table:

Sieve sizes	Percentage passing
2"	100
1"	75–100
3/4"	65–100
No. 4	35–60
No. 30	10–35
No. 200	5–15

Whenever 100 percent reclaimed asphalt concrete is used, shoulder backing must comply with the grading requirements for the sieve sizes shown in the following table:

Sieve sizes	Percentage passing
1-1/2"	100
3/4"	70–100
No. 4	30–80

Sand equivalent for shoulder backing must be from 10 to 35 except whenever 100 percent reclaimed asphalt concrete is used, the sand equivalent must be 10 minimum.

If a combination of broken stone, crushed gravel, natural rough surfaced gravel, and sand is used, shoulder backing must comply with the quality requirements shown in the following table:

Property	California Test	Requirements
Sand equivalent	217	10–30
Percentage crushed particles (%, min) [a]	205	
One fractured face		75
Two fractured faces		50
Durability index	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.

19-9.03 CONSTRUCTION

Shoulder backing placed within 100 feet measured horizontally from a culvert, watercourse, or bridge must not contain reclaimed asphalt concrete.

Remove weeds, grass, and debris from the area to receive shoulder backing.

Scarify basement material to receive shoulder backing at least 0.25 foot deep and water immediately before placing shoulder backing.

Place and spread shoulder backing directly on the basement material. After placement, water shoulder backing and compact with a minimum of 2 passes with a steel tired roller weighing not less than 8 tons. Wherever the total thickness of shoulder backing is more than 6 inches, place shoulder backing under section 19-5 and section 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.

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

20 LANDSCAPE

20-1 GENERAL

20-1.01 GENERAL

20-1.01A Summary

Section 20-1 includes general specifications for performing landscaping.

Wherever work requires removing materials, the work includes disposing of the materials unless incorporating the materials into the final work is described.

Immediately before performing any construction activity, remove weeds, trash and debris within the construction area.

20-1.01B Definitions

killing weeds: Killing weeds by hand, by the use of pesticides, or by other authorized methods.

mowing weeds: Mowing weeds by mower, string trimmer, sickle, or other authorized methods.

pesticides: Any substance or mixture of substances intended for preventing, repelling, mitigating or destroying weeds, insects, diseases, rodents, or nematodes and any substance or mixture of substances intended for use as a plant regulator, defoliant or desiccant. This includes herbicides, insecticides, fungicides, rodenticides, germicides, nematocides, bactericides, inhibitors, fumigants, defoliants, desiccants, soil sterilants, surfactants, and repellents.

20-1.01C Submittals

20-1.01C(1) General

At least 15 days before using any pesticide, submit a copy of the licensed pest control adviser's recommendation. The recommendation must be authorized before using any pesticides.

At the end of each week, submit a report documenting the application of all pesticides as an informational submittal. Use forms furnished by the Department.

20-1.01C(2) Notification

Notify the Engineer:

1. At least 72 hours before requiring initial access to the existing irrigation controllers.
2. At least 10 days before the shipment date when plants are to be shipped to the job site.
3. Of the location where cuttings are to be taken at least 10 days before taking *Carpobrotus* and *Delosperma* cuttings. If cuttings are taken from the highway no notification is required.
4. At least 15 days before gathering willow cuttings.
5. At least 24 hours before each application of pesticide and indicate the hours of application.
6. At least 4 business days before the completion of work for each stage of an area as part of the progress inspections.

20-1.01C(3) Quality Control and Assurance

20-1.01C(3)(a) General

Obtain permits and pay the inspection fees involved in obtaining willow cuttings.

20-1.01C(3)(b) Pesticides

Comply with all rules and regulations of the Department of Food and Agriculture, Department of Public Health, Department of Industrial Relations, and all other agencies that govern the use of pesticides. Unless prohibited by the County Agricultural Commissioner, pesticides may be used for highway planting work. Obtain a licensed pest control adviser's recommendations for the use of all pesticides under Food & Agri Code. The recommendation must include the pesticides to be used, rates of application, methods of application and application areas.

20-1.02 MATERIALS

20-1.02A Water

Water must be of a quality that will promote germination of seeds and growth of plants.

20-1.02B Pesticides

If requested, other pesticides may be submitted for use.

Do not use oil or pelleted forms of pesticides for weed control.

20-1.03 CONSTRUCTION

20-1.03A Progress Inspections

Progress inspections are performed by the Engineer for completed highway planting and irrigation system work at designated stages during the Contract.

Inspections are performed at the following stages of work:

1. During pressure testing of pipelines on the supply side of control valves
2. During testing of low voltage conductors
3. Before planting begins and after completion of work specified in section 20-7.03C
4. Before plant establishment work begins and after work specified in section 20-7.03I
5. Once a month during the plant establishment period

Do not progress beyond each stage of work until the inspection has been completed, corrective work has been performed and the work is accepted, unless otherwise authorized.

Allow at least 3 working days for the inspection.

20-1.03B Pesticides

Do not apply pesticides:

1. On Saturdays or holidays unless authorized
2. Whenever weather and wind conditions are unsuitable for application
3. Within the limits of the plant basins, except for transplant tree and transplant palm tree plant basins
4. So that the pesticides come in contact with the foliage and woody parts of the plant

Before mixing a pesticide, submit a copy of the registered label for the pesticide as an informational submittal. If unavailable to copy, allow the Engineer to read the label on the container.

Mix pesticides according to the instructions on the registered label.

Apply pesticides according to the instructions on the registered label.

Apply pesticides for weed control with a photosensitive dye that produces a contrasting color when sprayed on the ground. The color must disappear between 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.

Kill stolon-type weeds with glyphosate.

20-1.03C Watering

Water available from an existing Department-owned facility within the project limits or an irrigation system to be installed under the Contract is furnished at no charge. If water is not available, make arrangements for furnishing and applying water.

If fluctuations of water pressure, water supply or both are encountered during normal working hours, plants must be watered at other times, as often, and in sufficient amounts as conditions may require.

Water new plants and existing plants to be maintained as needed to keep the plants in a healthy growing condition until Contract acceptance.

The remote control valve master, ball valve, or gate valve on the discharge side of backflow preventers must be closed when the irrigation system is not in use.

Take precautions to prevent water from wetting vehicles, pedestrians, and pavement. Do not cause erosion of the soil.

20-1.03D Pruning

Pruning includes removing deadwood, suckers, and broken or bruised branches 1 inch or larger in diameter.

Prune plants under the latest edition of ANSI A300 part 1, *Pruning*, published by the Tree Care Industry Association.

Do not use tree seal compounds to cover pruning cuts.

Dispose of pruned materials.

20-1.04 PAYMENT

Not Used

20-2 EXISTING HIGHWAY PLANTING

20-2.01 GENERAL

20-2.01A Summary

Section 20-2 includes specifications for performing existing highway planting, including transplant tree, transplant palm tree and maintain existing planted areas.

20-2.01B Submittals

Submit the following:

1. A work plan that describes removing, transporting, storing, planting, guying, and maintaining the transplanted trees. Include root ball size, method of root ball containment, and a maintenance program for each tree to be transplanted.
2. A copy of the root stimulant manufacturer's product sheet and instructions for the application of the root stimulant.

20-2.02 MATERIALS

20-2.02A Packet Fertilizer for Transplant Tree and Transplant Palm Tree

Comply with the specifications for packet fertilizer under section 20-7.02D(1)(c).

20-2.02B Root Stimulant for Transplant Tree and Transplant Palm Tree

Reserved

20-2.02C Backfill Material for Transplant Palm Tree

Backfill material for the transplant palm tree planting holes must be 100 percent washed plaster sand.

20-2.03 CONSTRUCTION

20-2.03A Transplant Tree and Transplant Palm Tree

20-2.03A(1) General

Remove and transplant or store the trees to be transplanted before performing work within the areas where the existing trees to be transplanted are located.

Transplant trees on the same day the trees are removed. If the transplant locations are not ready to receive the trees, store and maintain the trees to be transplanted until the transplant locations are authorized. Store the trees upright.

Saturate the area around each tree with water before transplanting.

Backfill holes resulting from the removal of the transplanted trees the same day the trees are removed. You may use soil from the surrounding area to backfill. Mound the backfill in the plant basin slightly above the surrounding ground level. Grade the backfill to conform with the adjacent existing grade.

Cover exposed root balls with wet burlap or canvas and crown with 90 percent shade cloth until planted.

Do not drag trees. The use of chains is not allowed.

Do not lay trees on the ground. Trees are to remain upright.

Protect tree trunks from injury.

Apply root stimulant according to the manufacturer's instructions.

Saturate the planting holes before transplanting trees.

Place packet fertilizer at the time of planting at the rate shown.

After the planting holes have been backfilled, apply water to the full depth of the backfill soil.

If the backfill material settles below the required level after planting and watering, add additional backfill to bring the backfill to the required level after planting.

Construct a watering basin around each transplanted tree as shown.

20-2.03A(2) Transplant Tree

Prune trees to be transplanted immediately before removing.

20-2.03A(3) Transplant Palm Tree

Transplant palm trees between March 15 and October 15.

Before transplanting a palm tree, remove 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 manner that will not injure the trunk. Remove fronds and frond stubs for *Phoenix dactylifera* (Date Palm) approximately 4 inches from the trunk.

20-2.03B Replacement

20-2.03B(1) General

Comply with section 20-7.03I(16) for the replacement of damaged transplanted trees.

Dispose of damaged transplanted trees.

20-2.03B(2) Transplant Tree

The replacement trees must be planted in individual plant holes at the locations determined by the Engineer within the area of the tree being replaced.

Comply with section 20-7 for the planting of the replacement trees.

20-2.03B(3) Transplant Palm Tree

Palm tree replacement planting must comply with the work plan and be planted in the same planting hole.

20-2.03C Maintain Transplant Tree and Transplant Palm Tree

Kill weeds within the basin, including the basin walls. If pesticides are used to kill weeds, weeds must be killed before the weeds reach the seed stage of growth or exceed 4 inches in length, whichever occurs first. If weeds are to be killed by hand pulling, weeds must be hand pulled before the weeds reach the seed stage of growth or exceed 4 inches in length, whichever occurs first. Dispose of hand pulled weeds the same day they are pulled. Comply with section 20-1.02B.

20-2.03D Maintain Existing Planted Areas

Maintain existing planted areas as shown.

Maintain existing planted areas must be maintained from the 1st working day through Contract acceptance.

Existing plants to be maintained must comply with section 20-1.03C.

Inspect for deficiencies with the Engineer present. Complete the inspection within 15 days after the start of work.

Deficiencies requiring corrective action include:

1. Weeds

2. Dead, diseased, or unhealthy plants
3. Missing plant stakes and tree ties
4. Inadequate plant basins and basin mulch
5. Other deficiencies needing corrective action to promote healthy plant life
6. Rodents and pests

Correct deficiencies as ordered within 15 days of the order. Correction of deficiencies is change order work.

20-2.04 PAYMENT

Not Used

20-3 IRRIGATION

20-3.01 GENERAL

20-3.01A Summary

Section 20-3 includes specifications for (1) maintaining existing irrigation facilities, (2) installing or modifying manual and automatic irrigation systems, and (3) disposing of removed material.

20-3.01B Definitions

irrigation crossover: Irrigation crossover includes conduit, sprinkler control crossover, water line crossover and appurtenances.

sprinkler control crossover: Sprinkler control crossover is electrical conduit for control and neutral conductors installed in a larger conduit that is used as an irrigation crossover under a roadway or other facility.

water line crossover: Water line crossover is plastic pipe supply line installed in conduit.

20-3.01C Submittals

20-3.01C(1) General

Reserved

20-3.01C(2) Product Data

Submit the manufacturer's descriptive and technical literature for all materials.

20-3.01C(3) Control and Neutral Conductors Schedule of Values

Reserved

20-3.01C(4) Wiring Plans and Diagrams

Submit shop drawings for the electrical components of the irrigation system except electrical service. The drawings must:

1. Show wire and conduit sizes and the wire routes between electrical components
2. Bear the written approval of the controller manufacturer or the manufacturer's authorized agent

Before Contract acceptance, submit 3 copies of the as-built schematic wiring diagram, including any wiring modifications, for each type of 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 inches reduced irrigation plan showing the equipment controlled by the controller including the installed locations and station numbers for each remote control valve.

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.

Submit wire samples with colors to be used and a splice sample.

20-3.01C(5) Manufacturer's Instructions

Five business days before starting installation, submit the manufacturer's written instructions for the following items:

1. Couplings for conduits used for irrigation crossovers
2. Plastic pipe and fittings
3. Solvent cement for plastic pipe and flexible hose
4. Sprinklers Type D
5. Flow sensors

20-3.01C(6) Certificate of Compliance

Submit a certificate of compliance for (1) polyethylene pipe and (2) plastic pipe supply line for pipe with wall thickness of the bell less than the specified minimum wall thickness of the pipe.

20-3.01C(7) Notifications

Notify the Engineer:

1. At least 4 business days before shutting off the water supply to any portion of the existing irrigation system. Notify the Engineer immediately after restoring the water supply to any portion of the existing irrigation system.
2. At least 5 business days before testing backflow preventers.
3. At least 24 hours before performing any pressure tests.
4. At least 5 business days before performing any functional tests.

20-3.01C(8) Maintenance and Operations Manuals

Submit as an informational submittal a complete manufacturer’s maintenance and operations manual for each type of controller installed. Submit the manual at the time the wiring plans and diagrams are placed inside the controller enclosure or cabinet door.

20-3.01D Quality Control and Quality Assurance

20-3.01D(1) Certify Backflow Preventers

All backflow preventers must be certified by a backflow preventer tester with a valid certification from the local governing authority.

The local governing authority must be the county, city, or water purveyor having the governing authority over testing of backflow preventers involved. If the local governing authority does not have a certification program, the tester must be certified by AWWA or a county that has a certification program.

All backflow preventers must be recertified every year until Contract acceptance. An additional certification must be done 10 days before Contract acceptance.

20-3.01D(2) Plastic Pipe Irrigation Lines

Reserved

20-3.02 MATERIALS

20-3.02A General

Electrical material and equipment must comply with section 86-1.02.

20-3.02B Backflow Prevention Devices and Appurtenances

20-3.02B(1) Atmospheric Vacuum Breaker

Atmospheric vacuum breakers must have a brass or bronze body, silicone float disc, and a plastic float.

20-3.02B(2) Backflow Preventer Assemblies

Backflow preventer assemblies include backflow preventer, wye strainer, fittings, supports, concrete thrust blocks, and pad as described.

Backflow preventer must be a reduced-pressure principle type and comply with the requirements of the water utility company or water district that has jurisdiction over the job site.

Backflow preventers must be factory assembled and have 2 check valves, 1 pressure differential relief valve, 2 shut-off valves, and 4 test cocks. Backflow preventers and valves must be the same size as the pipeline where they are installed.

Shut-off valves must be manufactured from iron or bronze and be either (1) resilient wedge gate valves, (2) resilient seated and fully ported ball valves, or (3) resilient seated butterfly valves. Provide unions as shown. Unions must be brass or malleable iron.

Backflow preventer assembly components must be capable of withstanding a cold-water working pressure of 150 psi.

Gate valves attached to the outlets of the wye strainer must be:

1. Threaded
2. Brass or bronze body
3. Stem and wedge type
4. Same size as the outlet
5. Modified so that attachments cannot be made to the outlet valves

The seating rings on the discharge side of the gate valves must be Teflon. Valve wedges must be driven obliquely by cam action into the seating rings.

20-3.02B(3) Backflow Preventer Assembly Blanket

Backflow preventer assembly blanket must:

1. Be polyester fabric that is coated with vinyl or polymeric resin
2. Be resistant to UV, water, mildew, and flames
3. Have an R-value from R-30 to R-38
4. Be green as authorized

Blankets must have a securing mechanism that includes either zippers, velcro, 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. The padlock is furnished by the Engineer.

20-3.02B(4) Backflow Preventer Assembly Enclosures

Fabricate enclosures using structural steel angles and flattened expanded metal. The enclosure must comply with the following:

1. Expanded metal sides, ends, and top panels must be fabricated from 9-gauge minimum thickness sheet steel. The flattened expanded metal openings must be approximately 3/4 by 1-3/4 inches.
2. Expanded metal panels must be attached to the 3/16-inch thick steel frames by a series of welds that are not less than 1/4 inch in length, spaced not more than 4 inches on center along the edges of the enclosure.
3. Lock guards must be cold rolled steel with a minimum thickness of 3/16 inch.
4. Galvanize the enclosure after fabrication under section 75-1.05.
5. Hold-down bolt assemblies must be galvanized. Nuts must be hexagonal and washers must be lock type.
6. Enclosure must be painted by the manufacturer with 1 application of pretreatment, vinyl wash primer and a minimum of 1 application of exterior enamel for metal. The color must match no. 20450 of FED-STD-595.

The padlock is furnished by the Engineer.

20-3.02C Booster Pump

Booster pump must comply with section 74-4.

20-3.02D Concrete

Concrete must comply with the specifications for minor concrete, except the concrete must not contain less than 463 pounds of cementitious material per cubic yard. Hand mixing of the concrete is allowed.

20-3.02E Conductors, Electrical Conduit, and Pull Boxes

20-3.02E(1) Control and Neutral Conductors

Conductors must comply with section 86-2.08 and the following:

1. No. 12 AWG or larger.
2. For installations less than 50 V, rated for direct burial, underground feeder type identified as "UF" with a minimum PVC insulation thickness of 56 mils for conductors no. 10 and smaller and 70 mils for conductors no. 8 and larger, you may use UL listed polyethylene insulation conforming to UL 44 test standards with a minimum thickness of 41 mils for wire sizes 10 AWG and smaller.
3. The color of low voltage neutral and control conductor insulation, except for the striped portions, must be homogeneous throughout the entire thickness of the insulation.

New control and neutral conductors that are to replace existing control and neutral conductors must be the same size and color as the existing control and neutral conductors being replaced.

20-3.02E(2) Armor-Clad Conductors

Armor-clad conductors must comply with the following:

1. Conductors must be solid, uncoated copper.
2. Conductor size must be not less than 90 percent of the AWG diameter required and the proper size for the application.
3. Conductor insulation covering must be either of the following:
   3.1. PVC, UL style type UF 60 degrees C, 600 V. The average thickness of insulation must not be less than 60 mils with a minimum thickness of 54 mils.
   3.2. Polyethylene, UL listed, complying with UL 44 test standards with a minimum insulation thickness of 41 mils for wire sized 10 AWG and smaller.
4. Armor must be stainless steel tape, Type 304 helically wrapped over each conductor with a 33 percent minimum overlap. Tape size must be 0.5 inch wide and at least 0.005 inch thick.
5. Outer conductor jacket must be UV resistant PVC and comply with the ICEA S-61-402, NEMA standard WC5 and UL listing 1263. Jacket nominal thickness must be 30 mils with a minimum thickness of 24 mils.

20-3.02E(3) Electrical Conduit

Electrical conduit must comply with section 86-2.05A and section 86-2.05B.

20-3.02E(4) Pull Boxes

Pull boxes must comply with section 86-2.06A and be no. 5 or larger unless otherwise shown. Pull boxes for low voltage conductors must not have side openings.

Pull box covers used solely for electrical service must be marked to comply with 86-2.06B. All other irrigation system pull box covers must be marked "Sprinkler Control" under section 86-2.06B.

20-3.02F Filter Assembly Units

Filter assembly units include the filter housing, reusable filter cartridge, ball valve, fittings, pipe and valve box with woven wire cloth and gravel as shown.

Filter housing must (1) withstand a cold-water working pressure of 150 psi and (2) be manufactured of reinforced polypropylene plastic.

Comply with section 20-3.02R(1) for ball valves.

20-3.02G Flexible Hose

Flexible hose must be nonrigid PVC and comply with ASTM D 2287, cell Type 6564500. The hose wall thickness must comply with ASTM D 2122 and the dimensions shown in the following table:

Hose size, nominal (inch)	Minimum wall thickness[a] (inch)
1/2	0.147
3/4	0.154
1	0.179

[a]As measured at any point on the cross-section

The hose must provide leak-free, nonseparating connections suitable for the purpose intended when connected to the fittings specified.

Fittings for flexible hose must be injected molded PVC, Schedule 40 and comply with ASTM D 2466. Fittings must be solvent cemented type.

Solvent cement for flexible hose and fittings must be specifically manufactured for the use with nonrigid PVC hose. Primer for hose fittings must be the same as specified for plastic pipe supply line fittings.

20-3.02H Irrigation Controller System

20-3.02H(1) Irrigation Controllers

Irrigation controllers must be single, solid state independent controllers and comply with the following:

1. Fully automatic and operate a complete 14 day or longer irrigation program.
2. A switch or button on the face of the irrigation control panel must be so 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 activation of a single station.
3. Watering time of each station must be displayed on the face of the control panel.
4. Irrigation controller mechanism, panel and circuit board must be connected to the low voltage control and neutral conductors by means of a plug and receptacle connectors. The connection must be located within the cabinet enclosure.
5. Each station must have a variable or incremental timing adjustment ranging from a maximum of at least 90 minutes to a minimum of 1 minute.
6. Controllers must be capable of a minimum of 2 program schedules.
7. Controllers must have an output that can energize a pump start circuit or a remote control valve master.
8. Controllers and low voltage output source must be protected by fuses or circuit breakers.

Rain sensor unit must be a solid state, automatic shut-off type, compatible with the irrigation controller. Rain sensor unit must automatically interrupt the master remote control valves when approximately 1/8 inch of rain has fallen. The irrigation system must automatically be enabled again when the accumulated rainfall evaporates from the rain sensor unit collection cup. Rain sensor units must be rated 24 V(ac) to 30 V(ac).

Irrigation controllers must operate on 120 V, 60 Hz(ac) and supply 24 to 30 V, 60 Hz(ac) for operating electrical remote control valves.

House irrigation controllers in pedestal or wall mounted enclosures as described.

Irrigation controllers not installed in enclosure cabinets must be weatherproof, constructed of fiberglass or metal and have a door lock with 2 keys provided.

20-3.02H(2) Irrigation Controller Battery

Reserved

20-3.02H(3) Irrigation Controller Solar

Reserved

20-3.02I Irrigation Controller Enclosure Cabinets

Fabricate irrigation controller enclosure cabinet under section 86-3.04A.

Irrigation controller enclosure cabinets fabricated of cold rolled steel or aluminum must be cleaned and painted by the manufacturer and comply with section 86-3.04A.

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.

Include protection against lightning damage.

The inside of the cabinet doors must have provisions for storage of the as-built schematic wiring diagram and irrigation plans.

If a remote irrigation control system is specified, the equipment must be shop installed in the cabinet before field installation, except for field wiring.

20-3.02J Irrigation Crossovers

20-3.02J(1) Conduit

20-3.02J(1)(a) Corrugated Steel Pipe Conduit

Corrugated steel 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.

20-3.02J(1)(b) Welded Steel Pipe Conduit

Welded steel pipe must comply with ASTM A 53. Pipe must be either black or galvanized and have welded or threaded joints.

The minimum wall thickness for the various sizes of welded steel pipe must comply with the dimensions shown in the following table:

Pipe size, nominal (inch)	Minimum wall thickness[a] (inch)
3	0.216
4	0.237
6	0.280
8	0.277
10	0.279
12	0.330

[a]As measured at any point on the cross-section

Pipe must be sized to withstand jacking or drilling operations.

20-3.02J(1)(c) ABS Composite Pipe

ABS composite pipe and couplings must comply with ASTM D 2680. Couplings must be solvent cement type.

20-3.02J(1)(d) Bituminous Coated Corrugated Steel Pipe Conduit

Bituminous coated corrugated steel 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.

20-3.02J(1)(e) Corrugated High Density Polyethylene Pipe Conduit

Corrugated high density polyethylene pipe must comply with ASTM F 405 and F 667 or be Type S and comply with AASHTO M252 and M294. Couplings and fittings must be as recommended by the pipe manufacturer.

20-3.02J(2) Crossovers

20-3.02J(2)(a) Sprinkler Control Crossovers

Electrical conduit for sprinkler control crossovers must be rigid, nonmetallic type. Comply with section 86-2.05A, Type 3. The size of conduit is as described.

20-3.02J(2)(b) Water Line Crossovers

Water line crossover must comply with section 20-3.02M(3)(a).

Fittings must be Schedule 80.

20-3.02K Irrigation Sleeves

Irrigation sleeves must comply with section 20-3.02M(3)(a).

Fittings must be Schedule 80.

20-3.02L Location Markers

Location markers must be Schedule 40 white PVC plastic pipe.

20-3.02M Pipe

20-3.02M(1) Copper Pipe

Copper pipe must be Type K rigid pipe and comply with ASTM B 88. Fittings must be wrought copper or cast bronze either soldered or threaded.

Solder must be 95 percent tin and 5 percent antimony.

20-3.02M(2) Galvanized Steel Pipe Supply Lines

Galvanized steel pipe supply lines and couplings must be standard weight and comply with ASTM A 53, except that the zinc coating must not be less than 90 percent of the specified amount. Except for couplings, fittings must be galvanized malleable iron, banded and threaded, and comply with ANSI B16.3, Class 150.

20-3.02M(3) Plastic Pipe

Plastic pipe for irrigation systems includes plastic pipe supply line and plastic pipe irrigation line.

20-3.02M(3)(a) Plastic Pipe Supply Lines

Plastic pipe supply lines must be PVC 1120 or PVC 1220 pressure rated pipe.

Plastic pipe supply lines must be Schedule 40 PVC and comply with ASTM D 1785.

Plastic pipe supply lines must have solvent-cemented type joints. Primer must be used in the solvent-cemented type joints.

Bell end pipe must comply with ASTM D 2672 and be marked with either ASTM D 2672 or D 2241.

Threaded fittings and fittings to be solvent cemented to plastic pipe supply line must be injection molded PVC, Schedule 40, and comply with ASTM D 2466, except fittings for water line crossovers and irrigation sleeves must be Schedule 80.

Risers and threaded nipples for irrigation facilities must be Schedule 80, PVC 1120 or PVC 1220 pipe and comply with ASTM D 1785.

Solvent cement and primer for PVC plastic pipe and fittings for supply line must be specifically manufactured for use with rigid PVC plastic pipe and fittings and must be applied separately. Solvent cement must comply with the local Air Quality Management District requirements.

The solvent cement and primer must be made by the same manufacturer and the primer color must contrast with the color of the pipe and fittings.

Plastic pipe supply line must be NSF approved and comply with either ASTM D 2241 or D 2672.

20-3.02M(3)(b) Plastic Pipe Irrigation Lines

Reserved

20-3.02M(4) Recycled Water Supply Lines

Recycled water supply lines must be purple PVC and must:

1. Be Schedule 40, PVC 1120.
2. Comply with one of the following standards:
   2.1. ASTM D 1785
   2.2. ASTM D 3139

2.3. ASTM D 2241
2.4. ASTM D 2672

Pipe must have permanent wording "CAUTION RECYCLED WATER" in 2 rows on the pipe. The rows must be spaced approximately 180 degrees apart in the longitudinal direction of the pipe. Repeat the wording every 24 inches along pipe.

20-3.02M(5) Ultraviolet Resistant Plastic Pipe

UV-resistant plastic pipe supply line must be Schedule 40, Type I, Grade 1, UV-resistant PVC pipe (UVC-PVC) and must comply with ASTM D 1785.

Fittings must be Schedule 40, UV-resistant PVC, Type I, Grade 1, and comply with ASTM D 2466.

The pipe must be homogeneous, uniform color and be manufactured of:

1. At least 80 percent vinyl chloride resin with UV stabilizers
2. Non-PVC resin modifiers and coloring ingredients
3. Coloring ingredients that resist the damaging effects of UV wave lengths of solar radiation.

Solvent cement for UV-resistant plastic pipe and fittings must comply with the local Air Quality Management District and be recommended by the pipe manufacturer.

20-3.02N Recycled Water Warning Signs

Warning sign decals must show the phrase, "Recycled Water, Do Not Drink" and the "Do Not Drink" drinking glass graphic symbol.

Warning sign decals must be UV fade resistant, all weather, and manufactured from a flexible vinyl based or flexible vinyl based with mylar product. Decals must have a purple background, black text, and backing that has a peel-off cover that is self-adhesive.

Aluminum sign plates must be 1/16-inch aluminum.

Warning tags must show the phrase "Recycled Water" and the "Do Not Drink" drinking glass graphic symbol. Warning tags must be purple, double-sided, and manufactured from polyurethane, incorporating an integral neck attachment and attachment hole. The attachment hole must be capable of withstanding 178 pounds of pull out resistance. Tag lettering must be hot-stamped in black and capable of withstanding outdoor usage.

20-3.02O Remote Control Valve Actuator Systems

A remote control valve actuator system includes a portable handheld receiver, transmitter, field carrying case, (ac) power charging unit, and a receiver connector. The remote control valve actuator equipment must be fully compatible with the irrigation controller. The receiver and transmitter must comply with FCC, Rules and Regulations, part 15, as of the date of manufacture.

The receiver connector must be attached directly to the terminal strip or an existing plug of each irrigation controller. It must continue out to the socket head mounted to the outside of the irrigation controller enclosure cabinet as shown. The connector housing must be weather resistant thermoplastic with a hinged socket head cap and screw to be used as a locking mechanism.

The receiver must:

1. Operate the stations of the irrigation controller on radio signals from the transmitter
2. Receive radio signals at a minimum distance of 1 mile
3. Be protected from overload by a field replaceable fuse
4. Operate on 24 V(ac)

The transmitter must:

1. Provide a 2-way FM radio signal for a minimum range of 1 mile to the receiver located at the irrigation controller enclosure cabinet.

2. Have a digital keypad and instant actuation of the stations, master valves, or pumps. Actuation must be able to be random, numerical or reverse numerical sequences and by pressing a single key for each function.
3. Allow for remote data retrieval, manual control, and programming.
4. Operate a master valve or pump independently of the controller stations.

The power source for the portable units must include an internal charged battery pack, that is recharged by the charging unit. The charging unit must have an input of 110 V(ac) and an output of 24 V(ac) at 1.5 Amp.

20-3.02P Sprinklers

20-3.02P(1) General

Sprinklers include risers, riser supports, swing joints, flow shut-off devices, pressure compensation devices, check valves and fittings as shown.

Flexible risers must be UV resistant and brown.

Flow shut-off devices on risers must automatically and instantly stop the flow of water from a riser when the riser is broken on the downstream side of the device. Install the flow shut-off according to the manufacturer's instructions.

20-3.02P(2) Sprinkler Type C-2 Mod

Sprinkler Type C-2 Mod includes a sprinkler Type 2 inserted in a drainpipe with gravel and capped with a drain grate.

Drainpipe must be commercial type, rigid, perforated, PVC pipe with holes spaced not more than 6 inches on center on 1 side of the pipe.

Drain grate must be commercially available, 1 piece, injection molded drain 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. Gravel must be clean, washed, dry, and free from clay or organic material.

20-3.02P(3) Sprinkler Type D

Sprinkler Type D must be plastic, nonadjustable, pressure compensating emitters with automatic flushing action. Sprinkler must be regulated by dual silicone diaphragms with a flow rate and operating pressure range shown.

Flexible tubing for the emitters must be virgin polyethylene plastic containing 2 to 3 percent carbon black. The size of the tubing must be as recommended by the emitter manufacturer.

20-3.02Q Unions

Unions must be brass or malleable iron. Unions must withstand the working pressure range of the pipes for which the unions are used.

20-3.02R Valves

20-3.02R(1) Ball Valves

PVC or chlorinated PVC ball valves must comply with the requirements shown in the following table:

Property	Requirements
Nonshock cold-water working pressure for 3/4 to 4 inch valves, min	235 psi
Nonshock cold-water working pressure for 6 inch valves, min	150 psi
Seats	PTFE
O-ring seals	EPDM[a] or Viton

[a]EPDM (ethylene-propylene-diene-monomer)

Two-piece brass or bronze body, full port opening ball valves must comply with the requirements shown in the following table:

Property	Requirements
Nonshock cold-water working pressure, min	400 psi
Seats	Teflon
O-ring seals	Teflon

20-3.02R(2) Check Valves

Check valve springs must be factory set at 10 psi.

20-3.02R(3) Control Valves

Control valves must be manual or remote control as shown. Control valves must be capable of withstanding a cold-water pressure of 150 psi.

20-3.02R(3)(a) Manual Control Valves

Manual control valves must be made of brass or bronze. Valve handles must be brass or bronze.

20-3.02R(3)(b) Remote Control Valves

Remote control valves must be as specified.

Remote control valves must:

1. Be normally closed type.
2. Be completely serviceable from the top without removing the valve body from the system.
3. 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.
4. Be the same model series and compatible with the model series of the irrigation controller.
5. Have solenoids operate on the low voltage (ac) current supplied from the irrigation controller.
6. Have a manual bleed device.
7. Equipped with internal diaphragms installed in the valve body casting.

Compression discs or diaphragms in valves must be replaceable.

Valve inlets and outlets must have threaded fittings.

Valve must be of the same size as the pipeline that the valve serves, unless otherwise shown.

Valve solenoids for solar or battery controllers must be DC latching and operate on 3.5 V.

20-3.02R(3)(c) Remote Control Valve with Pressure Regulators

Remote control valve must be fitted with an adjustable pressure regulator. Pressure regulator must be compatible for use with the remote control valve and be made by the same manufacturer as the remote control valve.

Pressure regulators must regulate and maintain the outlet pressure regardless of the incoming pressure. Pressure regulators must withstand a cold-water working pressure of 200 psi. Adjust the pressure regulator to provide proper operation of the irrigation system downstream of the remote control valve.

20-3.02R(4) Flush Valves

Flush valves include a garden valve, riser, and location marker. Furnish 3 loose keys for the flush valves before Contract acceptance.

20-3.02R(5) Gate Valves

Gate valves must be:

1. Either flanged or threaded type
2. Iron or bronze body
3. Bronze trimmed valves with either of the following:
   3.1. Internally threading rising stem
   3.2. Nonrising stem
4. Able to withstand a cold-water working pressure of 150 psi
5. Same size as the pipeline that the valves serves unless otherwise shown

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. Furnish 3 long shank keys to operate the valve before Contract acceptance. Pipe flanges used to connect plastic or metal pipe to gate valves must be plastic or metal. Gate valves must have a solid bronze or brass wedge.

20-3.02R(6) Pressure Regulating Valves

Pressure regulating valves must be:

1. Either flanged or threaded type connections
2. Brass, bronze or cast iron body
3. Spring diaphragm
4. Hydraulically operated
5. Pilot controlled

Pressure regulating valves must not have internal filter screens.

Pressure gauges must be hermetically sealed with neoprene. The gauges must have watertight polycarbonate cases and covers with molded clear polycarbonate windows. Gauges must be 2 inches in diameter calibrated from 0 to 160 psi, and have brass stems and black aluminum pointers that contrast with gauge faces. Internal gauge parts must be brass or bronze.

20-3.02R(7) Pressure Relief Valves

Pressure relief valves must have brass or bronze bodies, stainless steel springs, bronze nickel chrome seats, composition seat discs, female bottom inlets and female side outlets.

20-3.02R(8) Quick Coupling Valves

Quick coupling valves must be 3/4 inch double slotted with a self-closing cap, 3/4-inch brass key and 3/4-inch brass hose swivel unless otherwise shown. Except for the cap, quick coupling valves must be brass or bronze construction. Furnish 3 loose quick coupling brass keys and brass hose swivels before Contract acceptance.

20-3.02R(9) Garden Valves

Garden valves must be the inverted nose type of brass or bronze construction with female thread inlet, replaceable seat washer, rising valve stem within a protective collar, and male thread hose outlet. Garden valves must have a loose key handle.

20-3.02S Cam Coupler Assemblies

Fabricate cam coupler assemblies as shown.

Cam coupler assemblies 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 and keys must be manufactured of brass or bronze and be able to withstand a cold-water working pressure of 150 psi.

Furnish 3 loose cam coupler brass keys before Contract acceptance.

20-3.02T Valve Assembly Units

A valve assembly unit includes a remote control valve, wye strainer, garden valve, and 5/8-inch diameter garden hose. The hose must be 3 feet long and attached with a 3/4-inch internal pipe size female fitting.

Pipe and fittings for valve assembly units must be Schedule 80 PVC.

20-3.02U Valve Boxes and Covers

Valve boxes must be precast concrete.

Valve boxes must not have side openings.

Covers must be concrete or steel. Steel covers must be hinged with brass hinge pins for valve boxes containing valves smaller than 2 inches.

Covers must be marked with "WATER" in cast-in letters not less than 1 inch high.

Covers must be 1 piece, except when the weight of the valve box cover exceeds 35 pounds, then the cover must be 2 pieces.

Identify valve boxes on the top surface of the covers with labels containing the appropriate abbreviation for the irrigation facility contained in the valve box as shown. Valve boxes that contain remote control valves must be identified with the appropriate controller letter and station number as shown. Label material must be polyurethane.

Paint the valve box covers for recycled water supply lines with exterior latex paint. The color must closely match the light purple of the recycled water supply lines.

Label remote control valves for recycled water supply lines as specified above and as specified under section 20-3.02N.

20-3.02V Water Meters

Reserved

20-3.02W Wye Strainers

Wye strainers must have a cast iron or all bronze body with a removable stainless steel or monel strainer. Wye strainers must be capable of withstanding a cold-water working pressure of 150 psi. Wye strainers at backflow preventer assemblies must be equipped with a gate valve at the outlet. All other wye strainers must be equipped with a garden valve at the outlet.

The strainer screen for the wye strainer in a backflow preventer assembly must have an open area equal to at least 3 times the cross-sectional area of the pipe based on an iron pipe size. Screen must be 20-mesh woven wire mesh or perforated sheet with 0.045-inch diameter holes.

Wye strainer for the valve assembly unit must be stainless steel with 80 size mesh. All other wye strainers must be equipped with 40-mesh strainer screens.

20-3.03 CONSTRUCTION

20-3.03A General

Check for deficiencies of existing plants that are to remain in place before starting irrigation work under section 20-2.03D.

Except for sprinkler locations, the irrigation systems shown are diagrammatic.

Supply lines, control and neutral conductors and electrical conduits installed in common trenches must not be installed above each other.

Install hold-down assemblies for the backflow preventer assembly enclosures when concrete is still plastic.

Install control valves and sprinklers:

1. 6-1/2 to 8 feet from curbs, dikes, and sidewalks
2. 10 feet from paved shoulders
3. 3 feet from fences, walls, or both

If control valves and sprinklers cannot be installed within these limits, the locations will be determined by the Engineer.

If the supply line location interferes with the excavation of plant holes, relocate the plant hole to clear the supply line. Do not install supply lines through plant holes unless shown.

Connect underground metallic pipes, valves, or fittings made of dissimilar metals through a dielectric coupling or bushing. Pipe installed in this manner must be physically separated from the other metal objects. Dielectric couplings must physically separate the pipes a minimum of 1/8 inch in all directions. Nonconducting spacers that ensure the physical separation of pipe from foreign objects may be required by the Engineer.

Prevent foreign material from entering the irrigation system during installation. Immediately before assembling, clean all pipes, valves, and fittings. Plug or cap all unattached ends of pipe, fittings, and valves pending attachment of additional pipe or fittings. Flush out all lines before attachment of sprinklers, emitters, and other terminal fittings.

Set risers for sprinklers on slopes perpendicular to the plane of the slope.

Repair irrigation systems within 7 days after a malfunction or damage has occurred.

Finish exposed top surfaces of concrete foundations and pads with a medium broom finish applied parallel to the long dimension of foundations and pads.

Use minor concrete for replacing removed concrete facilities.

HMA for replacing removed asphalt concrete surfacing and facilities must comply with section 39. You may use minor HMA if authorized.

20-3.03B Existing Facilities

20-3.03B(1) General

Reserved

20-3.03B(2) Existing Irrigation Facilities

Existing irrigation facilities must comply with section 15.

20-3.03B(3) Maintain Existing Water Supply

Maintain the existing water supply. A temporary water supply may be used if authorized.

If existing plants are to be maintained by the Department and Contractor from the same water supply, sufficient water must be supplied to the Department for watering plantings on and off the highway as necessary to maintain a healthy condition through Contract acceptance.

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

Keep existing irrigation facilities in place that are described to be removed, relocated, or salvaged until the Engineer determines their use is no longer required.

Repair or replace existing irrigation facilities damaged by your operations within 10 working days of the damage. The repaired or replaced irrigation facilities must be compatible with the irrigation systems to remain. After repair or replacement of the facilities is complete, demonstrate to the Engineer that the repaired or replaced facilities operate properly. If remote control valves are repaired or replaced, the valves must be tested with the irrigation controller in the automatic mode.

20-3.03B(4) Check and Test Existing Irrigation Facilities

Before performing irrigation system work, check existing irrigation facilities to remain in place or to be relocated for deficiencies including missing parts, damaged components, and improper operation.

Provide a list of irrigation system deficiencies within 7 days after checking the existing facilities.

The Engineer determines watering cycle lengths for checking and testing existing irrigation facilities.

Correction of deficiencies is change order work.

Except for work specified under section 15 and section 20-3.03B(5), perform additional repairs required to the existing irrigation system as ordered. This work is change order work.

20-3.03B(5) Maintain Existing Irrigation Facilities

Existing irrigation facilities shown to be maintained must be maintained through Contract acceptance. Maintain existing irrigation facilities begins after completion of repairs found during check and test existing irrigation facilities.

Maintain all existing irrigation facilities except for water meters, underground pipe supply lines, control and neutral conductors, and electrical conduits.

Maintaining existing irrigation facilities includes checking for proper operation and adjusting, repairing or replacing valves, valve boxes, sprinklers, risers, swing joints, wye strainers, valve assembly units, and filter assembly units. Check irrigation systems and facilities for proper operation at least once every 30 days. Complete adjustments and repairing or replacing irrigation facilities within 7 days after checking the irrigation system.

Operate automatic irrigation systems automatically until Contract acceptance. Manual operation is allowed for work during plant replacement, fertilization, weed germination and repair of irrigation facilities.

Program the irrigation controllers for seasonal requirements. During the winter season irrigation systems must be operated automatically a minimum of 2 minutes every 2 weeks.

Perform a final cleaning of wye strainers and filters within 15 working days of Contract acceptance.

20-3.03B(6) Locate Existing Crossovers

Before performing work on irrigation systems, locate existing crossovers and conduits shown to be incorporated into the new work.

Before removing or disturbing existing Type A pavement markers that show the location of the existing crossover conduit, mark the location of the existing crossover conduit on the pavement.

Locate existing conduits by excavating exploratory holes at the locations indicated by existing markers or as directed. Excavate exploratory holes to a maximum size of 2-1/2 feet wide by 5 feet deep parallel with the roadway 5 feet on each side of the marker or directed location.

Backfill exploratory holes and replace pavement markers.

If the size of the exploratory hole must be increased as authorized by the Engineer, the additional excavation and backfill is paid as change order work.

Remove debris found in the conduit before performing other work in the conduits. Debris found more than 3 feet from the ends of the conduits is removed as change order work.

20-3.03B(7) Relocate Existing Irrigation Facilities

Relocate existing irrigation facilities must comply with section 15-2.09D.

20-3.03B(8) Remove Existing Irrigation Facilities

Remove existing irrigation facilities must comply with section 15-2.02L.

20-3.03B(9) Replace Existing Valve Box Covers

Existing valve box covers shown to be replaced must remain until the new covers are ready to be installed.

Valve box covers must be (1) concrete or steel for concrete boxes and (2) glass fiber reinforced plastic for reinforced plastic and plastic boxes. Valve box covers must be the same size as the covers they replace.

Identification, labeling and color must comply with section 20-3.02U.

Dispose of removed valve box covers.

20-3.03C Irrigation Crossover

20-3.03C(1) Conduit Installation Methods for Irrigation Crossovers

20-3.03C(1)(a) Jack and Drill

Do not disturb pavement without authorization, and only when obstructions are encountered.

If authorized, small holes may be cut in the pavement to locate or remove obstructions. Jacking or drilling pits must be at least 2 feet from pavement edge whenever possible. Do not use excessive water that will soften subgrade or undermine pavement.

Install conduits not less than 18 inches below the top of curb grade in sidewalk areas and not less than 40 inches below finished grade in all other areas measured to the top of conduit. If possible install conduits within 1 foot below the minimum depth.

20-3.03C(1)(b) Open Trench

Install conduits in a trench under areas to be paved or under existing pavement in a trench approximately 12 inches wider than the outside diameter of the conduit to be installed. The top of the installed conduit must be a minimum of 24 inches below finished grade.

Do not cut or remove concrete curbs, concrete drainage gutters, and asphalt concrete dikes for the installation of conduits unless shown.

If no joint exists in a concrete sidewalk, cut the sidewalk on a straight line at the location determined by the Engineer.

Existing concrete must be cut to a straight line where new concrete is to join the existing concrete.

If no joint exists between the existing asphalt concrete or concrete surfacing to be removed and the asphalt concrete or concrete surfacing to remain in place, outline the areas to be removed as determined by the Engineer. Cut the outline of the surfacing to be removed using a power driven saw, on a straight line with no shatter outside of the removal area, to a minimum depth of 2 inches before removing the surfacing material.

Replaced concrete must be performed by methods that produce a surface of uniform smoothness, color and texture at least equal to the adjacent concrete surface.

Dispose of removed asphalt concrete, concrete, and surplus excavated material.

Grade and prepare the bottom of the trench to provide a firm and uniform bearing throughout the entire length of the conduit. During backfill operation, the conduit must be rigidly supported so that no movement or damage to the conduit or joints occurs.

Backfill for trenches must comply with section 19-3.02B.

Backfill under surfaced areas must comply with section 19-3. The compacted thickness of the replacement underlying material, HMA, or concrete must not be less than the thickness of the material removed. The finished surface of the replaced material must be flush with the adjacent surface.

20-3.03C(1)(c) Directional Boring

Reserved

20-3.03C(2) Irrigation Crossover Installation

20-3.03C(2)(a) General

Install conduits for water line crossovers and sprinkler control crossovers before installing other pipe supply lines.

Irrigation crossovers include conduit, water line crossovers, sprinkler control crossovers, concrete thrust blocks, and appurtenances as shown, as well as pressure testing of new water line crossovers. The size of conduit, water line crossovers and sprinkler control crossovers must be as shown.

Extend conduits 2 feet beyond all paving unless otherwise shown.

After installation of conduits for water line crossovers and sprinkler control crossovers, and placement of base and surfacing is complete, demonstrate the conduits are free of obstructions and restrictions.

If there are no conductors installed in electrical conduits, install pull boxes for irrigation crossovers on a foundation of compacted soil.

Cap the ends of conduits with a piece of no. 30 asphalt-felt building paper secured with galvanized wire.

Designate the location of each conduit by cementing a Type A pavement marker as shown to the paved shoulder near each end and over the centerline of the conduit using a standard set type adhesive. Type A pavement markers and adhesive must comply with section 85.

Replace ground cover plants that have been removed or damaged. Comply with section 20-7.03I(16).

20-3.03C(2)(b) Sprinkler Control Crossovers

Sprinkler control crossovers includes installing electrical conduit, pull boxes and appurtenances as described.

At each end of a sprinkler control crossover, install a no. 5 pull box that complies with section 20-3.03H(2)(c).

20-3.03C(2)(c) Water Line Crossovers

Installation of water line crossovers for irrigation crossovers includes:

1. Installing supply line pipes in conduits and appurtenances
2. Pressure testing under section 20-3.03N

After completing conduit backfill above irrigation crossover conduit, demonstrate that the water line crossover can be moved longitudinally within the conduit.

Repair leaks and retest until a satisfactory pressure test is achieved.

Where water line crossovers are not to be connected to other supply lines, cap the ends of the crossovers immediately after testing.

20-3.03C(2)(d) Extend Irrigation Crossovers

Extending irrigation crossovers includes conduit, water line crossovers and sprinkler control crossover extensions, concrete thrust blocks, and appurtenances as shown, locating existing crossovers, and pressure testing existing and new water line crossovers.

Before starting work in an area where an existing irrigation crossover conduit is to be extended, locate the existing conduit. If exploratory holes are used to located the existing conduit, excavate the exploratory holes under section 20-3.03B(6).

Before installation of water line crossover extension, pressure test the existing water line under section 20-3.03N.

After installation of water line crossover extensions, existing and extended water line crossovers must be retested for leakage under section 20-3.03P. Leaks that develop must be repaired and the water line crossovers must be retested until a satisfactory pressure test is achieved.

Existing conductors must be removed from existing sprinkler control crossovers to be extended.

After installation of the sprinkler control crossover extension, install conductors without splices in the existing extended sprinkler crossover. New conductors must match the removed conductors in color and size and be spliced to the existing conductors in adjacent pull boxes.

After the new conductors are installed, the conductors must be tested under section 86-2.14B.

20-3.03D Irrigation Sleeves

Install irrigation sleeves so that the top of a sleeve is at least 18 inches below finished grade. Extend sleeves 6 inches beyond paving, Class 2 AB, gravel access roads, and decomposed granite. Cap ends of sleeves until used.

20-3.03E Trenching and Backfilling

20-3.03E(1) General

Trench and backfill under sections 86-2.01 and 86-2.02.

Open trenches and excavation pits from a single water service point can be open 1 at a time. After pressure testing is complete, backfill trenches and pits before excavating for conduit or supply lines from another water service point.

Trenches for solvent-cemented plastic pipe supply lines must be a sufficient width to permit snaking of the pipe. Do not excavate other trenches wider than necessary for the proper installation of pipe supply lines.

Trenching must be smooth and free of jagged rubble or sharp objects that could cause bending stresses or uneven load distribution to pipes, conduits and conductors during backfill operations.

Rocks or debris encountered during trenching operations must be brought to the surface of the ground. Remove rocks or debris larger than 2 inches in maximum dimension unless otherwise authorized.

Dispose of any pavement removed during trenching.

Backfill pipe trenches so that the pipe is protected from damage by sharp objects. Do not place rocks directly on the pipe.

Except as specified, use material excavated from the trenches as backfill material. Compact by ponding or jetting with water until the backfill material is level with the surrounding soil after settlement.

The Engineer may determine that the excavated material is not suitable for backfilling against the pipe. If ordered, backfill against the pipe with sand or topsoil before backfilling the remainder of the trench. Backfilling with sand or topsoil is change order work.

If a backfill area has settled, refill the area with additional material and compact.

20-3.03E(2) Remove Existing Plants for Trenching

Removing existing plants for trenching includes removing and replacing ground cover, pruning trees and shrubs within the trench location, and disposing of removed plant material, including pruned material.

When trenching for irrigation facilities in areas where existing trees or shrubs are present, adjust the trench alignment to avoid damage to the trees or shrubs.

When trenching for irrigation facilities where ground cover is present, remove sufficient ground cover to permit the proper installation of the facilities, but do not remove more than a 6 foot width.

Existing *Carpobrotus* and *Delosperma* ground cover may be rototilled if the backfill for the trenches will not contain plants longer than 6 inches in length.

Replace ground cover removed or rototilled with the same variety as the existing ground cover. For *Carpobrotus* or *Delosperma* replacement plants, use cuttings that comply with section 20-7.02C(1). Plant cuttings 12 inches on center. Other replacement ground cover plants must be from flats and planted 12 inches on center.

Perform ground cover replacement planting before the start of the plant establishment period. If no plant establishment period is specified, plant at least 15 days before Contract acceptance.

Planting of ground cover plants must comply with section 20-7.03I(9).

Water replacement ground cover.

Replacement planting is not required in areas within 6 feet of fences, curbs, dikes or shoulders.

Trees and shrubs adjacent to dikes, walks, fences, guard railing and pavement edges may be pruned back 10 feet from these facilities for trenching work. Where trenching is adjacent to other trees and shrubs that can not be avoided, they may be pruned if authorized. If the Engineer determines these trees and shrubs must be removed after pruning, the removal and disposal is change order work.

Dispose of removed ground cover and pruned materials.

20-3.03E(3) Remove Existing Turf Sod for Trenching

Remove existing turf sod in trenching areas and replace under section 20-7.

If crossing existing turf sod areas, the trench width must not exceed 12 inches.

20-3.03E(4) Open Trenching in Existing Surfacing

Pipe supply lines and control and neutral conductors in electrical conduits must be installed in common open trench where trenching is (1) to be installed under concrete sidewalks or (2) below existing asphalt concrete surfacing not subject to traffic loads or (3) not being installed in an irrigation crossover.

Do not excavate open trenches across traffic lanes.

For pipe supply lines or electrical conduits 3 inches or less in diameter:

1. Trench width in asphalt concrete surfacing must not exceed 12 inches.
2. Trench width in concrete sidewalks must not exceed 18 inches.

The tops of the installed pipe supply lines and electrical conduits must be a minimum of 12 inches below finished grade.

Install pipes and conduits at the bottom of trenches and backfill with sand to a depth of 2 inches over the top of the pipes and conduits. Excluding the part of the trench backfilled with surfacing or pavement, the remainder of the trench must be backfilled with material that is excavated from the trench. Rock, broken concrete, asphalt concrete and other particles larger than 2 inches in greatest dimension must not be used.

For pipe supply lines between 3 to 12 inches in diameter and electrical conduits more than 3 inches in diameter, the trench width in asphalt concrete surfacing and concrete sidewalks must be a minimum of 6 inches outside the proposed pipe diameter and electrical conduit.

Trenches must be deep enough so that the tops of the pipe or conduit are a minimum of 4 diameters below the finished grade.

20-3.03F Pipe

20-3.03F(1) General

Supply line trenches located adjacent to curbs, dikes and paved shoulders must be at least 4 feet from the curbs, dikes and paved shoulders.

Pipe supply lines installed between water meters and backflow preventer assemblies must be installed not less than 18 inches below finished grade measured to the top of the pipe.

Where a connection is made to existing supply lines, compression type fittings may be used.

Cut pipe straight and true. After cutting, ream out the ends to the full inside diameter of the pipe.

You may install plastic pipe supply line with solvent-cemented fittings or plastic pipe irrigation line by methods other than trenching, provided that pipes are installed at the depths specified.

20-3.03F(2) Galvanized Steel Pipe Supply Lines

Coat male pipe threads on galvanized steel pipe with a joint compound that is nonhardening and noncorrosive. Apply joint compounds according to the manufacturer's instructions. Pipe thread sealant tape will not be allowed.

Supply lines that cross paved ditches more than 3 feet deep at their flow line must be galvanized steel pipe and span the ditches.

Comply with section 20-4 for supply lines that are surfaced mounted on concrete structures.

20-3.03F(3) Plastic Pipe Supply Lines

Plastic pipe supply lines with solvent-cemented type joints must be installed not less than 1 foot below finished grade measured to the top of the pipe.

Supply lines must be installed under paved ditches that are 3 feet deep or less at their flow line.

Install plastic pipe and fittings according to the manufacturer's instructions and as specified.

For PVC pipe 1-1/2 inches in diameter or smaller, cut the pipe with PVC cutters.

Solvent-cement welding must comply with the manufacturer's instructions for the solvent cement.

Wrap the male portion of each threaded plastic pipe fitting with at least 2 layers of pipe thread sealant tape.

Snake plastic pipe installed by trenching and backfilling methods.

20-3.03F(4) Plastic Pipe Irrigation Lines

Reserved

20-3.03F(5) Ultraviolet Resistant Plastic Pipe

UV resistant plastic pipe must be secured on grade as shown.

20-3.03F(6) Recycled Water Supply Line

Reserved

20-3.03G Thrust Blocks

Install thrust blocks on the main supply line at all changes in direction and terminus run and as shown.

20-3.03H Electrical Installation for Electrical Automatic Irrigation Systems

20-3.03H(1) General

Electrical systems for electrical automatic irrigation systems must comply with section 86-1.02.

Electrical components for electrical automatic irrigation systems include:

1. Controllers with enclosures
2. Controller enclosure cabinets
3. Base stations
4. Field units
5. Remote control valves
6. Valve boxes and pull boxes
7. Electrical conduits
8. Conductors between irrigation system components
9. Moisture sensors
10. Flow sensors
11. Remote control valve actuators
12. All appurtenances, incidentals and accessories required for the proper installation and operation of the electrical portion for the electrical automatic irrigation systems

The electrical service is not included in the electrical components.

Modifications to electrical components required to meet specifications must be done by the manufacturer before shipment to the job site.

20-3.03H(2) Conductors, Electrical Conduit, and Pull Boxes

20-3.03H(2)(a) Conductors

Conductors must be color coded where (1) 2 or more controllers are located within 1 irrigation controller enclosure cabinet or (2) conductors from more than 1 controller are installed in a common trench. The color of the conductors must be uniform from any one controller to its valves. Neutral conductors must be

white. Do not use white for control conductors. Conductors with green insulation must not be used except as permitted by the NEC.

Low voltage conductors must be 36 V or less.

Each irrigation controller must have a common neutral conductor to its respective remote control valves.

Each remote control valve must have a separate control conductor from the irrigation controller with no other valves connected.

If conductors are installed in a common trench and not in a conduit, they must be wrapped together with electrical tape at 5 foot intervals.

Leave at least 2 feet of slack for each conductor at each pull box.

At each valve box, at least 2 feet of slack must be left for each conductor that is (1) connected to other facilities within the box or (2) spliced within the box.

Splices for low voltage control and neutral conductors must comply with sections 86-2.09C, 86-2.09D, and 86-2.09E except method B splice insulation must not be used. Tape used for splice insulation must be PVC tape.

Splices must be made only in pull boxes or valve boxes.

Do not splice conductors in irrigation controller cabinets.

Do not use temporary splices used for testing valve circuits as permanent splices.

Permanent splice connections must be made with freshly cut and skinned conductors.

Where conductors are installed in the same trench or opening as supply line pipe, the conductors must be installed at the same depth as the pipe. At other locations the conductors must be installed not less than 12 inches below finished grade.

Where conductors are located adjacent to curbs, dikes and paved shoulders, and not in a supply line pipe trench, they must be at least 4 feet from the curbs, dikes and paved shoulders.

You may install conductors for an irrigation system by methods other than trenching provided that conductors are installed at the depths specified and the conductor insulation is not damaged.

Conductors must be installed 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 crossovers
5. Placed in concrete

Mark low voltage 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.

Markers for the control conductors must be identified with the appropriate number or letter designations or irrigation controllers and station numbers. Markers for neutral conductors must be identified with the appropriate number or letter designations of the irrigation controllers.

20-3.03H(2)(b) Electrical Conduit

Surface mounted conduits, conduits installed in or on a structure; conduits installed in concrete; and conduits installed by jacking and drilling must be the rigid steel type. All other electrical conduits, including

electrical conduit installed in irrigation crossover conduits for water line crossovers and sprinkler control crossovers and conduits under paved areas must be nonmetallic.

20-3.03H(2)(c) Pull Boxes

Install pull boxes as shown for the valve box.

Install pull boxes 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

If no conductors are installed in electrical conduits, pull boxes for irrigation crossovers must be installed on a foundation of compacted soil.

Installation intervals of pull boxes must not exceed 500 feet along any low voltage control and neutral conductor run.

Valve boxes installed along a conductor run must not be considered as pull boxes in determining the spacing. If authorized you may install additional pull boxes to facilitate the work.

20-3.03H(3) Conductor Testing

Perform field tests on all conductors. Field tests must comply with the specifications for lighting circuits in section 86-2.14B.

Where the conductors are installed by trenching and backfilling, field tests must be performed after at least 6 inches of backfill material has been placed over the conductors and the material has been compacted. Compact backfill material under section 20-3.03E.

20-3.03H(4) Controllers

20-3.03H(4)(a) Irrigation Controller

Install irrigation controllers per the manufacturer's instructions and as described.

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.

If 2 or more irrigation controllers operate the same remote control valve master, an isolation relay must be provided and installed per the controller manufacturer's instructions.

Irrigation controllers must be the same make.

Where direct burial conductors are to be connected to the terminal strip, the conductors must be connected with the proper size 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.

20-3.03H(4)(b) Irrigation Controller Battery

Reserved

20-3.03H(4)(c) Irrigation Controller Solar

Reserved

20-3.03H(5) Remote Control Valve Actuator System

The receiver connector must be attached directly to the terminal strip or an existing plug on each irrigation controller and continue out to the socket head mounted to the outside of the irrigation controller enclosure cabinet as shown.

The receiver must be plugged into the receiver connector.

20-3.03H(6) Rain Sensor

Install rain sensor units for irrigation controllers on the irrigation controller enclosure cabinets. Provide protection against lightning damage.

20-3.03I Service

Installation of electrical service must comply with section 86-2.11A and as described.

20-3.03J Recycled Water Warning Signs

Fasten recycled water warning signs to above ground irrigation facilities that are associated with recycled water.

Place signs on the above ground irrigation facilities in visible locations.

Place sign decals directly to clean, smooth surfaces. Clean the surface with alcohol, or an equivalent cleaner before applying the decal.

Apply warning sign decals directly to irrigation facilities with smooth surfaces or affixed to aluminum sign plates, that are attached to the various above-ground irrigation facilities.

Permanently attach warning sign decals or warning sign decals on aluminum sign plates to:

1. Backflow preventers
2. Valve boxes
3. Nozzle lines
4. Concrete sprinkler protectors
5. Sprinkler risers
6. Irrigation controller enclosure cabinets
7. Flow sensors
8. Irrigation controller enclosures not in cabinets
9. Gates
10. Fences
11. Other irrigation facilities as shown

Permanently attach sign decals approximately 2-1/2 by 3 inches to sprinkler risers.

Permanently attach a 4 by 4 inch warning sign decal to:

1. Irrigation controller enclosure cabinet doors.
    1.1. Attach decals for cabinets to aluminum sign plates and the plates attached with cadmium plated, nonremovable, self-tapping screws or cadmium plated bolts, nuts and washers.
2. Irrigation controller enclosures not in cabinets.
3. Backflow preventer assemblies.
4. Backflow preventer assembly enclosures.
5. Valve box covers.

Place a 12 by 12 inch warning sign decal on an aluminum sign plate and attach to gates, fences, and walls 5 feet above finished grade. Sign plates for gates and fences must be attached with S hooks and C clips or 14-gauge galvanized steel wire as shown. Sign plates for concrete walls or other rough surfaces must be affixed with a silicon-based adhesive.

Attach warning tags to the remote control valves and remote control valves (master). Tags must be 2 by 2 inches. Attach them inside the valve box according to the manufacturer’s instructions.

Post and fastening hardware for post mounted recycled water warning signs must comply with section 56-4.

Mark underground pipe for recycled water under section 20-3.02M(4).

20-3.03K Sprinklers Type D

Install Sprinklers Type D as shown and according to the manufacturer’s instructions.

Sprinklers must be equipped with a single barb inserted into a shrub nut. The shrub nut must be installed on a threaded PVC riser.

Discharge ends of tubing must be held in place by plastic or metal stakes within the basin and approximately 2 inches above grade. Comply with the sprinkler manufacturer's instructions for stake installation.

20-3.03L Valves and Valve Boxes

20-3.03L(1) General

Install and identify valve boxes as shown.

Install valves, flow sensor, wye strainers, filter assembly units, and cam coupler assemblies in valve boxes as shown.

Where installed in walkways and paved areas, install the tops of valve boxes flush with the surrounding finished grade. In other areas, the top of valve boxes must be installed 2 inches above the surrounding finished grade.

20-3.03L(2) Ball Valves

Ball valves must be the same size as the supply line that the valve serves unless otherwise shown.

20-3.03L(3) Check Valves

Install spring-action check valves used as anti-drain valves at locations shown. The size of the check valve must be the same size as the supply line it serves. If locations are not shown the Engineer will determine the location.

20-3.03L(4) Garden Valves

Where a garden valve is open on (1) a valve assembly unit or (2) a wye strainer in a valve box, the discharge must be up and out of the valve box.

20-3.03L(5) Pressure Regulating Valves

Install pressure regulating valves with threaded connections and a union on the inlet side of the valves.

20-3.03L(6) Flush Valves

Install location marker 8 to 10 inches from the back of the garden valve.

20-3.03M Wye Strainers

Install wye strainers other than within the backflow preventer assemblies on the upstream side of the remote control valves as shown.

20-3.03N Pressure Testing

Perform pressure testing before backfilling supply line trenches. Pressure testing must be performed in the presence of the Engineer.

Perform pressure tests between 8 a.m. and 5 p.m.. Do not test on Saturdays or holidays.

Perform pressure testing for leakage on all pipe supply lines installed, except for nonrigid pipelines and pipelines with spray nozzles or emitters installed into the pipe.

Test pipelines after installation with all open ends of the pipeline and fittings plugged or capped.

Choose either Method A or B to test (1) pipes installed by trenching and backfilling and (2) pipelines that are completely visible after installation. All other pipelines, including those installed in the ground by methods other than trenching and backfilling must be tested by Method A.

Test water line crossovers and extended water line crossovers by Method A with the testing period modified to 0.5 hour and allowable pressure drop is modified to no drop in pressure.

20-3.03N(1) Method A

Method A pressure testing procedures for leakage must comply with the following:

1. The pressure gauge must be calibrated from 0 to 200 psi in 5 psi increments and be accurate to within a tolerance of 2 psi.

2. Fill the pipeline to be tested with water and connect a pressure gauge to the pipeline. Place the pipeline under a pressure of 125 psi by air or water pressure. Remove the source of pressure and leave the line under the required pressure.
3. Test the pipeline under the required pressure for a period of 1 hour. The pressure gauge must remain in place until each test period is completed.
4. Leaks that develop in the tested portion of the system must be located and repaired 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.

If a system consists of new pipelines connected to existing pipelines, the new pipelines must be isolated from the existing pipelines and the new pipelines must be tested.

20-3.03N(2) Method B

Method B pressure testing procedures for leakage must comply with the following:

1. Before any portion of the pipeline on the supply side of a control valve is backfilled, water must be turned on for that portion of the line and maintained at full pressure from the water source for a period not less than 8 consecutive hours after all air has been expelled from the line. Before any portion of the pipeline on the discharge side of the control valve is backfilled, perform the same test for a period not less than 1 hour.
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 as determined by the Engineer.

20-3.03O Repairs and Sprinkler Coverage

Leaks that develop and defective material in any portion of the irrigation system installed under this Contract must be repaired or replaced.

After installation of the sprinklers, check and adjust the entire sprinkler system for uniform and complete coverage. Check emitters for proper orientation and clean or replace.

Any ordered changes to the new irrigation system necessary to achieve complete and accurate coverage of an area to be watered is change order work.

20-3.03P Irrigation System Functional Test

Functional tests must be satisfactorily completed before:

1. Planting the plants. Upon completion of a satisfactory functional test, the plants to be planted in the areas watered by the irrigation system may be planted, if the planting areas have been prepared as specified.
2. The 2nd test must be performed after the planting of plants and before the start of the plant establishment period.

The functional tests for each irrigation controller and associated automatic irrigation system served by a single electric service point or a group of irrigation controllers and associated automatic irrigation systems served by a single electric service point must consist of not less than 1 complete cycle of operation.

The Engineer determines the length of the cycle.

20-3.03Q Final Irrigation System Check

A final check of the existing and new irrigation facilities must be performed not more than 30 working days and not less than 20 working 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 performance when the controllers are in automatic mode.

Unsatisfactory performance of irrigation facilities installed or modified must be repaired and rechecked until satisfactory performance is obtained.

20-3.04 PAYMENT

Work described in this section is paid under bid items specified in section 20-3.02 except for check and test existing irrigation facilities, maintain existing irrigation facilities, replace existing valve box covers, and extend irrigation crossover.

Pipes and conduits are measured along the slope.

Payment for maintain existing water supply is included in payment for the various items of work.

Payment for irrigation crossovers is included in payment for the various types and sizes of conduit.

Payment for extend irrigation crossover is included in payment for the various sizes of conduit extensions.

Payment for water line crossover, appurtenances, and for pressure testing the water line crossover is included in payment for the various types and sizes of plastic pipe supply line.

Payment for sprinkler control crossovers, water line crossovers, pavement markers, pull wires, pull boxes, and appurtenances, and for pressure testing the water line crossover is included in payment for various types and sizes of conduit.

Payment for pipe supply line from water meter through the backflow preventer to plastic pipe supply line is included in payment for the various sizes of backflow preventers.

Payment for remove existing turf sod for trenching or remove existing plants for trenching is included in payment for the various types and sizes of pipe supply line.

Payment for flush valves and atmospheric vacuum breakers is included in payment for the various types and sizes of plastic pipe supply line.

Payment for remote control valve (master) and remote control valve with pressure regulator is paid for as remote control valve.

Payment for remote control valve actuator system is included in payment for the various types of irrigation controllers.

Payment for rain sensor is included in payment for the irrigation controller enclosure cabinet.

Payment for checking and cleaning emitters and for checking and adjusting the various types of sprinklers for proper flow and coverage after installation is included in the payment for the various types of sprinklers.

Electrical conduit and pull boxes are measured and paid for as control and neutral conductors.

Armor-clad conductors are measured and paid for as control and neutral conductors.

Payment for recycled water supply lines and UV-resistant plastic pipe will be measured and paid for as plastic pipe supply line.

Payment for functional tests and final irrigation system check are included in payment for the various items of work.

20-4 SUPPLY LINE ON STRUCTURES

20-4.01 GENERAL

20-4.01A General

20-4.01A(1) Summary

Section 20-4 includes specifications for installing water supply lines through bridges and on the exterior of concrete structures.

20-4.01A(2) Definitions

Reserved

20-4.01A(3) Submittals

Submit a work plan for temporary casing support at the abutments as an informational submittal.

20-4.01A(4) Quality Control and Assurance

20-4.01A(4)(a) General

Before installing seismic expansion assemblies or expansion assemblies, the Engineer must authorize the extension setting.

20-4.01A(4)(b) Regulatory Requirements

Piping materials must bear the label, stamp, or other markings of the specified standards.

20-4.01A(4)(c) Site Tests

Test water supply lines before:

1. Backfilling
2. Beginning 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 20-3.03N(1), except that the testing period must be 4 hours with no pressure drop.

For water supply lines 4 inches and larger testing must meet the following additional requirements:

1. Testing pressure must be at least 120 psi
2. Air relief valve must not be subjected to water pressure due to testing

If water supply lines fail testing, retest the lines after repair.

20-4.01B Materials

20-4.01B(1) 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.

20-4.01B(2) Air Release Valve Assemblies

Air release valve assemblies include an air release valve, ball valve, tank vent, nipples, and pipe saddle. Assemblies must comply with the following:

1. 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.
2. Ball valves must have a 2-piece bronze body with chrome plated or brass ball, 1-inch full-size port, and be rated for at least 400 psi.
3. Tank vents must have a 1/2-inch NPT inlet and downward-facing double openings with screened covers.
4. Nipples must be schedule 40 galvanized steel pipe.
5. Pipe saddle must be rated for at least 150 psi and compatible with water supply line. Pipe saddle must be (1) single strap pipe saddle for water supply lines smaller than 4 inches or (2) double strap pipe saddle for water supply lines 4 inches and larger. You may use a tee fitting for galvanized steel water supply lines.

20-4.01B(3) Casings

Casings must be welded steel pipe casing complying with section 70-7.

20-4.01B(4) 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.

20-4.01B(5) 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 casings weight.

20-4.01B(6) Epoxy Adhesives

Epoxy used for anchoring concrete pipe supports must comply with section 70-7.02D.

20-4.01B(7) Concrete Pipe Supports

Concrete pipe supports must comply with section 70-7.02D.

20-4.01B(8) Pipe Clamps and Anchors

Metal clamps must be commercial quality steel complying with section 75-1.02. Anchors must comply with the specifications for concrete anchorage devices in section 75-1.03C.

20-4.01B(9) Pull Boxes

Pull boxes and covers must comply with section 20-3.03H(2)(c).

20.4.01C Construction

20-4.01C(1) 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.

20-4.01C(2) 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 next pipe section is installed.

20-4.01C(3) Installation

20-4.01C(3)(a) General

Reserved

20-4.01C(3)(b) Casings

Install casings under section 70-7.03.

Seal casing end with 8 inches of polyurethane foam at dirt stop or pipe end seal.

20-4.01C(3)(c) 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 comply with the following:

1. Clean and prime area as recommended by the tape manufacturer.
2. Tightly wrap tape with 1/2 uniform overlap, free from wrinkles and voids, to provide not less than a 100 mil thickness.
3. The tape must conform to joint or fitting contours.
4. Extend tape at least 6 inches over adjacent pipe.

20-4.01C(3)(d) Pipe Clamps and Anchors

Install water supply lines on the exterior surfaces of bridges or other concrete structures with metal clamps and anchors.

Drilling of holes for anchors must comply with the following:

1. Drill holes to manufacturers recommended depth.
2. Drilling tools must be authorized.
3. Do not drill holes closer than 6 inches to the edge of a concrete structure.

4. 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 centers unless otherwise shown.

20-4.01C(4) 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.

20-4.01D Payment

Supply line on structures is measured from end to end, along the centerline.

The Department does not pay for failed tests.

20-4.02 SUPPLY LINE ON STRUCTURES, LESS THAN 4 INCHES

20-4.02A General

20-4.02A(1) Summary

Section 20-4.02 includes specifications for installing water supply lines smaller than 4 inches.

20-4.02A(2) Definitions

Reserved

20-4.02A(3) 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

20-4.02A(4) Quality Control and Assurance

Reserved

20-4.02B Materials

20-4.02B(1) General

Reserved

20-4.02B(2) Water Supply Line

Water supply lines must comply with section 20-3.02M(2).

20-4.02B(3) Expansion Assemblies

Expansion assemblies must consist of a hose with ends, insulated flange connections, and elbows. Expansion assemblies 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, rated for at least 150 psi. Cover must be flexible, oil resistant rubber or synthetic, reinforced with at least 2-ply synthetic yarn or steel wire. The inner tube must meet 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.

20-4.02B(4) Casing Insulators

Casing insulators must be:

1. 2-piece, high-density, injection-molded polyethylene, nonconductive inner liner, with cadmium-plated nuts and bolts.
2. Factory constructed to ensure the water supply line is centered in the casing. Insulators must not allow any contact between 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.

20-4.02B(5) Pipe Anchorages

Pipe anchorages 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 75-1.02. Concrete anchorage devices must comply with section 75-1.03C.

20-4.02B(6) Pipe End Seals

Pipe end seals 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.

20-4.02C 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.

20-4.02D Payment

Supply line on structures is paid for as galvanized steel pipe (supply line on bridge).

20-4.03 SUPPLY LINE ON STRUCTURES, 4 INCHES AND LARGER

20-4.03A General

20-4.03A(1) Summary

Section 20-4.03 includes specifications for installing water supply lines 4 inches and larger.

20-4.03A(2) Definitions

Reserved

20-4.03A(3) 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.

20-4.03A(4) Quality Control and Assurance

Reserved

20-4.03B Materials

20-4.03B(1) General

Reserved

20-4.03B(2) 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, 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 75-1.02, 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 proprietary 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.

20-4.03B(3) Expansion Assemblies

Expansion assemblies 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 at least 15 mils thick
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.

20-4.03B(4) Flange Insulating Gaskets

Flange insulating gaskets 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.

20-4.03B(5) Casing Insulators

Casing insulators must be:

1. 2-piece, 8-inch, 14-gauge epoxy-coated or galvanized steel band, four 2-inch-wide glass-reinforced polyester or polyethylene runners, with cadmium-plated nuts and bolts.
2. Coated with at least 15-mils heat-fused PVC to provide a nonconductive inner liner.

3. Factory constructed to ensure 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.

20-4.03B(6) Dirt Stops

Dirt stops must consist of a redwood cover with polyurethane foam.

Use construction heart grade redwood complying with 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.

20-4.03B(7) Seismic Expansion Assemblies

Seismic expansion assemblies must be a sleeve type expansion joint with integral ball joints at each end.

Seismic expansion assemblies must have:

1. Ability to withstand at least 15 degree angular deflection at each end and 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 at least 15 mils thick
5. Internal expansion sleeve limiting stop collars and 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.

20-4.03B(8) Lateral Restraint Assemblies

Lateral restraint assemblies must be (1) constructed from commercial quality steel components complying with section 75-1.02, (2) adjustable, and (3) able to resist a horizontal force of 10 percent of the contributory dead load.

20-4.03C Construction

Each ductile iron pipe must be connected and fully extended (pulled out) after joint assembly before the next pipe section is added.

Install flange insulating gaskets on the outside flange of seismic expansion assemblies and expansion assemblies.

20-4.03D Payment

Supply line on structures is paid for as supply line (bridge).

20-5 REMOTE IRRIGATION CONTROL SYSTEM

Reserved

20-6 REMOTE IRRIGATION CONTROL SYSTEM FUNCTIONAL TEST

Reserved

20-7 HIGHWAY PLANTING

20-7.01 GENERAL

20-7.01A Summary

Section 20-7 includes specifications for planting including clearing planting areas, preparing planting areas, and planting plants.

Some plants required for this Contract may not be readily available and must be grown specifically for this project.

20-7.01B Submittals

20-7.01B(1) Vendor Statement

Within 30 days after Contract approval, submit a statement from the vendor that the order for the plants to be grown for this Contract, including inspection plants and replacement plants, has been received and accepted by the vendor. The statement from the vendor must include the names, sizes, and quantities of plants ordered and the anticipated delivery date. Notify the Engineer when the vendor has started to grow the plants.

At least 60 days before planting the plants, submit a statement from the vendor that the order for the plants required for this Contract, including inspection plants, has been received and accepted by the vendor. The statement from the vendor must include the names, sizes, and quantities of plants ordered and the anticipated delivery date.

20-7.01B(2) Certificate of Compliance

Submit a certificate of compliance for:

1. Turf sod
2. Soil amendment
3. Mulch

Submit a 2 cu ft mulch sample with the mulch source listed on the bag and obtain approval before delivery of mulch to the job site.

20-7.01B(3) Product Data

Submit a copy of the root stimulant manufacturer's product sheet and the instructions for the application of the root stimulant.

20-7.01B(4) Nursery Invoice

Submit nursery invoices for plants furnished showing species or variety.

20-7.01C Quality Control and Assurance

Plants must comply with federal and state laws requiring inspection for plant diseases and infestations. Inspection certificates required by law must accompany each shipment of plants and must be furnished to the Engineer.

Obtain clearance from the county agricultural commissioner as required by law before planting plants delivered from a source outside the county where the plants are to be planted. Furnish evidence that clearance is obtained.

20-7.02 MATERIALS

20-7.02A General

Plant groups described but not specified under section 20-7.02 must comply with section 20-7.

Plants must be the variety and size shown and 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 *Carpobrotus* and *Delosperma* cuttings.

Furnish healthy, shapely and well-rooted plants with roots that show no evidence of being restricted or deformed. Plants must be well-grown, free from insect pests and disease, and grown in nurseries inspected by the Department of Food and Agriculture.

Root condition of plants furnished in containers are determined by removal of earth from the roots 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 provided from several sources, the roots of not less than 2 plants of each species or variety from each source must be inspected to determine the root condition.

If the sample plants inspected are found to be defective, including plants that are root bound or have an underdeveloped root ball, the entire lot or lots of plants represented by the defective samples may be rejected. Sample plants rendered unsuitable for planting because of this inspection are considered as samples at your expense.

20-7.02B Delivery, Storage, and Handling

Trucks used for transporting plants must be equipped with covers to protect plants from windburn.

Deliver fertilizer in labeled containers showing weight, chemical analysis, and name of the manufacturer.

Roots of plants not in containers must be kept moist and covered until the plants are planted.

Before transporting the plants to the planting area, thoroughly wet the root ball.

Handle and pack plants in an authorized way for the species or variety.

Protect turf sod with tarps or other protective covers during delivery. Do not allow turf sod to dry out during delivery or before placement.

Any plant, determined to be damaged or is dry or in a wilted condition when delivered to the planting area must be replaced.

20-7.02C Plants

20-7.02C(1) *Carpobrotus* and *Delosperma* Cuttings for Plant Group H

Carpobrotus cuttings must be 10 inches or more in length and not rooted. *Delosperma* cuttings must be 6 inches or more in length and not rooted. Cuttings must be tip cuttings from healthy, vigorous, and strong growing plants free from insects and disease.

Carpobrotus cuttings must not be taken from any plants that show the presence of ice plant scale (*Pulvinaria* species).

Mature or brown stem growths or cuttings that have been trimmed are not accepted.

Carpobrotus and *Delosperma* cuttings may be taken from existing plantings to the extent available within the highway under permit. Cuttings available from existing plants on the highway may not be enough to complete the work. Contact the Department's encroachment permit office in the district where the work is to be performed for information concerning areas where the removal of cuttings will be permitted.

Plant cuttings no more than 2 days after being cut. Do not allow cuttings to dry or wither.

20-7.02C(2) Liner Plants for Plant Group M

Do not use containers made of biodegradable material.

20-7.02C(3) Plug Plants for Plant Group P

Plug plants must be grown in individual container cells.

Do not use containers made of biodegradable material.

20-7.02C(4) Seedling Plants for Plant Group S

Seedling plants must be bare root.

20-7.02C(5) Turf Sod

Turf sod must be grown to comply with the Food & Agri Code. Turf sod must be free from disease, weeds, insects, and undesirable types of grasses and clovers. Soil upon which the turf sod is grown must contain less than 50 percent silt and clay.

Turf sod must be machine-cut to a uniform soil thickness of 5/8 ± 1/4 inch, not including top growth and thatch.

20-7.02D Miscellaneous

20-7.02D(1) Fertilizer

20-7.02D(1)(a) General

Fertilizer must comply with the requirements of the Food & Agri Code.

20-7.02D(1)(b) Slow-Release or Controlled-Release Fertilizer

Slow-release or controlled-release fertilizer must be a pelleted or granular form, must be slow-release or controlled-release with a nutrient release over an 8 to 12 month period, and must fall within the following guaranteed chemical analysis range:

Ingredient	Content (percent)
Nitrogen	16–21
Phosphoric acid	6-8
Water soluble potash	4-10

20-7.02D(1)(c) Packet Fertilizer

Packet fertilizer must be slow release or controlled release in a biodegradable packet. The packet must gradually release nutrients over a 12 month period. Each packet must have a weight of 10 ± 1g and have the following guaranteed chemical analysis:

Ingredient	Content (percent)
Nitrogen	20
Phosphoric acid	10
Water soluble potash	5

20-7.02D(1)(d) Organic Fertilizer

Reserved

20-7.02D(2) Root Stimulant

Reserved

20-7.02D(3) Foliage Protector

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

Wire edges at the top of the cylinder must be the uncut manufactured finished edge free of sharp points. 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

Comply with the specifications for jute mesh under section 21-1.02O(2).

Twine required to hold the jute mesh cover in place must be 1/8-inch diameter manila hemp twine.

20-7.02D(4) Iron Sulfate

Iron sulfate must be ferrous sulfate in pelleted or granular form containing not less than 18.5 percent iron expressed as metallic iron. Iron sulfate must comply with the Food & Agri Code.

20-7.02D(5) Edging

20-7.02D(5)(a) Header Board Edging

Anchor edging with stakes. Stakes must be the size and shape shown.

Lumber must be one of the following types:

1. Construction grade cedar

2. Pressure-treated Douglas fir
3. Construction heart grade redwood complying with 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.

20-7.02D(5)(b) Metal Edging

Metal edging must be commercial quality, made of aluminum or steel, and have an L-shaped design. Edging must be a minimum of 4 inches in height. Thickness must be as recommended by the manufacturer for commercial installation for the use intended. Anchor edging with steel spikes or stakes, whichever is provided by the manufacturer. Spike or stake size must comply with the manufacturer's recommendations for use and site conditions.

20-7.02D(5)(c) High Density Polyethylene Edging

Edging must be commercial quality HDPE edging. Edging must be a minimum of 4 inches in height. Thickness must be as recommended by the manufacturer for commercial installation for the use intended. Anchor edging with spikes or stakes, whichever is provided by the manufacturer. Spike or stake size must comply with the manufacturer's recommendations for use and site conditions.

20-7.02D(5)(d) Concrete Edging

Concrete for edging must be minor concrete.

20-7.02D(6) Mulch

20-7.02D(6)(a) 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 other chemical residues harmful to plant or animal life.

20-7.02D(6)(b) Tree Bark Mulch

Tree bark mulch must be derived from cedar, Douglas fir, or redwood species.

Tree bark mulch must be ground so that a minimum of 95 percent of the material by volume is less than 2 inches and no more than 30 percent by volume is less than 1 inch.

20-7.02D(6)(c) Wood Chip Mulch

Wood chip mulch must be derived from clean wood and not contain leaves or small twigs.

Wood chip mulch must have an average thickness of 1/16 inch, length between 1/2 inch and 3 inches, and a width 3/8 inch or greater. At least 95 percent of wood chips, by volume, must conform to these dimensions.

20-7.02D(6)(d) Shredded Bark Mulch

Shredded bark mulch must be a blend of loose, long, thin wood or bark pieces derived from trees with a high length-to-width ratio. A minimum of 95 percent of the wood strands must have lengths from 2 to 8 inches, with a width and thickness from 1/8 to 1-1/2 inches.

20-7.02D(6)(e) Tree Trimming Mulch

Tree trimming mulch must be derived from chipped trees and may contain leaves and small twigs.

Tree trimming mulch must have a particle size such that a minimum of 95 percent of the material by volume is less than 3 inches and no more than 30 percent by volume is less than 1 inch.

20-7.02D(7) Root Barrier

Reserved

20-7.02D(8) Root Protector

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

Wire edges at the top of the cylinder must be the uncut manufactured finished edge free of sharp points.

Galvanized wire mesh must be treated with a chemical solution that will remove the galvanized material prior to installation.

20-7.02D(9) Soil Amendment

Soil amendment must comply with the requirements in the Food & Agri Code.

20-7.02D(10) Wood Plant Stakes

Plant stakes installed at trees and shrubs must be of sufficient lengths to support each plant in an upright position. Plant stakes must be either 2 inch nominal diameter or 2 by 2 inch nominal size stakes.

Plant stakes for vines must be 1 by 1 inch nominal size stakes, 18 inches long.

20-7.02D(11) Plant Ties

Plant ties must be extruded vinyl-based tape, 1 inch wide and a minimum of 10 mils thick.

20-7.03 CONSTRUCTION

20-7.03A General

Planting includes delivery, storage, and handling.

Planting includes plant stakes and plant ties.

20-7.03B Roadside Clearing

20-7.03B(1) General

Roadside clearing includes:

1. Removing of trash and debris
2. Removing of existing plants
3. Killing, controlling, and mowing weeds
4. Controlling rodents and pests

Perform roadside clearing where described.

Remove existing plants where described. 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 finished grade with material obtained from adjacent areas.

Weeds within the wildflower seeding areas must be controlled by mowing until the start of the wildflower seeding operation.

Where pesticides are used to kill weeds, weeds must be killed before they reach the seed stage of growth or exceed 4 inches in length, whichever occurs first.

Areas to be mowed must be mowed before the weeds reach the seed stage of growth or exceed 6 inches in length, whichever occurs first. Weeds must be mowed to a height of 3 inches. Remove trash and debris before mowing.

A growth regulator may be applied to weed growth in mowed areas. Growth regulator must be applied before the weeds reach the seed stage of growth or exceed 6 inches in length, whichever occurs first.

Weeds to be hand pulled must be pulled before they reach the seed stage of growth or exceed 4 inches in length, whichever occurs first, except for tumbleweeds.

Tumbleweeds must be killed by hand pulling before they reach the seed stage of growth or exceed 6 inches in length, whichever occurs first.

20-7.03B(2) Initial Roadside Clearing

Disposal of weeds killed during the initial roadside clearing is not required except for:

1. Weeds killed from within areas where asphalt concrete surfacing, concrete surfacing, rock blankets, graveled or decomposed granite areas are to be placed, and unpaved gore areas between the edge of pavement and planting areas as shown.
2. Weeds killed by hand pulling. Dispose of them the same day they are pulled.
3. Tumbleweeds. Dispose of them the same day they are pulled.

Dispose of weeds controlled by mowing that are outside of mulched areas, plant basins, ground cover and within wildflower seeding areas.

Dispose of existing ground cover.

20-7.03B(3) After Initial Roadside Clearing

After the initial roadside clearing work is complete, additional roadside clearing work must be performed as often as required to maintain the areas in a neat and presentable condition. Continue the work as specified under initial roadside clearing until Contract acceptance or the start of the plant establishment period. This work includes killing weeds in plant basins, including basin walls by hand pulling after the plants have been planted.

Disposal of mowed material and weeds killed during the after initial roadside clearing is not required except for:

1. Weeds killed from within areas where asphalt concrete surfacing, concrete surfacing, rock blankets, graveled or decomposed granite areas are to be placed, and unpaved gore areas between the edge of pavement and planting areas as shown.
2. Weeds killed by hand pulling. Dispose of them the same day they are pulled.
3. Tumbleweeds. Dispose of them the same day they are pulled.

Dispose of existing ground cover.

20-7.03C Prepare Planting Area

Prepare planting area includes:

1. Preparing holes including constructing plant basins
2. Preparing trenches including constructing plant basins
3. Cultivating
4. Weed germination
5. Constructing edging

20-7.03D Prepare Hole

The Engineer designates the ground location of all plants by directing the placing of the plants or placing of stakes or other suitable markers.

Conduct work so the existing flow line in drainage ditches is maintained. Material displaced by your operations that interferes with drainage must be removed.

Unless larger planting holes are specified, plants must be planted in holes 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 holes from being excavated, new holes must be excavated and the abandoned holes backfilled.

Excavate planting holes by hand digging or by drilling. Do not use water for the excavation of planting holes.

At locations shown, longitudinal basins must be formed by constructing a continuous dike on each side of the planting line. Form cross checks to pond irrigation water around each plant.

Remove existing pavement shown where planting holes are to be excavated.

20-7.03E Prepare Trench

Center planting trenches on the planting line.

Unless otherwise described, the trench width and depth must be large enough to receive the plant roots or root ball, soil amendments, and fertilizer.

Soil amendments, if specified to be added to the plants, must be added to the plant location of each plant at the rate shown and thoroughly mixed with the trench soil.

Remove existing pavement shown where planting trenches are to be excavated.

20-7.03F Cultivate

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 use of rubber-tired equipment will be permitted for cultivating operations provided the equipment used completely eradicates any compaction caused by the tires. Rubber-tired equipment of any kind will not be allowed on cultivated areas after cultivation.

The outer limits of the areas to be cultivated must extend 12 inches beyond the outer rows of plants requiring cultivation, unless otherwise described.

Cultivate areas to be cultivated before adding soil amendment and fertilizer.

Add soil amendment and fertilizer at the rates shown.

Recultivate to thoroughly mix soil amendment and fertilizer with the soil.

Planting areas that have been cultivated and become compacted must be recultivated.

Rocks or debris encountered during soil preparation in planting areas must be brought to the surface of the ground. Remove rocks or debris larger than 2 inches in maximum dimension unless otherwise authorized.

Remove existing pavement shown where cultivation is to be done.

20-7.03G Weed Germination

Reserved

20-7.03H Edging

Construct edging as shown, including excavation and backfill.

Spike or stake spacing must comply with the manufacturer's instructions for use and site conditions.

Saw cut surfaces where (1) asphalt concrete or concrete surfacing must be removed to permit 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.

20-7.03I Planting

20-7.03I(1) General

Planting work includes:

1. Planting plants
2. Applying or placing fertilizer, applying iron sulfate, adding soil amendment, and placing or spreading mulch
3. Staking plants
4. Installing turf sod

5. Watering
6. Installing foliage protector, root barrier, and root protector
7. Plant replacement

Do not begin planting until authorized.

Do not perform planting in an area until the functional test has been completed for the irrigation system serving that area.

Adjust plant locations for trees and shrubs so no plant is closer than 8 feet to an impact, rotary gear driven or pop-up type sprinkler.

Trees, shrubs, and vines planted within ground cover or cutting planting areas or both must be planted before ground cover plants or cuttings are planted.

Where shrubs and ground covers 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 ground covers in adjacent rows. Adjustment in the number or alignment of plants must be made between the outer rows.

Where vines are to be planted against walls or fences, plant as close as possible to the wall or fence.

Vines planted next to walls and fences must be staked and tied thereto as shown, at the time of planting.

Vines planted next to fences must be tied to the fence with plant tie material at the time of planting.

Core holes in concrete masonry block wall as shown.

Do not distribute more plants than can be planted and watered on that day.

Remove containers from plants when planting.

Remove containers from plants in such a manner that the ball of earth surrounding the roots is not broken. Plant containers must not be cut before delivery of the plants to the planting area. Plant and water plants immediately after removal from their containers.

Before planting, apply water to the backfill with a pipe or tube inserted into the bottom of the hole or trench until the backfill material is saturated for the full depth.

Set plants in the backfill material in flat bottom holes to a depth so that after settlement of the backfill, the backfill is 1 inch below the top of the root ball as shown. If the backfill material settles below this level after planting and watering, add additional backfill to bring the backfill to the required level after planting.

Plants must be planted in such a manner that the roots are not restricted or distorted.

Any plant that has settled deeper than shown must be raised back to the required level after planting.

The Department rejects or suspends planting work if (1) planting is done in soil that is too wet, too dry or not properly conditioned as specified or (2) planting is in a condition not generally accepted as satisfactory for planting from a horticultural standpoint.

Backfill material for plant holes must be a mixture of native soil and soil amendment. Soil amendment must be added at the rate shown. Thoroughly mix backfill material and uniformly distribute throughout the entire depth of the plant hole without clods or lumps.

Remove nursery stakes after planting.

20-7.03I(2) *Carpobrotus* or *Delosperma* Cuttings for Plant Group H

Plant *Carpobrotus* cuttings to a depth where not less than 2 nodes are covered with soil. The basal end of *Delosperma* cuttings must not be less than 2 inches below the surface of the soil and the basal end of *Carpobrotus* cuttings must be not less than 4 inches below the surface of the soil.

Apply root stimulant to *Delosperma* cuttings before planting and apply root stimulant according to the manufacturer's instructions.

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.

20-7.03I(3) Liner Plants for Plant Group M

Reserved

20-7.03I(4) Plug Plants for Plant Group P

Reserved

20-7.03I(5) Seedling Plants for Plant Group S

Reserved

20-7.03I(6) Fertilizer

Apply or place fertilizer at the time of planting, at the rate shown.

Slow-release, controlled-release or organic fertilizer required during planting as described, must be mixed into the plant hole backfill a minimum depth of 2 inches near the root ball.

Packet fertilizer required during planting as described, must be placed in the backfill of each plant. Place to 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.

Fertilizer required during planting as described, must be applied to ground cover plants planted from cuttings, plugs, or flats immediately after planting and watered into the soil.

20-7.03I(7) Foliage Protector

Install foliage protectors over the plants within 2 days after planting.

Install foliage protectors vertically and centered over the plant as shown. If foliage protectors are not installed in plant basins, 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.

Install 2 support stakes for foliage protectors vertically and embed in the soil on opposite sides of the plant as shown and in a transverse direction to the prevailing wind.

Either weave the support stakes through the wire cylinder mesh at 6 inch maximum centers or fasten the wire cylinder to the support stakes at 6 inch maximum centers.

The wire cylinder must be snug against the support stakes but loose enough to be raised for pesticide application or to perform weeding within the plant basin.

Install jute mesh cover over the foliage protector and secure with twine as shown.

20-7.03I(8) Iron Sulfate

Apply iron sulfate at the time of planting, at the rate shown.

Comply with the manufacturer's instructions.

Iron sulfate required during planting as described, must be evenly distributed within the plant basin and mixed into the plant hole backfill a minimum depth of 2 inches.

20-7.03I(9) Ground Cover

Ground cover plants in areas with an irrigation system must be planted in blocks that comply with the design of the irrigation system.

Each ground cover planting area covered by a single control valve must be completely planted and watered before planting other ground cover planting areas.

Plant ground cover plants in moist soil, and in neat, straight rows, spaced as shown. Do not plant ground cover plants closer than 5 feet to trees or shrubs, nor closer than 6'-6" to curbs, dikes, paved areas, walls, and fences, unless shown.

20-7.03I(10) Mulch

Spread mulch placed in areas outside of plant basins to a uniform thickness as shown.

Mulch must be placed at the rate described and placed in the plant basins or spread in areas as shown after the plants have been planted. Mulch placed in plant basins must not come in contact with the plant crown and stem.

Spread mulch from the outside edge of the proposed plant basin or plant without basin to the adjacent edges of shoulders, paving, retaining walls, dikes, curbs, sidewalks, walls, fences, and existing plantings. If the proposed plant or plant without basin is 12 feet or more from the adjacent edges of shoulders, paving, retaining walls, dikes, curbs, sidewalks, walls, fences, and existing plantings, spread the mulch 6 feet beyond the outside edge of the proposed plant basin or plant without basin.

Do not place mulch within 4 feet of the (1) flow line of earthen drainage ditches, (2) edge of paved ditches, or (3) drainage flow lines.

20-7.03I(11) Watering

Plants must be watered immediately after planting. Water must be applied until the backfill soil around and below the roots or ball of earth around the roots of each plant is thoroughly saturated. When watering with a hose, an accepted nozzle, water disbursement device or pressure reducing device must be used. Do not allow the full force of the water from the open end of the hose to fall within the basin around any plant. Ground cover plants in areas provided with an irrigation system must be watered by sprinklers. Several consecutive waterings may be necessary to thoroughly saturate the soil around each plant.

20-7.03I(12) Root Barrier

Reserved

20-7.03I(13) Root Protector

Install root protectors at the time the plant holes are being prepared as shown. Place root protectors in the plant holes as shown.

20-7.03I(14) Turf Sod

Areas to be planted with sod must be cultivated.

Fine grade and roll areas to be planted with sod after completing cultivation, installation of irrigation systems, and excavation and backfilling of plant holes. Grade to drain. Grade to a smooth and uniform surface before placing sod.

Areas planted with sod 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 ends of adjacent strips of sod are staggered a minimum of 2 feet. Place edges and ends 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 sod. Water the sodded areas so that the soil is moistened 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.

Turf sod edges, including edges adjacent to sidewalks, edging, and other paved borders and surfaced areas, must be trimmed to a uniform edge not extending beyond the edge of turf or the facilities. Mowed and trimmed growth must be removed.

20-7.03I(15) Plant Stakes and Ties

Plants to be staked must be staked at the time of planting as shown.

Install 2 plant stakes for each plant to be staked as shown, against but not through the root ball.

Tie the plant to the stakes with plant ties, 1 tie to each stake. Install ties at the lowest position that will support the plant in an upright position. Ties must provide trunk flexibility but not allow the trunk to rub against the stakes. Each tie must form a figure 8 by crossing the tie between the plant and the stake as shown. The figure 8 must be formed twice. Wrap each end of the tie 1-1/2 turns around the stake and securely tie.

The top of the stakes must have a minimum 4 inch clearance from the bottom of the tree crown where applicable after installation of tree stakes.

20-7.03I(16) Replacement Plants

Plants that show signs of failure to grow at any time or 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 requirements, spacing, and size provisions described for the plants being replaced.

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 the appropriate time so 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.

20-7.04 PAYMENT

Measure root barriers by the total length of the installed panels, measured parallel to the ground surface.

Items paid by the sq yd are calculated by actual or computed slope measurements.

Measurement for slow-release or controlled-release fertilizer, organic fertilizer, or iron sulfate is determined from marked weight or sack count.

Mulch and soil amendment are measured in the vehicle at the point of delivery.

Cultivation area is measured from areas shown to be planted with plants requiring cultivation, plus the area 12 inches beyond the outer row of plants in each area. Planting areas for plants within the cultivation areas that do not require cultivation will not be deducted from the cultivation payment area.

Various sizes and types of plants are measured by either the product of the average plant density and the total area planted or by actual count of the living plants in place, determined by the Engineer. The average plant density is the number of living plants per sq yd determined from actual count of test areas chosen representing the total planted area. The size and location of the test areas is determined by you and the Engineer, except that the total area tested must be equal to not less than 3 percent nor more than 5 percent of the planted area being determined. The Engineer will make the final determination of the areas to be tested.

Work described in this section is paid under bid items specified under section 20-7.02, except for Roadside Clearing, Prepare Hole, Prepare Trench, Cultivate, and Weed Germination.

20-8 WILDFLOWER SEEDING

20-8.01 GENERAL

20-8.01A Summary

Section 20-8 includes specifications for planting wildflower seeds including mowing weeds, scarifying the soil, incorporating fertilizer, and dry applying native wildflower seed to wildflower seeding areas shown.

Pesticides must not be used on wildflower seeding areas after the seed has been applied.

Comply with section 20-9.03F.

20-8.01B Submittals

Submittals must comply with section 21-1.01B.

20-8.01C Quality Control and Assurance

Quality control and assurance must comply with section 21-1.01C.

20-8.01D Site Conditions

The Engineer designates the extent of wildflower seeding 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 wildflower seeding.

20-8.02 MATERIALS

20-8.02A General

Reserved

20-8.02B Delivery, Storage, and Handling

Delivery, storage, and handling must comply with section 21-1.02B.

20-8.02C Seed

Seed must comply with section 21-1.02G.

20-8.02D Fertilizer

20-8.02D(1) Organic Fertilizer

Reserved

20-8.03 CONSTRUCTION

20-8.03A General

Reserved

20-8.03B Site Preparation

Immediately before applying wildflower seed to wildflower seeding areas, trash and debris must be removed and weeds must be mowed as close to the ground as possible. Disposal of mowed material is not required.

After mowing and just before seed application, wildflower seeding areas must be scarified to a minimum depth of 1 inch.

20-8.03C Application

Apply seed and fertilizer at the rates shown and incorporate into the soil to a maximum depth of 1/4 inch by raking, dragging, or drilling.

Watering of wildflower seeding areas is not required unless ordered. If ordered, watering is change order work.

20-8.03D Maintenance

Reserved

20-8.04 PAYMENT

Wildflower seeding is measured by the area parallel to the ground surface.

20-9 PLANT ESTABLISHMENT WORK

20-9.01 GENERAL

20-9.01A Summary

Section 20-9 includes specifications for performing plant establishment work that consists of caring for the highway planting, including watering plants, pruning plants, replacing damaged plants, weed, rodent and pest control, and the operation and repair of all existing irrigation facilities used and irrigation facilities installed as part of the new irrigation system.

20-9.01B Definitions

Type 1 plant establishment: Plant establishment period with the number of working days specified for plant establishment beginning 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 beginning after all planting work has been completed except for plant establishment work and other bid items specified to be performed until Contract acceptance, provided that the Contract must not be accepted 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 completed portion of the work under section 5-1.38, Type 2 plant establishment period for the completed portion of the work is the time between completion of all planting work except for plant establishment work, and the granting of maintenance and protection relief, provided that the relief must not be granted 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.

20-9.01C Submittals

20-9.01C(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 utilize 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 not less than 30 days before completion of the plant establishment period.

20-9.01C2) Notification

The Engineer will notify you in writing when the plant establishment period begins and will furnish 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.

20-9.02 MATERIALS

20-9.02A General

Reserved

20-9.02B Fertilizer

Fertilizer must comply with section 20-7.02D(1)(b) and 20-7.02D(1)(d).

20-9.03 CONSTRUCTION

20-9.03A General

Working days on which no work is required, as determined by the Engineer, will be credited as a plant establishment working day, regardless of whether or not you perform plant establishment work.

Working days whenever you fail to adequately perform plant establishment work will not be credited toward the plant establishment working days.

Remove trash and debris.

Surplus earth accumulated in roadside clearing and planting areas must be removed.

20-9.03B Plant Growth Control

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 proposed and existing ground cover from within the plant basins, including basin walls, turf areas, and planting areas within edging.

Vines next to walls and fences must be kept staked and tied. Train vines on fences and walls or through cored holes in walls.

20-9.03C Fertilizer

Apply fertilizer to the plants as specified and water into the soil after each application.

Apply fertilizer at the rates shown and spread with a mechanical spreader, whenever possible.

20-9.03D Weed Control

Weeds in roadside clearing and planting areas as described must be controlled as specified in section 20-7.03B.

A growth regulator may be applied to weed growth in mowed areas. Growth regulator must be applied before the weeds reach the seed stage of growth or exceed 6 inches in length, whichever occurs first.

Where pesticides are used to kill weeds, weeds must be killed before they reach the seed stage of growth or exceed 4 inches in length, whichever occurs first.

Where weeds are to be mowed, mow weeds before they reach the seed stage of growth or exceed 6 inches in length, whichever occurs first. Mow weeds to a height of 3 inches. Disposal of mowed weeds is not required. Remove trash and debris before mowing.

Where weeds are to be killed by hand pulling, weeds must be hand pulled before they reach the seed stage of growth or exceed 4 inches in length, whichever occurs first, except for tumbleweeds. Dispose of weeds the same day they are pulled.

Tumbleweeds are to be killed by hand pulling before the tumbleweeds reach the seed stage of growth or exceed 6 inches in length, whichever occurs first. Dispose of tumbleweeds the same day they are pulled.

Remove dead weed growth if the Engineer determines it will interfere with subsequent plant establishment or become unsightly.

Perform weed control to maintain the highway in a neat and presentable condition.

20-9.03E Rodent and Pest Control

Control rodents and pests.

20-9.03F Wildflower Seeding Restrictions

The Engineer notifies you of the start of the plant establishment period if (1) wildflower seeding cannot be performed within the time limits specified and (2) the Engineer determines that the work except for wildflower seeding and plant establishment work has been completed.

Wildflower seeding that is not performed before the start of the plant establishment period must be performed during the plant establishment period at a time determined by the Engineer.

Plant establishment work, except for mowing, is not required for wildflower seeding areas after sowing wildflower seed. Mow after wildflower seeds have set and the wildflowers have started to die back. Mow wildflowers to a height of 3 inches. Remove trash and debris before mowing.

20-9.03G Plant Staking

Replace the plant stakes that are inadequate to support plants with larger stakes at your expense if authorized.

Remove plant stakes when the Engineer determines they are no longer needed.

20-9.03H Replacement Plants

Replacement plants must comply with section 20-7.03I(16).

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.

Replacement of plants after the 125th plant establishment working day must comply with the following size requirements:

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 comply with the following spacing requirements:

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

20-9.03I Watering

Operate the electric automatic irrigation systems in the automatic mode unless authorized.

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.

Water plants utilizing the remote irrigation control system software program unless authorized.

Implement the watering schedule program not less than 10 working days before completion of the plant establishment period.

20-9.03J Miscellaneous Plant Establishment Work

Mow and trim turf areas. Dispose of mowed and trimmed material.

If irregular or uneven areas appear within turf areas, restore to a smooth and even appearance. Re-seed turf seed areas.

Remove the tops of foliage protectors if plants become restricted.

Remove foliage protectors, including support stakes, within 20 working 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 working 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 working days before the completion of the plant establishment period.

20-9.03K Training

Provide training by a qualified person on the use and adjustment of the irrigation controllers installed, 30 working days before completion of the plant establishment period.

20-9.03L Final Inspection

Complete the final inspection not more than 30 working days and not less than 20 working days before the completion of the plant establishment period.

20-9.04 PAYMENT

Not Used

20-10 DECOMPOSED GRANITE

20-10.01 GENERAL

20-10.01A Summary

Section 20-10 includes specifications for placing and stabilizing decomposed granite as shown.

20-10.01B Submittals

Submit the following:

1. Product data including the manufacturer's product sheet together with the instructions for installing the filter fabric and solidifying emulsion.
2. Certificates of compliance for the following items at least 5 business days before delivery of the materials to the job site:
   2.1. Filter fabric.
   2.2. Solidifying emulsion.
3. Five pound sample of the decomposed granite.

20-10.01C Quality Control and Assurance

20-10.01C(1) Test Plot

Construct a test plot at least 3 by 12 feet at a location designated by the Engineer. Notify the Engineer not less than 7 days before constructing the test plot. Construct the test plot with the same materials, tools, equipment, and methods to be used in the final placement of the decomposed granite.

The test plot must be constructed so that the decomposed granite is (1) mixed with the solidifying emulsion and water under the manufacturer’s rates and instructions and (2) compacted to a relative compaction of not less than 90 percent. If ordered, construct additional test plots. Additional test plots are change order work.

Obtain authorization of the test plot before placing the decomposed granite. Use the authorized test plot as the standard for comparison in determining acceptability of the decomposed granite. If the test plot is not incorporated into the work and the Engineer determines it is no longer needed, remove of it.

20-10.02 MATERIALS

20-10.02A General

Reserved

20-10.02B Soil Sterilant

Soil sterilant must be oxadiazon granular preemergent and must comply with section 20-1.02B.

20-10.02C Edging

Edging and stakes must comply with section 20-7.02D(5).

20-10.02D Aggregate Base

Aggregate base must comply with the 3/4-inch maximum, aggregate grading under section 26-1.02B.

20-10.02E Filter Fabric

Filter fabric must be Class A.

20-10.02F Fasteners

Staples for filter fabric must comply with section 21-1.02R.

20-10.02G Decomposed Granite

Reserved

20-10.02H 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 alter the decomposed granite color.

20-10.03 CONSTRUCTION

20-10.03A General

Reserved

20-10.03B Earthwork

Earthwork must comply with section 19.

Excavate areas to receive decomposed granite to the depth shown after clearing. Where decomposed granite is to be placed adjacent to existing curbs, dikes, pavement, sidewalks or sound walls, excavate so that the finished decomposed granite elevation adjacent to those items will maintain the planned flow lines, slope gradients, and contours of the job site. After excavation, grade subgrade to receive decomposed granite to a smooth, uniform surface, and compact to not less than 90 percent relative compaction.

20-10.03C Treatment of Soil

Sterilize areas with oxadiazon after compaction. Apply soil sterilant at the maximum label rate. Do not apply soil sterilant more than 12 inches beyond the decomposed granite limits. The soil sterilant application and decomposed granite placement must be completed in these areas within the same work day.

20-10.03D Edging

Install edging to delineate the limits of the decomposed granite areas. Edging will not be required between decomposed granite areas and the adjacent face of sound walls, pavement edges, curbs, dikes or rock blanket areas.

20-10.03E Aggregate Base

Spread and compact aggregate base as specified under section 26-1.03C and section 26-1.03D.

20-10.03F Filter Fabric

Immediately before placing filter fabric, 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 fabric to prevent movement of fabric by placement of decomposed granite.

Repair or replace fabric damaged during placement of decomposed granite with sufficient fabric to comply with overlap requirements.

20-10.03G Decomposed Granite

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 delivered in mixer trucks from a local ready-mixed plant.

Place decomposed granite uniformly in layers no more than 1-1/2 inch thick. Compact each layer of decomposed granite to a relative compaction of not less than 90 percent. Compaction must not begin less than 6 hours or more than 48 hours after placement.

Apply a final application of solidifying emulsion 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 and uniform, compacted to a relative compaction of not less than 90 percent, maintaining original flow lines, slope gradients, and contours of the job site.

20-10.04 PAYMENT

Decomposed granite is measured parallel to the decomposed granite surface.

20-11 GRAVEL MULCH

20-11.01 GENERAL

20-11.01A Summary

Section 20-11 includes specifications for placing gravel mulch as shown.

20-11.01B Submittals

Submit the following:

1. Product data including the manufacturer's product sheet and the instructions for installing the filter fabric
2. Certificate of compliance for filter fabric at least 5 business days before delivery of the material to the job site
3. Five pound sample of the gravel mulch

20-11.02 MATERIALS

20-11.02A General

Reserved

20-11.02B Soil Sterilant

Soil sterilant must be oxadiazon granular preemergent and must comply with section 20-1.02B.

20-11.02C Edging

Edging and stakes must comply with section 20-7.02D(5).

20-11.02D Aggregate Base

Aggregate base must comply with 3/4 inch maximum, aggregate grading under section 26-1.02B.

20-11.02E Filter Fabric

Filter fabric must be Class A.

20-11.02F Fasteners

Staples for filter fabric must comply with section 21-1.02R.

20-11.02G Gravel Mulch

Reserved

20-11.03 CONSTRUCTION

20-11.03A General

Reserved

20-11.03B Earthwork

Earthwork must comply with section 19.

Excavate areas to receive gravel mulch to the depth shown after clearing. Where gravel mulch is to be placed adjacent to existing curbs, dikes, pavement, sidewalks or sound walls, excavate so that the

finished gravel mulch elevation adjacent to those items will maintain the planned flow lines, slope gradients, and contours of the job site. After excavation, grade subgrade to receive gravel mulch to a smooth, uniform surface, and compact to not less than 90 percent relative compaction.

20-11.03C Treatment of Soil

Sterilize areas with oxadiazon after compaction. Apply soil sterilant at the maximum label rate. Do not apply soil sterilant more than 12 inches beyond the gravel mulch limits. The soil sterilant application and gravel mulch placement must be completed in these areas within the same work day.

20-11.03D Edging

Install edging to delineate the limits of the gravel mulch areas. Edging is not required between gravel mulch areas and the adjacent face of sound walls, pavement edges, curbs, dikes or rock blanket areas.

20-11.03E Aggregate Base

Spread and compact aggregate base as specified under section 26-1.03C and section 26-1.03D.

20-11.03F Filter Fabric

Immediately before placing filter fabric, 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 fabric to prevent movement of fabric by placement of gravel mulch.

Repair or replace fabric damaged during placement of gravel mulch with sufficient fabric to comply with overlap requirements.

20-11.03G Gravel Mulch

Do not place gravel mulch during rainy conditions.

Place gravel and compact by rolling.

The finished gravel mulch surface must be smooth and uniform, maintaining original flow lines, slope gradients, and contours of the job site.

20-11.04 PAYMENT

Gravel mulch is measured parallel to the gravel mulch surface.

20-12 ROCK BLANKET

20-12.01 GENERAL

20-12.01A Summary

Section 20-12 includes specifications for placing rock blanket as shown.

20-12.01B Submittals

Submit a 1 sq yd sample of the various rock sizes.

20-12.02 MATERIALS

20-12.02A General

Reserved

20-12.02B Soil Sterilant

Soil sterilant must be oxadiazon granular preemergent and must comply with section 20-1.02B.

20-12.02C Concrete

Concrete must comply with the specifications for minor concrete and have a maximum aggregate size of 3/4 inch.

20-12.02D Rock

Reserved

20-12.02E Mortar

Mortar must comply with section 51-1.02F.

20-12.03 CONSTRUCTION

20-12.03A General

Reserved

20-12.03B Earthwork

Earthwork must comply with section 19.

Excavate areas to receive rock blanket to the depth shown after clearing. Where rock blanket is to be placed adjacent to existing curbs, dikes, pavement, sidewalks or sound walls, excavate so that the finished rock blanket elevation adjacent to those items will maintain the planned flow lines, slope gradients, and contours of the job site. After excavation, grade subgrade to receive rock blanket to a smooth, uniform surface, and compact to not less than 90 percent relative compaction.

20-12.03C Treatment of Soil

Sterilize areas with oxadiazon after compaction. Apply soil sterilant at the maximum label rate. Do not apply soil sterilant more than 12 inches beyond the rock blanket limits. The soil sterilant application and rock blanket placement must be completed in these areas within the same work day.

20-12.03D Placement

Place concrete as shown.

Rock must be placed while concrete is still plastic.

Space rocks a maximum of 1/2 inch apart.

Rocks must have a 1 inch maximum separation between the top of adjacent rock surfaces.

Remove concrete adhering to the exposed surfaces of the rock.

Loose rocks, or rocks with a gap greater than 3/8 inch, must be reset by methods accepted by the Engineer. The rock gap is measured from the edge of the rock to the surrounding concrete bedding.

Place mortar as shown.

20-12.04 PAYMENT

Rock blanket is measured parallel to the rock blanket surface.

20-13 ROCK STAINING

20-13.01 GENERAL

20-13.01A Summary

Section 20-13 includes specifications for applying stain to the exterior surface of landscape boulders, native rock that has been damaged or scarred, rock energy dissipaters, rock slope protection and gabion surfaces.

20-13.01B Submittals

Submit the following:

1. Work plan showing methods to control overspray and spillage, and to protect adjacent surfaces
2. Product data including the manufacturer's product sheet and the instructions for the application of the stain

20-13.01C Quality Control and Assurance

20-13.01C(1) Test Plot

Apply stain to a test plot rock area not less than 3 by 3 feet at a location designated by the Engineer. Notify the Engineer not less than 7 days before staining the test plot. Prepare and stain the test plot with the same materials, tools, equipment, and methods to be used in staining final surfaces. Separate test plots are required for staining rock slope protection and native rock. If ordered, prepare additional test plots. Additional test plots are change order work.

Obtain authorization of the test plot before staining surfaces. Use the authorized test plot as the standard for comparison in determining acceptability of staining. If the test plot is not incorporated into the work and the Engineer determines it is no longer needed, remove of it.

20-13.02 MATERIALS

20-13.02A General

Reserved

20-13.02B Stain

Reserved

20-13.03 CONSTRUCTION

20-13.03A General

Reserved

20-13.03B Application

Before applying stain, the areas to be stained must be identified and authorized.

Remove oils, dirt, and other contaminants and then dry surfaces before staining.

After areas to be stained have been identified, prepared, and test plot authorized, stain exposed surfaces under the manufacturer's instructions to achieve a color consistent with, or as close as possible to, the authorized test area color.

Control overspray and protect adjacent surfaces.

Stained surfaces must be kept dry for a minimum of 20 days following the application of stain.

20-13.04 PAYMENT

Rock stain areas are measured along the slope face.

20-14 WILLOW CUTTINGS FOR PLANT GROUP W

20-14.01 GENERAL

20-14.01A Summary

Section 20-14 includes specifications for obtaining, transporting, preparing planting holes, and planting willow cuttings.

20-14.01B Submittals

Submit the following:

1. Work plan for maintaining willow cuttings
2. Product data including a copy of the root stimulant manufacturer's product sheet and the instructions for the application of the root stimulant

20-14.02 MATERIALS

20-14.02A General

Reserved

20-14.02B Willow Cuttings for Plant Group W

Take cuttings from areas shown or designated by the Engineer. Take cuttings at random from healthy, vigorous plants. Do not cut more than 50 percent of the plants in an area. Do not cut more than 25 percent of an individual plant. Make cuts with sharp, clean tools.

A cutting must be:

1. Reasonably straight
2. 20 to 24 inches in length
3. 3/4 to 1-1/2 inch in diameter at the base of the cutting

The top of each cutting must be cut square above a leaf bud. The base must be cut below a leaf bud at approximately a 45 degree angle.

Trim off leaves and branches flush with the stem of the cutting.

Keep cuttings wet until planted.

20-14.02C Packet Fertilizer

Comply with the specifications for packet fertilizer under section 20-7.02D(1)(c).

20-14.02D Root Stimulant

Reserved

20-14.03 CONSTRUCTION

20-14.03A General

Reserved

20-14.03B Planting

Before planting, remove trash, debris, and weeds within an area 2 feet in diameter centered at each proposed planting location as shown. Pesticides must not be used for weed control within the 2 foot diameter.

Plant cuttings within 48 hours after cutting. Cuttings not planted within 48 hours after cutting or allowed to dry out must not be used.

Planting holes must be made perpendicular to the ground line and must be formed with a steel bar or excavated by the use of an auger, post hole digger, or similar tools. Plant holes must be large enough to receive the cuttings and planted to the specified depths without damaging the bark.

Where rock or other hard material prohibits the excavation of the planting holes, excavate new holes and backfill the unused holes.

If the soil in and around the plant hole is not wet before planting, the soil must be watered and kept wet until the cuttings are planted.

Apply root stimulant according to the manufacturer's instructions.

Plant the base of the cutting from 10 to 12 inches deep and have from 3 to 5 bud scars exposed above the ground. If more than 5 bud scars are exposed, remove the excess scars by pruning.

Place 1 fertilizer packet in the backfill of each cutting. Place to within 6 to 8 inches of the ground surface and approximately 1 inch from the cutting.

After planting, the plant holes must be backfilled with excavated material. The excavated material must be distributed evenly within the hole without clods, lumps, or air pockets. Compact the backfill without damaging the cutting's bark. Compaction must be enough so that the cutting is prevented from being easily removed from the soil.

Dispose of trimmings, prunings, and unused cuttings.

Replace dead cuttings under section 20-7.03I(16).

20-14.03C Maintain Planted Willow Cuttings

Reserved

20-14.04 PAYMENT

Willow cuttings are measured from actual count in place. No payment is made for unused cuttings and replacement cuttings.

20-15 SITE FURNISHINGS

Reserved

21 EROSION CONTROL

21-1.01 GENERAL

21-1.01A Summary

Section 21 includes specifications for applying permanent erosion control measures to the soil surface.

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.

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.

21-1.01B Submittals

Submit a certificate of compliance for tackifier, bonded fiber matrix, and polymer-stabilized fiber matrix at least 5 business days before application. Certificates of compliance must include:

1. *Material Safety Data Sheet*
2. Product label
3. List of applicable nonvisible pollutant indicators for soil amendment and stabilization products as shown in the table titled "Pollutant Testing Guidance Table" in the Caltrans *Construction Site Monitoring Program Guidance Manual*
4. Report of acute and chronic toxicity tests on aquatic organisms conforming to EPA methods
5. List of ingredients, including chemical formulation
6. Properties of polyacrylamide in tackifier including (1) percent purity by weight, (2) percent active content, (3) average molecular weight, and (4) charge density

Submit a certificate of compliance for straw, fiber, RECP, and fasteners before application.

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 the compost producer's *Compost Technical Data Sheet* including test results and *Seal of Testing Assurance* certificate before application.

Submit a copy of the *Analysis Report* for each seed species before application.

Submit quality control 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.

21-1.01C Quality Control and Assurance

Obtain seed from lots that have been 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 not more than 12 months before application.

Seed must not contain prohibited noxious weed seed or more than 1.0 percent total weed seed by weight.

Provide seed labels from the seed supplier that indicate:

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, which is equal to the sum of the percent germination, percent hard seed, and the percent dormant seed
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

Compost producers must be permitted by the California Department of Resources Recycling and Recovery, Local Enforcement Agencies, and any other State and local agencies that regulate solid waste facilities. If exempt from State permitting requirements, the composting facility must certify it complies with the guidelines and procedures for production of compost under the environmental health standards of CA Code of Regs §§ 17868.1–17868.4.

Compost producers must be participants in the United States Composting Council's Seal of Testing Assurance program.

21-1.02 MATERIALS

21-1.02A General

Reserved

21-1.02B Delivery, Storage, and Handling

Deliver seed to the job site in unopened, separate containers with the seed tag attached.

The Engineer takes a sample of approximately 1 ounce or 1/4 cup of seed for each seed lot greater than 2 pounds. At the time of seed sampling, provide the Engineer with a glassine-lined bag and custody seal tag for each seed lot sample.

Deliver fertilizer in labeled containers showing weight, chemical analysis, and name of the manufacturer.

Furnish RECP in suitable wrapping to protect against moisture and extended ultraviolet exposure occurring before placement. Label RECP to provide identification sufficient for inventory and quality control purposes.

21-1.02C 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.

21-1.02D Topsoil

Obtain topsoil from sources within or outside the job site as shown.

Topsoil must comply with the following requirements:

1. Local topsoil must conform to the requirements for selected material in section 19 and consists of (1) excavating topsoil, including organic material and leaf litter, in designated areas to the depth indicated, (2) stockpiling the soil on site, and (3) maintaining the stockpile until the material is reused in the work.
2. Imported topsoil must consist of fertile, friable soil of loamy character that contains organic matter in amounts natural to the region and be capable of sustaining healthy plant life. Imported topsoil must 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.

21-1.02E 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 thermomechanically processed from clean whole wood chips.

Celullose 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 3/4-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 CA 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 the procedure designated in the Department's Final Report, CA-DOT-TL-2176-1-76-36, "Water Holding Capacity for Hydromulch," available from METS.
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. Contain less than 7 percent ash when tested under Technical Association of the Pulp and Paper Industry, TAPPI Standard T 413.
10. Be colored to contrast with the area on which the fiber 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.

Fiber for temporary hydraulic mulch must be at least 50 percent wood fiber. The remaining percentage must be cellulose fiber, alternate fiber, or a combination.

Fiber for temporary bonded fiber matrix and bonded fiber matrix must be 100 percent wood fiber and comply with the requirements for fiber except the sieve requirement must be at least 50 percent retained on a no. 25 sieve.

Fiber for polymer stabilized fiber matrix must be at least 50 percent wood fiber. The remaining percentage must be cellulose fiber, alternate fiber, or a combination.

21-1.02F Tackifier

21-1.02F(1) General

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.

General purpose tackifier may be either a plant based product or a polymeric emulsion blend as follows:

1. Plant based tackifier must be a natural high molecular weight polysaccharide, a high viscosity hydrocolloid that is miscible in water, and labeled as either guar, psyllium, or starch, as follows:
   1.1. Guar gum based product 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 product 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 product must be a nonionic, water-soluble, granular material derived from corn, potato, or other plant-based source.
2. Polymeric emulsion blend tackifier must be a prepackaged liquid or dry powder, 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.

21-1.02F(2) Polymer Stabilized Fiber Matrix Tackifier

Tackifier for polymer stabilized fiber matrix must be:

1. A liquid formulation with polyacrylamide as the primary active ingredient with the following requirements:
   1.1. Linear, anionic copolymer of acrylamide and sodium acrylate.
   1.2. Anionic with a residual monomer content that is at most 0.05 percent by weight.
2. Formulated and labeled as one of the following:
   2.1. Water-in-oil emulsion containing at least 2.6 pounds of pure polyacrylamide per gallon. Pure polyacrylamide must be at least 30 percent active.
   2.2. Liquid dispersed polyacrylamide containing at least 4.4 pounds pure polyacrylamide per gallon. Pure polyacrylamide must be at least 35 percent active.

21-1.02F(3) Bonded Fiber Matrix Tackifier

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

21-1.02G Seed

Seed with a germination rate lower than the minimum rate shown may be used if authorized.

Measure and mix individual seed species in the presence of the Engineer before applying seed.

21-1.02H Fertilizer

Fertilizer must comply with the material specifications for fertilizer in section 20-7.02D(1).

21-1.02I 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.

21-1.02J Polymer Stabilized Fiber Matrix

Polymer stabilized fiber matrix must be a hydraulically applied material composed of fiber and tackifier and may also include seed and fertilizer as shown.

21-1.02K 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.

21-1.02L Hydraulically Applied Erosion Control Products

Reserved

21-1.02M Compost

Compost must be derived from one or a combination of the following types of materials:

1. Green material consisting of chipped, shredded, or ground vegetation or clean, processed, recycled wood products
2. Biosolids
3. Manure
4. Mixed food waste

Compost must not be derived from mixed, municipal solid waste and must not contain paint, petroleum products, pesticides or other chemical residues harmful to plant or animal life. Materials must be composted to reduce weed seeds, pathogens, and deleterious materials under 14 CA Code of Regs §17868.3.

Metal concentrations in compost must not exceed the maximum listed under 14 CA Code of Regs §17868.2.

Compost must comply with the requirements shown in the following table:

Compost

Property	Test method [a]	Requirement	
pH	TMECC 04.11-A Elastomeric pH 1:5 slurry method pH	6–8.5	
Soluble salts	TMECC 04.10-A Electrical conductivity 1:5 slurry method dS/m (mmhos/cm)	0–10	
Moisture content	TMECC 03.09-A Total solids & moisture at 70 ± 5 °C % wet weight basis	30–60	
Organic matter content	TMECC 05.07-A Loss-on-ignition organic matter method (LOI) % dry weight basis	40–100	
Maturity	TMECC 05.05-A Germination and vigor	--	
	Seed emergence	80 or above	
	Seedling vigor	80 or above	
	% relative to positive control		
Stability	TMECC 05.08-B Carbon dioxide evolution rate mg CO_2-C/g OM per day	8 or below	
Particle size: fine compost	TMECC 02.02-B Sample sieving for aggregate Size classification % dry weight basis	min	max
	Pass 5/8-inch sieve	95%	--
	Pass 3/8-inch sieve	70%	--
	Maximum particle length: 6 inches		
Particle size: medium compost	TMECC 02.02-B sample sieving for aggregate Size classification % dry weight basis	min	max
	Pass 2-inch sieve	95%	--
	Pass 1-inch sieve (minimum 70% retained)	--	30%
	Maximum particle length: 6 inches		
Particle size: coarse compost	TMECC 02.02-B sample sieving for aggregate Size classification % dry weight basis	min	max
	Pass 2-1/2-inch sieve	99%	--
	Pass 3/8-inch sieve (minimum 60% retained)	--	40%
	Maximum particle length: 6 inches		
Pathogen	TMECC 07.01-B Salmonella < 3 MPN per 4 grams, dry weight basis	pass	
Pathogen	TMECC 07.01-B Fecal coliform bacteria < 1,000 MPN per gram, dry weight basis	pass	
Physical contaminants	TMECC 02.02-C Man-made inert removal and classification: Plastic, glass, and metal % > 4 mm fraction	combined total: < 1.0	
Physical contaminants	TMECC 02.02-C Man-made inert removal and classification:	none detected	

	Sharps (sewing needles, straight pins and hypodermic needles) % > 4mm fraction	

[a] TMECC refers to "Test Methods for the Examination of Composting and Compost," published by the United States Department of Agriculture and the United States Compost Council (USCC).

21-1.02N Reserved

21-1.02O Rolled Erosion Control Products

21-1.02O(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 Erosion Control Technology Council.

21-1.02O(2) Jute Mesh

Jute mesh must be made of processed natural jute yarns woven into a matrix. Jute mesh must comply with the requirements shown in the following table:

Jute Mesh

Property	Requirements	Test method
Classification	ECTC Type 3B	--
Minimum strands per foot in each direction	14–20	--
Minimum roll width	48 inches	--
Matrix	Unbleached and undyed woven jute	--
Universal soil loss equation (USLE) C-Factor for a 1.5:1 (H:V) unvegetated slope.	≤ 0.25	--
Maximum shear stress	2.0 psf	ASTM D 6460
Minimum tensile strength	100 psf	ASTM D 5035
Functional longevity	12 months	--
Average open area	65 ± 5%	--
Minimum weight of fabric	14.4–19.2 oz/sq yd	ASTM D 3776

21-1.02O(3) Netting

Netting must be made of coconut fiber woven into a matrix. Netting must comply with the requirements shown in the following table:

Netting

Property	Type	Requirements	Test method
Classification	--	ECTC Type 4	--
Minimum thickness	A, B, C	0.30 inch	--
Roll width	A, B, C	72–158 inches	--
Matrix	A, B, C	100% woven coir (coconut fiber)	--
Universal Soil Loss Equation (USLE) C-Factor for a 1:1 (H:V) unvegetated slope	A, B, C	≤ 0.25	--
Maximum shear stress	A B C	2.25 psf 4.4 psf 4.6 psf	ASTM D 6460

Minimum tensile strength	A, B, C	125 psf	ASTM D 5035
Functional longevity	A, B, C	36 months	--
Average open area	A B C	63 ± 5% 48 ± 5% 38 ± 5%	--
Minimum weight of fabric	A B C	11.8 oz/sq yd 20 oz/sq yd 26 oz/sq yd	ASTM D 3776

21-1.02O(4) Erosion Control Blankets

Erosion control blanket must be 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. The erosion control blanket must comply with the requirements shown in the following table:

Erosion Control Blanket

Property	Type	Requirements	Test Method
Classification	--	ECTC Type 2D	--
Net type	A, B, C	Natural	--
Number of nets	A, B, C	Double	--
Minimum roll width	A, B, C	72 inches	--
Matrix	A B C	70/30% (straw/coconut fiber) 100% woven coir (coconut fiber) Wood excelsior (80 percent of the fiber 6 inches or longer)	--
Universal soil loss equation (USLE) C-Factor for a 2:1 (H:V) unvegetated slope.	A, B, C	≤ 0.20	--
Maximum shear stress	A, B, C	1.75 psf	ASTM D 6460
Minimum tensile strength	A, B, C	75 psf	ASTM D 5035
Functional longevity	A, B, C	12 months	--

21-1.02O(5) Turf Reinforcement Mats

Turf reinforcement mat must be a nondegradable, open-weave textile made of synthetic fibers, filaments, nets, wire mesh or other elements, processed into a permanent, three-dimensional matrix. Turf reinforcement mat must comply with requirements shown in the following table:

Turf Reinforcement Mat

Property	Type	Requirements	Test Method
Classification	--	ECTC Type 5	--
Net type	A, B, C	Synthetic	--
Number of nets	A, B, C	Per manufacturer's specifications	--
Minimum thickness	A, B, C	0.25 inch	ASTM D 6525

Minimum roll width	A, B, C	72 inches	--
Matrix	A, B, C	Per manufacturer's specifications	--
Universal soil loss equation (USLE) C-Factor for a 1.5:1 (H:V) unvegetated slope.	A, B, C	≤ 0.25	--
Maximum shear stress	A B C	6 psf 8.4 psf 10 psf	ASTM D 6460
Minimum tensile strength	A B C	125 psf 150 psf 175 psf	ASTM D 5035
Functional longevity	A, B, C	36 months	--
UV stability	A, B, C	80% at 500 hours	ASTM D 4355

21-1.02P Fiber Rolls

Fiber roll must have a minimum functional longevity of 1 year and comply with the following requirements:

1. Type A fiber roll must be fabricated from an erosion control blanket rolled along its width. Secure with natural fiber twine at 6-foot intervals, and 6 inches from each end. Fiber roll size must comply with either one of the following:
   1.1. 8 to 10 inches in diameter, 10 to 20 feet long, and at least 0.5 lb/ft
   1.2. 10 to 12 inches in diameter, at least 10 feet long, and at least 2 lb/ft
2. Type B fiber roll must be a premanufactured roll filled with rice or wheat straw, wood excelsior, or coconut fiber. Rolls must be covered with biodegradable jute, sisal, or coir fiber netting secured tightly at each end. Fiber roll size must comply with either one of the following:
   2.1. 8 to 10 inches in diameter, 10 to 20 feet long, and at least 1.1 lb/ft
   2.2. 10 to 12 inches in diameter, at least 10 feet long, and at least 3 lb/ft

21-1.02Q Compost Socks

Compost sock must be a mesh tube 12 inches in diameter filled with compost and must have a functional longevity of 1 year.

The mesh tube must be composed of a natural biodegradable product such as cotton, jute, sisal, burlap, or coir. The mesh tube must be clean, evenly woven, and free of encrusted concrete or other contaminating materials, cuts, tears, broken or missing yarns, and thin, open, or weak places.

Compost particle size for compost sock must comply with the material specification for coarse compost in the table titled "Compost Properties" specified in section 21-1.02M.

21-1.02R 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 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 and compost socks must be 1/4 inch in diameter and biodegradable, such as sisal or manila.

21-1.02S Water

Water must be of a quality that promotes germination of seeds and growth of plants.

21-1.03 CONSTRUCTION

21-1.03A General

Before applying erosion control measures, verify that finished grades meet the requirements for grade, compaction and finish as specified in section 19.

Apply erosion control materials within 24 hours after the final preparation of the erosion control areas. Do not apply hydraulically applied materials under the following conditions:

1. Precipitation
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

21-1.03B Site Preparation

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.

21-1.03C Duff

Upon completion of the earthwork in an area, spread duff to a uniform thickness. Do not apply duff within 10 feet of the pavement edge. Roadway and adjacent areas must be left in a neat and finished appearance.

Trackwalk duff with tracked equipment run perpendicular to slope contours. Water may be used to assist this process but must not cause erosion.

21-1.03D Topsoil

Place topsoil after all other earthwork in an area is complete.

Spread topsoil to a uniform thickness.

Trackwalk topsoil with tracked equipment run perpendicular to slope contours. Water may be used to assist the process but must not cause erosion.

21-1.03E Hydromulch and Hydroseed

Apply hydromuch 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 utilize 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. Begin application within 60 minutes after adding seed to the tank.
2. Apply in successive passes as necessary to achieve the required application rate.
3. Apply all hydromulch or hydroseed materials indicated for a single area within 72 hours.

When 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 onto the treated areas.

21-1.03F Dry Seed

Apply dry seed and fertilizer at the rates shown after 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.

21-1.03G 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 3 passes in different directions with seeding equipment to reduce any uniform row appearance.
3. Do not apply seed within 8 feet of the pavement edge.

21-1.03H Straw

Apply straw by spreading it uniformly without clumping or piling at the rates shown, based upon slope measurements. Once straw work is started in an area, apply all materials for that area in the same working day.

21-1.03I Polymer Stabilized Fiber Matrix

Apply polymer stabilized fiber matrix materials from multiple directions and angles to ensure complete coverage in the locations, application rate, and number of applications shown.

21-1.03J 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 required 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.

21-1.03K Hydraulic Erosion Control Products

Reserved

21-1.03L 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.

21-1.03M Reserved

21-1.03N 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 percent and 90 percent except as otherwise specified in section 19-5.

21-1.03O 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 upon RECP following placement.

21-1.03P 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 that the top of the stake is less then 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.

Maintain fiber roll in a manner that provides sediment holding capacity and reduces runoff velocities as follows:

1. Remove sediment from behind the fiber roll when sediment is 1/3 of fiber roll height above ground.
2. Repair or adjust the fiber roll when rills or other evidence of concentrated runoff occur beneath the fiber roll.
3. Repair or replace the fiber roll when they become split, torn, or unraveled.
4. Add stakes when 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 or when ordered. If removed sediment is deposited within project limits, it must be stabilized and not exposed to erosion by wind or water.

21-1.03Q 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 following the procedures for fiber rolls and the following:

1. Place mesh tube, secure the end, and fill uniformly with compost. Secure the remaining end.
2 Fasten compost sock to soil surface following the procedures for Type 1 and Type 2 installation of fiber roll.
3. Remove sock when ordered. Cut sock and empty contents in place. Dispose of sock.

21-1.04 PAYMENT

Items paid for by area or length are measured parallel to the ground surface excluding overlaps.

A move-in followed by a move-out counts as 1 unit. The Department does not adjust the unit price for an increase or decrease in the move-in/move-out quantity.

Collecting, processing, and stockpiling of duff is paid for as clearing and grubbing as specified in section 16. Spreading duff is paid for as duff. Local topsoil is paid for as roadway excavation as specified in section 19-2.

Imported topsoil is measured in the vehicle at the point of delivery.

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 next 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 edge of shoulder and hinge point of slopes
2. At 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

23 RESERVED

DIVISION IV SUBBASES AND BASES

24 STABILIZED SOILS

24-1 GENERAL

Reserved

24-2 LIME STABILIZED SOIL

24-2.01 GENERAL

24-2.01A Summary

Section 24 includes specifications for stabilizing soil by mixing lime and water with soil and compacting the mixture.

24-2.01B Definitions

mellowing period: Time between the initial and final mixing to promote initial chemical reactions between lime, water, and soil.

24-2.01C Submittals

From 30 to 180 days before use, submit one 10 lb sample of each lime product proposed and from each source.

Submit lime samples in airtight containers under ASTM C 50. Mark the sample date on the container. Include the MSDS and chemical and physical analysis with the submittal.

Submit a certificate of compliance with the lime samples that includes a statement certifying the lime furnished is the same as on the Authorized Material Source List.

At least 15 days before starting soil stabilization activities, submit the name of the authorized laboratory you will use for QC tests. The laboratory must be qualified under the Department's Independent Assurance Program.

At least 25 days before applying lime in slurry form, submit the slurry's lime content for authorization.

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.

24-2.01D Quality Control and Assurance

24-2.01D(1) General

Perform QC testing in the presence of the Engineer.

Place unique, sequentially numbered lock seals on each load and affix them to trailer blow down 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(2) Preparing Soil

After preparing an area for lime soil stabilization verify the surface grades. For every 500 cu yd of soil prepared for lime soil stabilization:

1. Test the relative compaction under California Test 231
2. Test the moisture content under California Test 226

24-2.01D(3) Applying Lime

The Engineer determines the final application rate for each lime product proposed from the samples submitted. Wherever the soil to be stabilized changes, the Engineer changes the application rate. Based on California Test 373, the Engineer reports the application rate as the percent of lime by dry weight of soil. The Engineer provides the optimum moisture content determined under California Test 373 for each application rate.

Whenever lime is used in dry form, the Engineer verifies the application rate using the drop pan method once per 40,000 square feet stabilized, or twice per day, whichever is greater.

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 square feet stabilized, or twice per day, whichever is greater.

24-2.01D(4) Mixing

For each day of initial mixing, test the moisture content under California Test 231 and verify moisture content under California Test 226. Sample the material immediately after initial mixing.

Randomly test the adequacy of the final mixing with a phenolphthalein indicator solution.

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.

24-2.01D(5) Compaction

Test relative compaction on a wet weight basis.

After initial compaction determine in-place density under California Test 231 and moisture content under California Test 226, at the same locations. Perform one test per 250 cu yd of lime stabilized soil. Test in 0.50-foot depth intervals.

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.

24-2.01D(6) Test Strip

Construct test strips with materials, tools, equipment, and methods you will use in the work.

24-2.01D(7) Test Result Disputes

Work with the Engineer to avoid potential conflicts and resolve disputes regarding test result discrepancies. If you dispute the test result notify the Engineer within 5 days of receiving the test result.

If you or the Engineer dispute each other's test results, submit written quality control test results and copies of paperwork including worksheets used to determine the disputed test results. An Independent Third Party (ITP) must perform referee testing. Before the ITP participates in a dispute resolution, the ITP must be accredited under the Department's Independent Assurance Program. The ITP must be independent of the project. By mutual agreement, the ITP is chosen from:

1. A Department laboratory
2. A Department laboratory in a district or region not in the district or region the project is located
3. The Transportation Laboratory
4. A laboratory not currently employed by you or your lime producer

If split quality control or acceptance samples are not available, the ITP uses any available material representing the disputed material for evaluation.

24-2.02 MATERIALS

24-2.02A General

Reserved

24-2.02B Lime

Lime sources must be on the Authorized Material Source List.

Lime must comply with ASTM C 977 and the requirements shown in the following table:

Lime Quality

Property	ASTM	Requirements
Available calcium and magnesium oxide (min, %)	C 25 or C 1301 and C 1271	High calcium quicklime: CaO > 90 Dolomitic quicklime: CaO > 55 and CaO + MgO > 90
Loss on ignition (max, %)	C 25	7 (total loss) 5 (carbon dioxide) 2 (free moisture)
Slaking rate	C 110	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 grading shown in the following table:

Lime Grading

Sieve sizes	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.

24-2.02C Water

Whenever available, use potable water for mixing soil and lime. Notify the Engineer if water other than potable water is used. Water, other than potable water must:

1. Contain no more than 650 parts per million of chlorides as Cl, and no more than 1,300 parts per million of sulfates as SO_4
2. Not contain an amount of impurities that will cause a reduction in the strength of the stabilized soil

24-2.02D Curing Seal

Curing seal must comply with section 94, Grade SS1, SS1h, CSS1, or CSS1h.

24-2.03 CONSTRUCTION

24-2.03A General

Do not mix different types of lime or lime from more than one source. The Engineer determines separate application rates.

Deliver lime in full loads unless it is the last load needed for a work shift.

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 soil to be stabilized a minimum 3 percent above the optimum moisture determined under California Test 216 as modified in section 24-2.03D. 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 soil.

24-2.03B Preparing Soil

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 and disposing of rocks and solids is change order work.

Before adding lime, place the soil to be stabilized to within 0.08 foot of the specified lines and grades and compact to not less than 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.

Do not vary from the Engineer's determined application rate by more than 5 percent.

Lime slurry must be in suspension during application. Apply lime slurry uniformly making successive passes over a measured section or 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

Lime and soil to be stabilized must be uniformly mixed at least twice to within 0.10 foot of the depth shown at any point. If the mixing depth exceeds the depth shown by more than 10 percent, add lime in proportion to the exceeded depth. The Department does not pay for this added lime.

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. Moisture content during the mellowing period determined under California Test 226 must be at least 3 percent higher than the optimum moisture content. You may add water and mix during the mellowing period.

Remix until the mixture is uniform with no streaks or pockets of lime.

Except for clods larger than 1 inch, mixed material must have a color reaction with sprayed phenolphthalein alcohol indicator solution.

Complete all the mixing work within 7 days of the initial application of lime.

Before compaction, the mixed material excluding rock must have the grading shown in the following table:

Mixed Material Grading

Sieve sizes	Percentage passing
1"	98–100
No. 4	60–100

24-2.03E Compaction

Begin compacting immediately after final mixing.

Compact using a sheepsfoot or segmented wheel rollers immediately followed by steel drum or pneumatic-tired rollers. Do not use vibratory 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 lime and achieve the specified compaction. The test strip must contain no more material than 1 day's production.

Use other compaction methods in areas inaccessible to rollers.

Compact the lime stabilized soil to at least 95 percent relative compaction determined under California Test 216 as modified in section 24-2.03D The relative compaction is determined on a wet weight basis.

24-2.03F Finish Grading

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.

The finished surface of the lime stabilized soil must not vary more than 0.08 foot above or below the grade established by the Engineer unless the lime stabilized soil 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.

Wherever lime stabilized soil is above the allowable tolerance, trim, remove, and dispose of 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.

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.

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 lime stabilized soil.

24-2.03G Curing

24-2.03G(1) General

Cure by any one of the following methods:

1. Water cure
2. Curing seal
3. Moist material blanket

Choose the method of curing and apply the chosen cure method within 48 hours of completing the sheepsfoot or segmented wheel compaction and within the same day of any trimming and finish grading.

24-2.03G(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 lime 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.

24-2.03G(3) Curing Seal

Curing seal equipment must have a gauge indicating the volume of curing seal in the storage tank.

Apply curing seal:

1. To the finished surface of lime stabilized soil under section 94-1.06
2. At a rate from 0.10 to 0.20 gallon per square yard. The exact rate is ordered
3. When the lime stabilized soil is at optimum moisture
4. When the ambient temperature is above 40 degrees F and rising

Repair damaged curing seal the same day the damage occurs.

24-2.03G(4) Moist Material Blanket

Moist material blanket must be moist structural material. Moist material blanket may be either a temporary or permanent layer of material of sufficient thickness to prevent drying of the lime stabilized soil. You may use moist material blanket if the lime 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.

24-2.04 PAYMENT

Lime stabilized soil is measured from horizontal measurements of the planned surface of the lime stabilized soil.

Curing seal quantity is determined under section 94. The amount of curing seal used is determined from the gauge on the curing equipment.

The Department does not adjust the unit price for an increase or decrease in lime quantity.

Quantities of lime wasted or disposed of in a manner not specified, or remaining on hand after completion of the work, will not be paid for. If you use a partial load of lime, weigh the truck and the remaining lime on a scale and submit a weighmaster certificate.

If the dispute resolution ITP determines the Engineer's test results are correct, the Engineer deducts the ITP's testing costs from payments and pays the ITP. If the ITP determines your test results are correct, the Department pays the ITP testing costs without deduction.

24-3–24-6 RESERVED

25 AGGREGATE SUBBASES

25-1.01 GENERAL

Section 25 includes specifications for spreading and compacting AS.

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

Class 5 AS is specified in the special provisions.

25-1.02B Class 1, Class 2, and Class 3 Aggregate Subbases

When tested under California Test 202, aggregate must comply with the grading requirements for the sieve sizes shown in the following table:

Aggregate Grading

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

Aggregate must comply with the quality requirements for the classes shown in the following table:

Aggregate Quality

Property	California Test	Class 1		Class 2		Class 3	
		Operating range	Contract compliance	Operating range	Contract compliance	Operating range	Contract compliance
Sand equivalent (min)	217	21	18	21	18	21	18
Resistance (R-value) (min)	301	--	60	--	50	--	40

If the aggregate grading 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.

If the aggregate grading 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 for each noncompliant test result. An aggregate grading and a sand equivalent test represents up to (1) 500 cu yd or (2) 1 day's production if less than 500 cu yd.

25-1.02C Class 4 Aggregate Subbase

Reserved

25-1.02D Class 5 Aggregate Subbase

Reserved

25-1.03 CONSTRUCTION

25-1.03A General

Water AS under section 17-3.

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.

Areas of the subgrade lower than the grade established by the Engineer may be filled with AS. AS used to fill low areas of the subgrade is not included in the quantity for payment.

25-1.03C 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 25-1.03D. 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 shown subbase thickness 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.

25-1.03D Compacting

Compact each AS layer to at least 95 percent relative compaction under California Test 231.

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 AS is based on the dimensions shown.

26 AGGREGATE BASES

26-1.01 GENERAL

Section 26 includes specifications for spreading and compacting AB.

26-1.02 MATERIALS

26-1.02A General

Aggregate for Class 2 and Class 3 AB 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 aggregate grading. Do not change your selected aggregate grading without authorization.

If the aggregate grading test results, sand equivalent test results, or both comply with contract compliance requirements but not 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 grading 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. An aggregate grading and a sand equivalent test represents up to (1) 500 cu yd or (2) 1 day's production if less than 500 cu yd.

26-1.02B Class 2 Aggregate Base

When tested under California Test 202, aggregate must comply with the grading requirements for the sieve sizes shown in the following table:

Aggregate Grading

Sieve sizes	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

Aggregate must comply with the quality requirements shown in the following table:

Aggregate Quality

Property	California Test	Operating range	Contract compliance
Resistance (R-value) (min)	301	--	78
Sand equivalent (min)	217	25	22
Durability index (min)	229	--	35

Aggregate samples must not be treated with lime, cement, or chemicals before testing for durability index. Aggregate from untreated reclaimed processed asphalt concrete, PCC, LCB, or CTB is not considered treated.

26-1.02C Class 3 Aggregate Base

When tested under California Test 202, aggregate must comply with the grading requirements for the sieve sizes shown in the following table:

Aggregate Grading

Sieve sizes	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

Aggregate must comply with the quality requirements shown in the following table:

Aggregate Quality

Property	California Test	Operating range	Contract compliance
Resistance (R-value) (min)	301	--	50
Sand equivalent (min)	217	21	18

26-1.03 CONSTRUCTION

26-1.03A General

Water AB under section 17-3.

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.

If AB is paid by volume, fill areas of finished AS that are lower than the grade established by the Engineer with AB. AB used to fill low areas is not included in the quantity for payment.

If the subgrade is not AS and AB is paid by volume, areas that are lower than the grade established by the Engineer may be filled with AB. AB used to fill low areas where AS is not specified is not included in the quantity for payment. If the basement material is imported borrow, AB placed to fill low areas is not measured or paid for as imported borrow.

26-1.03C 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 26-1.03D. 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.

Where the subgrade is cohesionless sand you may dump AB in piles and spread it ahead in sufficient quantities to stabilize the subgrade, if authorized.

Where the shown AB thickness is 0.50 foot or less you may spread and compact the AB 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 AB by any means that will obtain the specified results.

26-1.03D Compacting

Compact each AB layer to at least 95 percent relative compaction under California Test 231.

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 per cubic yard or the item bid price adjusted for cubic yards, whichever is higher

26-1.04 PAYMENT

If AB is paid for by volume, the quantity is determined from the dimensions shown.

If AB is paid for by weight, the Engineer adjusts the weight in the weighmaster certificate of the delivered AB by deducting the water weight over one percent plus the optimum moisture content. The Engineer determines the AB water content under California Test 226 and AB optimum moisture content under California Test 216. The Engineer does not pay for the deducted water weight.

27 CEMENT TREATED BASES

27-1 GENERAL

27-1.01 GENERAL

Section 27-1 includes general specifications for mixing and placing cement treated bases.

27-1.02 MATERIALS

Cement must comply with section 90-1.02B(2), Type ll.

Water must comply with section 90-1.02D.

27-1.03 CONSTRUCTION

Reserved

27-1.04 PAYMENT

If an increase or decrease in the specified cement content is ordered, payment will be adjusted based on the cost of cement per ton, f.o.b. the cement mill including sales tax plus the freight cost per ton for delivery from the mill to the plant. In determining payment, any cash or trade discount offered or available regardless of whether it was taken by the purchaser will be credited to the Department.

Submit evidence of the cost of cement used for an ordered increase or decrease. Maintain records that allow a clear determination of the cement costs associated with the increase or decrease.

If your records show an excessive price for the increase or decrease of cement or you furnish inadequate evidence for the cost, the Engineer determines the price to be the lowest wholesale cost that the cement was available 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 by the Engineer. No additional adjustment of compensation will be made for variations in the cost of work resulting from the change in the quantity of portland cement.

27-2 CEMENT TREATED BASE

27-2.01 GENERAL

27-2.01A Summary

Section 27-2 includes specifications for mixing aggregate, cement and water, and spreading and compacting the mixture.

27-2.01B Definitions

coarse aggregate: Aggregate retained on a no. 4 sieve.

fine aggregate: Aggregate passing a no. 4 sieve.

27-2.02 MATERIALS

When tested under California Test 202, the percentage composition by weight of the aggregate must comply with the grading requirements for the sieve sizes shown in the following table:

Aggregate Grading[a]

Sieve sizes	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 whenever the difference in sp gr between the coarse and fine portions of the aggregate or between the blends of different aggregates is 0.2 or more.

Aggregate must comply with the quality requirements shown in the following table:

Aggregate Quality

Property	California Test	Operating range	Contract compliance
Sand equivalent (min)	217	21	18
Compressive strength (psi) (min)[a]	312	--	750

[a]For Class A CTB only

When tested under California Test 301, aggregate for Class B CTB must have (1) a resistance (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.

Aggregate must be clean and free from deleterious substances. Aggregate samples must not be treated with lime, cement, or chemicals before testing for sand equivalent.

If the aggregate grading 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 the CTB to be placed complies with the operating range requirements.

If the aggregate grading 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 by weight, the Engineer converts tons to cu yd for the purpose of reducing payment for noncompliant CTB left in place. An aggregate grading and a sand equivalent test represents up to (1) 500 cu yd or (2) 1 day's production if less than 500 cu yd.

27-2.03 CONSTRUCTION

27-2.03A General

After the CTB has been spread on the subgrade 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.

27-2.03B 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.

27-2.03C Depositing Aggregate and Mixing Road-Mixed Cement Treated Base

27-2.03C(1) Depositing Aggregate

For road-mixed CTB, deposit sufficient untreated aggregate on the roadbed to comply with the width and depth specifications in section 27-2.03E and grade tolerance specifications in section 27-2.03F. Do not mix the aggregate to be treated with roadbed material that is not to be treated.

Whenever 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 grading.

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 27-2.03E.

27-2.03C(2) Mixing

Mix road-mixed CTB by any of the following methods:

1. Road-mixed method:
   1.1. On the roadbed
   1.2. At a location off the roadbed
2. Plant-mixed method under section 27-2.03D 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. Whenever 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.

Just before initial compaction the moisture content of the completed mixture, when tested under California Test 226, must be at least the optimum moisture content less 1 percent. The optimum moisture content is determined under California Test 312.

For CTB spread and compacted in 2 or more layers, mix material for each layer separately.

Whenever 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 27-2.03G.

27-2.03D Proportioning and Mixing Plant-Mixed Cement Treated Base

27-2.03D(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.

Provide safe, convenient facilities in the supply line to the weigh hopper or pugmill for sampling cement.

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. Determine moisture content under California Test 226 and optimum moisture content under California Test 312.

27-2.03D(2) Batch Mixing

Whenever 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. Sufficient number of 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 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 27-2.03A. 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.

27-2.03D(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. Whenever different aggregate sizes are used, arrange feeders so 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 27-2.03D(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.

27-2.03E 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 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. Whenever 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 27-2.03F 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 one 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 27-2.03F without material segregation.

Whenever a spreading type is not specified, use Type 3 on ramps and Type 1 at all other locations.

Except as otherwise specified, do not used motor graders for spreading and compacting operations. In order 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. Equipped with end wings on the blade
2. Blade is locked in a position perpendicular to the direction of travel
3. Equipped with cross slope and automatic grade controls that comply with the requirements for the specified type of spreading operation

27-2.03F Compacting

Compacting equipment must produce the required compaction within the operation time limit specified in 27-2.03G.

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 so 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.

Whenever CTB is spread and compacted in more than 1 layer, compact each lower 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 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 relative compaction of CTB must not be less than 95 percent. For Class A CTB, compaction is tested under California Test 312 or 231. Each layer of CTB may be tested for compaction, or all layers may be tested together, at the option of the Engineer. Whenever all layers are tested together, you are not relieved of the responsibility to achieve the required compaction in each layer placed.

The finished CTB surface must be uniform and must not deviate at any point more than 0.03 foot from the bottom of a 12-foot straight edge laid in any direction.

The finished CTB surface must not vary 0.05 foot above or below the grade established by the Engineer, except whenever concrete pavement will be placed on CTB, the finished CTB surface must not extend above the grade established by the Engineer.

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 HMA 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.

The surface must be kept moist at all times until the curing seal is applied.

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 linear foot of shoulder. Whenever trimmed material exceeds this limit, it must be removed and placed in other areas to comply with the 25 percent limit.
4. Excess material is uniformly distributed in the shoulder area prior to spreading additional shoulder aggregate.

Excess material may be used in other work provided the material complies with the applicable specifications.

27-2.03G Operation Time Requirement

Do not allow more than 2 hours to elapse from the time water is added to the aggregate and cement to completion of initial compaction before trimming. Do not allow more than 2-1/2 hours to elapse from the time water is added to the aggregate and cement to completion of final compaction after trimming.

27-2.03H 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 27-2.03F.

27-2.03I Curing

Cover the completed CTB with asphaltic emulsion curing seal. Asphaltic emulsion curing seal must comply with section 94, Grade SS1 or CSS1.

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 exact rate will be ordered.

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.

27-2.04 PAYMENT

Whenever excess material is placed in an area in which the item is measured by the ton, payment as the item where placed will not be allowed unless applicable measurement specifications for the item where placed are complied with.

Whenever CTB is paid for by the ton, the quantity of excess material will be deducted from the measured quantity of CTB except, the quantity of CTB used in shoulders.

For CTB paid for by the cu yd, a deduction will be made when areas that are deficient in thickness and for which the deficient thickness has not been compensated for by filling of low areas with CTB. 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.

Whenever CTB is measured by the cu yd:

1. The volume will be calculated on the basis of the dimension shown
2. CTB placed below the grade established by the Engineer will not be measure or paid for.
3. If an increase or decrease in the specified quantity of portland cement is ordered, 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 theoretical quantity of cement will be determined by use of 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 CTB 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

Whenever CTB is measured by the ton:

1. Quantity of CTB to be paid for will be the sum of the weight of the aggregate used in the mix and the weight of cement to be added to the mix.
2. Quantity of aggregate for road-mixed CTB that is mixed on the roadbed will be measured before delivery to the roadbed under section 9-1.02 except, the weight to be paid for will be determined by deducting from the weight of the aggregate, and 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. Quantity of portland cement for road-mixed CTB that is mixed on the roadbed to be included in the quantity of the combined item of road-mixed CTB for payment will be the weight, in tons, calculated by multiplying the specified percentage of cement to be added to the mix by the weight of dry aggregate.
4. Quantity of plant-mixed CTB or road-mixed CTB that is mixed by the plant-mixed method will be measured, after mixing, under section 9-1.02 except that moisture in excess of 3 percent of the dry weight of the mixture will be deducted from the weight of the combined aggregate, cement and water. When the specified quantity of portland cement is increased in plant-mixed CTB or road-mixed CTB mixed by the plant-mixed method, the weight of cement subject to increased compensation, as provided in section 27-1.04 is deducted from the combined weight of aggregate and cement.

27-3 RESERVED

28 CONCRETE BASES

28-1 GENERAL

Reserved

28-2 LEAN CONCRETE BASE

28-2.01 GENERAL

28-2.01A Summary

Section 28 includes specifications for mixing aggregate, portland cement, water, and chemical admixtures and spreading, shaping, and compacting the mixture.

28-2.01B Submittals

Submit the grading of the aggregate to be used as an information submittal. The material must be available for sampling and testing at least 45 days before placing LCB. If you change the aggregate source, submit the new source and grading and have the aggregate available for sampling and testing at least 45 days before use.

28-2.01C Definitions

coarse aggregate: Aggregate retained on a no. 4 sieve.

fine aggregate: Aggregate passing a no. 4 sieve.

28-2.02 MATERIALS

Cement must comply with section 90-1.02B(2), Type II.

Water must comply with section 90-1.02D.

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.

The portland cement content of LCB must be at least 270 lb/cu yd except, after testing samples from the proposed aggregate supply an increase in the cement content may be ordered. Compensation for an ordered increase is specified in section 28-2.04.

A water-reducing chemical admixture may be used. Water-reducing chemical admixture must comply with ASTM C 494, Type A or Type F.

Air-entraining admixtures must comply with section 90-1.02E.

Aggregate must be clean and free from decomposed material, organic material, and other deleterious substances. Aggregate samples must not be treated with lime, cement, or chemicals before testing for sand equivalent.

Use either 1-1/2 inch or 1 inch grading. Do not change your selected aggregate grading without authorization.

When tested under California Test 202, the percentage composition by weight of the aggregate must comply with the grading requirements for the sieve sizes shown in the following table:

Aggregate Grading[a]

Sieve sizes	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

[a]Modify California Test 202 under California Test 105 whenever the difference in the specific gravities of the coarse and fine portions of the aggregate or the blends of different aggregates is 0.2 or more.

Aggregate must comply with the quality requirements shown in the following table:

Aggregate Quality

Property	California Test	Operating range	Contract compliance
Sand equivalent (min)	217	21	18
Compressive strength (psi) (min)	548	--	700

If the aggregate grading or the sand equivalent test results, or both comply with contract compliance requirements but not operating range requirements, you may continue placing LCB for the remainder of the work day. Do not place additional LCB until you demonstrate to the Engineer the LCB to be placed complies with the operating range requirements.

If the aggregate grading or sand equivalent test results, or both do not comply with contract compliance requirements, remove the LCB or request a payment deduction. If your request is authorized, $2.50/cu yd is deducted. An aggregate grading and a sand equivalent test represents up to (1) 500 cu yd or (2) 1 day's production if less than 500 cu yd.

28-2.03 CONSTRUCTION

28-2.03A General

Reserved

28-2.03B Subgrade

Immediately before spreading LCB, 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 LCB. LCB used to fill low areas of subgrade is not included in the quantity of LCB for payment.

28-2.03C Proportioning, Mixing, and Transporting

Proportion LCB under section 90-1.02F except, 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.

Nominal penetration range for LCB must be from 0 to 1-1/2 inches. Maximum penetration must not exceed 2 inches.

28-2.03D Placing

Place LCB under section 40-1.03H(1) except the 3rd paragraph does not apply.

Unless shown or specified, 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.

Longitudinal contraction joints must comply with section 40-1.03E(5).

For LCB to be paved with concrete pavement, construct longitudinal construction and contraction joints in LCB to provide at least 1 foot horizontal clearance from planned longitudinal construction and contraction joints in the concrete pavement.

Do not mix or place LCB when the atmospheric temperature is below 35 degrees F. Do not place LCB on frozen ground.

28-2.03E Spreading, Compacting, and Shaping

Spread, compact, and shape LCB under section 40-1.03H(4) or under section 40-1.03H(5).

For LCB to be paved with HMA, before curing operation texture the LCB finished surface by dragging 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.

Do not texture LCB to be paved with concrete pavement. Before applying curing compound, finish LCB to a smooth surface free from mortar ridges and other projections.

The finished surface must be free from porous areas.

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, the finished surface must not be above the grade, or more than 0.05 foot below the grade established by the Engineer.

28-2.03F Curing

Cure LCB with pigmented curing compound under section 90-1.03B(3) and 40-2.03J except, for LCB to be paved with concrete pavement use curing compound no. 3 that contains a minimum of 22 percent nonvolatile vehicles consisting of at least 50 percent paraffin wax. Apply curing compound to the area to be paved with concrete pavement:

1. In 2 separate applications
2. At a rate of 1 gal/150 sq ft for each application
3. Before the atmospheric temperature falls below 40 degrees F
4. Within 4 days after the last application, clean the surface and apply curing compound at a rate of 1 gal/200 sq ft

Do not allow traffic or equipment on the LCB for 72 hours after application of the curing compound. After 72 hours, limit traffic and equipment on the LCB to that used in paving operations or placing additional layers of LCB.

Immediately repair damage to the curing compound or LCB.

28-2.03G Surfaces Not Within Tolerance

Where LCB will be paved with concrete pavement, remove the base wherever the surface is higher than the grade established by the Engineer and replace it with LCB. Where LCB will not be paved with concrete pavement, remove the base wherever the surface is higher than 0.05 foot above 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 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

LCB is measured from the dimensions shown.

If an increase in the specified cement content is ordered, payment for the increase in cement will be the cost of cement per ton, f.o.b. the cement mill including sales tax plus the freight cost per ton for delivery from the mill to the plant. In determining payment, any cash or trade discount offered or available regardless of whether it was taken by the purchaser will be credited to the Department.

Submit evidence of the cost of cement used for an ordered increase. Maintain records that allow a clear determination of the cement costs associated with the increase.

If your records show an excessive price for the increase of cement or you furnish inadequate evidence for the cost, the Engineer determines the price to be the lowest wholesale cost that the cement was available in the quantities delivered to the point of production, less any available discounts.

The quantity of cement subject to increased compensation will be the difference between the specified theoretical quantity of cement and the theoretical quantity of cement ordered by the Engineer. No additional adjustment of compensation will be made for variations in the cost of work resulting from the change in the quantity of portland cement.

28-3–28-6 RESERVED

29 TREATED PERMEABLE BASES

29-1.01 GENERAL

Section 29 includes specifications for mixing aggregate with asphalt binder or mixing aggregate with portland cement and water, spreading, compacting, and shaping the mixture.

29-1.02 MATERIALS

29-1.02A General

Reserved

29-1.02B Asphalt Treated Permeable Base

Aggregates must be clean and free from decomposed material, organic material, and other deleterious substances.

When tested under California Test 202, aggregate must comply with the grading requirements for the sieve sizes shown in the following table:

Aggregate Grading

Sieve sizes	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

Aggregate must comply with the quality requirements shown in the following table:

Aggregate Quality

Property	California Test	Value
Percentage of crushed particles (min)	205	90%
Los Angeles rattler loss at 500 rev (max)	211	45%
Cleanness value (min)	227	57
Film stripping (max)	302	25%

29-1.02C Cement Treated Permeable Base

Aggregate must comply with section 90-1.02C. Aggregate grading must comply with the specifications for the 1" x no. 4 primary aggregate nominal size coarse grading in section 90-1.02C(4)(b).

Cement must comply with section 90-1.02B(2),Type II.

Water must comply with section 90-1.02D.

29-1.03 CONSTRUCTION

29-1.03A General

Immediately before spreading 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 treated permeable base. Treated permeable base used to fill low areas of subgrade is not included in the quantity of treated permeable base for payment.

Spread treated permeable base when the atmospheric temperature is above 40 degrees F.

Finish treated 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 treated permeable base for edge drains under section 68-4.02C.

29-1.03B Asphalt Treated Permeable Base

Produce ATPB under section 39-1.08 except:

1. Aggregate does not need to be separated into sizes.
2. Temperature of the aggregate before adding the asphalt binder must be from 275 to 325 degrees F.
3. Do not store ATPB longer than 2 hours.
4. 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. If an ordered increase or decrease exceeds the specified amount of asphalt content by more than 0.1 percent by weight of dry aggregate, compensation for ATPB is determined by the total increase or decrease in asphalt.
5. The Engineer has the option of determining the asphalt content of the asphalt mixture under California Test 310, 362, or 379. 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 amount 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 amount designated by the Engineer, less 0.7 lb of asphalt per 100 lb of dry aggregate.

Spreading and compacting ATPB must comply with the specifications for spreading and compacting HMA in section 39-3 except, spread and compact base 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 250 to 200 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 150 to 100 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.

29-1.03C Cement Treated Permeable Base

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 water amount and penetration requirements do not apply.

The cement content of CTPB must be at least 287 lb/cu yd.

The water to cement ratio must be approximately 0.37. The Engineer determines the exact water to cement ratio.

Place CTPB under section 40-1.03H(1) except the 3rd paragraph does not apply.

Spread, compact, and shape CTPB under section 40-1.03H(4) or under section 40-1.03H(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 base. 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.

29-1.03D Surfaces Out of Tolerance

Where the surface of treated 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 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

ATPB and CTPB is measured from the dimensions shown. Unless ordered, base placed outside of the shown dimensions will not be measured or paid for.

Treated permeable base for edge drains installed adjacent to treated permeable base is not measured or paid for as treated permeable base.

30–36 RESERVED

DIVISION V SURFACING AND PAVEMENTS

37 BITUMINOUS SEALS

37-1 GENERAL

37-1.01 GENERAL

Section 37-1 includes general specifications for applying bituminous seals.

37-2 SEAL COATS

37-2.01 GENERAL

37-2.01A Summary

Section 37-2 includes specifications for applying seal coats and screenings.

Seal coat includes applying asphaltic emulsion followed by screenings.

Fog seal coat includes applying slow-setting asphaltic emulsion.

Flush coat includes applying a fog seal coat to the surface of a seal coat, followed by sand.

Modified emulsion seal coat includes applying polymer modified asphaltic emulsion, followed by screenings, and then a flush coat.

37-2.01B Definitions

Reserved

37-2.01C Submittals

37-2.01C(1) General

Reserved

37-2.01C(2) Asphaltic Emulsion Seal Coat

Submit a 1/2 gallon sample of asphaltic emulsion in a plastic container. Take the sample from the distributor truck spray bar at mid load.

37-2.01C(3) Fog Seal Coat

Submit a 1/2 gallon sample of asphaltic emulsion for fog seal coats in a plastic container. Take the sample from the distributor truck spray bar at mid-load.

37-2.01C(4) Polymer Modified Asphaltic Emulsion Seal Coat

At least 10 days before starting modified emulsion seal coat application, submit the name of an authorized laboratory for polymer modified asphaltic emulsion quality control testing.

Submit a sample of polymer modified asphaltic emulsion to the authorized laboratory and the Engineer. Each sample must be submitted in an insulated shipping container within 24 hours of sampling.

Within 7 days after taking samples, submit the authorized laboratory's test results for polymer modified asphaltic emulsion.

At least 10 days before starting modified-emulsion seal coat application, submit a signed copy of the test result report of the Vialit test method for aggregate retention in chip seals (french chip) to the Engineer and to:

DEPARTMENT OF TRANSPORTATION
Division of Maintenance, Roadway Maintenance Office
1120 N Street, MS 31
Sacramento, CA 95814

37-2.01C(5) Reserved

37-2.01C(6) Unsuitable Day Notice

Submit the name of a representative and provide a means for the Engineer to communicate an unsuitable day notice.

37-2.01D Quality Control and Assurance

37-2.01D(1) General

Reserved

37-2.01D(2) Asphaltic Emulsion Seal Coat

Samples for the screenings grading and cleanness value must be taken from the spreader conveyor belt.

37-2.01D(3) Polymer Modified Asphaltic Emulsion Seal Coat

Samples for the screenings grading and cleanness value must be taken from the spreader conveyor belt.

Within 3 business days of sampling, the authorized laboratory must test polymer modified asphaltic emulsion for the following properties:

1. Viscosity (AASHTO T 59)
2. Sieve test(AASHTO T 59)
3. Demulsibility (AASHTO T 59)
4. Torsional recovery (California Test 332)

The authorized laboratory must test screenings for retention under the Vialit test method for aggregate in chip seals (french chip). The Vialit test results are not used for acceptance. The Vialit test is available at the METS Web site.

Circulate polymer modified 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. Take two 1/2-gallon samples in the presence of the Engineer.

If the test results for polymer modified asphaltic emulsion do not comply with the specifications, the Engineer assesses a pay factor value for the following properties and increments:

Polymer Modified Asphaltic Emulsion Pay Factor Table

Test method and property	Increment	Pay factor
Test on asphaltic emulsion (polymer modified)		
AASHTO T 59 (Viscosity, sec Saybolt Furol, at 50 °C)	Each 10 seconds above max or below min	1
AASHTO T 59 (settlement, 5 days, percent)	Each 1.5 percent above max	1
AASHTO T 59 (sieve test, percent max)	Each 0.2 percent above max	1
AASHTO T 59 (demulsibility percent)	Each 2 percent below min	1
Test on residue from evaporation test		
AASHTO T 49 (penetration, 15 °C)	Each 2 dm above max or below min	1
ASTM D 36 (field softening point °C)	2 °C below min	1
California Test 332 (torsional recovery [a)])	For each 1 increment below the min value of 18	1
	For each 2 increments below the min value of 18	3
	For each 3 or more increments below the min value of 18	10

[a] The highest pay factor applies

The Engineer assesses a pay factor of 1 for sampling not performed in compliance with the specifications, including shipping and sampling containers.

If test results for polymer modified asphaltic emulsion are not in compliance with the specifications, you may request that the seal coat represented by the tests remain in place with a payment deduction based on the pay factors.

If a test result for the screenings cleanness value is from 75 to 86, you may request that the seal coat represented by the test remain in place. A payment deduction is made as specified in section 37-2.04 If the screenings cleanness value is less than 75, remove the seal coat.

37-2.01D(4) Reserved

37-2.02 MATERIALS

37-2.02A General

Reserved

37-2.02B Asphaltic Emulsion

Reserved

37-2.02C Asphaltic Emulsion for Fog Seal Coat

Asphaltic emulsion for fog seal coat must be any of the slow-setting grades of asphaltic emulsion.

If additional water is added to the asphaltic emulsion, the resultant mixture must not be more than 1 part asphaltic emulsion to 1 part water. The Engineer determines the exact amount of additional water.

37-2.02D Asphaltic Emulsion for Flush Coat

The Engineer selects the type of asphaltic emulsion from Grade CSS1, Grade CSS1h, or Grade CQS1h.

37-2.02E Prime Coat

Liquid asphalt for prime coat must comply with section 93.

37-2.02F Polymer Modified Asphaltic Emulsion

Polymer modified asphaltic emulsion must include elastomeric polymer.

Modified emulsion must comply with section 94, Table 3, under the test on residue from evaporation test for Grades PMRS2, PMRS2h, PMCRS2, and PMCRS2h and the following:

1. The penetration at 59 degrees F (7 oz for 60 seconds) determined under AASHTO T 49 must be at least 6.
2. Test elastic recovery under AASHTO T 301.
3. Polymer content in percent by weight does not apply.
4. The minimum ring and ball softening point temperature determined under AASHTO T 53 for Test on Residue from Evaporation Test must comply with the following:
   - 4.1. 126 degrees F for a geographical ambient temperature from 32 to 104 degrees F
   - 4.2. 129 degrees F for a geographical ambient temperature from 18 to 104 degrees F
   - 4.3. 135 degrees F for a geographical ambient temperature from 18 to greater than 104 degrees F

37-2.02G Reserved

37-2.02H Screenings

37-2.02H(1) General

Screenings must be broken stone, crushed gravel, or both. At least 90 percent of screenings by weight must be crushed particles as determined under California Test 205.

Screenings for seal coats must have the properties specified in the following table:

Seal Coat Screenings

Properties	Test method	Specification
Los Angeles Rattler, %, max Loss at 100 revolutions. Loss at 500 revolutions.	California Test 211	 10 40
Film stripping, %, max	California Test 302	25

37-2.02H(2) Asphaltic Emulsion Seal Coat

Screenings for asphaltic emulsion seal coat must have the gradation as determined under California Test 202 in the following table.

Asphaltic Emulsion Seal Coat Screenings Gradation

	Percentage passing			
Sieve sizes	Coarse 1/2" max	Medium 3/8" max	Medium fine 5/16" max	Fine 1/4" max
3/4"	100	--	--	--
1/2"	95–100	100	--	--
3/8"	50–80	90–100	100	100
No. 4	0–15	5–30	30–60	60–85
No. 8	0–5	0–10	0–15	0–25
No. 16	--	0–5	0–5	0–5
No. 30	--	--	0–3	0–3
No. 200	0–2	0–2	0–2	0–2

The cleanness value determined under California Test 227 must be 80.

37-2.02H(3) Polymer Modified Asphaltic Emulsion Seal Coat

Screenings for polymer modified asphaltic emulsion seal coat must have the gradation as determined under California Test 202 in the following table:

Polymer Modified Asphaltic Emulsion Seal Coat Screenings Gradation

	Percentage passing			
Sieve sizes	Coarse 1/2" max	Medium 3/8" max	Medium fine 5/16" max	Fine 1/4" max
3/4"	100	--	--	--
1/2"	85–100	100	--	--
3/8"	0–30	85–100	100	100
No. 4	0–5	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	0–2

The cleanness value determined under California Test 227 must be 86.

37-2.02H(4) Reserved

37-2.02I Polymer Modified Asphaltic Emulsion and Screenings Test

Polymer modified asphaltic emulsion and screenings must have 90 percent retention when tested under the Vialit test method for aggregate in chip seals (french chip).

37-2.02J Sand

Sand for flush coat must comply with the material specifications for fine aggregate grading in section 90-1.02C(3). Sand must not include organic material or clay.

37-2.03 CONSTRUCTION

37-2.03A General

Wherever final sweeping or brooming of the seal coat surface is complete, place permanent traffic stripes and pavement markings within 10 days.

37-2.03B Equipment

37-2.03B(1) General

Equipment for seal coats must include and comply with the following:

1. Screenings haul trucks. Haul trucks must have:
   1.1. Tailgates that discharge screenings
   1.2. Devices to lock onto the rear screenings spreader hitch
   1.3. Dump beds that will not push down on the spreader when fully raised
   1.4. Dump beds that will not spill screenings on the roadway when transferred to the spreader hopper

2. Self-propelled screenings spreader. The spreader must have:
   2.1. Screenings hopper in the rear
   2.2. Belt conveyors that carry the screenings to the front
   2.3. Spreading hopper capable of providing a uniform screening spread rate over the entire width of the traffic lane in 1 application.

3. Self-propelled power brooms. Do not use gutter brooms or steel-tined brooms. Brooms must be capable of removing loose screenings adjacent to barriers that prevent screenings from being swept off the roadway, including curbs, gutters, dikes, berms, and railings.
4. Pneumatic-tired rollers. Pneumatic-tired rollers must be an oscillating type at least 4 feet wide. Each roller must be self-propelled and reversible. Pneumatic tires must be of equal size, diameter, type, and ply. The roller must carry at least 3,000 lb of load on each wheel and each tire must have an air pressure of 100 ± 5 psi.

37-2.03B(2) Reserved

37-2.03C Unsuitable Day

The Engineer may notify you of unsuitable conditions before 4:00 p.m. on the day before your 1st intended working day to place seal coat. After you have started seal coat placement activities, the Engineer has until 4:00 p.m. on the day before the next working day to give you an unsuitable day notice. If the Engineer gives you an unsuitable day notice (1) do not place seal coat on the next working day and (2) the Department does not pay for the return, storage or disposal of materials delivered to the job site or the time of workers. If maintenance of previously applied seal coat can be performed, continue to perform maintenance.

In the absence of an unsuitable day notice or if the Engineer gives notice after 4:00 p.m. of the previous day:

1. Comply with specifications restricting seal coat application.
2. Return, store, or dispose of any seal coat materials you deliver to the job site when conditions are unsuitable.
3. The Department adjusts payment for the return, storage or disposal of materials delivered to the job site.
4. The Department adjusts payment for the show-up time of workers who would have applied seal coat.
5. Payment of materials and labor will be determined under section 9-1.04, except markups are not added.

It is a nonworking day if the seal coat work is the controlling operation and (1) the Engineer provides you timely notice of an anticipated unsuitable day or (2) there is untimely or no notice and conditions are unsuitable for placing seal coat.

If you fail to submit the name of a person authorized to communicate with the Engineer about unsuitable day notices, the specifications for payment do not apply.

37-2.03D Surface Preparation

Before applying seal coat, 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 of adhesive to the facility being covered. Reference the covered facilities with a sufficient number of control points to relocate the facilities after the application of the seal coat.

After completion of the seal coat operation, remove covers from the facilities.

Immediately before applying seal coat, clean the surface to receive seal coat by removing extraneous material and drying. Cleaning the existing pavement includes the use of brooms.

If seal coat is applied to untreated material, apply a prime coat of liquid asphalt. The prime coat application rate must be from 0.20 to 0.33 gal/sq yd. The Engineer determines the exact rate.

37-2.03E Reserved

37-2.03F Applying Emulsion

37-2.03F(1) General

For areas not accessible to a truck distributor bar, apply the emulsion with a squeegee, rake or other means authorized by the Engineer.

Prevent spray on existing pavement not intended for seal coat or on previously applied seal coat using a material such as building paper. Remove the material after use. At longitudinal joints, you may overlap the emulsion applications before the application of screenings if the overlap is dispersed with squeegees or rakes.

Align longitudinal joints between seal coat applications with designated traffic lanes. Overlap longitudinal joints by not more than 4 inches. You may overlap longitudinal joints up to 8 inches if authorized.

Do not apply the emulsion unless there are sufficient screenings at the job site to cover the emulsion or binder.

Discontinue application of emulsion early enough to comply with lane closure specifications and darkness. Apply to 1 lane at a time and cover the lane entirely in 1 operation.

37-2.03F(2) Asphaltic Emulsion for Fog Seal Coat

Apply asphaltic emulsion for fog seal coat at a residual asphalt rate from 0.02 to 0.06 gal/sq yd. The Engineer determines the exact rate.

Apply fog seal coat when the ambient air temperature is above 40 degrees F.

Sprinkle water on fog seal coat that becomes tacky in an amount determined by the Engineer,.

If fog seal coat and seal coat with screenings are specified on the same project, apply fog seal coat at least 4 days before applying the adjoining seal coat with screenings. The joint between the seal coats must be neat and uniform.

37-2.03F(3) Asphaltic Emulsion for Seal Coat

Asphaltic emulsion must be applied within the application rate ranges shown in the following table:

Asphaltic Emulsion Application Rates

Screenings	Application rate range(gallons per square yard)
Fine	0.15–0.30
Medium fine	0.25–0.35
Medium	0.25–0.40
Coarse	0.30–0.40

The Engineer determines the exact application rate.

At the time of application, the temperature of the asphaltic emulsion must be from 130 to 180 degrees F.

Apply asphaltic emulsion 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 emulsion when weather forecasts predict the ambient air temperature will fall below 39 degrees F within 24 hours after application.

When tested under California Test 339, the application rate for asphaltic emulsion must not vary from the average by more than:

1. 15 percent in the transverse direction
2. 10 percent in the longitudinal direction

37-2.03F(4) Polymer Modified Asphaltic Emulsion for Modified Emulsion Seal Coat

Polymer modified asphaltic emulsion must be applied within the application rate ranges shown in the following table:

Polymer Modified Asphaltic Emulsion Application Rates

Screenings	Application rate range(gallons per square yard)
Fine	0.15–0.30
Medium fine	0.25–0.35
Medium	0.25–0.40
Coarse	0.30–0.40

The Engineer determines the exact application rate.

At the time of application, the temperature of polymer modified asphaltic emulsion must be from 130 to 180 degrees F.

Apply polymer modified asphaltic emulsion when the ambient air temperature is from 60 to 105 degrees F and the pavement surface temperature is at least 55 degrees F.

Do not apply polymer modified asphaltic emulsion when weather forecasts predict the ambient air temperature will fall below 39 degrees F within 24 hours after application.

When tested under California Test 339, the application rate for polymer modified asphaltic emulsion must not vary from the average by more than:

1. 15 percent in the transverse direction
2. 10 percent in the longitudinal direction

37-2.03F(5) Asphaltic Emulsion for Flush Coat

Apply asphaltic emulsion for flush coat at a residual asphalt rate from 0.02 to 0.06 gal/sq yd. The Engineer determines the exact rate.

During flush coat activities, close adjacent lanes to traffic. Do not track asphaltic emulsion on existing pavement surfaces.

Apply sand immediately after the asphaltic emulsion application.

Spread sand with a self-propelled screenings spreader equipped 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. The Engineer determines the exact rate.

37-2.03F(6) Reserved

37-2.03G Spreading Screenings

37-2.03G(1) General

Prevent vehicles from driving on asphaltic emulsion before spreading screenings.

Spread screenings at a uniform rate over the full lane width in 1 application.

Broom excess screenings at joints before spreading adjacent screenings.

Operate the spreader at speeds slow enough to prevent screenings from rolling over after dropping.

If the spreader is not moving, screenings must not drop. If you stop spreading and screenings drop, remove the excess screenings before resuming activities.

37-2.03G(2) Asphaltic Emulsion Seal Coat Screenings

You may stockpile screenings for asphaltic emulsion seal coat if you prevent contamination. Screenings must have damp surfaces at spreading. If water visibly separates from the screenings, do not spread. You may redampen them in the delivery vehicle.

Spread screenings before the asphaltic emulsion sets or breaks.

Spread screenings within 10 percent of the rate determined by the Engineer. Screenings must have a spread rate within the ranges shown in the following table:

Screening Spread Rates

Seal coat type	Range (lb/sq yd)
Fine	12–20
Medium fine	16–25
Medium	20–30
Coarse	23–30

Do not spread screenings more than 2,500 feet ahead of the completed initial rolling.

37-2.03G(3) Polymer Modified Asphaltic Emulsion Seal Coat Screenings

You may stockpile screenings for polymer modified emulsion seal coat if you prevent contamination. Screenings must have damp surfaces at spreading. If water visibly separates from the screenings, do not spread. You may redampen them in the delivery vehicle.

Spread screenings before the modified emulsion sets or breaks.

Spread screenings within 10 percent of the rate determined by the Engineer. Screenings must have a spread rate within the ranges shown in the following table:

Screening Spread Rates

Seal coat type	Range (lb/sq yd)
Fine	12–20
Medium fine	16–25
Medium	20–30
Coarse	23–30

Do not spread screenings more than 2,500 feet ahead of the completed initial rolling.

37-2.03G(4) Reserved

37-2.03H Finishing

37-2.03H(1) General

Remove piles, ridges, or unevenly distributed screenings. Repair permanent ridges, bumps, or depressions in the finished surface. Spread additional screenings and roll if screenings are picked up by rollers or vehicles.

Seal coat joints between adjacent applications of seal coat must be smooth, straight, uniform, and completely covered. Longitudinal joints must be at lane lines and not overlap by more than 4 inches. Blend the adjacent applications by brooming.

A coverage is the number of passes a roller needs to cover the width. A pass is 1 roller movement parallel to the seal coat 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 coverage until completing the previous coverage.

Before opening to traffic, finish seal coat in the following sequence:

1. Perform initial rolling consisting of 1 coverage with a pneumatic roller
2. Perform final rolling consisting of 3 coverage's with pneumatic-tired rollers
3. Broom excess screenings from the roadway and adjacent abutting areas

4. Apply flush coat if specified

The Engineer may order salvaging of excess screenings.

Dispose of excess screenings the Engineer determines are not salvageable. Dispose of screenings in any of the following ways or locations:

1. Under section 14-10
2. On embankment slopes
3. In authorized areas

Salvaging and stockpiling excess screenings is change order work.

37-2.03H(2) Reserved

37-2.03I Seal Coat Maintenance

Seals coat surfaces must be maintained for 4 consecutive days from the day screenings are applied. Maintenance must include brooming to maintain a surface free of loose screenings, to distribute screenings over the surface so as to absorb any free asphaltic material, to cover any areas deficient in cover coat material, and to prevent formation of corrugations

After 4 consecutive days, excess screenings must be removed from the paved areas. Brooming must not displace screenings set in asphaltic material.

The exact time of brooming will be determined by the Engineer. As a minimum, brooming will be 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 seal coat
2. On multilane roadways, from 2 to 4 hours after screenings have been placed
3. In addition to previous brooming, immediately before opening any lane to public traffic, not controlled with pilot cars
4. As the 1st order of work on the morning following the application of screenings on any lane that has been open to public traffic not controlled with pilot cars.

For 2-lane 2-way roadways under 1-way traffic control, upon completion of secondary rolling, public traffic must be controlled with pilot cars and routed over the new seal coat for a period of 2 to 4 hours. The Engineer will determine the exact period of time.

Schedule the operations so that seal coat is placed on both lanes of the traveled way each work shift and so that 1-way traffic control is discontinued 1 hour before darkness. At the end of the work shift, the end of the seal coat on both lanes must generally match.

On multilane roadways, initial brooming must begin after the screenings have been in place for a period of 2 to 4 hours. When the initial brooming is not completed during the work shift in which the screenings were placed, the initial brooming must be completed as the 1st order of work at the beginning of the next work shift.

Public traffic must be controlled with pilot cars and be routed on the new seal coat surface of the lane for a minimum of 2 hours after completion of the initial brooming and before opening the lane to traffic not controlled with pilot cars. When traffic is controlled with pilot cars, a maximum of 1 lane in the direction of travel must be open to public traffic. Once traffic controlled with pilot cars is routed over the seal coat at a particular location, continuous control must be maintained at that location until the seal coat placement and brooming on adjacent lanes to receive seal coat is completed.

37-2.04 PAYMENT

If there is no bid item for a traffic control system, furnishing and using a pilot car is included in the various items of the work involved in applying the seal coat.

If test results for the screenings grading do not comply with specifications, you may remove the seal coat represented by these tests or request that it remain in place with a payment deduction. The deduction is $1.75 per ton for the screenings represented by the test results.

If asphaltic emulsion seal coat with screenings does not comply with the cleanness value specifications, you may request that the seal coat remain in place with a pay deduction corresponding to the cleanness value shown in the following table:

Asphaltic Emulsion Seal Coat 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 polymer modified asphaltic emulsion seal coat with screenings does not comply with the specifications for cleanness value you may request that the seal coat remain in place with a pay deduction corresponding by the cleanness value shown in the following table:

Polymer Modified Asphaltic Emulsion Seal Coat Cleanness Value Deductions

Cleanness value	Deduction
86 or over	None
81–85	$2.20/ton
77–80	$4.40/ton
75–76	$6.60/ton

If test results for polymer modified asphaltic emulsion aggregate grading and cleanness value test results do not comply with the specifications, all deductions are made. A test for asphaltic emulsion (polymer modified) represents the smaller of 55 tons or 1 day's production. A test for the screenings grading or cleanness value represents the smaller of 300 tons or 1 day's production.

The Department does not adjust the unit price for an increase or decrease in the sand cover for the flush coat quantity.

The Department does not adjust the unit price for an increase or decrease in the asphaltic emulsion (fog seal coat) quantity.

The payment deduction for noncompliant modified emulsion is based on the total pay factor value determined from the table titled, "Polymer Modified Asphaltic Emulsion Pay Factor Deduction." You must remove modified emulsion seal coat with a pay factor value greater than 20. You may request seal coat with noncompliant modified emulsion to remain in place with a pay deduction for the total pay factor value shown in the following table:

Polymer Modified Asphaltic Emulsion Pay Factor Deductions

Total pay factor value	Deduction
0	none
1–2	$5.00/ton
3–5	$10.00/ton
6–9	$15.00/ton
10–14	$25.00/ton
15–20	$50.00/ton

37-3 SLURRY SEAL AND MICRO-SURFACING

37-3.01 GENERAL

37-3.01A Summary

Section 37-3 includes specifications for applying slurry seal and micro-surfacing .

Slurry seal includes applying a mixture of asphaltic emulsion or polymer modified asphaltic emulsion, aggregate, set-control additives, and water spread on a surface or pavement.

Micro-surfacing includes applying a mixture of micro-surfacing emulsion, water, additives, mineral filler, and aggregate spread on pavement.

37-3.01B Definitions

Reserved

37-3.01C Submittals

37-3.01C(1) General

The testing laboratory must sign the original laboratory report and mix design.

If the mix design consists of the same materials covered by a previous laboratory report, you may submit the previous laboratory report, which must include material testing data performed within the previous 12 months for authorization.

If requesting substitute materials, submit a new laboratory report and mix design at least 7 days before starting placement.

37-3.01C(2) Slurry Seal

Submit a laboratory report of test results and a proposed mix design 7 days before starting placement of slurry seal. The report and mix design must include the specific materials to be used.

The laboratory report must include:

1. Test results used in the mix design
2. Proportion of the following material based on the aggregate's dry weight:
   2.1. Aggregate
   2.2. Filler determined from tests, minimum and maximum
   2.3. Water, minimum and maximum
   2.4. Asphalt solids content
   2.5. Set control agent
3. Comparison of slurry seal test results to the specified values

Each day, submit moisture data for the aggregate collected every 2 hours when you are unable to maintain the moisture content to within a maximum daily variation of ± 0.5 percent.

37-3.01C(3) Micro-surfacing

Submit a laboratory report of test results and a proposed mix design 10 days before starting placement of micro-surfacing. The report and mix design must include the specific materials to be used and show a comparison of test results and specifications.

Submit a certificate of compliance with each shipment of micro-surfacing emulsion as specified for asphaltic emulsion in section 94-1.01B.

Before micro-surfacing activities start, submit the name of a person authorized to communicate with the Engineer about days when unsuitable weather conditions prevent micro-surfacing.

The mix design report must include:

1. Test results used in the mix design
2. Proportions of the following material based on the aggregate's dry weight:
   2.1. Aggregate
   2.2. Water, minimum and maximum
   2.3. Additives
   2.4. Mineral filler, minimum and maximum
   2.5. Micro-surfacing emulsion residual asphalt content, minimum and maximum
3. Recommended changes to the following proportions based on heating the mixture to 100 degrees F and mixing for 60 seconds:
   3.1. Water
   3.2. Additives

3.3. Mineral filler

Do not recommend these changes when nighttime applications are specified or when atmospheric temperatures below 90 degrees F are forecast for daytime applications.

4. Comparison of each individual material's test results to its specified values.
5. Quantitative moisture effects on the aggregate's unit weight determined under ASTM C 29M.

37-3.01D Quality Control and Assurance

37-3.01D(1) General

Your laboratory must be able to perform International Slurry Surfacing Association tests and mix designs.

37-3.01D(2) Slurry Seal

Calibrate each truck mounted mixer-spreader used in the presence of the Engineer. Calibration must comply with California Test 109.

Calibrate the adjustable cut-off gate settings of each mixer-spreader truck on the project to achieve the correct delivery rate of aggregate and emulsion per revolution of the aggregate feeder in compliance with California Test 109.

Checks must be performed for each aggregate source using an approved California Test 109 vehicle scale.

Individual checks of the aggregate belt feeder's delivery rate to the pugmill mixer must not vary more than 2 percent from the average of 3 runs of at least 3 tons each.

Individual checks of the emulsion pump's delivery rate to the pugmill mixer must not vary more than 2 percent from the average of 3 runs of at least 500 gal each.

Measure aggregate moisture every 2 hours during slurry seal placement or maintain the moisture content within a maximum daily variation of ± 0.5 percent.

37-3.01D(3) Micro-surfacing

Calibrate each truck-mounted mixer-spreader used in the presence of the Engineer. Notify the Engineer at least 5 business days before calibrating. Calibration must comply with the Department's Material Plant Quality Program.

If the Department authorizes a truck-mounted mixer-spreader, its calibration is valid for 6 months provided you:

1. Use the same truck 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

Before using a variable-rate emulsion pump, the pump must be calibrated and sealed in the calibrated condition under the Department's Material Plant Quality Program.

For the aggregate belt feeder, the delivery rate for any individual check run must not deviate more than 2 percent from the average of the rates of 3 runs of at least 3 tons each.

For the emulsion pump, the delivery rate for any individual check run must not deviate more than 2 percent from the average of the rates of 3 runs of at least 300 gallons each.

37-3.01D(4) Mix Design

37-3.01D(4)(a) General

Reserved

37-3.01D(4)(b) Slurry Seal

The slurry seal mix design must comply with the requirements shown in the following table:

Slurry Seal Mix Design Requirements

Properties	International Slurry Surfacing Association test method	Specification
Consistency, mm, max	Technical Bulletin 106	30
Wet stripping	Technical Bulletin 114	Pass
Compatibility	Technical Bulletin 115	Pass [a]
Cohesion test [b], kg-mm within 1 hour, min	Technical Bulletin 139	200
Wet track abrasion, g/m^{2,}, max	Technical Bulletin 100	800

[a] Mixing test must pass at the maximum expected air temperature at the job site during placement.
[b] Using project source aggregate, asphaltic emulsion, and set-control agents, if any.

The mix design must have the percent of asphaltic emulsion, based on percentage by weight of the dry aggregate, within the ranges shown in the following table:

Asphaltic Emulsion Percentage

Aggregate type	Range
I	15–20
II	12–18
III	10–15

The Engineer determines the exact percentage based on the design asphalt binder content and the asphalt solids content of the asphaltic emulsion furnished

Aggregate type is described in section 37-3.02A.

37-3.01D(4)(c) Micro-surfacing

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 residual asphalt	5.5–9.5% of aggregate dry weight
Water and additives	No limit
Mineral filler	0–3% of aggregate dry weight

The micro-surfacing mix design must have the properties as specified in the following table:

Micro-surfacing Mix Design Tests

Property	International Slurry Surfacing Association test method	Specification
Wet cohesion @ 30 minute (set), min, kg-cm @ 60 minute (traffic), min, kg-cm	Technical Bulletin 139	 12 20
Excess asphalt, max, g/m2	Technical Bulletin 109	540
Wet stripping, min, %	Technical Bulletin 114	90
Wet track abrasion loss 6-day soak, max, g/m2	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 @ 25 °C, min	Technical Bulletin 113	Controllable to 120 seconds

37-3.02 MATERIALS

37-3.02A General

Aggregate must have the following gradation as determined under California Test 202:

Aggregate Grading

	Percentage passing by aggregate type		
Sieve sizes	I	II	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

Aggregate must be rock dust or sand such as plaster sand. Aggregate larger than the no. 50 sieve must be 100 percent crushed rock. Aggregate must be free from vegetable matter, deleterious substances, caked or clay lumps, and oversized particles.

37-3.02B Slurry Seal

37-3.02B(1) General

Reserved

37-3.02B(2) Aggregate

If the specific gravities differ by 0.2 or more, California Test 202 is replaced with California Test 105 for blends of different aggregates.

Aggregate for slurry seal must have the quality characteristics as specified in the following table:

Aggregate Quality

Quality characteristic	Test method	Specification by aggregate type		
		I	II	III
Sand equivalent, min	California Test 217	45	55	60
Durability index, min	California Test 229	55	55	55

Each day's aggregate moisture content measurements must not vary more than ±0.5 percent.

37-3.02B(3) Asphaltic Emulsion

37-3.02B(3)(a) General

Asphaltic emulsion must be either Grade QS1h anionic or Grade CQS1h cationic.

Water must not allow separation of the asphaltic emulsion from the emulsion before you place the slurry seal. You may use a set-control agent that does not adversely affect the slurry seal.

37-3.02B(3)(b) Polymer Modified Asphaltic Emulsion

Polymer modified asphaltic emulsion must:

1. Consist of a polymer mixed with a bituminous 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. Polymer modified asphaltic emulsion must be Grade PMCQS1h cationic and have the values of the properties shown in the following table:

Polymer Modified Asphaltic Emulsion

Property	Test method	Value	
		Min	Max
Tests on emulsion:			
Saybolt Furol Viscosity @ 25 °C, SFS[a]	AASHTO T 59	15	90
Sieve test, %	AASHTO T 59	--	0.30
Storage stability, 1 day, %	AASHTO T 59	--	1
Residue by evaporation, %	California Test 331	57	--
Particle charge	AASHTO T 59	Positive	
Tests on residue by evaporation test			
Penetration, 25 °C	AASHTO T 49	40	90
Ductility, 25 °C, mm	AASHTO T 51	400	--
Torsional recovery, %	California Test 332	18	--
or			
Polymer content, %	California Test 401	2.5	--

Note:
[a]SFS means Saybolt Furol seconds
Sampling must comply with section 94-1.03.

37-3.02C Micro-surfacing

37-3.02C(1) General

Reserved

37-3.02C(2) Aggregate

If you blend aggregate from different sources, each source's aggregate must comply with the aggregate specifications except grading.

Aggregate for micro-surfacing excluding mineral filler must have the quality characteristics as specified in the following table:

Micro-surfacing Aggregate

Quality characteristic	Test method	Specification
Sand equivalent, min	California Test 217	65
Durability index, min	California Test 229	65
Percentage of crushed particles, min[a]	California Test 205	95%
Los Angeles Rattler Loss at 500 revolutions, max[b]	California Test 211	35%

[a] Crushed particles must have at least 1 fractured face.
[b] California Test 211 must be performed on the aggregate before crushing.

37-3.02C(3) Micro-surfacing Emulsion

Micro-surfacing emulsion must be a homogeneous mixture of asphalt, polymer, and emulsifier solution.

Add polymer modifier to asphalt or emulsifier solution before emulsification. Polymer solids must be a minimum 3 percent by weight of the micro-surfacing emulsion's residual asphalt.

Micro-surfacing emulsion must have the values of the properties as specified in the following table:

Micro-surfacing Emulsion

Property	Test method	Value
Saybolt Furol Viscosity @ 25 °C, SFS[a]	AASHTO T 59	15–90 seconds
Sieve test, max	AASHTO T 59	0.30%
Settlement, 5 days, max[b]	ASTM D 244	5%
Storage stability, 1 day, max	AASHTO T 59	1%
Residue by evaporation, min	California Test 331	62%

[a]SFS means Saybolt Furol seconds
[b]Waived if used within 48 hours of shipment.

The micro-surfacing emulsion's residue by evaporation must have the values of the properties shown in the following table:

Micro-surfacing Emulsion Residue By Evaporation

Property	Test method	Value
G* @ 20 ºC, 10 rad/sec, MPa	AASHTO T 315	Report only
Penetration @ 25 ºC	AASHTO T 49	40–90
Phase angle @ 50 °C, 10 rad/sec, PA (maximum) - PA base	AASHTO T 315	Report only
Softening point, min, ºC	AASHTO T 53	57
Stiffness @ -12 °C, MPa, and M-value	AASHTO T 313	Report only

37-3.02C(4) Mineral Filler

If portland cement is used as mineral filler, it must be any combination of Type I, Type II, or Type III cement.

37-3.03 CONSTRUCTION

37-3.03A General

Before applying slurry seal or micro-surfacing, 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 of adhesive to the facility being covered. Reference the covered facilities with a sufficient number of control points to relocate the facilities after the application of the seal coat.

In areas inaccessible to spreading equipment, spread the slurry seal or micro-surfacing mixture with hand tools or other authorized methods. If placing with hand tools, first lightly dampen the area. Do not handle or shift the material.

37-3.03B Proportioning

37-3.03B(1) General

The Engineer determines the asphalt distribution under California Test 310. The bitumen ratio, in kilograms of asphalt per 100 kg of dry aggregate, must not vary more than ±0.5 kg of asphalt from the determined amount.

37-3.03B(2) Slurry Seal

Proportion slurry seal ingredients in compliance with the authorized mix design. Proportion and blend different aggregate types before adding other ingredients.

After proportioning, the slurry seal mixture must be workable and permit traffic within 1 hour after placement without occurrences of bleeding, raveling, separation or other distresses. None of the same occurrences must be present 15 days after placing the slurry seal.

37-3.03B(3) Micro-surfacing

Proportion the micro-surfacing materials using the authorized mix design.

Field conditions may require adjustments during construction. Obtain authorization before adjusting proportions.

37-3.03C Mixing and Spreading Equipment

37-3.03C(1) General

Mixing and spreading equipment for slurry seal and micro-surfacing must proportion asphaltic emulsion, water, aggregate, and any set-control additives by volume and mix them in continuous pugmill mixers. Continuous pugmill mixers must be of adequate size and power for the type of materials to be mixed.

37-3.03C(2) Truck Mounted Mixer Spreaders

Truck mounted mixer spreaders must comply with the following:

1. Rotating and reciprocating equipment must be covered with metal guards.

2 Proportion aggregate using a belt feeder with an adjustable cutoff gate. The height of the gate opening must be determinable.
3. The belt feeder must have a depth monitor device. The depth monitor device must automatically shut down power to the belt feeder whenever the aggregate depth is less than 70 percent of the target depth.
4. A 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. The 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. The 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 and comply with California Test 109. Low-flow indicators must be visible while walking alongside the equipment.

37-3.03C(3) Continuous Self-Loading Mixing Machine

Continuous self-loading mixing machines must be automatically sequenced and self-propelled. The mixing machine must deliver the materials to a double shafted mixer and discharge the mixed product on a continuous flow basis. The mixing machine must have sufficient storage capacity to maintain a continuous supply of materials to the proportioning controls. The mixing machine must be self-loading without interrupting placement. The mixing machine operator must have full control of forward and reverse speeds during placement.

37-3.03C(4) Slurry Seal Equipment

37-3.03C(4)(a) General

Introduce emulsion 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 with a meter that measures gallons.

Identifying numbers for equipment must be at least 2 inches high and located on the front and rear of the vehicle.

37-3.03C(4)(b) Spreader Box

Spread the slurry mixture with a spreader box that complies with the following:

1. Capable of spreading a lane width
2. Equipped with material such as flexible rubber belting on each side and in contact with the pavement to prevent loss of slurry from the box
3. If wider than 7.5 feet, a spreader box equipped with a means, such as baffles or reversible motor-driven augers, to uniformly apply slurry seal on superelevated sections and shoulder slopes
4. Equipped with rear flexible strike-off blades making close contact with the pavement and adjustable to various crown shapes in order to apply a uniform slurry seal
5. Equipped with flexible drags attached to the rear and cleaned daily and changed if longitudinal scouring occurs
6. Clean and free of slurry seal or emulsion at the start of each work shift

37-3.03C(5) Micro-surfacing Equipment

37-3.03C(5)(a) General

Choose a continuous self-loading mixing machine or truck mounted mixer-spreader.
Proportion micro-surfacing emulsion using a positive displacement pump.

Identifying numbers for equipment must be at least 3 inches high and located on the front and rear of the vehicle

37-3.03C(5)(b) Spreader Box

The spreader box must be capable of spreading the micro-surfacing a minimum of 12 feet wide and preventing the loss of micro-surfacing. Spreader boxes over 8 feet in application width must have a device, such as baffles or reversible motor driven augers, to ensure uniform application on superelevated sections and shoulder slopes. Clean micro-surfacing and micro-surfacing emulsion from the spreader box before each work shift.

The spreader box must have a series of strike-off devices at its rear.

The leading strike-off device must be:

1. Fabricated of a suitable material such as steel or stiff rubber
2. Designed to maintain close contact with the pavement during spreading
3. Capable of obtaining the specified thickness
4. Capable of being adjusted to the various pavement cross sections

The final strike-off device must be:

1. Fabricated of flexible material that produces a uniform texture in the finished surface
2. Cleaned daily and changed if longitudinal scouring occurs in the micro-surfacing

Do not use flexible drags attached to the rear of the spreader box.

37-3.03C(5)(c) Shoulder Equipment

Spread micro-surfacing on shoulders with a device such as an edge box that forms clean and straight joints and edges.

37-3.03C(5)(d) Scratch Course Box

Spread scratch course with the same type of spreader box used to spread micro-surfacing except use an adjustable steel strike-off device instead of a final strike-off device.

37-3.03C(5)(e) Wheel Path Depression (Rut) Box

Wheel path depression (rut) boxes must have adjustable strike-off devices between 5 and 6 feet wide that regulate depth. The rut 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

37-3.03D Placing

37-3.03D(1) General

If truck-mounted mixer-spreaders are used, keep at least 2 operational spreaders at the job site during placement.

In areas inaccessible to spreading equipment, spread the slurry seal or micro-surfacing mixture with hand tools. If placing with hand tools, first lightly dampen the area. Do not handle or shift the mixture.

37-3.03D(2) Surface Preparation

37-3.03D(2)(a) General

Before you place slurry seal or micro-surfacing, clean the pavement surface.

Remove loose particles of extraneous materials, including paving and dirt. Use any nondestructive method, such as flushing or sweeping.

37-3.03D(2)(b) Slurry Seal

If slurry seal operations affect access to public parking, residential property, or commercial property, 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 work hours
4. Be authorized

Before starting slurry seal activities, post signs at 100-foot intervals on the affected streets. Signs must display "No Parking – Tow Away." Signs must state the day of the week and hours parking or access will be restricted.

Within 1 hour after placement, slurry seal must be set enough to allow traffic without pilot cars. Slurry seal must not exhibit distress from traffic such as bleeding, raveling, separation or other distresses.

37-3.03D(2)(c) Micro-surfacing

37-3.03D(2)(c)(i) General

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

37-3.03D(2)(c)(ii) Repair Wheel Path Depression

If repair wheel path depression is specified, 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 with a wheel path depression (rut) box.

Spread scratch course by adjusting the steel strike-off of a scratch course box until it is directly in contact with the pavement surface.

Spread micro-surfacing with a rut 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-surfacing.

37-3.03D(3) Test Strip

37-3.03D(3)(a) General

Reserved

37-3.03D(3)(b) Slurry Seal

Test strip does not apply to slurry seal.

37-3.03D(3)(c) Micro-surfacing

Reserved

37-3.03D(4) Placement

37-3.03D(4)(a) General

Reserved

37-3.03D(4)(a)(i) General

Longitudinal and transverse joints must be:

1. Uniform
2. Straight
3. Neat in appearance
4. Butt-type joints
5. Without material buildup
6. Without uncovered areas

Place longitudinal joints:

1. On centerlines, lane lines, edge lines, or shoulder lines
2. With overlaps not more than 3 inches

Set the leading edge of roofing felt on transverse joints to create a straight butt joint with the next application when the roofing felt is removed.

37-3.03D(4)(a)(ii) Weather Conditions

Only place slurry seal or micro-surfacing if both the pavement and air temperatures are at least 50 degrees F and rising. Do not place slurry seal or micro-surfacing if either the pavement or air temperature is below 50 degrees F and falling. The expected high temperature must be at least 65 degrees F within 24 hours after placement.

Do not place slurry seal or micro-surfacing if rain is imminent or the air temperature is expected to be below 36 degrees F within 24 hours after placement.

37-3.03D(4)(a)(iii) Unsuitable Day

The Engineer may notify you of unsuitable conditions before 4:00 p.m. on the day before your 1st intended working day to place slurry seal or micro-surfacing. After you have started slurry seal or micro-surfacing placement activities, the Engineer has until 4:00 p.m. on the day before the next working day to give you an unsuitable day notice. If the Engineer gives you an unsuitable day notice (1) do not place slurry seal or micro-surfacing on the next working day and (2) the Department does not pay for return, storage or disposal of materials delivered to the job site and the time of workers. If maintenance of previously applied slurry seal or micro-surfacing can be performed, continue to perform maintenance.

In the absence of an unsuitable day notice or if the Engineer gives notice after 4:00 p.m. of the previous day:

1. Comply with specifications restricting slurry seal or micro-surfacing application.
2. Return, store, or dispose of any slurry seal or micro-surfacing materials you deliver to the job site when conditions are unsuitable.
3. The Department adjusts payment for the return, storage or disposal of materials delivered to the job site.
4. The Department adjusts payment for the show-up time of workers who would have applied slurry seal or micro-surfacing.
5. Payment of materials and labor will be determined under section 9-1.04, except markups are not added.

It is a nonworking day if the slurry seal or micro-surfacing work is the controlling operation and (1) the Engineer provides you timely notice of an anticipated unsuitable day or (2) there is untimely or no notice and conditions are unsuitable for placing slurry seal or micro-surfacing.

If you fail to submit the name of a person authorized to communicate with the Engineer about unsuitable day notices, the specifications for payment do not apply.

37-3.03D(4)(b) Slurry Seal

Spread slurry seal uniformly within the specified rate. Do not spot, rehandle, or shift the mixture.

If there is a bid item for tack coat, coat the pavement surface with an SS or CSS grade asphaltic emulsion mixed with additional water. The ration of water to asphaltic emulsion must be 3 to 1. Apply the tack coat at a rate from 0.08 to 0.15 gal/sq yd. The exact rate must be authorized.

The Engineer determines the exact spread rate for slurry seal. The completed rate must be within 10 percent of the Engineer's determined spread rate. The slurry seal spread rates must be within the ranges shown in the following table:

Slurry Seal Spread Rates

Type of aggregate	Range (lb of dry aggregate/sq yd)
I	8–12
II	10–15
III	20–25

Longitudinal joints must correspond with lane lines. You may request other longitudinal joint patterns if they do not adversely affect the slurry seal.

Spread slurry seal in full lane widths. Do not overlap slurry seal between adjacent lanes more than 3 inches.

Use a material, such as building paper at transverse joints and over previously placed slurry seal to prevent double placement. Remove the material after use. Use hand tools to remove spillage.

The finished surface must be smooth.

The mixture must be uniform and homogeneous after spreading and there must not be separation of the emulsion and aggregate after setting.

Protect the slurry seal from damage until it has cured and will not adhere or be picked up by vehicle tires.

37-3.03D(4)(c) Micro-surfacing

37-3.03D(4)(c)(i) General

The Engineer determines the exact spread rate for micro-surfacing, The completed spread rate must be within 10 percent of the Engineer's determined spread rate. The micro-surfacing spread rates must be within the ranges shown in the following table:

Micro-surfacing Spread Rates

Micro-surfacing type	Location	Range (lb of dry aggregate/sq yd)
Type II	Full lane width	10–20
Type III[a]	Full lane width	20–32
Type III[b]	Full lane width	30–32

[a] Over asphalt concrete pavement
[b] Over concrete pavement and concrete bridge decks

Spread micro-surfacing either in the direction of traffic or in the opposite direction.

Keep hand tools available to remove spillage.

37-3.03D(4)(c)(ii) Joints

The maximum difference between the pavement surface and the bottom edge of a 12-foot straightedge placed perpendicular to the joint must be:

1. 0.04 foot for longitudinal joints
2. 0.03 foot for transverse joints

37-3.03D(4)(c)(iii) Finished Surface

Finished micro-surfacing must be free of irregularities such as scratch or tear marks. You may leave up to 4 marks that are 1/2 inch or more wide and 6 inches or more long per 75 linear feet of micro-surfacing placed. Do not leave any marks that are over 1 inch wide or 6 inches long.

Sweep the micro-surfacing 24 hours after placement without damaging the micro-surfacing. For 5 days afterward, sweep the micro-surfacing daily.

37-3.03D(4)(c)(iv) Repair of Early Distress

If bleeding, raveling, delaminating, rutting, or washboarding occurs after placing the micro-surfacing, make repairs using an authorized method.

37-3.04 PAYMENT

37-3.04A General

If tack coat is specified, it will be measured under section 94-1.04.

37-3.04B Slurry Seal

Slurry seal is measured by combining the weight of the aggregate and asphaltic emulsion. The weight of added water and set-control additive are not measured.

If test results for aggregate grading or sand equivalent do not comply with the specifications, you may remove the installed slurry seal represented by the test results or request it remain in place with a payment deduction. The deduction is $1.75 per ton.

If test results for both aggregate grading and sand equivalent do not comply with the specifications, both deductions are made. An aggregate grading or cleanness value test represents 300 tons or 1 day's production, whichever is less.

37-3.04C Micro-surfacing

Micro-surfacing is measured by combining the weight of the aggregate and micro-surfacing emulsion, including test strips. The weight of added water and set-control additives are not measured for payment.

If test results for aggregate grading or sand equivalent do not comply with the specifications, you may remove the installed micro-surfacing represented by the test results or request it remain in place with a payment deduction. The deduction is $2.00 per ton.

If test results for both aggregate grading and sand equivalent do not comply with the specifications, both deductions are made.

37-4 PARKING AREA SEALS

37-4.01 GENERAL

37-4.01A Summary

Section 37-4 includes specifications for applying a mixture of asphaltic emulsion, aggregate, polymer, and water spread on a surface or pavement.

37-4.01B Definitions

Reserved

37-4.01C Submittals

At least 15 days before starting placement, submit samples of the aggregate to be used. The samples must be processed the same way as the aggregate to be used in the work.

At least 10 days before starting placement, submit the name of a laboratory to perform testing and mix design.

At least 7 days before starting placement, submit a 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 amount of water allowed to be added at the job site. The laboratory performing the tests must sign the original laboratory report and mix design.

If the mix design consists of the same materials covered by a previous laboratory report, you may submit the previous laboratory report which 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.

At least 10 days before use, submit the manufacturer's product data for oil seal primer and polymer.

Submit a certificate of compliance for the parking area seal material.

37-4.01D Quality Control and Assurance

Sample the undiluted parking area seal material.

37-4.02 MATERIALS

37-4.02A 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. Asphaltic emulsion must comply with section 94, except in Tables 1 and 2, the values for penetration at 25 degrees C for tests on residue from distillation must be from 20 to 60. You may use clay-stabilized emulsion with a solids content not less than 45 percent by weight.

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 slurry seal from pavement with residual oils, petroleum grease, and spilled gasoline.

Crack sealant must comply with section 37-5.

Water must be potable and not separate from the emulsion before the material is placed.

37-4.02B Mix Design

The proposed mix design for parking area seals must have the values of the properties shown in the following table:

Parking Area Seal Mix Design Requirements

Property	Test method	Requirement	
		Min	Max
Mass per liter	ASTM D 244	1.1 kg	
Cone penetration, mm	California Test 413	340	700
% Nonvolatile % Nonvolatile soluble in tri-clorethylene	ASTM D 2042[a]	50 10	 35
Wet track abrasion, g/m^2	ASTM D 3910		380
Dried film color		Black	
Viscosity	ASTM D 562	75 KU[b]	

[a] Weigh 10 g of homogenous product 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

Parking area seals must contain a minimum of 2 percent polymer by volume of undiluted asphaltic emulsion.

37-4.03 CONSTRUCTION

37-4.03A General

Reserved

37-4.03B Proportioning

Mix parking area seal ingredients in a central plant. The plant must include mechanical or electronic controls that consistently proportion the ingredients. Mix 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.

37-4.03C Surface Preparation

If cracks in the existing pavement are from 1/4 to 1 inch wide, treat the cracks under section 37-5. Do not place the parking area seal until the Engineer determines that the crack treatment is cured.

If cracks in the existing pavement are greater than 1 inch wide, the Engineer orders the repair.

After any crack treatment and before placing parking area seal, 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 standing water to dry before placing parking area seal.

You must seal oil and grease spots that remain after cleaning. Use an oil seal primer and follow 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.

37-4.03D Placement

Do not place parking area seal when the ambient temperature is less than 55 degrees F or the surface temperature is less than 60 degrees F. Do not place seal within 24 hours of rain or within 24 hours of forecast rain or freezing temperatures. 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.

Add polymer at the job site in the Engineer's presence.

If adding water at the job site based on the manufacturer's recommendations for consistency and spreadabilty, do not exceed 15 percent by volume of undiluted asphaltic emulsion.

Before placing the parking area seal, 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.

Place the parking area seal in 1 or more application. The seal 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 seal for at least 24 hours after placement.

Do not stripe the parking area seal until it is dry.

37-4.04 PAYMENT

Parking area seal is measured by combining the weight of the aggregate and asphaltic emulsion. Added water and set-control additive are not measured.

37-5 CRACK TREATMENT

37-5.01 GENERAL

37-5.01A Summary

Section 37-5 includes specifications for treating cracks in asphalt concrete pavement, including shoulders.

37-5.01B Definitions

Reserved

37-5.01C Submittals

Submit a certificate of compliance if your selected crack treatment material is on the Authorized Material List. The submittal must include:

1. Manufacturer's name
2. Production location
3. Product brand or trade name
4. Product 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 submit a sample and test results from each batch or lot 20 days before use. Testing must be done 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. Hot-applied crack treatment material samples must be 3 pounds minimum in a silicone release container. Cold-applied crack treatment material samples must be submitted in a minimum 2-quart plastic container.

Submit the following with each delivery of crack treatment material to the job site:

1. Manufacturer's heating and application instructions
2. Manufacturer's MSDS
3. Name of the manufacturer's recommended detackifier

37-5.01D Quality Control and Assurance

Hot-applied crack treatment material must be sampled at least once per project in the Engineer's presence. Collect two 3-pound minimum samples of crack treatment material from the dispensing wand into silicone release boxes. Submit 1 sample.

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 and submit 1 sample.

37-5.02 MATERIALS

Crack treatment material must have the values of the properties shown in the following table:

Crack Treatment Material

Property [a]	ASTM test method [b]	Type 1 material	Type 2 material	Type 3 material	Type 4 material	Type 5 material
Softening point (min)	D 36	102 °C	96 °C	90 °C	84 °C	84 °C
Cone penetration at 77 °F (max)	D 5329	35	40	50	70	90
Resilience at 77 °F, unaged, %	D 5329	20–60	25–65	30–70	35–75	40–80
Flexibility [c]	D 3111	0 °C	0 °C	0 °C	-11 °C	-28 °C
Tensile adhesion, %, (min)	D 5329	300	400	400	500	500
Specific gravity (max)	D 70	1.25	1.25	1.25	1.25	1.25
Asphalt compatibility	D 5329	Pass	Pass	Pass	Pass	Pass
Sieve test (percent passing)	See note d	100	100	100	100	100

[a] Cold-applied crack treatment material residue collected under ASTM D 6943, Method B and sampled under ASTM D 140 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 product 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.

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. Product brand or trade name
4. Product 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.

Sand applied to tacky crack treatment material must be clean, free of clay, and have the following gradation:

Sand Gradation

Sieve size	Percent passing
No. 4	100
No. 50	0–30
No. 200	0–5

37-5.03 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.

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 hot-applied crack treatment material in compliance with the manufacturer's instructions. Comply with the manufacturer's application 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 National Pipe Tapered Thread (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.

37-5.04 PAYMENT

Crack treatment is measured by the lane-mile. A lane-mile consists of a paved lane and any adjacent shoulders. The Engineer determines the quantity paid from actual measurements along the edge of each paved lane parallel with the pavement centerline.

38 RESERVED

39 HOT MIX ASPHALT

39-1 GENERAL

39-1.01 GENERAL

39-1.01A Summary

Section 39-1 includes general specifications for producing and placing HMA by mixing aggregate and asphalt binder at a mixing plant and spreading and compacting the HMA mixture.

HMA includes one or more of the following types:

1. Type A
2. Type B
3. OGFC, including HMA-O, RHMA-O, and RHMA-O-HB
4. RHMA-G

The HMA construction process includes one or more of the following:

1. Standard
2. Method
3. QC/QA

39-1.01B Definitions

coarse aggregate: Aggregate retained on a no. 4 sieve.

fine aggregate: Aggregate passing the no. 4 sieve.

supplemental fine aggregate: Aggregate passing the no. 30 sieve, including hydrated lime, portland cement, and fines from dust collectors.

39-1.02 MATERIALS

39-1.02A 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.

39-1.02B Tack Coat

Tack coat must comply with the specifications for asphaltic emulsion or asphalts. Choose the type and grade.

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 in compliance with section 9-1.02 or you may 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

39-1.02C Asphalt Binder

Asphalt binder in HMA must comply with the specifications for asphalts or section 39-1.02D.

Asphalt binder for geosynthetic pavement interlayer must comply with the specifications for asphalts. Choose from Grades PG 64-10, PG 64-16, or PG 70-10.

39-1.02D Asphalt Rubber Binder

39-1.02D(1) General

Use asphalt rubber binder in RHMA-G, RHMA-O, and RHMA-O-HB. 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 asphalt rubber binder.

39-1.02D(2) Asphalt Modifier

Asphalt modifier must be a resinous, high flash point and aromatic hydrocarbon and must have the values for the quality characteristics shown in the following table:

Asphalt Modifier for Asphalt Rubber Binder

Quality characteristic	Test method	Value
Viscosity, m^2/s (x 10^{-6}) at 100 °C	ASTM D 445	X ± 3 [a]
Flash point, Cleveland Open Cup, °C	ASTM D 92	207 min
Molecular analysis		
Asphaltenes, percent by mass	ASTM D 2007	0.1 max
Aromatics, percent by mass	ASTM D 2007	55 min

[a] The symbol "X" is the proposed asphalt modifier viscosity. "X" must be from 19 to 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.

39-1.02D(3) Crumb Rubber Modifier

CRM consists of a ground or granulated combination of scrap tire crumb rubber and high natural rubber. CRM must be 75.0 ± 2.0 percent scrap tire rubber and 25.0 ± 2.0 percent high natural rubber by total weight of CRM. Scrap tire crumb rubber must be from any combination of automobile tires, truck tires, or tire buffings.

Sample and test the scrap tire crumb rubber and high natural rubber separately. CRM must have the values for the quality characteristics shown in the following table:

Crumb Rubber Modifier for Asphalt Rubber Binder

Quality characteristic	Test method	Value
Scrap tire crumb rubber gradation (% passing no. 8 sieve)	LP-10	100
High natural rubber gradation (% passing no. 10 sieve)	LP-10	100
Wire in CRM (% max.)	LP-10	0.01
Fabric in CRM (% max.)	LP-10	0.05
CRM particle length (inch max.) [a]	--	3/16
CRM specific gravity [a]	California Test 208	1.1–1.2
Natural rubber content in high natural rubber (%) [a]	ASTM D 297	40.0–48.0

[a] Test at mix design and for certificate of compliance.

CRM must be ground and granulated at ambient temperature. If steel and fiber are cryogenically separated, it must occur before grinding and granulating. If cryogenically produced, CRM particles must be large enough to 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.

39-1.02D(4) Asphalt Rubber Binder Design and Profile

Submit a proposal for asphalt rubber binder design and profile. In the design, include the asphalt, asphalt modifier, and CRM and their proportions. The profile is not a performance specification and only serves to indicate expected trends in asphalt rubber binder properties during binder production. The profile must include the same component sources for the asphalt rubber binder used.

Design the asphalt rubber binder from testing you perform for each quality characteristic and for the reaction temperatures expected during production. 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

Test	Minutes of reaction [a]							Limits
	45	60	90	120	240	360	1440	
Cone penetration @ 77 °F, 0.10-mm (ASTM D 217)	X [b]				X		X	25–70
Resilience @ 77 °F, percent rebound (ASTM D 5329)	X				X		X	18 min.
Field softening point, °F (ASTM D 36)	X				X		X	125–165
Viscosity, centipoises (LP-11)	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 (1,320-minutes) cooldown 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

39-1.02D(5) Asphalt Rubber Binder

After interacting for at least 45 minutes, asphalt rubber binder must have the values for the quality characteristics shown in the following table:

Asphalt Rubber Binder

Quality characteristic	Test for quality control or acceptance	Test method	Value	
			Minimum	Maximum
Cone penetration @ 77 °F, 0.10 mm	Acceptance	ASTM D 217	25	70
Resilience @ 77 °F, percent rebound	Acceptance	ASTM D 5329	18	--
Field softening point, °F	Acceptance	ASTM D 36	125	165
Viscosity @ 375 °F, centipoises	Quality control	LP-11	1,500	4,000

39-1.02E Aggregate

Aggregate must be clean and free from deleterious substances.

The specified aggregate gradation must be determined before the addition of asphalt binder and includes supplemental fine aggregate. The Department tests for aggregate grading under California Test 202, modified by California Test 105 if there is a difference in specific gravity of 0.2 or more between the coarse and fine parts of different aggregate blends.

Choose sieve size TV within each TV limit presented in the aggregate gradation tables.

The proposed aggregate gradation must be within the TV limits for the specified sieve sizes shown in the following tables:

Aggregate Gradation (Percentage Passing) HMA Types A and B

3/4-inch HMA Types A and B

Sieve sizes	TV limits	Allowable tolerance
1"	100	--
3/4"	90–100	TV ± 5
1/2"	70–90	TV ± 6
No. 4	45–55	TV ± 7
No. 8	32–40	TV ± 5
No. 30	12–21	TV ± 4
No. 200	2.0–7.0	TV ± 2

1/2-inch HMA Types A and B

Sieve sizes	TV limits	Allowable tolerance
3/4"	100	—
1/2"	95–99	TV ± 6
3/8"	75–95	TV ± 6
No. 4	55–66	TV ± 7
No. 8	38–49	TV ± 5
No. 30	15–27	TV ± 4
No. 200	2.0–8.0	TV ± 2

3/8-inch HMA Types A and B

Sieve sizes	TV limits	Allowable tolerance
1/2"	100	--
3/8"	95–100	TV ± 6
No. 4	58–72	TV ± 7
No. 8	34–48	TV ± 6
No. 30	18–32	TV ± 5
No. 200	2.0–9.0	TV ± 2

No. 4 HMA Types A and B

Sieve sizes	TV limits	Allowable tolerance
3/8"	100	--
No. 4	95–100	TV ± 7
No. 8	72–77	TV ± 7
No. 30	37–43	TV ± 7
No. 200	2.0–12.0	TV ± 4

RHMA-G

3/4-inch RHMA-G

Sieve sizes	TV limits	Allowable tolerance
1"	100	—
3/4"	95–100	TV ± 5
1/2"	83–87	TV ± 6
3/8"	65–70	TV ± 6
No. 4	28–42	TV ± 7
No. 8	14–22	TV ± 5
No. 200	0–6.0	TV ± 2

1/2-inch RHMA-G

Sieve sizes	TV limits	Allowable tolerance
3/4"	100	--
1/2"	90–100	TV ± 6
3/8"	83–87	TV ± 6
No. 4	28–42	TV ± 7
No. 8	14–22	TV ± 5
No. 200	0–6.0	TV ± 2

OGFC

1-inch OGFC

Sieve sizes	TV limits	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	1.0–6.0	TV ± 2

1/2-inch OGFC

Sieve sizes	TV limits	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	0–3.0	TV ± 2

3/8-inch OGFC

Sieve sizes	TV limits	Allowable tolerance
1/2"	100	--
3/8"	90–100	TV ± 6
No. 4	29–36	TV ± 7
No. 8	7–18	TV ± 6
No. 30	0–10	TV ± 5
No. 200	0–3.0	TV ± 2

Before the addition of asphalt binder and lime treatment, aggregate must have the values for the quality characteristics shown in the following table:

Aggregate Quality

Quality characteristic	Test method	HMA type			
		A	B	RHMA-G	OGFC
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	California Test 205	 90 75 70	 25 -- 20	 -- 90 70	 90 75 90
Los Angeles Rattler (% max.) Loss at 100 rev. Loss at 500 rev.	California Test 211	 12 45	 -- 50	 12 40	 12 40
Sand equivalent (min.) [a]	California Test 217	47	42	47	--
Fine aggregate angularity (% min.) [b]	California Test 234	45	45	45	--
Flat and elongated particles (% max. by weight @ 5:1)	California Test 235	10	10	10	10

[a] Reported value must be the average of 3 tests from a single sample.

[b] The Engineer waives this specification if HMA contains less than 10 percent of nonmanufactured sand by weight of total aggregate. Manufactured sand is fine aggregate produced by crushing rock or gravel.

39-1.02F Reclaimed Asphalt Pavement

You may produce HMA Type A or B, using RAP. HMA produced using RAP must comply with the specifications for HMA, except aggregate quality specifications do not apply to RAP. You may substitute RAP aggregate for a part of the virgin aggregate in HMA in a quantity not exceeding 15.0 percent of the aggregate blend. Do not use RAP in OGFC and RHMA-G.

Assign the substitution rate of RAP aggregate for virgin aggregate with the JMF submittal. The JMF must include the percent of RAP used. If you change your assigned RAP aggregate substitution rate by more than 5 percent (within the 15.0 percent limit), submit a new JMF.

Process RAP from asphalt concrete. You may process and stockpile RAP during the entire project. Prevent material contamination and segregation. Store RAP in stockpiles on smooth surfaces free of debris and organic material. Processed RAP stockpiles must be only homogeneous RAP.

39-1.03 HOT MIX ASPHALT MIX DESIGN REQUIREMENTS

39-1.03A General

The mix design process consists of performing California Test 367 and laboratory procedures on combinations of aggregate gradations and asphalt binder contents to determine the OBC and HMA mixture qualities. The results become the proposed JMF.

Use the *Contractor Hot Mix Asphalt Design Data* form to record aggregate quality and mix design data. Use the *Contractor Job Mix Formula Proposal* form to present the JMF.

Laboratories testing aggregate qualities and preparing the mix design and JMF must be qualified under the Department's Independent Assurance Program. Take samples under California Test 125.

The Engineer reviews the aggregate qualities, mix design, and JMF and verifies and authorizes the JMF.

You may change the JMF during production. Do not use the changed JMF until it is authorized. Except if adjusting the JMF as specified in section 39-1.03E, perform a new mix design and submit a new JMF submittal if you change any of the following:

1. Target asphalt binder percentage
2. Asphalt binder supplier
3. Asphalt rubber binder supplier
4. Component materials used in asphalt rubber binder or percentage of any component materials

5. Combined aggregate gradation
6. Aggregate sources
7. Substitution rate for RAP aggregate of more than 5 percent
8. Any material in the JMF

For OGFC, submit a complete JMF submittal, except for asphalt binder content. 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.

39-1.03B Hot Mix Asphalt Mix Design

Perform a mix design that produces HMA with the values for the quality characteristics shown in the following table:

HMA Mix Design Requirements

Quality characteristic	Test method	HMA type		
		A	B	RHMA-G
Air void content (%)	California Test 367	4.0	4.0	Section 39-1.03B
Voids in mineral aggregate (% min.)	California Test 367			
No. 4 grading		17.0	17.0	--
3/8" grading		15.0	15.0	--
1/2" grading		14.0	14.0	18.0–23.0[a]
3/4" grading		13.0	13.0	18.0–23.0[a]
Voids filled with asphalt (%)	California Test 367			Note c
No. 4 grading		76.0–80.0	76.0–80.0	
3/8" grading		73.0–76.0	73.0–76.0	
1/2" grading		65.0–75.0	65.0–75.0	
3/4" grading		65.0–75.0	65.0–75.0	
Dust proportion	California Test 367			Note c
No. 4 and 3/8" gradings		0.9–2.0	0.9–2.0	
1/2" and 3/4" gradings		0.6–1.3	0.6–1.3	
Stabilometer value (min.) [b]	California Test 366			
No. 4 and 3/8" gradings		30	30	--
1/2" and 3/4" gradings		37	35	23

[a] Voids in mineral aggregate for RHMA-G must be within this range.
[b] California Test 304, Part 2.13.
[c] Report this value in the JMF submittal.

Report the average of 3 tests. If the range of stability for the 3 briquettes is more than 8 points, prepare new briquettes and test again. The average air void content may vary from the specified air void content by ±0.5 percent.

39-1.03C Job Mix Formula Submittal

Each JMF submittal must consist of:

1. Proposed JMF on a *Contractor Job Mix Formula Proposal* form
2. Mix design records on a *Contractor Hot Mix Asphalt Design Data* form dated within 12 months of submittal
3. JMF verification on a *Caltrans Hot Mix Asphalt Verification* form, if applicable
4. JMF renewal on a *Caltrans Production Start-Up Evaluation* form, if applicable
5. MSDS for the following:
   - 5.1. Asphalt binder
   - 5.2. Base asphalt binder used in asphalt rubber binder
   - 5.3. CRM and asphalt modifier used in asphalt rubber binder
   - 5.4. Blended asphalt rubber binder mixture
   - 5.5. Supplemental fine aggregate except fines from dust collectors
   - 5.6. Antistrip additives

If the Engineer requests, sample the following materials in the presence of the Engineer and place in labeled containers weighing no more than 50 lb each:

1. Coarse, fine, and supplemental fine aggregate from stockpiles, cold feed belts, or hot bins. 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. The Department combines these aggregate samples to comply with the JMF TVs submitted on a *Contractor Job Mix Formula Proposal* form.
2. RAP from stockpiles or RAP system. Samples must be at least 60 lb.
3. Asphalt binder from the binder supplier. Samples must be in two 1-quart cylindrical-shaped cans with open top and friction lids.
4. Asphalt rubber binder with the components blended in the proportions to be used. Samples must be in four 1-quart cylindrical-shaped cans with open top and friction lids.

Notify the Engineer at least 2 business days before sampling materials. For aggregate and RAP, split the samples into at least 4 parts. Submit 3 parts to the Engineer and use 1 part for your testing.

For HMA Type A or B produced under the QC/QA construction process, submit with the JMF submittal:

1. California Test 204 plasticity index results
2. California Test 371 tensile strength ratio results for untreated HMA
3. California Test 371 tensile strength ratio results for treated HMA if untreated HMA tensile strength ratio is below 70

For RHMA-G produced under the QC/QA construction process, submit with the JMF submittal:

1. California Test 371 tensile strength ratio results for untreated RHMA-G
2. California Test 204 plasticity index results on the aggregate blend if untreated RHMA-G tensile strength ratio is below 70
3. California Test 371 tensile strength ratio results for treated RHMA-G if untreated RHMA-G tensile strength ratio is below 70

For any HMA produced under the QC/QA construction process, submit the California Test 371 test results to the Engineer and to:

Moisture_Tests@dot.ca.gov

39-1.03D Job Mix Formula Review

The Engineer reviews each mix design and proposed JMF within 5 business days from the complete JMF submittal. The review consists of reviewing the mix design procedures and comparing the proposed JMF with the specifications.

The Engineer may verify aggregate quality characteristics during this review period.

39-1.03E Job Mix Formula Verification

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.

Based on your testing and production experience, you may submit an adjusted JMF on a *Contractor Job Mix Formula Proposal* form before verification testing. JMF adjustments may include a change in the:

1. Asphalt binder content TV up to ±0.6 percent from the OBC value submitted on a *Contractor Hot Mix Asphalt Design Data* form, except for RHMA-G, do not adjust the TV for asphalt rubber binder below 7.0 percent
2. Aggregate gradation TVs within the TV limits specified in the aggregate gradation tables

For HMA Type A, Type B, and RHMA-G, the Engineer verifies the JMF from samples taken from HMA produced by the plant to be used. Notify the Engineer at least 2 business days before sampling materials.

In the Engineer's presence and from the same production run, take samples of:

1. Aggregate
2. Asphalt binder

3. RAP
4. HMA

Sample aggregate from cold feed belts or hot bins. Sample RAP from the RAP system. Sample HMA under California Test 125, except if you request and if authorized, you may sample from any of the following locations:

1. Plant
2. Truck
3. Windrow
4. Paver hopper
5. Mat behind the paver

You may sample from a different project, including a non-Department project, if you make arrangements for the Engineer to be present during sampling.

For aggregate, RAP, and HMA, split the samples into at least 4 parts and label their containers. Submit 3 split parts and keep 1 part for your testing.

The Engineer verifies each proposed JMF within 20 days of receiving all verification samples and the JMF submittal has been accepted. If you request, the Engineer verifies RHMA-G quality requirements within 3 business days of sampling. Verification is testing for compliance with the specifications for:

1. Aggregate quality
2. Aggregate gradation TVs within the TV limits
3. Asphalt binder content TV within the TV limit
4. HMA quality specified in the table HMA Mix Design Requirements except:
   4.1. Air void content, design value ±2.0 percent
   4.2. Voids filled with asphalt, report only if an adjustment for asphalt binder content TV is less than ± 0.3 percent from OBC
   4.3. Dust proportion, report only if an adjustment for asphalt binder content TV is less than ±0.3 percent from OBC

The Engineer prepares 3 briquettes from a single split sample. To verify the JMF for stability and air void content, the Engineer tests the 3 briquettes and reports the average of 3 tests. The Engineer prepares new briquettes if the range of stability for the 3 briquettes is more than 8 points.

The Engineer may use the briquettes used for stability testing to determine bulk specific gravity under California Test 308. If the same briquettes are used and the tests using bulk specific gravity fail, the Engineer prepares 3 new briquettes and determines a new bulk specific gravity.

If the JMF is verified, the Engineer provides you a *Caltrans Hot Mix Asphalt Verification* form.

If tests on plant-produced samples do not verify the JMF, the Engineer notifies you and you must submit a new JMF submittal or submit an adjusted JMF based on your testing. JMF adjustments may include a change in:

1. Asphalt binder content TV up to ±0.6 percent from the OBC value submitted on a *Contractor Hot Mix Asphalt Design Data* form except do not adjust the TV for asphalt rubber binder for RHMA-G below 7.0 percent
2. Aggregate gradation TVs within the TV limits specified in the aggregate gradation tables

You may adjust the JMF only once due to a failed verification test. An adjusted JMF requires a new *Contractor Job Mix Formula Proposal* form and verification of a plant-produced sample.

The Engineer reverifies the JMF if HMA production has stopped for longer than 30 days and the verified JMF is older than 12 months.

For each HMA type and aggregate size specified, the Engineer verifies at the Department's expense up to 2 proposed JMF, including a JMF adjusted after verification failure. 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.

For any HMA produced under the QC/QA construction process, the Department does not use California Test 371 test results for JMF verification.

39-1.03F 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

If the Engineer requests, sample the following materials in the presence of the Engineer and place in labeled containers weighing no more than 50 lb each:

1. Coarse, fine, and supplemental fine aggregate from stockpiles, cold feed belts, or hot bins. Samples must include at least 120 lb for each coarse aggregate, 80 lb for each fine aggregate, and 10 lb for each type of supplemental fines. The Department combines these aggregate samples to comply with the JMF TVs submitted on a *Contractor Job Mix Formula Proposal* form.
2. RAP from stockpiles or RAP system. Samples must be at least 60 lb.
3. Asphalt binder from the binder supplier. Samples must be in two 1-quart cylindrical-shaped cans with open top and friction lids.
4. Asphalt rubber binder with the components blended in the proportions to be used. Samples must be in four 1-quart cylindrical-shaped cans with open top and friction lids.

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 to the Engineer and use 1 part for your testing.

The Engineer reviews each complete JMF renewal submittal within 5 business days.

The Engineer may verify aggregate qualities during this review period.

The Engineer verifies the JMF under section 39-1.03E except:

1. Engineer retains 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 specifications for the quality characteristics in section 39-1.03E.
3. Engineer verifies each proposed JMF within 30 days of receiving verification samples.
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 the Department's expense 1 proposed JMF.

If the Engineer verifies the JMF renewal, the Engineer provides you a *Caltrans Hot Mix Asphalt Verification* form.

39-1.03G Job Mix Formula Acceptance

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

39-1.04 CONTRACTOR QUALITY CONTROL

39-1.04A General

Establish, maintain, and change a quality control system to ensure materials and work comply with the specifications. Submit quality control test results within 3 days of a request, except if the QC/QA construction process is specified.

You must identify the HMA sampling location in your QC plan. During production, take samples under California Test 125, except if you request and if authorized, sample HMA from any of the following locations:

1. Plant
2. Truck
3. Windrow
4. Paver hopper
5. Mat behind the paver

39-1.04B Prepaving Conference

Hold a prepaving conference with the Engineer at a mutually agreed time and place. Discuss methods of performing the production and paving work.

39-1.04C Asphalt Rubber Binder

Take asphalt rubber binder samples from the feed line connecting the asphalt rubber binder tank to the HMA plant. Sample and test asphalt rubber binder under Laboratory Procedure LP-11.

Test asphalt rubber binder for compliance with the viscosity specifications in section 39-1.02. During the asphalt rubber binder production and HMA production using asphalt rubber binder, measure the viscosity every hour with not less than 1 reading for each asphalt rubber binder batch. Log the measurements with the corresponding time and asphalt rubber binder temperature. Submit the log daily.

Submit a certificate of compliance and test results for CRM and asphalt modifier with each truckload delivered to the HMA plant. A certificate of compliance for asphalt modifier must not represent more than 5,000 lb. Use an AASHTO-certified laboratory for testing.

Sample and test gradation and wire and fabric content of CRM once per 10,000 lb of scrap tire crumb rubber and once per 3,400 lb of high natural rubber. Sample and test scrap tire crumb rubber and high natural rubber separately.

Submit certified weight slips for the furnished CRM and asphalt modifier.

39-1.04D Aggregate

Determine the aggregate moisture content and RAP moisture content in continuous mixing plants at least twice a day during production and adjust the plant controller. Determine the RAP moisture content in batch mixing plants at least twice a day during production and adjust the plant controller.

39-1.04E Reclaimed Asphalt Pavement

Perform RAP quality control testing each day.

Sample RAP once daily and determine the RAP aggregate gradation under California Test 367, appendix B, and submit the results with the combined aggregate gradation.

39-1.04F Density Cores

To determine density for Standard and QC/QA construction process projects, 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 designates. 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. Relocate any density core located within 1 foot of a rumble strip to 1 foot transversely away from the rumble strip.

39-1.04G Briquettes

Prepare 3 briquettes for each stability and air void content determination. Report the average of 3 tests. Prepare new briquettes and test again when the range of stability for the 3 briquettes is more than 8 points.

You may use the same briquettes used for stability testing to determine bulk specific gravity under California Test 308. If you use these briquettes and tests using bulk specific gravity fail, you may prepare 3 new briquettes and determine a new bulk specific gravity.

39-1.05 ACCEPTANCE CRITERIA

HMA acceptance is specified in the sections for each HMA construction process.

The Department samples materials for testing under California Test 125 and the applicable test method, except samples may be taken:

1. At the plant from a truck or an automatic sampling device
2. From the mat behind the paver

Sampling must be independent of Contractor quality control, statistically based, and random.

If you request, the Department splits samples and provides you with a part.

HMA acceptance is based on:

1. Authorized JMF
2. Accepted QC plan for Standard and QC/QA construction process projects
3. Compliance with the HMA acceptance tables
4. Lot acceptance for QC/QA construction process projects
5. Visual inspection

The Department prepares 3 briquettes for each stability and air void content determination. The average of 3 tests is reported. If the range of stability for the 3 briquettes is more than 8 points, new briquettes are prepared and tested.

The Department may use the briquettes used for stability testing to determine bulk specific gravity under California Test 308. If the Engineer uses the same briquettes and the tests using that bulk specific gravity fail, the Engineer prepares 3 new briquettes and determines a new bulk specific gravity.

39-1.06 DISPUTE RESOLUTION

Work with the Engineer to avoid potential conflicts and to resolve disputes regarding test result discrepancies. Notify the Engineer within 5 days of receiving a test result if you dispute the test result.

If you or the Engineer dispute each other's test results, submit quality control 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, the party must be accredited under the Department's Independent Assurance Program. The independent third party must be independent of the project. By mutual agreement, the independent third party is chosen from:

1. Department laboratory
2. Department laboratory in a district or region not in the district or region the project is located
3. Transportation Laboratory
4. Laboratory not currently employed by you or your HMA producer

If split quality control or acceptance samples are not available, the independent third party uses any available material representing the disputed HMA for evaluation.

39-1.07 PRODUCTION START-UP EVALUATION

The Engineer evaluates 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. Aggregate
2. Asphalt binder
3. RAP
4. HMA

Sample aggregate from cold feed belts or hot bins. Take RAP samples from the RAP system. Sample HMA under California Test 125, except if you request and if authorized, you may sample HMA from any of the following locations:

1. Plant
2. Truck
3. Windrow
4. Paver hopper
5. Mat behind the paver

For aggregate, RAP, and HMA, split the samples into at least 4 parts and label their containers. Submit 3 split parts and keep 1 part.

For Standard and QC/QA construction process projects, you and the Department must test the split samples and report test results within 3 business 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.

For Standard and QC/QA construction process projects, take 4- or 6-inch diameter density cores within the first 750 tons on the 1st day of HMA production. For each density core, the Department reports the bulk specific gravity determined under California Test 308, Method A, in addition to the percent of maximum theoretical density. You may test for in-place density at the density core locations and include them in your production tests for percent of maximum theoretical density.

39-1.08 PRODUCTION

39-1.08A General

Produce HMA in a batch mixing plant or a continuous mixing plant. Proportion aggregate by hot or cold feed control.

HMA plants must be Department qualified. Before production, the HMA plant must have current qualification under the Department's Materials Plant Quality Program.

During production, you may adjust:

1. Hot or cold feed proportion controls for virgin aggregate and RAP
2. Set point for asphalt binder content

39-1.08B Mixing

Mix HMA ingredients into a homogeneous mixture of coated aggregates.

Asphalt binder must be from 275 to 375 degrees F when mixed with aggregate.

Asphalt rubber binder must be from 350 to 425 degrees F when mixed with aggregate.

When mixed with asphalt binder, aggregate must not be more than 325 degrees F, except aggregate for OGFC must be not more than 275 degrees F. These aggregate temperature specifications do not apply if you use RAP.

HMA with or without RAP must not be more than 325 degrees F.

39-1.08C Asphalt Rubber Binder

Deliver scrap tire crumb rubber and high natural rubber in separate bags.

Either proportion and mix asphalt binder, asphalt modifier, and CRM simultaneously or premix the asphalt binder and asphalt modifier before adding CRM. If you premix the asphalt binder and asphalt modifier, the asphalt binder must be from 375 to 425 degrees F when you add the asphalt modifier. Mix for at least 20 minutes. When you add CRM, the asphalt binder and asphalt modifier must be from 375 to 425 degrees F.

Do not use asphalt rubber binder during the first 45 minutes of the reaction period. During this period, the asphalt rubber binder mixture must be from 375 to the lower of 425 degrees F or 25 degrees F below the asphalt binder's flash point described in the MSDS.

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 react for 45 minutes. 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 for asphalt rubber binder in section 39-1.02D. Do not reheat asphalt rubber binder more than twice.

39-1.09 SUBGRADE, TACK COAT, AND GEOSYNTHETIC PAVEMENT INTERLAYER

39-1.09A General

Prepare subgrade or apply tack coat to surfaces receiving HMA. If specified, place geosynthetic pavement interlayer over a coat of asphalt binder.

39-1.09B Subgrade

Subgrade to receive HMA must comply with the compaction and elevation tolerance specifications in the sections for the material involved. Subgrade must be free of loose and extraneous material. If HMA is paved on existing base or pavement, remove loose paving particles, dirt, and other extraneous material by any means including flushing and sweeping.

39-1.09C Tack Coat

Apply 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

Before placing HMA, apply tack coat in 1 application. The application rate must be the minimum residual rate specified for the underlying surface conditions shown in the following tables:

Tack Coat Application Rates for HMA Type A, Type B, and RHMA-G

HMA overlay 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
PCC and existing HMA (AC) surfaces	0.03	0.04	0.03
Planed PCC and HMA (AC) surfaces	0.05	0.06	0.04

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
PCC and existing HMA (AC) surfaces	0.05	0.06	0.04
Planed PCC and HMA (AC) surfaces	0.06	0.07	0.05

If you dilute asphaltic emulsion, mix until homogeneous before application.

For vertical surfaces, apply a residual tack coat rate that will thoroughly coat the vertical face without running off.

If you request and 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 track tack coat onto pavement surfaces beyond the job site.

Asphalt binder tack coat must be from 285 to 350 degrees F when applied.

39-1.09D Geosynthetic Pavement Interlayer

Place geosynthetic pavement interlayer under the manufacturer's instruction.

Before placing the geosynthetic pavement interlayer and asphalt binder:

1. Repair cracks 1/4 inch and wider, spalls, and holes in the pavement. These repairs are change order work.
2. Clean the pavement of loose and extraneous material.

Immediately before placing the interlayer, apply 0.25 ± 0.03 gal of asphalt binder per square yard of interlayer or until the fabric is saturated. Apply asphalt binder the width of the geosynthetic pavement interlayer plus 3 inches on each side. At interlayer overlaps, apply asphalt binder on the lower interlayer the same overlap distance as the upper interlayer.

Asphalt binder must be from 285 to 350 degrees F and below the minimum melting point of the geosynthetic pavement interlayer when applied.

Align and place the interlayer with no folds that result in a triple thickness, except that triple thickness layers less than 1 inch in width may remain if less than 1/2 inch in height. Folds that result in a triple layer greater than a 1 inch width must be slit and overlapped in a double thickness at least 2 inches in width.

The minimum HMA thickness over the interlayer must be 0.12 foot thick, including conform tapers. Do not place the interlayer on a wet or frozen surface.

Overlap the interlayer borders from 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.

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.

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.

39-1.10 SPREADING AND COMPACTING EQUIPMENT

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 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.

39-1.11 TRANSPORTING, SPREADING, AND COMPACTING

Do not pave HMA on wet pavement or a 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 deposit, pickup, loading, and paving are continuous
4. HMA temperature in the windrow does not fall below 260 degrees F

You may pave 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

Longitudinal joints in the top layer must match specified lane edges. Alternate the longitudinal joint offsets in the lower layers at least 0.5 foot from each side of the specified lane edges. You may request other longitudinal joint placement patterns.

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 leveling with HMA is specified, 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 HMA (leveling).

If placing HMA against the edge of existing pavement, sawcut or grind the pavement straight and vertical along the joint and remove extraneous material.

Rolling must leave the completed surface compacted and smooth without tearing, cracking, or shoving. 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
3. Below 200 degrees F for RHMA-G

If a vibratory roller is used as a finish roller, turn the vibrator off.

Do not use a pneumatic-tired roller to compact RHMA-G.

For Standard and QC/QA construction processes, if 3/4-inch aggregate grading is specified, you may use 1/2-inch aggregate grading if the total layer thickness is from 0.125 to 0.20 foot thick.

Spread and compact HMA under sections 39-3.03 and 39-3.04 if any of the following applies:

1. Specified paved thickness is less than 0.15 foot.
2. Specified paved thickness is less than 0.20 foot and 3/4-inch aggregate grading is specified and used.
3. You spread and compact at:
   3.1. Asphalt concrete surfacing replacement areas
   3.2. Leveling courses
   3.3. Areas for which the Engineer determines conventional compaction and compaction measurement methods are impeded

Do not allow traffic on new HMA pavement until its mid-depth temperature is below 160 degrees F.

If you request and if authorized, you may cool HMA Type A and Type B with water when rolling activities are complete. Apply water under section 17-3.

Spread sand at a rate from 1 to 2 lb/sq yd on new RHMA-G, RHMA-O, and RHMA-O-HB pavement when finish rolling is complete. Sand must be free of clay or organic matter. Sand must comply with section 90-1.02C(4)(c). Keep traffic off the pavement until spreading sand is complete.

39-1.12 SMOOTHNESS

39-1.12A General

Determine HMA smoothness with a profilograph and a straightedge.

Smoothness specifications do not apply to OGFC placed on existing pavement not constructed under the same project.

If concrete pavement is placed on HMA:

1. Cold plane the HMA finished surface to within specified tolerances if it is higher than the grade ordered.
2. Remove and replace HMA if the finished surface is lower than 0.05 foot below the grade ordered.

39-1.12B Straightedge

The top layer of HMA pavement must not vary from the lower edge of a 12-foot straightedge:

1. More than 0.01 foot when the straightedge is laid parallel with the centerline
2. More than 0.02 foot when the straightedge is laid perpendicular to the centerline and extends from edge to edge of a traffic lane
3. More than 0.02 foot when the straightedge is laid within 24 feet of a pavement conform

39-1.12C Profilograph

For the top layer of HMA Type A, Type B, and RHMA-G pavement, determine the PI_0 and must-grinds under California Test 526. Take 2 profiles within each traffic lane, 3 feet from and parallel with the edge of each lane.

A must-grind is a deviation of 0.3 inch or more in a length of 25 feet. You must correct must-grinds.

For OGFC, only determine must-grinds if placed over HMA constructed under the same project. The top layer of the underlying HMA must comply with the smoothness specifications before placing OGFC.

Profile the pavement in the Engineer's presence.

On tangents and horizontal curves with a centerline radius of curvature of 2,000 feet, the PI_0 must be at most 3 inches per 0.1-mile section.

On horizontal curves with a centerline radius of curvature from 1,000 to 2,000 feet, including pavement within the superelevation transitions, the PI_0 must be at most 6 inches per 0.1-mile section.

Before the Engineer accepts HMA pavement for smoothness, submit final profilograms.

Submit 1 copy of profile information in Microsoft Excel and 1 copy of longitudinal pavement profiles in ".erd" format or other ProVAL compatible format to the Engineer and to:

Smoothness@dot.ca.gov

The following HMA pavement areas do not require a PI_0. You must measure these areas with a 12-foot straightedge and determine must-grinds with a profilograph:

1. New HMA with a total thickness less than 0.25 foot
2. HMA sections of city or county streets and roads, turn lanes, and collector lanes less than 1,500 feet in length

The following HMA pavement areas do not require a PI_0 and you must measure them with a 12-foot straightedge:

1. Horizontal curves with a centerline radius of curvature less than 1,000 feet, including pavement within the superelevation transitions of those curves
2. Within 12 feet of a transverse joint separating the pavement from:
   2.1. Existing pavement not constructed under the same project
   2.2. A bridge deck or approach slab
3. Exit ramp termini, truck weigh stations, and weigh-in-motion areas
4. If steep grades and superelevation rates greater than 6 percent are present:
   4.1. Ramps
   4.2. Connectors
5. Turn lanes
6. Areas within 15 feet of manholes or drainage transitions
7. Acceleration and deceleration lanes for at-grade intersections
8. Shoulders and miscellaneous areas
9. HMA pavement within 3 feet from and parallel to the construction joints formed between curbs, gutters, or existing pavement

39-1.12D Smoothness Correction

If the top layer of HMA Type A, Type B, or RHMA-G pavement does not comply with the smoothness specifications, grind the pavement to within specified tolerances, remove and replace it, or place an overlay of HMA. Do not start corrective work until your choice of methods is authorized.

Remove and replace areas of OGFC not in compliance with the must-grind and straightedge specifications, except you may grind OGFC for correcting smoothness:

1. At transverse joints separating the OGFC from pavement not constructed under the same project
2. Within 12 feet of a transverse joint separating the OGFC from a bridge deck or approach slab

Corrected HMA pavement areas must be uniform rectangles with edges:

1. Parallel to the nearest HMA pavement edge or lane line
2. Perpendicular to the pavement centerline

Measure the corrected HMA pavement surface with a profilograph and a 12-foot straightedge and correct the pavement to within specified tolerances. If a must-grind area or straightedged pavement cannot be corrected to within specified tolerances, remove and replace the pavement.

On areas ground but not overlaid with OGFC, apply fog seal coat under section 37-2.

39-1.13 HOT MIX ASPHALT ON BRIDGE DECKS

Produce and place HMA on bridge decks under the Method construction process.

Aggregate must comply with the 1/2-inch HMA Types A and B gradation.

If authorized, aggregate may comply with the no. 4 HMA Types A and B gradation for a section or taper at a bridge end that is less than 1 inch in total depth.

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.

Do not leave a vertical joint more than 0.15 foot high between adjacent lanes open to traffic.

The tack coat application rate must be the minimum residual rate specified in section 39-1.09C. For HMA placed on a deck seal, use the minimum residual rate specified for a PCC underlying surface.

HMA placed on a deck seal must be placed in at least 2 approximately equal layers. The 1st layer must be at least 1 inch thick after compaction. Protect the deck seal throughout all operations.

For placement of the 1st HMA layer on a deck seal:

1. Comply with the HMA application temperature recommended by the deck seal manufacturer.
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.
3. Deposit HMA on the deck seal in such a way that the deck seal is not damaged. Do not windrow the HMA material on the bridge deck seal.
4. Place HMA in a downhill direction on bridge decks with grades over 2 percent.
5. Spreading equipment need not be self-propelled.

39-1.14 MISCELLANEOUS AREAS AND DIKES

The following specifications in section 39 do not apply to miscellaneous areas and dikes:

1. HMA construction process
2. HMA mix design requirements
3. Contractor quality control
4. Production start-up evaluation

Miscellaneous areas are outside the traveled way and include:

1. Median areas not including inside shoulders

2. Island areas
3. Sidewalks
4. Gutters
5. Gutter flares
6. Ditches
7. Overside drains
8. Aprons at the ends of drainage structures

Spread miscellaneous areas in 1 layer and compact to the specified lines and grades.

For miscellaneous areas and dikes:

1. Do not submit a JMF.
2. Choose the 3/8-inch or 1/2-inch HMA Type A and Type B aggregate gradations.
3. Minimum asphalt binder content must be 6.8 percent for 3/8-inch aggregate and 6.0 percent for 1/2-inch aggregate. If you request and if authorized, you may reduce the minimum asphalt binder content.
4. Choose asphalt binder Grade PG 70-10 or the same grade specified for HMA.

39-1.15 MINOR HOT MIX ASPHALT

39-1.15A GENERAL

39-1.15A(1) Summary

The following specifications in section 39 do not apply to minor HMA:

1. HMA construction process
2. HMA mix design requirements
3. Contractor quality control
4. Production start-up evaluation

39-1.15A(2) Definitions

Reserved

39-1.15A(3) Submittals

Reserved

39-1.15A(4) Quality Control and Assurance

Reserved

39-1.15B MATERIALS

The minimum asphalt binder content must be 6.8 percent for 3/8-inch aggregate gradation and 6.0 percent for 1/2-inch aggregate gradation.

Choose asphalt binder Grade PG 64-10, PG 64-16, or PG 70-10.

If you request and if authorized, you may reduce the minimum asphalt binder content.

Choose the 3/8-inch or 1/2-inch HMA Type A or Type B aggregate gradation.

39-1.15C CONSTRUCTION

Produce HMA at a central mixing plant.

Choose any method and equipment to spread and compact.

The surface must be:

1. Textured uniformly
2. Compacted firmly
3. Without depressions, humps, and irregularities

Smoothness specifications do not apply.

39-1.16 RUMBLE STRIPS

Reserved

39-1.17 DATA CORES

Reserved

39-1.18 HOT MIX ASPHALT AGGREGATE LIME TREATMENT—DRY LIME METHOD

Reserved

39-1.19 HOT MIX ASPHALT AGGREGATE LIME TREATMENT—SLURRY METHOD

Reserved

39-1.20 LIQUID ANTISTRIP TREATMENT

Reserved

39-1.21 REPLACE ASPHALT CONCRETE SURFACING

Reserved

39-1.22 LIQUID ASPHALT PRIME COAT

Reserved

39-1.23 HOT MIX ASPHALT TYPE C

Reserved

39-1.24 BONDED WEARING COURSE—GAP GRADED

Reserved

39-1.25 RUBBERIZED BONDED WEARING COURSE—GAP GRADED

Reserved

39-1.26 RUBBERIZED BONDED WEARING COURSE—OPEN GRADED

Reserved

39-1.27 BONDED WEARING COURSE—OPEN GRADED

Reserved

39-1.28 ROADSIDE PAVING

Reserved

39-1.29 SOIL TREATMENT

Reserved

39-1.30–39-1.40 RESERVED

39-2 STANDARD CONSTRUCTION PROCESS

39-2.01 GENERAL

Section 39-2 includes specifications for HMA produced and constructed under the Standard construction process.

39-2.02 CONTRACTOR QUALITY CONTROL

39-2.02A Quality Control Plan

Establish, implement, and maintain a QC plan for HMA. The QC plan must describe the organization and procedures you will use to:

1. Control the quality characteristics
2. Determine when corrective actions are needed (action limits)
3. Implement corrective actions

When you submit the proposed JMF, submit the proposed QC plan. You and the Engineer must discuss the QC plan during the prepaving conference.

The QC plan must address the elements affecting HMA quality including:

1. Aggregate
2. Asphalt binder
3. Additives
4. Production
5. Paving

The Engineer reviews each QC plan within 5 business days from the submittal. Do not produce HMA until the Engineer authorizes the QC plan.

39-2.02B Quality Control Testing

Perform sampling and testing at the specified frequency for the quality characteristics shown in the following table:

Minimum Quality Control—Standard Construction Process

Quality characteristic	Test method	Minimum sampling and testing frequency	HMA type			
			A	B	RHMA-G	OGFC
Aggregate gradation[a]	California Test 202	1 per 750 tons and any remaining part	JMF ± Tolerance[b]	JMF ± Tolerance[b]	JMF ± Tolerance[b]	JMF ± Tolerance[b]
Sand equivalent (min)[c]	California Test 217		47	42	47	--
Asphalt binder content (%)	California Test 379 or 382		JMF ± 0.45	JMF ± 0.45	JMF ± 0.50	JMF ± 0.50
HMA moisture content (%, max)	California Test 226 or 370	1 per 2,500 tons but not less than 1 per paving day	1.0	1.0	1.0	1.0
Percent of maximum theoretical density (%)[d, e]	QC plan	2 per business day (min.)	91–97	91–97	91–97	--
Stabilometer value (min)[c, f]	California Test 366	One per 4,000 tons or 2 per 5 business days, whichever is greater				
No. 4 and 3/8" gradings			30	30	--	--
1/2" and 3/4" gradings			37	35	23	--
Air void content (%)[c, g]	California Test 367		4 ± 2	4 ± 2	TV ± 2	--
Aggregate moisture content at continuous mixing plants and RAP moisture content at continuous mixing plants and batch mixing plants[h]	California Test 226 or 370	2 per day during production	--	--	--	--
Percent of crushed particles coarse aggregate (%, min)	California Test 205	As designated in the QC plan. At least once per project				
One fractured face			90	25	--	90
Two fractured faces			75	--	90	75
Fine aggregate (%, min) (Passing no. 4 sieve and retained on no. 8 sieve.)						
One fractured face			70	20	70	90
Los Angeles Rattler (%, max)	California Test 211					
Loss at 100 rev.			12	--	12	12

Loss at 500 rev.			45	50	40	40
Flat and elongated particles (%, max by weight @ 5:1)	California Test 235		Report only	Report only	Report only	Report only
Fine aggregate angularity (%, min)	California Test 234		45	45	45	--
Voids filled with asphalt (%)[i] No. 4 grading 3/8" grading 1/2" grading 3/4" grading	California Test 367		 76.0–80.0 73.0–76.0 65.0–75.0 65.0–75.0	 76.0–80.0 73.0–76.0 65.0–75.0 65.0–75.0	Report only	--
Voids in mineral aggregate (% min)[i] No. 4 grading 3/8" grading 1/2" grading 3/4" grading	California Test 367		 17.0 15.0 14.0 13.0	 17.0 15.0 14.0 13.0	 -- -- 18.0–23.0 [j] 18.0–23.0 [j]	--
Dust proportion [i] No. 4 and 3/8" gradings 1/2" and 3/4" gradings	California Test 367		0.9–2.0 0.6–1.3	0.9–2.0 0.6–1.3	Report only	--
Smoothness	Section 39-1.12	--	12-foot straight-edge, must grind, and PI_0	12-foot straight-edge, must grind, and PI_0	12-foot straight-edge, must grind, and PI_0	12-foot straight-edge, must grind, and PI_0
Asphalt rubber binder viscosity @ 350 °F, centipoises	Section 39-1.02D	Section 39-1.04C	--	--	1,500–4,000	1,500–4,000
Asphalt modifier	Section 39-1.02D	Section 39-1.04C	--	--	Section 39-1.02D	Section 39-1.02D
CRM	Section 39-1.02D	Section 39-1.04C	--	--	Section 39-1.02D	Section 39-1.02D

[a] Determine combined aggregate gradation containing RAP under California Test 367.
[b] The tolerances must comply with the allowable tolerances in section 39-1.02E.
[c] Report the average of 3 tests from a single split sample.
[d] Required for HMA Type A, Type B, and RHMA-G if the specified paved thickness is at least 0.15 foot.
[e] Determine maximum theoretical density (California Test 309) at the frequency specified for Test Maximum Density under California Test 375, Part 5.D.
[f] California Test 304, Part 2.13.
[g] Determine the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[h] For adjusting the plant controller at the HMA plant.
[i] Report only if the adjustment for the asphalt binder content TV is less than or equal to ±0.3 percent from OBC value submitted on a *Contractor Hot Mix Asphalt Design Data* form.
[J] Voids in mineral aggregate for RHMA-G must be within this range.

For any single quality characteristic except smoothness, if 2 consecutive quality control test results do not comply with the action limits or specifications:

1. Stop production.
2. Notify the Engineer.
3. Take corrective action.

4. Demonstrate compliance with the specifications before resuming production and placement.

39-2.03 ACCEPTANCE CRITERIA

39-2.03A Testing

The Department samples for acceptance testing and tests for the quality characteristics shown in the following table:

HMA Acceptance—Standard Construction Process

Quality characteristic				Test method	HMA type			
					A	B	RHMA-G	OGFC
Aggregate gradation [a]				California Test 202	JMF ± tolerance [c]	JMF ± tolerance [c]	JMF ± tolerance [c]	JMF ± tolerance [c]
Sieve	3/4"	1/2"	3/8"					
1/2"	X [b]							
3/8"		X						
No. 4			X					
No. 8	X	X	X					
No. 200	X	X	X					
Sand equivalent (min) [d]				California Test 217	47	42	47	--
Asphalt binder content (%)				California Test 379 or 382	JMF ± 0.45	JMF ± 0.45	JMF ± 0.50	JMF ± 0.50
HMA moisture content (%, max)				California Test 226 or 370	1.0	1.0	1.0	1.0
Percent of maximum theoretical density (%) [e, f]				California Test 375	91–97	91–97	91–97	--
Stabilometer value (min) [d,g]				California Test 366				
No. 4 and 3/8" gradings					30	30	--	--
1/2" and 3/4" gradings					37	35	23	--
Air void content (%) [d, h]				California Test 367	4 ± 2	4 ± 2	TV ± 2	--
Percent of crushed particles				California Test 205				
Coarse aggregate (%, min)								
One fractured face					90	25	--	90
Two fractured faces					75	--	90	75
Fine aggregate (%, min) (Passing no. 4 sieve and retained on no. 8 sieve.)								
One fractured face					70	20	70	90
Los Angeles Rattler (%, max)				California Test 211				
Loss at 100 rev.					12	--	12	12
Loss at 500 rev.					45	50	40	40
Fine aggregate angularity (%, min)				California Test 234	45	45	45	--
Flat and elongated particles (%, max by weight @ 5:1)				California Test 235	Report only	Report only	Report only	Report only
Voids filled with asphalt (%) [i]				California Test 367				
No. 4 grading					76.0–80.0	76.0–80.0		
3/8" grading					73.0–76.0	73.0–76.0	Report only	--
1/2" grading					65.0–75.0	65.0–75.0		
3/4" grading					65.0–75.0	65.0–75.0		
Voids in mineral aggregate (% min) [i]				California Test 367				
No. 4 grading					17.0	17.0	--	--
3/8" grading					15.0	15.0	--	
1/2" grading					14.0	14.0	18.0–23.0 [j]	
3/4" grading					13.0	13.0	18.0–23.0 [j]	
Dust proportion [i]				California Test 367				
No. 4 and 3/8" gradings					0.9–2.0	0.9–2.0	Report only	--
1/2" and 3/4" gradings					0.6–1.3	0.6–1.3		
Smoothness				Section 39-1.12	12-foot straight-edge, must grind, and	12-foot straight-edge, must grind, and	12-foot straight-edge, must grind, and	12-foot straight-edge and must grind

		PI_0	PI_0	PI_0	
Asphalt binder	Various	Section 92	Section 92	Section 92	Section 92
Asphalt rubber binder	Various	--	--	Section 92-1.01D(2) and section 39-1.02D	Section 92-1.01D(2) and section 39-1.02D
Asphalt modifier	Various	--	--	Section 39-1.02D	Section 39-1.02D
CRM	Various	--	--	Section 39-1.02D	Section 39-1.02D

[a] The Engineer determines combined aggregate gradations containing RAP under California Test 367.
[b] "X" denotes the sieves the Engineer tests for the specified aggregate gradation.
[c] The tolerances must comply with the allowable tolerances in section 39-1.02E.
[d] The Engineer reports the average of 3 tests from a single split sample.
[e] The Engineer determines percent of maximum theoretical density if the specified paved thickness is at least 0.15 foot under California Test 375, except the Engineer uses:

1. California Test 308, Method A, to determine in-place density of each density core instead of using the nuclear gauge in Part 4, "Determining In-Place Density By The Nuclear Density Device."
2. California Test 309 to determine maximum theoretical density instead of calculating test maximum density in Part 5, "Determining Test Maximum Density."

[f] The Engineer determines maximum theoretical density (California Test 309) at the frequency specified for Test Maximum Density under California Test 375, Part 5.D.
[g] California Test 304, Part 2.13.
[h] The Engineer determines the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[i] Report only if the adjustment for the asphalt binder content TV is less than or equal to ±0.3 percent from the OBC value submitted on a *Contractor Hot Mix Asphalt Design Data* form.
[j] Voids in mineral aggregate for RHMA-G must be within this range.

No single test result may represent more than 750 tons or 1 day's production, whichever is less.

For any single quality characteristic except smoothness, if 2 consecutive acceptance test results do not comply with the specifications:

1. Stop production.
2. Take corrective action.
3. Take samples and split each sample into 4 parts in the Engineer's presence. Test 1 part for compliance with the specifications and submit 3 parts to the Engineer. The Department tests 1 part for compliance with the specifications and reserves and stores 2 parts.
4. Demonstrate compliance with the specifications before resuming production and placement.

The Department tests the density core you take from each 250 tons of HMA production. The Department determines the percent of maximum theoretical density for each density core by determining the density core's density and dividing by the maximum theoretical density.

If the specified total paved thickness is at least 0.15 foot and any layer is less than 0.15 foot, the Department determines the percent of maximum theoretical density from density cores taken from the final layer measured the full depth of the total paved HMA thickness.

For percent of maximum theoretical density, the Engineer determines a deduction for each test result outside the specifications using the reduced payment factors shown in the following table:

Reduced Payment Factors for Percent of Maximum Theoretical Density

HMA Type A and B and RHMA-G percent of maximum theoretical density	Reduced payment factor	HMA Type A and B and RHMA-G 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

39-2.04 TRANSPORTING, SPREADING, AND COMPACTING

Determine the number of rollers needed to obtain the specified density and surface finish.

39-3 METHOD CONSTRUCTION PROCESS

39-3.01 GENERAL

Section 39-3 includes specifications for HMA produced and constructed under the Method construction process.

39-3.02 ACCEPTANCE CRITERIA

39-3.02A Testing

The Department samples for acceptance testing and tests for the quality characteristics shown in the following table:

HMA Acceptance—Method Construction Process

Quality characteristic	Test method	HMA type			
		A	B	RHMA-G	OGFC
Aggregate gradation [a]	California Test 202	JMF ± tolerance [b]	JMF ± tolerance [b]	JMF ± tolerance [b]	JMF ± tolerance [b]
Sand equivalent (min) [c]	California Test 217	47	42	47	--
Asphalt binder content (%)	California Test 379 or 382	JMF ± 0.45	JMF ± 0.45	JMF ± 0.50	JMF ± 0.50
HMA moisture content (%, max)	California Test 226 or 370	1.0	1.0	1.0	1.0
Stabilometer value (min) [c, d]	California Test 366				
No. 4 and 3/8" gradings		30	30	--	--
1/2" and 3/4" gradings		37	35	23	--
Percent of crushed particles	California Test 205				
Coarse aggregate (% min)					
One fractured face		90	25	--	90
Two fractured faces		75	--	90	75
Fine aggregate (% min) (Passing no. 4 sieve and retained on no. 8 sieve.)					
One fractured face		70	20	70	90
Los Angeles Rattler (% max)	California Test 211				
Loss at 100 rev.		12	--	12	12
Loss at 500 rev.		45	50	40	40
Air void content (%) [c, e]	California Test 367	4 ± 2	4 ± 2	TV ± 2	--
Fine aggregate angularity (% min)	California Test 234	45	45	45	--
Flat and elongated particles (% max by weight @ 5:1)	California Test 235	Report only	Report only	Report only	Report only
Voids filled with asphalt (%) [f]	California Test 367				
No. 4 grading		76.0–80.0	76.0–80.0	Report only	--
3/8" grading		73.0–76.0	73.0–76.0		
1/2" grading		65.0–75.0	65.0–75.0		
3/4" grading		65.0–75.0	65.0–75.0		
Voids in mineral aggregate (% min) [f]	California Test 367				
No. 4 grading		17.0	17.0	--	--
3/8" grading		15.0	15.0	--	
1/2" grading		14.0	14.0	18.0–23.0 [g]	
3/4" grading		13.0	13.0	18.0–23.0 [g]	
Dust proportion [f]	California Test 367				
No. 4 and 3/8" gradings		0.9–2.0	0.9–2.0	Report only	--
1/2" and 3/4" gradings		0.6–1.3	0.6–1.3		
Smoothness	Section 39-1.12	12-foot straight-edge and must-grind	12-foot straight-edge and must-grind	12-foot straight-edge and must-grind	12-foot straight-edge and must-grind
Asphalt binder	Various	Section 92	Section 92	Section 92	Section 92
Asphalt rubber binder	Various	--	--	Section 92-1.01D(2) and section 39-1.02D	Section 92-1.01D(2) and section 39-1.02D

Asphalt modifier	Various	--	--	Section 39-1.02D	Section 39-1.02D
CRM	Various	--	--	Section 39-1.02D	Section 39-1.02D

[a] The Engineer determines combined aggregate gradations containing RAP under California Test 367.
[b] The tolerances must comply with the allowable tolerances in section 39-1.02E.
[c] The Engineer reports the average of 3 tests from a single split sample.
[d] California Test 304, Part 2.13.
[e] The Engineer determines the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[f] Report only if the adjustment for the asphalt binder content TV is less than or equal to ±0.3 percent from the OBC value submitted on a *Contractor Hot Mix Asphalt Design Data* form.
[g] Voids in mineral aggregate for RHMA-G must be within this range.

No single test result may represent more than 750 tons or 1 day's production, whichever is less.

For any single quality characteristic except smoothness, if 2 consecutive acceptance test results do not comply with the specifications:

1. Stop production.
2. Take corrective action.
3. Take samples and split each sample into 4 parts in the Engineer's presence. Test 1 part for compliance with the specifications and submit 3 parts to the Engineer. The Department tests 1 part for compliance with the specifications and reserves and stores 2 parts.
4. Demonstrate compliance with the specifications before resuming production and placement.

39-3.03 SPREADING AND COMPACTING EQUIPMENT

Each paver spreading HMA Type A and Type B must be followed by 3 rollers as follows:

1. One 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. One 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. One 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.

Compact RHMA-G as specified for HMA Type A and Type B except do not use pneumatic-tired rollers.

Compact OGFC with steel-tired, 2-axle tandem rollers. If placing 300 tons or more 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.

39-3.04 TRANSPORTING, SPREADING, AND COMPACTING

Pave HMA in maximum 0.25-foot thick compacted layers.

If the surface to be paved is both in sunlight and shade, pavement surface temperatures must be taken in the shade.

Spread HMA Type A and Type B at the atmospheric and surface temperatures shown in the following table:

Minimum Atmospheric and Surface Temperatures

Compacted layer thickness, feet	Atmospheric, °F		Surface, °F	
	Unmodified asphalt binder	Modified asphalt binder[a]	Unmodified asphalt binder	Modified asphalt binder[a]
< 0.15	55	50	60	55
0.15–0.25	45	45	50	50

[a] Except asphalt rubber binder.

If the asphalt binder for HMA Type A and Type B is unmodified asphalt binder, complete:

1. First coverage of breakdown compaction before the surface temperature drops below 250 degrees F
2. Breakdown and intermediate compaction before the surface temperature drops below 200 degrees F
3. Finish compaction before the surface temperature drops below 150 degrees F

If the asphalt binder for HMA Type A and Type B is modified asphalt binder, complete:

1. First coverage of breakdown compaction before the surface temperature drops below 240 degrees F
2. Breakdown and intermediate compaction before the surface temperature drops below 180 degrees F
3. Finish compaction before the surface temperature drops below 140 degrees F

For RHMA-G:

1. Only spread and compact if the atmospheric temperature is at least 55 degrees F and the surface temperature is at least 60 degrees F.
2. Complete the 1st coverage of breakdown compaction before the surface temperature drops below 280 degrees F.
3. Complete breakdown and intermediate compaction before the surface temperature drops below 250 degrees F.
4. Complete finish compaction before the surface temperature drops below 200 degrees F.
5. Cover loads in trucks with tarpaulins, if the atmospheric temperature is below 70 degrees F. The tarpaulins must completely cover the exposed load until you transfer the mixture to the paver's hopper or to the pavement surface.

For HMA-O with unmodified asphalt binder:

1. Only spread and compact if the atmospheric temperature is at least 55 degrees F and the surface temperature is at least 60 degrees F.
2. Complete the 1st coverage using 2 rollers before the surface temperature drops below 240 degrees F.
3. Complete all compaction before the surface temperature drops below 200 degrees F.
4. Cover loads in trucks with tarpaulins, if the atmospheric temperature is below 70 degrees F. The tarpaulins must completely cover the exposed load until you transfer the mixture to the paver's hopper or to the pavement surface.

For HMA-O with modified asphalt binder, except asphalt rubber binder:

1. Only spread and compact if the atmospheric temperature is at least 50 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 240 degrees F.
3. Complete all compaction before the surface temperature drops below 180 degrees F.
4. Cover loads in trucks with tarpaulins, if the atmospheric temperature is below 70 degrees F. The tarpaulins must completely cover the exposed load until you transfer the mixture to the paver's hopper or to the pavement surface.

For RHMA-O and RHMA-O-HB:

1. Only spread and compact if the atmospheric temperature is at least 55 degrees F and surface temperature is at least 60 degrees F.

2 Complete the 1st coverage using 2 rollers before the surface temperature drops below 280 degrees F.
3. Complete compaction before the surface temperature drops below 250 degrees F.
4. Cover loads in trucks with tarpaulins, if the atmospheric temperature is below 70 degrees F. The tarpaulins must completely cover the exposed load until you transfer the mixture to the paver's hopper or to the pavement surface.

For RHMA-G and OGFC, tarpaulins are not required if the time from discharging to the truck until transfer to the paver's hopper or the pavement surface is less than 30 minutes.

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.

Start rolling at the lower edge and progress toward the highest part.

Perform breakdown compaction of each layer of HMA Type A, Type B, and RHMA-G 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 thickness of the HMA layer is less than 0.08 foot, turn the vibrator off. The Engineer may order fewer coverages if the thickness of the HMA layer is less than 0.15 foot.

Perform intermediate compaction of each layer of HMA Type A and Type B with 3 coverages using a pneumatic-tired roller at a speed not exceeding 5 mph.

Perform finish compaction of HMA Type A, Type B, and RHMA-G with 1 coverage using a steel-tired roller.

Compact OGFC with 2 coverages using steel-tired rollers.

39-4 QUALITY CONTROL/QUALITY ASSURANCE CONSTRUCTION PROCESS

39-4.01 GENERAL

Section 39-4 includes specifications for HMA produced and constructed under the Quality Control / Quality Assurance construction process.

The QC/QA construction process consists of:

1. Establishing, maintaining, and changing if needed a quality control system providing assurance the HMA complies with the specifications
2. Sampling and testing at specified intervals, or sublots, to demonstrate compliance and to control the process
3. Department sampling and testing at specified intervals to verify the testing process and HMA quality
4. Engineer using test results, statistical evaluation of verified quality control tests, and inspection to accept HMA for payment

A lot is a quantity of HMA. The Engineer designates a new lot when:

1. 20 sublots are complete
2. JMF changes
3. Production stops for more than 30 days

Each lot consists of no more than 20 sublots. A sublot is 750 tons, except a quantity of HMA paved at day's end greater than 250 tons is a sublot. If a quantity of HMA paved at day's end is less than 250 tons, you may either make this quantity a sublot or include it in the previous sublot's test results for statistical evaluation.

39-4.02 CONTRACTOR QUALITY CONTROL

39-4.02A General

Use a composite quality factor, QF_C, and individual quality factors, QF_{QCi}, to control your process and evaluate the quality control program. For quality characteristics without quality factors, use your QC plan's action limits to control your process.

Control HMA quality including:

1. Materials
2. Proportioning
3. Spreading and compacting
4. Finished roadway surface

Develop, implement, and maintain a quality control program that includes:

1. Inspection
2. Sampling
3. Testing

39-4.02B Quality Control Plan

With the JMF submittal, submit a QC plan. The QC plan must comply with the Department's *Quality Control Manual for Hot Mix Asphalt Production and Placement*. Discuss the QC plan with the Engineer during the prepaving conference.

The Engineer reviews each QC plan within 5 business days from the submittal. Do not produce HMA until the Engineer authorizes the QC plan.

The QC plan must include the name and qualifications of a QC manager. The QC manager administers the QC plan and during paving must be at the job site within 3 hours of receiving notice. The QC manager must not be any of the following on the project:

1. Foreman
2. Production or paving crewmember
3. Inspector
4. Tester

The QC plan must include action limits and details of corrective action you will take if a test result for any quality characteristic falls outside an action limit.

As work progresses, you must submit a QC plan supplement to change quality control procedures, personnel, tester qualification status, or laboratory accreditation status.

39-4.02C Quality Control Inspection, Sampling, and Testing

Sample, test, inspect, and manage HMA quality control.

Provide a roadway inspector while HMA paving activities are in progress. Provide a plant inspector during HMA production.

Inspectors must comply with the Department's *Quality Control Manual for Hot Mix Asphalt Production and Placement*.

Provide a testing laboratory and personnel for quality control testing. Provide the Engineer unrestricted access to the quality control activities. Before providing services for the project, the Engineer reviews, accredits, and qualifies the testing laboratory and personnel under the Department's Independent Assurance Program.

For HMA at production start-up and every 5,000 tons, sample and test under California Test 371. Submit the test results to the Engineer and to:

Moisture_Tests@dot.ca.gov

For HMA at production start-up and once during production, submit samples split from your HMA production sample for California Test 371 to the Engineer and the Transportation Laboratory, Attention: Moisture Test.

The Department does not use results from California Test 371 to determine specification compliance.

Comply with the values for the HMA quality characteristics and minimum random sampling and testing for quality control shown in the following table:

Minimum Quality Control—QC/QA Construction Process

Quality characteristic	Test method	Minimum sampling and testing frequency	HMA Type			Location of sampling	Maximum reporting time allowance
			A	B	RHMA-G		
Aggregate gradation[a]	California Test 202	1 per 750 tons	JMF ± tolerance [b]	JMF ± tolerance [b]	JMF ± tolerance [b]	California Test 125	24 hours
Asphalt binder content (%)	California Test 379 or 382		JMF ±0.45	JMF ±0.45	JMF ±0.50	Loose mix behind paver See California Test 125	
Percent of maximum theoretical density (%)[c,d]	QC plan		92–96	92–96	91–96	QC plan	
Aggregate moisture content at continuous mixing plants and RAP moisture content at continuous mixing plants and batch mixing plants[e]	California Test 226 or 370	2 per day during production	--	--	--	Stockpiles or cold feed belts	--
Sand equivalent (min) [f]	California Test 217	1 per 750 tons	47	42	47	California Test 125	24 hours
HMA moisture content (%,max)	California Test 226 or 370	1 per 2,500 tons but not less than 1 per paving day	1.0	1.0	1.0	Loose Mix Behind Paver See California Test 125	24 hours
Stabilometer value (min)[f,g] No. 4 and 3/8" gradings 1/2" and 3/4" gradings	California Test 366	1 per 4,000 tons or 2 per 5 business days, whichever is greater	 30 37	 30 35	 -- 23		48 hours
Air void content (%)[f,h]	California Test 367		4 ± 2	4 ± 2	TV ± 2		

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	California Test 205	As design-ated in QC plan. At least once per project.	90 75 70	25 -- 20	-- 90 70	California Test 125	48 hours
Los Angeles Rattler (% max): Loss at 100 rev. Loss at 500 rev.	California Test 211		12 45	-- 50	12 40	California Test 125	
Fine aggregate angularity (% min)	California Test 234		45	45	45	California Test 125	
Flat and elongated particle (% max by weight @ 5:1)	California Test 235		Report only	Report only	Report only	California Test 125	
Voids filled with asphalt (%)[i]: No. 4 grading 3/8" grading 1/2" grading 3/4" grading	California Test 367		 76.0–80.0 73.0–76.0 65.0–75.0 65.0–75.0	 76.0–80.0 73.0–76.0 65.0–75.0 65.0–75.0	Report only	California Test 367	
Voids in mineral aggregate (% min.)[i]: No. 4 grading 3/8" grading 1/2" grading 3/4" grading	California Test 367		 17.0 15.0 14.0 13.0	 17.0 15.0 14.0 13.0	 -- -- 18.0–23.0[j] 18.0–23.0[j]	California Test 367	

Dust proportion[i]: No. 4 and 3/8" gradings 1/2" and 3/4" gradings	California Test 367		0.9–2.0 0.6–1.3	0.9–2.0 0.6–1.3	Report only	California Test 367	
Smoothness	Section 39-1.12	--	12-foot straight-edge, must-grind, and PI_0	12-foot straight-edge, must-grind, and PI_0	12-foot straight-edge, must-grind, and PI_0	--	
Asphalt rubber binder viscosity @ 350 °F, centipoises	Section 39-1.02D	--	--	--	1,500–4,000	Section 39-1.02D	24 hours
CRM	Section 39-1.02D	--	--	--	Section 39-1.02D	Section 39-1.02D	48 hours

[a] Determine combined aggregate gradation containing RAP under California Test 367.
[b] The tolerances must comply with the allowable tolerances in section 39-1.02E.
[c] Required for HMA Type A, Type B, and RHMA-G if the specified paved thickness is at least 0.15 foot.
[d] Determine maximum theoretical density (California Test 309) at the frequency specified for test maximum density under California Test 375, Part 5 D.
[e] For adjusting the plant controller at the HMA plant.
[f] Report the average of 3 tests from a single split sample.
[g] California Test 304, Part 2.13.
[h] Determine the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[i] Report only if the adjustment for the asphalt binder content TV is less than or equal to ±0.3 percent from the OBC value submitted on a *Contractor Hot Mix Asphalt Design Data* form.
[j] Voids in mineral aggregate for RHMA-G must be within this range.

Within the specified reporting time, submit test results including:

1. Sampling location, quantity, and time
2. Testing results
3. Supporting data and calculations

If test results for any quality characteristic are beyond the action limits in the QC plan, take corrective actions. Document the corrective actions taken in the inspection records under section 39-4.02E.

Stop production, notify the Engineer, take corrective action, and demonstrate compliance with the specifications before resuming production and placement if:

1. A lot's composite quality factor, QF_C, or an individual quality factor, QF_{QCi} for i = 3, 4, or 5, is below 0.90 determined under section 39-4.02F using quality control data
2. An individual quality factor, QF_{QCi} for i = 1 or 2, is below 0.75 using quality control data
3. Quality characteristics for which a quality factor, QF_{QCi}, is not determined has 2 consecutive quality control tests not in compliance with the specifications

39-4.02D Charts and Records

Record sampling and testing results for quality control on forms provided in the *Quality Control Manual for Hot Mix Asphalt Production and Placement*, or on forms you submit with the QC plan. The QC plan must also include posting locations and submittal times for forms.

Submit quality control test results using the Department's statistical evaluation program, HMAPay. For HMAPay, go to the Department's Construction Web site.

39-4.02E Records of Inspection and Testing

During HMA production, submit a daily:

1. *HMA Construction Daily Record of Inspection*. Also make this record available at the HMA plant and job site each day.
2. *HMA Inspection and Testing Summary*. Include in the summary:
   2.1. QC worksheet with updated test results from the HMAPay program
   2.2. Test forms with the testers' signatures and QC manager's initials
   2.3. Inspection forms with the inspectors' signatures and QC manager's initials
   2.4. List and explanation of deviations from the specifications or regular practices
   2.5. Signed statement by the QC manager that says:

   "It is hereby certified that the information contained in this record is accurate, and that information, tests, or calculations documented herein comply with the specifications of the Contract and the standards set forth in the testing procedures. Exceptions to this certification are documented as part of this record."

Retain for inspection the records generated as part of quality control, including inspection, sampling, and testing for at least 3 years after final acceptance.

39-4.02F Statistical Evaluation

39-4.02F(1) General

Determine a lot's composite quality factor, QF_C, and the individual quality factors, QF_{QCi}. Perform statistical evaluation calculations to determine these quality factors based on quality control test results for:

1. Aggregate gradation
2. Asphalt binder content
3. Percent of maximum theoretical density

The Engineer grants a waiver and you must use 1.0 as the individual quality factor for percent of maximum theoretical density, QF_{QC5}, for HMA paved in:

1. Areas where the total paved thickness is less than 0.15 foot
2. Areas where the total paved thickness is less than 0.20 foot and 3/4-inch grading is specified and used
3. Dig outs
4. Leveling courses
5. Areas where compaction or compaction measurement by conventional methods is impeded

39-4.02F(2) Statistical Evaluation Calculations

Use the Variability-Unknown / Standard Deviation Method to determine the percentage of a lot not in compliance with the specifications.

Determine the percentage of work not in compliance with the specification limits for each quality characteristic as follows:

1. Calculate the arithmetic mean ($\overline{X}$) of the test values

$$\overline{X} = \frac{\Sigma x}{n}$$

where:

x = individual test values
n = number of test values

2. Calculate the standard deviation

$$s = \sqrt{\frac{n(\Sigma x^2)-(\Sigma x)^2}{n(n-1)}}$$

where:

$\sum(x^2)$ = sum of the squares of individual test values
$(\sum x)^2$ = sum of the individual test values squared
n = number of test values

3. Calculate the upper quality index (Qu)

$$Q_u = \frac{USL - \overline{X}}{s}$$

where:

USL = TV plus the production tolerance or upper specification limit
s = standard deviation
$\overline{X}$ = arithmetic mean

4. Calculate the lower quality index (QL);

$$Q_L = \frac{\overline{X} - LSL}{s}$$

where:

LSL = TV minus production tolerance or lower specification limit
s = standard deviation
$\overline{X}$ = arithmetic mean

5. From the table, Upper Quality Index Q_U or Lower Quality Index Q_L, determine P_U ;

where:

P_U = estimated percentage of work outside the USL
P_U = 0, if USL is not specified

6. From the table, Upper Quality Index Q_U or Lower Quality Index Q_L, determine P_L;

where:

P_L = estimated percentage of work outside the LSL
P_L = 0, if LSL is not specified

7. Calculate the total estimated percentage of work outside the USL and LSL, percent defective

Percent defective = PU + PL

The P_U and P_L are determined from the following:

P_U or P_L	**Upper Quality Index Q_U or Lower Quality Index Q_L**												
	Sample Size (n)												
	5	6	7	8	9	10-11	12-14	15-17	18-22	23-29	30-42	43-66	>66
0	1.72	1.88	1.99	2.07	2.13	2.20	2.28	2.34	2.39	2.44	2.48	2.51	2.56
1	1.64	1.75	1.82	1.88	1.91	1.96	2.01	2.04	2.07	2.09	2.12	2.14	2.16
2	1.58	1.66	1.72	1.75	1.78	1.81	1.84	1.87	1.89	1.91	1.93	1.94	1.95
3	1.52	1.59	1.63	1.66	1.68	1.71	1.73	1.75	1.76	1.78	1.79	1.80	1.81
4	1.47	1.52	1.56	1.58	1.60	1.62	1.64	1.65	1.66	1.67	1.68	1.69	1.70
5	1.42	1.47	1.49	1.51	1.52	1.54	1.55	1.56	1.57	1.58	1.59	1.59	1.60
6	1.38	1.41	1.43	1.45	1.46	1.47	1.48	1.49	1.50	1.50	1.51	1.51	1.52
7	1.33	1.36	1.38	1.39	1.40	1.41	1.41	1.42	1.43	1.43	1.44	1.44	1.44
8	1.29	1.31	1.33	1.33	1.34	1.35	1.35	1.36	1.36	1.37	1.37	1.37	1.38
9	1.25	1.27	1.28	1.28	1.29	1.29	1.30	1.30	1.30	1.31	1.31	1.31	1.31
10	1.21	1.23	1.23	1.24	1.24	1.24	1.25	1.25	1.25	1.25	1.25	1.26	1.26
11	1.18	1.18	1.19	1.19	1.19	1.19	1.20	1.20	1.20	1.20	1.20	1.20	1.20
12	1.14	1.14	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
13	1.10	1.10	1.10	1.10	1.10	1.10	1.11	1.11	1.11	1.11	1.11	1.11	1.11
14	1.07	1.07	1.07	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
15	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
16	1.00	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
17	0.97	0.96	0.95	0.95	0.95	0.95	0.94	0.94	0.94	0.94	0.94	0.94	0.94
18	0.93	0.92	0.92	0.92	0.91	0.91	0.91	0.91	0.90	0.90	0.90	0.90	0.90
19	0.90	0.89	0.88	0.88	0.88	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
20	0.87	0.86	0.85	0.85	0.84	0.84	0.84	0.83	0.83	0.83	0.83	0.83	0.83
21	0.84	0.82	0.82	0.81	0.81	0.81	0.80	0.80	0.80	0.80	0.80	0.80	0.79
22	0.81	0.79	0.79	0.78	0.78	0.77	0.77	0.77	0.76	0.76	0.76	0.76	0.76
23	0.77	0.76	0.75	0.75	0.74	0.74	0.74	0.73	0.73	0.73	0.73	0.73	0.73
24	0.74	0.73	0.72	0.72	0.71	0.71	0.70	0.70	0.70	0.70	0.70	0.70	0.70
25	0.71	0.70	0.69	0.69	0.68	0.68	0.67	0.67	0.67	0.67	0.67	0.67	0.66
26	0.68	0.67	0.67	0.65	0.65	0.65	0.64	0.64	0.64	0.64	0.64	0.64	0.63
27	0.65	0.64	0.63	0.62	0.62	0.62	0.61	0.61	0.61	0.61	0.61	0.61	0.60
28	0.62	0.61	0.60	0.59	0.59	0.59	0.58	0.58	0.58	0.58	0.58	0.58	0.57
29	0.59	0.58	0.57	0.57	0.56	0.56	0.55	0.55	0.55	0.55	0.55	0.55	0.54
30	0.56	0.55	0.54	0.54	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.52	0.52
31	0.53	0.52	0.51	0.51	0.50	0.50	0.50	0.49	0.49	0.49	0.49	0.49	0.49
32	0.50	0.49	0.48	0.48	0.48	0.47	0.47	0.47	0.46	0.46	0.46	0.46	0.46
33	0.47	0.48	0.45	0.45	0.45	0.44	0.44	0.44	0.44	0.43	0.43	0.43	0.43
34	0.45	0.43	0.43	0.42	0.42	0.42	0.41	0.41	0.41	0.41	0.41	0.41	0.40
35	0.42	0.40	0.40	0.39	0.39	0.39	0.38	0.38	0.38	0.38	0.38	0.38	0.38
36	0.39	0.38	0.37	0.37	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
37	0.36	0.35	0.34	0.34	0.34	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.32
38	0.33	0.32	0.32	0.31	0.31	0.31	0.30	0.30	0.30	0.30	0.30	0.30	0.30
39	0.30	0.30	0.29	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
40	0.28	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
41	0.25	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
42	0.23	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
43	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
44	0.16	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
45	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
46	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
47	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
48	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
49	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

NOTES:

1. If the value of Q_U or Q_L does not correspond to a value in the table, use the next lower value.
2. If Q_U or Q_L are negative values, P_U or P_L is equal to 100 minus the table value for P_U or P_L.

39-4.02F(3) Quality Factor Determination

Determine individual quality factors, QF_{QCi}, using percent defective = $P_U + P_L$ and the following:

Quality Factors

Quality factor	Maximum allowable percent defective ($P_U + P_L$) Sample size (n)												
	5	6	7	8	9	10-11	12-14	15-17	18-22	23-29	30-42	43-66	>66
1.05				0	0	0	0	0	0	0	0	0	0
1.04			0	1	3	5	4	4	4	3	3	3	3
1.03		0	2	4	6	8	7	7	6	5	5	4	4
1.02		1	3	6	9	11	10	9	8	7	7	6	6
1.01	0	2	5	8	11	13	12	11	10	9	8	8	7
1.00	22	20	18	17	16	15	14	13	12	11	10	9	8
0.99	24	22	20	19	18	17	16	15	14	13	11	10	9
0.98	26	24	22	21	20	19	18	16	15	14	13	12	10
0.97	28	26	24	23	22	21	19	18	17	16	14	13	12
0.96	30	28	26	25	24	22	21	19	18	17	16	14	13
0.95	32	29	28	26	25	24	22	21	20	18	17	16	14
0.94	33	31	29	28	27	25	24	22	21	20	18	17	15
0.93	35	33	31	29	28	27	25	24	22	21	20	18	16
0.92	37	34	32	31	30	28	27	25	24	22	21	19	18
0.91	38	36	34	32	31	30	28	26	25	24	22	21	19
0.90	39	37	35	34	33	31	29	28	26	25	23	22	20
0.89	41	38	37	35	34	32	31	29	28	26	25	23	21
0.88	42	40	38	36	35	34	32	30	29	27	26	24	22
0.87	43	41	39	38	37	35	33	32	30	29	27	25	23
0.86	45	42	41	39	38	36	34	33	31	30	28	26	24
0.85	46	44	42	40	39	38	36	34	33	31	29	28	25
0.84	47	45	43	42	40	39	37	35	34	32	30	29	27
0.83	49	46	44	43	42	40	38	36	35	33	31	30	28
0.82	50	47	46	44	43	41	39	38	36	34	33	31	29
0.81	51	49	47	45	44	42	41	39	37	36	34	32	30
0.80	52	50	48	46	45	44	42	40	38	37	35	33	31
0.79	54	51	49	48	46	45	43	41	39	38	36	34	32
0.78	55	52	50	49	48	46	44	42	41	39	37	35	33
0.77	56	54	52	50	49	47	45	43	42	40	38	36	34
0.76	57	55	53	51	50	48	46	44	43	41	39	37	35
0.75	58	56	54	52	51	49	47	46	44	42	40	38	36
	60	57	55	53	52	51	48	47	45	43	41	40	37
	61	58	56	55	53	52	50	48	46	44	43	41	38
Reject	62	59	57	56	54	53	51	49	47	45	44	42	39
	63	61	58	57	55	54	52	50	48	47	45	43	40
	64	62	60	58	57	55	53	51	49	48	46	44	41
Reject values greater than those shown above													

NOTE: To obtain a quality factor if the estimated percent outside specification limits from table titled, "Upper Quality Index Q_U or Lower Quality Index Q_L," does not correspond to a value in the table, use the next larger value.

Compute the composite of single quality factors, QF_C, for a lot using:

$$QF_C = \sum_{i=1}^{5} w_i \, QF_{QC_i}$$

where:

QF_C = the composite quality factor for the lot rounded to 2 decimal places
QF_{QCi} = the quality factor for the individual quality characteristic

w = the weighting factor listed in the table titled "HMA Acceptance – QC/QA Construction Process"

i = the quality characteristic index number in the table titled "HMA Acceptance – QC/QA Construction Process"

39-4.03 QUALITY ASSURANCE

39-4.03A General

The Department assures quality by:

1. Reviewing mix designs and proposed JMF
2. Inspecting procedures
3. Conducting oversight of quality control inspection and records
4. Verification sampling and testing during production and paving

39-4.03B Verification Sampling and Testing

39-4.03B(1) General

The Department samples:

1. Aggregate to verify gradation
2. HMA to verify asphalt binder content

39-4.03B(2) Verification

For aggregate gradation and asphalt binder content, the ratio of verification testing frequency to the minimum quality control testing frequency is 1:5. The Department performs at least 3 verification tests per lot.

Using the t-test, the Engineer compares quality control tests results for aggregate gradation and asphalt binder content with corresponding verification test results. The Engineer uses the average and standard deviation of up to 20 sequential sublots for the comparison. The Engineer uses production start-up evaluation tests to represent the 1st sublot. If there are less than 20 sequential sublots, the Engineer uses the maximum number of sequential sublots available. The 21st sublot becomes the 1st sublot (n = 1) in the next lot.

The t-value for a group of test data is computed as follows:

$$t = \frac{\left|\overline{X}_c - \overline{X}_v\right|}{S_p\sqrt{\frac{1}{n_c} + \frac{1}{n_v}}} \qquad \text{and} \qquad S_p^2 = \frac{S_c^2(n_c - 1) + S_v^2(n_v - 1)}{n_c + n_v - 2}$$

where:

n_c = Number of quality control tests (2 min, 20 max).

n_v = Number of verification tests (min of 1 required).

$\overline{X}_c$ = Mean of quality control tests.

$\overline{X}_v$ = Mean of verification tests.

S_p = Pooled standard deviation (when $n_v = 1$, $S_p = S_c$).

S_c = Standard deviation of quality control tests.

S_v = Standard deviation of verification tests (when $n_v > 1$).

The comparison of quality control test results and the verification test results is at a level of significance of $\alpha = 0.025$. The Engineer computes t and compares it to the following critical t-values, t_{crit}:

Critical T-Value

Degrees of freedom (n_c+n_v-2)	t_{crit} (for $\alpha = 0.025$)	Degrees of freedom (n_c+n_v-2)	t_{crit} (for $\alpha = 0.025$)
1	24.452	18	2.445
2	6.205	19	2.433
3	4.177	20	2.423
4	3.495	21	2.414
5	3.163	22	2.405
6	2.969	23	2.398
7	2.841	24	2.391
8	2.752	25	2.385
9	2.685	26	2.379
10	2.634	27	2.373
11	2.593	28	2.368
12	2.560	29	2.364
13	2.533	30	2.360
14	2.510	40	2.329
15	2.490	60	2.299
16	2.473	120	2.270
17	2.458	∞	2.241

If the t-value computed is less than or equal to t_{crit}, quality control test results are verified.

If the t-value computed is greater than t_{crit} and both $\overline{X}_v$ and $\overline{X}_c$ comply with acceptance specifications, the quality control tests are verified. You may continue to produce and place HMA with the following allowable differences:

1. $\left|\overline{X}_v - \overline{X}_c\right|$ ≤ 1.0 percent for any grading
2. $\left|\overline{X}_v - \overline{X}_c\right|$ ≤ 0.1 percent for asphalt binder content

If the t-value computed is greater than t_{crit} and the $\left|\overline{X}_v - \overline{X}_c\right|$ for grading and asphalt binder content are greater than the allowable differences, quality control test results are not verified and:

1. Engineer notifies you.
2. You and the Engineer must investigate why the difference exists.
3. If the reason for the difference cannot be found and corrected, the Department's test results are used for acceptance and pay.

39-4.04 ACCEPTANCE CRITERIA

39-4.04A Testing

The Engineer samples for acceptance testing and tests for the following quality characteristics:

HMA Acceptance—QC/QA Construction Process

Index (i)	Quality characteristic				Weight-ing factor (w)	Test method	HMA type		
							A	B	RHMA-G
		Aggregate gradation [a]				California Test 202	JMF ± Tolerance [c]		
	Sieve	3/4"	1/2"	3/8"					
1	1/2"	X [b]	--	--	0.05				
1	3/8"	--	X	--	0.05				
1	No. 4	--	--	X	0.05				
2	No. 8	X	X	X	0.10				
3	No. 200	X	X	X	0.15				
4	Asphalt binder content (%)				0.30	California Test 379 or 382	JMF ± 0.45	JMF ± 0.45	JMF ± 0.5
5	Percent of maximum theoretical density (%) [d, e]				0.40	California Test 375	92–96	92–96	91–96
	Sand equivalent (min) [f]					California Test 217	47	42	47
	Stabilometer value (min) [f,g] No. 4 and 3/8" gradings 1/2" and 3/4" gradings					California Test 366	 30 37	 30 35	 -- 23
	Air void content (%) [f, h]					California Test 367	4 ± 2	4 ± 2	TV ± 2
	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					California Test 205	 90 75 70	 25 -- 20	 -- 90 70
	HMA moisture content (%, max)					California Test 226 or 370	1.0	1.0	1.0
	Los Angeles Rattler (% max) Loss at 100 rev. Loss at 500 rev.					California Test 211	 12 45	 -- 50	 12 40
	Fine aggregate angularity (% min)					California Test 234	45	45	45
	Flat and elongated particle (% max by weight @ 5:1)					California Test 235	Report only	Report only	Report only
	Voids in mineral aggregate (% min) [i] No. 4 grading 3/8" grading 1/2" grading 3/4" grading					California Test 367	 17.0 15.0 14.0 13.0	 17.0 15.0 14.0 13.0	(Note j) -- -- 18.0–23.0 18.0–23.0

	Voids filled with asphalt (%) [i] No. 4 grading 3/8" grading 1/2" grading 3/4" grading		California Test 367	76.0–80.0 73.0–76.0 65.0–75.0 65.0–75.0	76.0–80.0 73.0–76.0 65.0–75.0 65.0–75.0	Report only
	Dust proportion [i] No. 4 and 3/8" gradings 1/2" and 3/4" gradings		California Test 367	0.9–2.0 0.6–1.3	0.9–2.0 0.6–1.3	Report only
	Smoothness		Section 39-1.12	12-foot straight-edge, must grind, and PI_0	12-foot straight-edge, must grind, and PI_0	12-foot straight-edge, must grind, and PI_0
	Asphalt binder		Various	Section 92	Section 92	Section 92
	Asphalt rubber binder		Various	--	--	Section 92-1.01D(2) and section 39-1.02D
	Asphalt modifier		Various	--	--	Section 39-1.02D
	CRM		Various	--	--	Section 39-1.02D

[a] The Engineer determines combined aggregate gradations containing RAP under California Test 367.
[b] "X" denotes the sieves the Engineer tests for the specified aggregate gradation.
[c] The tolerances must comply with the allowable tolerances in section 39-1.02E.
[d] The Engineer determines percent of maximum theoretical density if the specified total paved thickness is at least 0.15 foot under California Test 375 except the Engineer uses:

1. California Test 308, Method A, to determine in-place density of each density core instead of using the nuclear gauge in Part 4, "Determining In-Place Density By The Nuclear Density Device."
2. California Test 309 to determine maximum theoretical density instead of calculating test maximum density in Part 5, "Determining Test Maximum Density."

[e] The Engineer determines maximum theoretical density (California Test 309) at the frequency specified for Test Maximum Density under California Test 375, Part 5.D.
[f] The Engineer reports the average of 3 tests from a single split sample.
[g] California Test 304, Part 2.13.
[h] The Engineer determines the bulk specific gravity of each lab-compacted briquette under California Test 308, Method A, and theoretical maximum specific gravity under California Test 309.
[i] Report only if the adjustment for the asphalt binder content TV is less than or equal to ±0.3 percent from the OBC value submitted on a *Contractor Hot Mix Asphalt Design Data* form.
[j] Voids in mineral aggregate for RHMA-G must be within this range.

The Department determines the percent of maximum theoretical density from the average density of 3 density cores you take from every 750 tons of production or part thereof divided by the maximum theoretical density.

If the specified total paved thickness is at least 0.15 foot and any layer is less than 0.15 foot, the Department determines the percent of maximum theoretical density from density cores taken from the final layer measured the full depth of the total paved HMA thickness.

The Engineer calculates QF_{QCi} for i = 1, 2, 3, and 4 using quality control data and QF_{QCi} for i = 5 using quality assurance data,

The Engineer stops production and terminates a lot if:

1. A lot's composite quality factor, QF_C, or an individual quality factor, QF_{QCi} for i = 3, 4, or 5, is below 0.90 determined under section 39-4.02F
2. An individual quality factor, QF_{QCi} for i = 1 or 2, is below 0.75

3. Quality characteristics for which a quality factor, QF_{QCi}, is not determined has 2 consecutive acceptance or quality control test results not in compliance with the specifications

For any single quality characteristic for which a quality factor, QF_{QCi}, is not determined, except smoothness, if 2 consecutive acceptance test results do not comply with specifications:

1. Stop production.
2. Take corrective action.
3. Take samples and split each sample into 4 parts in the Engineer's presence. Test 1 part for compliance with the specifications and submit 3 parts to the Engineer. The Department tests 1 part for compliance with the specifications and reserves and stores 2 parts.
4. Demonstrate compliance with the specifications before resuming production and placement.

39-4.04B Statistical Evaluation, Determination of Quality Factors, and Acceptance

39-4.04B(1) Statistical Evaluation and Determination of Quality Factors

To determine the individual quality factor, $QF_{QCi,}$ for any quality factor i = 1 through 5 or a lot's composite quality factor, QF_C, for acceptance and payment adjustment, the Engineer uses the evaluation specifications under section 39-4.02F and the following:

1. Verified quality control test results for aggregate gradation
2. Verified quality control test results for asphalt binder content
3. Department's test results for percent of maximum theoretical density

39-4.04B(2) Lot Acceptance Based on Quality Factors

The Engineer accepts a lot based on the quality factors determined for aggregate gradation and asphalt binder content, QF_{QCi} for i = 1 through 4, using the total number of verified quality control test result values and the total percent defective ($P_U + P_L$).

The Engineer accepts a lot based on the quality factor determined for maximum theoretical density, QF_{QC5}, using the total number of test result values from cores and the total percent defective ($P_U + P_L$).

The Engineer calculates the quality factor for the lot, QF_C, which is a composite of weighted individual quality factors, QF_{QCi}, determined for each quality characteristic in the HMA Acceptance – QC/QA table in section 39-4.04A.

The Engineer accepts a lot based on quality factors if:

1. Current composite quality factor, QF_C, is 0.90 or greater
2. Each individual quality factor, QF_{QCi} for i = 3, 4, and 5, is 0.90 or greater
3. Each individual quality factor, QF_{QCi} for i = 1 and 2, is 0.75 or greater

No single quality characteristic test may represent more than 750 tons or 1 day's production, whichever is less.

39-4.04B(3) Payment Adjustment

If a lot is accepted, the Engineer adjusts payment with the following formula:

$$PA = \sum_{i=1}^{n} HMACP * wi * \left[QF_{QCi} * (HMATT - WHMATT_i) + WHMATT_i\right] - (HMACP * HMATT)$$

where:

PA =	payment adjustment rounded to 2 decimal places
HMACP =	HMA Contract price
HMATT =	HMA total tons represented in the lot
$WHMATT_i$ =	total tons of waived quality characteristic HMA
QF_{QCi} =	running quality factor for the individual quality characteristic
	QF_{QCi} for i = 1 through 4 must be from verified Contractor's QC results. QF_{QC5} must be determined from the Engineer's results on density cores taken for percent of maximum theoretical density determination.
w =	weighting factor listed in the HMA acceptance table
i =	quality characteristic index number in the HMA acceptance table

If the payment adjustment is a negative value, the Engineer deducts this amount from payment. If the payment adjustment is a positive value, the Engineer adds this amount to payment.

The 21st sublot becomes the 1st sublot (n = 1) in the next lot. If the 21st sequential sublot becomes the 1st sublot, the previous 20 sequential sublots become a lot for which the Engineer determines a quality factor. The Engineer uses this quality factor to pay for the HMA in the lot. If the next lot consists of less than 8 sublots, these sublots must be added to the previous lot for quality factor determination using 21 to 27 sublots.

39-4.04C Dispute Resolution

For a lot, if you or the Engineer dispute any quality factor, QF_{QCi}, or verification test result, every sublot in that lot must be retested.

Referee tests must be performed under the specifications for acceptance testing.

Any quality factor, QF_{QCi}, must be determined using the referee tests.

For any quality factor, QF_{QCi}, for i = 1 through 5, dispute resolution:

1. If the difference between the quality factors for QF_{QCi} using the referee test result and the disputed test result is less than or equal to 0.01, the original test result is correct
2. If the difference between the quality factor for QF_{QCi} using the referee test result and the disputed test result is more than 0.01, the quality factor determined from the referee tests supersedes the previously determined quality factor

39-5 RESERVED

39-6 PAYMENT

Section 39-6 includes specifications for HMA payment. The weight of each HMA mixture designated in the Bid Item List must be the combined mixture weight.

If the QC/QA construction process is specified, the Engineer adjusts payment under section 39-4.

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 asphalt binder weight per batch is printed.
3. Each truckload's zero tolerance weight is printed before weighing the 1st 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 weighmaster and submitted to the Engineer.

If tack coat, asphalt binder, and asphaltic emulsion are paid with separate contract items, their contract items are measured under section 92 or section 94.

The Department does not adjust the unit price for an increase or decrease in the tack coat quantity. Section 9-1.06 does not apply to tack coat.

Place hot mix asphalt dike of the type specified is measured along the completed length.

Place hot mix asphalt (miscellaneous areas) is measured as the in-place compacted area.

HMA dike is paid for as place hot mix asphalt dike of the type specified in the Bid Item List and by weight for hot mix asphalt.

HMA specified to be placed in miscellaneous areas is paid for as place hot mix asphalt (miscellaneous area) and by weight for hot mix asphalt.

If the QC/QA construction process is specified, HMA placed in dikes and miscellaneous areas is paid for as hot mix asphalt as specified in section 39-4 except section 39-4.04B does not apply.

If minor hot mix asphalt is paid by area, it is measured from the dimensions shown.

Payment for tack coat for minor HMA is included in payment for minor hot mix asphalt or the bid item that requires minor HMA.

Geosynthetic pavement interlayer is measured for the actual pavement area covered.

If the dispute resolution independent third party determines the Department's test results are correct, the Engineer deducts the independent third party's testing costs from payments. If the independent third party determines your test results are correct, the Department pays the independent third party's testing costs.

40 CONCRETE PAVEMENT

40-1 GENERAL

40-1.01 GENERAL

40-1.01A Summary

Section 40-1 includes general specifications for constructing concrete pavement and applying crack treatment.

40-1.01B Definitions

Reserved

40-1.01C Submittals

40-1.01C(1) General

Reserved

40-1.01C(2) Certificates of Compliance

Submit a certificate of compliance for the following materials:

1. Tie bars
2. Threaded tie bar splice couplers
3. Dowel bars
4. Tie bar baskets
5. Dowel bar baskets
6. Chemical adhesive for drilling and bonding tie bars and dowel bars
7. Silicone joint sealant
8. Asphalt rubber joint sealant
9. Preformed compression seal
10. Backer rods, including the manufacturer's statement of compatibility with the sealant to be used.
11. Joint filler material
12. Epoxy powder coating

40-1.01C(3) Drilled Corings

Submit each core taken in a plastic bag for acceptance. Mark each core with a location description.

40-1.01C(4) Independent Third Party Air Content Testing Laboratory

Submit for authorization, the name of a laboratory that will test drilled core specimens for air content in case of dispute.

40-1.01C(5) Frequency Measuring Device (Tachometer)

Submit as an information submittal, calibration documentation and operational guidelines for frequency measuring devices for concrete consolidation vibrators.

40-1.01C(6) Manufacturer's Recommendations and Instructions

At least 15 days before delivery to the job site, submit manufacturer's recommendations and instructions for storage and installation of:

1. Threaded tie bar splice couplers
2. Chemical adhesive for drilling and bonding tie bars and dowel bars
3. Silicone liquid sealant
4. Asphalt rubber liquid sealant
5. Preformed compression seals
6. Joint filler material

40-1.01C(7) Preformed Compression Seal

Submit the manufacturer's data sheet used to develop the recommended preformed compression seal based on the joint dimensions.

40-1.01C(8) Protecting Concrete Pavement During Cold Weather

Submit a plan for protecting concrete pavement during the initial 72 hours after paving when the average ambient daily temperature is below 40 degrees F and daytime ambient temperature is less than 50 degrees F.

40-1.01C(9) Mix Design

At least 15 days before testing for mix proportions, submit a copy of the AASHTO accreditation for your laboratory determining the mix proportions. At least 30 days before starting field qualification, submit the proposed concrete mix proportions determined under California Test 559, the corresponding mix identifications, and laboratory test reports including the modulus of rupture for each trial mixture at 10, 21, 28, and 42 days.

40-1.01C(10) Quality Control Plan

Submit a concrete pavement QC plan. The QC plan must detail the methods used to ensure the quality of the work. You or the Engineer may request a meeting. The meeting must include you and the Engineer to discuss the QC plan. Allow 30 days for the Department's review.

40-1.01C(11) 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 time of concrete beam testing

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(12) Quality Control Charts

Submit updated quality control charts each paving day.

40-1.01C(13) Profilograms

Submit profilograms within 5 business days of initial profiling and within 2 business days of profiling corrected sections.

Submit 1 electronic copy of profile information to the Engineer and to:

Smoothness@dot.ca.gov

The Contract will not be accepted until the original final profilograms are submitted and accepted.

Submitted profilograms become the Department's property.

40-1.01C(14) Reserved

40-1.01D Quality Control and Assurance

40-1.01D(1) General

Reserved

40-1.01D(2) Just-In-Time-Training

Reserved

40-1.01D(3) Prepaving Conference

Schedule a prepaving conference at a mutually agreed upon time and place to meet with the Engineer. Make the arrangements for the conference facility. Discuss methods of performing each item of the work.

Prepaving conference attendees must sign an attendance sheet provided by the Engineer. The prepaving conference must be attended by your:

1. Project superintendent
2. QC manager
3. Paving construction foreman
4. Workers and your subcontractor's workers, including:
   4.1. Foremen
   4.2. Concrete plant manager
   4.3. Concrete plant operator
   4.4. Personnel performing saw cutting and joint sealing

Do not start paving activities including test strips until the listed personnel have attended a prepaving conference.

40-1.01D(4) Quality Control Plan

Establish, implement, and maintain a QC plan for JPCP and CRCP. 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 details of corrective action to be taken if any process is out of control. As a minimum, a process is out of control 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 fine and coarse aggregates, the moisture content of either aggregate changes by more than 0.5 percentage point from any reading
3. For individual penetration or air content measurements:
   3.1. One point falls outside the suspension limit line
   3.2. Two 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 material. You may continue production when fine and coarse aggregate moisture content is out of control, but take corrective action.

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. Surface smoothness
16. Joint sealant and compression seal installation

40-1.01D(5) Mix Design for Portland Cement Concrete

Your laboratory must determine the minimum cementitious materials content or the maximum water to cementitious materials ratio under California Test 559.

Make trial mixtures no more than 24 months before field qualification.

Modulus of rupture used to determine the minimum cementitious materials content or maximum water to cementitious materials ratio must be at least 570 psi at 28 days age and at least 650 psi at 42 days age.

Your laboratory must determine an increase in the cementitious materials content or a decrease in the water to cementitious materials ratio from the trial mixtures to ensure compliance with the specifications.

If changing an aggregate supply source or the mix proportions, produce a trial batch and field-qualify the new concrete. The Engineer does not adjust contract time for performing sampling, testing, and qualifying new mix proportions or changing an aggregate supply source.

40-1.01D(6) Field Qualification

Before placing concrete pavement, proposed mix proportions must be field qualified. Use an ACI certified "Concrete Laboratory Technician, Grade I" to perform field qualification tests and calculations.

40-1.01D(7) Quality Control Testing

Select random locations and perform sampling and testing for the tests shown in the following table:

Quality Control Testing

Test	Frequency	Test method
Cleanness value	2 per day	California Test 227
Sand equivalent	2 per day	California Test 217
Aggregate gradation	2 per day	California Test 202
Air content (freeze thaw) [a]	1 per hour	California Test 504
Air content (non-freeze thaw) [a]	1 per 4 hours	California Test 504
Density	1 per 4 hours	California Test 518
Penetration	1 per 4 hours	California Test 533
Calibration of moisture meter [b, c]	1 per day	California Test 223 or California Test 226

[a] If air entrainment is specified, make at least 1 air content measurement per hour. If air entrainment is not specified, make at least 1 air content measurement per 4 hours.
[b] Make at least 1 measurement of moisture content per week to check the calibration of an electronically actuated moisture meter.
[c] Random location sampling and testing does not apply.

If air entrainment is specified, the testing laboratory and tester must be qualified under the Department's *Independent Assurance Manual*. The manual is available at the METS web site.

40-1.01D(7)a–40-1.01D(7)h Reserved

40-1.01D(8) Control Charts

Maintain control charts to identify potential problems and assignable causes. Post a copy of each control chart at a location determined by the Engineer.

Individual measurement control charts 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. Quality control test results

For fine and coarse aggregate gradation control charts, record the running average of the previous 4 consecutive gradation tests for each sieve and superimpose the specification limits.

For penetration and air content control charts, record the individual measurements and superimpose the action and suspension limits shown in the following table:

Penetration and Air Content Action and Suspension Limits

	Individual measurements	
Control parameter	Action limit	Suspension limit
Penetration, California Test 533	1 inch	1-1/2 inch
Air content, California Test 504	±1.0 %	±1.5 %

The action limit is the limiting value at which corrective actions must be made while production may continue. The suspension limit is the limiting value at which production must be suspended while corrections are made.

40-1.01D(9) Concrete Pavement Smoothness

For the following concrete pavement areas, a profilograph is not required. Test and correct high points determined by a 12-foot straightedge placed parallel with and perpendicular to the centerline:

1. Horizontal curves with a centerline radius of curvature less than 1,000 feet including concrete pavement within the superelevation transitions of those curves.
2. Exit ramp termini, truck weigh stations, and weigh-in-motion areas
3. Where steep grades and superelevation rates greater than 6 percent are present on:
   3.1. Ramps
   3.2. Connectors
4. Turn lanes and areas around manholes or drainage transitions
5. Acceleration and deceleration lanes for at-grade intersections
6. Miscellaneous gore areas
7 Shoulders

Measure the PI_0 of new concrete pavement surface using a zero (null) blanking band under California Test 526 within 10 days after paving.

Use a California profilograph or equivalent to determine the concrete pavement profile. If the profilograph uses a mechanical recorder, use an electronic scanner to reduce the profilogram.

The profilograph operator must be qualified under the Department's *Independent Assurance Manual*. The manual is available at the METS web site.

Notify at least 2 business days before performing profilograph testing. Each day before performing profilograph testing, notify the Engineer of the start location. Perform profilograph testing in the Engineer's presence.

Before starting profilograph testing, remove foreign objects from the concrete pavement surface.

Before starting profilograph testing, calibrate the profilograph in the Engineer's presence. If the Engineer chooses not to be present during profilograph testing, you may perform the testing with authorization. Note the Engineer's absence on the profilogram.

Determine PI_0 values for the final concrete pavement surface of each 0.1-mile section of a traffic lane. Take 2 profiles within each traffic lane, 3 feet from and parallel with the edge of each lane. Each section's PI_0 is the average of the PI_0 values for the measurements within that traffic lane. A section that is less than 0.01 mile and is the result of an interruption to continuous concrete pavement surface must comply with the PI_0 specifications for a full section. Adjust the PI_0 for a partial section to reflect a full section.

Use stationing to locate vertical deviations greater than 0.3 inch. The profilogram stationing must be the same as the project stationing. Note 0.1-mile segments on the profilogram.

Label the profilogram with:

1. Contract number
2. County and route number
3. Stationing
4. Operator's name
5. Test date
6. Test number
7. Traffic direction
8. Traffic lane (numbered from left to right in direction of travel)
9. Test wheel path (left or right in direction of travel)
10. Test direction
11. Paving direction

40-1.01D(10) Laboratory Requirements

Use a laboratory that complies with ASTM C 1077 to determine the mix proportions for concrete pavement. The laboratory must have a current AASHTO accreditation for:

1. AASHTO T 97 or ASTM C 78
2. ASTM C 192/C 192M

40-1.01D(11) Joint Sealant and Compression Seal Installation Training

Before installing joint sealant or compression seals, arrange for a representative from the joint sealant or compression seal manufacturer to provide training on the cleaning and preparation of the joint and installing the sealant or seal. Until your personnel and the Department's personnel have been trained, do not install joint sealant or compression seals.

40-1.01D(12) Frequency Measuring Device (Tachometer)

Before each day's concrete pavement placement and at intervals not to exceed 4 hours of production, test and record vibration frequency for concrete consolidation vibrators.

40-1.01D(13) Acceptance Criteria

40-1.01D(13)(a) General

Concrete pavement is accepted based on the Department's testing for the concrete pavement quality characteristics shown in the following table:

Concrete Pavement Acceptance Criteria

Quality characteristic	Quantity [b]	Test method
28-day modulus of rupture, for PCC	1,000 CY	California Test 523
Thickness	1,200 sq yd for primary area measurements	California Test 531
Dowel bar placement	700 sq yd	measurement
Tie bar placement	4,000 sq yd	measurement
Coefficient of friction	One day's paving	California Test 342
Air content (freeze-thaw) [a]	One day's paving	California Test 504

[a] If air entrainment is specified, air content tests must be performed.
[b] A single test represents no more than the quantity specified.

Concrete pavement may be accepted based on the Department's testing for smoothness. A single test represents no more than 0.1 mile.

Other concrete pavement quality characteristics are considered in determining final acceptance. Acceptance of modulus of rupture, thickness, dowel bar and tie bar placement, coefficient of friction, smoothness, and air content, does not constitute final concrete pavement acceptance.

40-1.01D(13)(b) Field Qualification

Field qualification is accepted under the following criteria:

1. California Test 523 must be performed at 10, 21, and 28 days of age
2. At an age not later than 28 days, when 5 beams are tested under California Test 523, no single beam's modulus of rupture is less than 550 psi and the average modulus of rupture is at least 570 psi

40-1.01D(13)(c) Modulus of Rupture

40-1.01D(13)(c)(1) General

Reserved

40-1.01D(13)(c)(2) Portland Cement Concrete

Concrete pavement is accepted for modulus of rupture on a lot basis. The minimum modulus of rupture for each lot is 570 psi at 28 days.

For modulus of rupture, a lot of concrete for concrete pavement must comply with the following:

1. Quantity must not exceed 1,000 cubic yards.
2. Department determines the modulus of rupture of test beams aged 10 days and 28 days.
3. Department calculates the modulus of rupture by averaging the individual test results of 2 beams aged for 28 days.
4. Difference in the individual test results of beams aged 28 days must not exceed 12 percent when tested by Method 1, or 16 percent when tested by Method 2. The Engineer calculates the difference relative to the average of the 2 test results.

The Department provides molds and machines for modulus of rupture acceptance testing. Provide the material and labor the Engineer may require.

40-1.01D(13)(d) Concrete Pavement Smoothness

If the Department tests for smoothness, testing complies with section 40-1.01D(9).

The Engineer accepts concrete pavement for smoothness in compliance with the following:

1. For tangents and horizontal curves having a centerline radius of curvature 2,000 feet or more, the PI_0 must be at most 3 inches per 0.1-mile section.

2. For horizontal curves having a centerline radius of curvature from 1,000 to 2,000 feet including concrete pavement within the superelevation transitions of those curves, the PI_0 must be at most 6 inches per 0.1-mile section.
3. If using a profilograph to measure smoothness, the surface must not have individual high points greater than 0.3 inch.
4. If using a straightedge to measure smoothness, the surface must be within 0.02 foot of the straightedge's lower edge.

Profile index specifications apply to existing pavement within 50 feet of the transverse joint separating new concrete pavement and the existing pavement.

If the Department's profilograph test results do not match yours, the Engineer may order you to recalibrate your profilograph equipment and perform a retest. If your test results are inaccurate due to operator error, the Engineer may disqualify your profilograph operator. If the Engineer determines your test results are inaccurate, the Department does not make adjustments to payment or contract time for recalibrating, retesting, and delays.

40-1.01D(13)(e) Concrete Pavement Thickness

Concrete pavement is accepted for thickness based on coring in the primary area, which is the area placed in 1 day for each thickness. Concrete pavement thickness must not be deficient by more than 0.05 foot.

After corrective grinding has been completed, core concrete pavement in the primary area under section 40-1.03F at locations determined by the Engineer and in the Engineer's presence. 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. Specifications that may affect concrete pavement thickness such as allowable tolerances for subgrade construction do not change the thickness specified for concrete pavement.

In each primary area, the Engineer measures concrete pavement thickness every 1,200 square yards and any remaining area. The Engineer measures cores under California Test 531 to the nearest 0.01 foot. Core at least 1 foot from existing, contiguous, and parallel concrete pavement not constructed as part of this Contract.

You may request the Engineer make additional thickness measurements and use them to determine the average thickness variation. The Engineer determines the locations with random sampling methods.

If each thickness measurement in a primary area is less than 0.05 foot deficient, 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.

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 thickness deficient by 0.05 foot or less is determined.

Slabs without bar reinforcement are defined as the areas bound by longitudinal and transverse joints and concrete pavement edges. Slabs with bar reinforcement are defined as the areas bound by longitudinal joints and concrete pavement edges and 15-foot lengths. Secondary area thickness measurements in a slab determine that entire slab's thickness.

The Engineer measures the remaining primary area thickness after removing the secondary areas from consideration for determining the average thickness deficiency.

The Engineer determines the slabs to remove and replace.

40-1.01D(13)(f) Required Use of Air-Entraining Admixtures

If air-entraining admixtures are specified, the Engineer may choose to accept concrete pavement for air content based on your air content quality control tests. The Engineer decides to use your air content quality control tests based on a *t*-test that determines the difference in the means of your test and the Engineer's verification tests. The Engineer calculates the t-value of the test data as follows:

$$t = \frac{\left|\overline{X}_c - \overline{X}_v\right|}{S_p\sqrt{\frac{1}{n_c}+\frac{1}{n_v}}} \qquad \text{and} \qquad S_p^2 = \frac{S_c^2(n_c - 1)+S_v^2(n_v - 1)}{n_c+n_v - 2}$$

where:

n_c = Number of your quality control tests (minimum of 2 required)
n_v = Number of verification tests (minimum of 1 required)
$\overline{X}_c$ = Mean of your quality control tests
$\overline{X}_v$ = Mean of the verification tests
S_p = Pooled standard deviation
(When $n_v = 1$, $S_p = S_c$)
S_c = Standard deviation of your quality control tests
S_v = Standard deviation of the verification tests (when $n_v > 1$)

The Engineer compares your quality control test results with the Department's verification test results at a level of significance of $\alpha = 0.01$. The Engineer compares the *t*-value to t_{crit}, determined from:

t_{crit}

degrees of freedom (n_c+n_v-2)	t_{crit} (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 *t*-value calculated is less than or equal to t_{crit}, your quality control test results are verified. If the *t*-value calculated is greater than t_{crit}, quality control test results are not verified.

If your quality control test results are not verified, core at least 3 specimens from concrete pavement under section 40-1.03F. The Engineer selects the core locations. Your approved third party independent testing laboratory must test these specimens for air content under ASTM C 457. The Engineer compares these test results with your quality control test results using the *t*-test method. If your quality control test results are verified based on this comparison, the Engineer uses the quality control test results for acceptance of concrete pavement for air content. If your quality control test results are not verified based on this comparison, the Engineer uses the air content of core specimens determined under ASTM C 457 for acceptance.

40-1.01D(13)(g) Dowel Bar and Tie Bar Placement

Core specimens are used to evaluate and accept concrete pavement. Except for CRCP, core specimens for:

1. Dowel bar placement
2. Tie bar placement
3. Concrete consolidation around dowel and tie bars

Obtain cores under section 40-1.03F. The Engineer determines the core locations. Each core must have a nominal diameter of 4 inches. Core each day's paving within 2 business days in compliance with:

1. One test for every 700 square yards of doweled concrete pavement or remaining fraction of that area. Each dowel bar test consists of 2 cores, 1 on each dowel bar end to expose both ends and allow measurement.
2. One test for every 4,000 square yards of concrete pavement with tie bars or remaining fraction of that area

If the tests indicate dowel or tie bars are not placed within the specified tolerances or if there are air voids around the dowel or tie bars, core additional specimens to determine the limits of unacceptable work.

The Engineer determines the slabs to remove and replace.

If authorized, slabs may remain in place with an adjustment in payment for:

1. Dowel bars with centers from ± 2 to 3 inches from the saw cut of a transverse contraction joint or with deficient concrete consolidation around the dowel bars
2. Tie bars placed outside their specified placement and position or with deficient concrete consolidation around the tie bars

40-1.01D(13)(h) Bar Reinforcing Steel

Bar reinforcing steel is accepted based on inspection before concrete placement.

40-1.02 MATERIALS

40-1.02A General

Reserved

40-1.02B Concrete

40-1.02B(1) General

Reserved

40-1.02B(2) Portland Cement Concrete

PCC for concrete pavement must comply with section 90-1.

40-1.02B(2)(a) Cementitious Material

PCC for concrete pavement must contain from 505 pounds to 675 pounds cementitious material per cubic yard. The specifications for reducing cementitious material content in section 90-1.02E(2) do not apply to concrete pavement.

40-1.02B(2)(b) Admixture

For a project shown in the low and south mountain climate regions, add air-entraining admixture specified in section 90-1.02E to attain an air content of 4 ± 1.5 percent in the freshly mixed concrete.

For a project shown in the high desert and high mountain climate regions, add air-entraining admixture specified in section 90-1.02E to attain an air content of 6 ± 1.5 percent in the freshly mixed concrete.

40-1.02B(2)(c) Aggregate

Aggregate must comply with section 90-1.02C except the specifications for reduction in operating range and contract compliance for cleanness value and sand equivalent specified in section 90-1.02C(2) and section 90-1.02C(3) do not apply to concrete pavement.

For combined aggregate gradings, 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.

40-1.02C Curing Compound

Curing compound must be curing compound no. 1 or 2.

40-1.02D Bar Reinforcement

Bar reinforcement must comply with section 52.

If the job site is shown to be in high desert or any mountain climate regions, bar reinforcement must be one of the following:

1. Epoxy-coated steel reinforcing bar:
   1.1. Bar must comply with ASTM A 615/A 615M, Grade 40 or 60; ASTM A 996/A 996M; or ASTM A 706/A 706M.
   1.2. Epoxy coating must comply with section 52-2.03B for prefabricated bar reinforcement. Handle under ASTM D 3963/D 3963M and section 52-2.02C.

2. Low carbon, chromium steel bar:
   2.1. Low carbon, chromium steel bar must comply with ASTM A 1035/A 1035 M.

40-1.02E Tie Bars

Tie bars must be one of the following:

1. Epoxy-coated steel reinforcing bar:
   1.1. Bar reinforcing must comply with ASTM A 615/A 615M, Grade 40 or 60; ASTM A 996/A 996M; or ASTM A 706/A 706M
   1.2. Epoxy coating must comply with section 52-2.02B for epoxy coated bar reinforcement or section 52-2.03B for prefabricated bar reinforcement.
2. Stainless-steel bar:
   2.1. Stainless-steel bar must be descaled, pickled, and polished solid stainless-steel bars UNS Designation S31603 or S31803, Grade 60 under ASTM A 955/A 955M.
3. Low carbon, chromium-steel bar:
   3.1. Low carbon, chromium-steel bar must comply with ASTM A 1035/A 1035M.

For a project shown to be in high desert or any mountain climate region, tie bars must be one of the following:

1. Epoxy-coated steel reinforcing bar:
   1.1. Bar must comply with ASTM A 615/A 615M, Grade 40 or 60; ASTM A 996/A 996M; or ASTM A 706/A 706M.
   1.2. Epoxy coating must comply with section 52-2.03B for prefabricated bar reinforcement.
2. Stainless-steel bar:
   2.1. Stainless-steel bar must be descaled, pickled, and polished solid stainless-steel bars UNS Designation S31603 or S31803, Grade 60 under ASTM A 955/A 955M

Fabricate, sample, and handle epoxy-coated tie bars under ASTM D 3963/D 3963M, section 52-2.02B or section 52-2.03C.

Do not bend epoxy-coated tie bars.

40-1.02F Dowel Bars

Dowel bars must be plain steel bars and one of the following:

1. Epoxy-coated bar
   1.1 Bar must comply with ASTM A 615/A 615M, Grade 40 or 60
   1.2 Epoxy coating must comply with section 52-2.02B for epoxy-coated wire reinforcement and section 52-2.03B for epoxy-coated prefabricated wire reinforcement.
2. Stainless-steel bar:
   2.1. Stainless-steel bar must be descaled, pickled, and polished solid stainless-steel bars, UNS Designation S31603 or S31803, Grade 60 under ASTM A 276/A 276M, and ASTM A 955/A 955M.
3. Low carbon, chromium-steel bar:
   3.1. Low carbon, chromium-steel bar must comply with ASTM A 1035/A 1035M.

For a project shown to be in high desert or any mountain climate region, dowel bars must be one of the following:

1. Epoxy-coated bar
   1.1 Bar must comply with ASTM A 615/A 615M, Grade 40 or 60

1.2 Epoxy coating must comply with 52-2.03B for epoxy-coated prefabricated wire reinforcement.

2. Stainless-steel bar:
   2.1. Stainless-steel bar must be descaled, pickled, and polished solid stainless-steel bars, UNS Designation S31603 or S31803, Grade 60 under ASTM A 276/A 276M, and ASTM A 955/A 955M.

Fabricate, sample, and handle epoxy-coated dowel bar and dowel bar baskets at the job site under ASTM D 3963/D 3963M and section 52-2.03C except each sample must be 18 inches long.

40-1.02F(1) Dowel Bar Lubricant

Dowel bar lubricant must be petroleum paraffin based or a curing compound. Paraffin-based lubricant must be Dayton Superior DSC BB-Coat or Valvoline Tectyl 506 or an approved equal and must be factory-applied. Curing compound must be curing compound no. 3.

40-1.02F(2) Reserved

40-1.02G Dowel and Tie Bar Baskets

Dowel and tie bar baskets must be:

1. Minimum W10 wire size number in compliance with ASTM A 82/A 82M
2. Either U-frame or A-frame shape
3. Welded under ASTM A 185/A 185M, section 7.4

Dowel and tie bar baskets may be epoxy-coated.

Epoxy coating must comply with section 52-2.02B for epoxy-coated wire reinforcement and section 52-2.03B for epoxy-coated prefabricated wire reinforcement.

For a project shown to be in high desert or any mountain climate region, dowel bar and tie bar baskets must be one of the following:

1. Epoxy-coated
   1.1 Epoxy coating must comply with section 52-2.03B for epoxy-coated prefabricated wire reinforcement.
2. Stainless-steel
   2.2. Stainless-steel baskets must comply with ASTM A 1022 / A 1022M, UNS S31600 or S31603 and be descaled, pickled, and polished solid stainless steel wire, Grade 60 under ASTM A 276 /A 276 M.

If tie bars or dowel bars are stainless steel, tie bar and dowel bar baskets must be stainless steel.

If tie bars or dowel bars comply with ASTM A 1035/A 1035M, tie bar or dowel bar baskets must comply with ASTM A 1035/A 1035M.

Handle epoxy-coated tie bar and dowel bar baskets under ASTM D 3963/D 3963M, section 52-2.02B or 52-2.03B.

Fasteners must be driven fasteners in compliance with ASTM F 1667. Fasteners on lean concrete base or HMA must have a minimum shank diameter of 3/16 inch and a minimum shank length of 2-1/2 inches. For asphalt treated permeable base or cement treated permeable base, 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 either by electroplating or galvanizing.

40-1.02H Chemical Adhesive for Drill and Bond

Chemical adhesive for drilling and bonding dowels and tie bars must be prequalified. A list of prequalified chemical adhesives is available on the Department's METS Web site. The prequalified list indicates the appropriate chemical adhesive system for the concrete temperature and installation conditions.

Each chemical adhesive system must clearly and permanently show the following:

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. Warnings or precautions required by state and federal laws and regulations

40-1.02I Joint Sealant

40-1.02I(1) General

Reserved

40-1.02I(2) Silicone Joint Sealant

Silicone joint sealant must be low modulus furnished in a 1-part silicone formulation. Do not use acid cure sealant. Silicone joint sealant must be compatible with the surface it is applied to and have properties shown in the following table:

Silicone Joint Sealant

Property	Test method	Specification
Tensile stress, 150% elongation, 7-day cure at 77 ± 2 °F and from 45% to 55% R.H. [a]	ASTM D 412 (Die C)	45 psi max.
Flow at 77 ± 2 °F	ASTM C 639 [b]	must not flow from channel
Extrusion rate at 77 ± 2 °F	ASTM C 603 [c]	3 to 9 oz/min.
Specific gravity	ASTM D 792 Method A	1.01 to 1.51
Durometer hardness, at 0 °F, Shore A, cured 7 days at 77 ± 2 °F	ASTM C 661	10 to 25
Ozone and UV resistance, after 5,000 hours	ASTM C 793	no chalking, cracking or bond loss
Tack-free at 77 ± 2 °F and 45% to 55% R.H. [a]	ASTM C 679	less than 75 minutes
Elongation, 7 day cure at 77 ± 2 °F and 45% to 55% R.H. [a]	ASTM D 412 (Die C)	500 percent min.
Set to Touch, at 77 ± 2 °F and 45% to 55% R.H. [a]	ASTM D 1640	Less than 75 minutes
Shelf Life, from date of shipment	--	6 months min.
Bond, to concrete mortar-concrete briquettes, air cured 7 days at 77 ± 2 °F	AASHTO T 132 [d]	50 psi min.
Movement capability and adhesion, 100% extension at 0 °F after, air cured 7 days at 77 ± 2 °F, and followed by 7 days in water at 77 ± 2 °F	ASTM C 719 [e]	no adhesive or cohesive failure after 5 cycles

[a] R.H. equals relative humidity.
[b] ASTM C 639 Modified (15 percent slope channel A).
[c] ASTM C 603, through 0.12-inch opening at 50 psi.
[d] Mold briquettes under AASHTO T 132, saw in half and bond with a 0.60-inch maximum thickness of sealant and test under AASHTO T 132. Briquettes must be dried to constant mass at 212 ±10 °F.
[e] Prepare 12 by 1 by 3 inch concrete blocks under ASTM C 719. Use a sawed face for bond surface. Seal 2 inches of block leaving 0.50 inch on each end of specimen unsealed. The depth of sealant must be 0.40 inch and the width 0.50 inch.

After application, silicone joint sealant must not flow on grades up to 15 percent.

40-1.02I(3) Asphalt Rubber Joint Sealant

Asphalt rubber joint sealant must be paving asphalt mixed with ground rubber containing not less than 22 percent ground rubber by weight. One hundred percent of ground rubber must pass a no. 8 sieve. Ground rubber must be vulcanized or a combination of vulcanized and devulcanized materials.

Asphalt rubber joint sealant must comply with the following:

1. ASTM D 6690, Type II except:

2.1. Cone penetration requirement must not exceed 120 at 77 degrees F, 5 ounces, 5 seconds.
2.2. Resilience requirement must be a minimum 50 percent recovery when tested at 77 degrees F

2. Ring and Ball softening point must be 135 degrees F minimum when tested under AASHTO T 53
3. Capable of being melted and applied to cracks and joints at temperatures below 400 degrees F

Do not apply asphalt rubber joint sealant when the concrete pavement surface temperature is below 50 degrees F.

40-1.02I(4) Preformed Compression Joint Seals

Preformed compression joint seals must comply with ASTM D 2628. Lubricant adhesive used with the seals must comply with ASTM D 2835. Preformed compression joint seals must have 5 or 6 cells, except seals for Type A2 and Type B joints may have 4 cells. Install preformed compression joint seals in compliance with the manufacturer's instructions. Show evidence that the seals are compressed from 40 to 50 percent for the joint width and depth.

40-1.02I(5) Backer Rods

Backer rods must comply with ASTM D 5249, Type 1. Backer rod diameter must be at least 25 percent greater than the saw cut joint width. Backer rod material must be expanded, crosslinked, closed-cell polyethylene foam. Do not allow bonding or an adverse reaction to occur between the backer rod and sealant. Do not use hot-pour sealant that will melt the backer rod.

40-1.02I(6) Joint Filler Material

Joint filler for isolation joints must be preformed expansion joint filler for concrete (bituminous type) in compliance with ASTM D 994.

40-1.02J Nonshrink Hydraulic Cement Grout

Nonshrink hydraulic cement grout must comply with ASTM C 1107/C 1107M. Clean, uniform, rounded aggregate filler may be used to extend the grout. Aggregate filler must not exceed 60 percent of the grout mass or the maximum recommended by the manufacturer, whichever is less. Aggregate filler moisture content must not exceed 0.5 percent. Aggregate filler must comply the grading shown in the following table:

Aggregate Filler Grading

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

40-1.02K Tack Coat

Tack coat must comply with section 39.

40-1.02L Water For Core Drilling

Water for core drilling must be from a local domestic water supply. Water must not contain:

1. More than 1,000 parts per million of chlorides as CL
2. More than 1,300 parts per million of sulfates as SO_4
3. Impurities that cause concrete discoloration or surface etching

40-1.03 CONSTRUCTION

40-1.03A General

Aggregate and bulk cementitious material must be proportioned by weight by means of automatic proportioning devices of approved types.

40-1.03B Water Supply

Before placing concrete pavement, develop enough water supply for the work.

40-1.03C Subgrade Preparation

Immediately before placing concrete, the subgrade to receive concrete must be:

1. In compliance with the specified compaction and elevation tolerances
2. Free of loose and extraneous material
3. Uniformly moist, but free of standing or flowing water
4. Excavated for thickened parts of concrete pavement end anchors with no disturbed compaction outside the end anchor dimensions

For cement treated permeable base, cover the base surface with asphaltic emulsion before placing concrete pavement. Apply the asphaltic emulsion uniformly at a rate of 0.1 gal/sq yd. Asphaltic emulsion must comply with anionic slow-setting type, SS1h grade in section 94. Repair damaged asphaltic emulsion before placing concrete pavement.

40-1.03D Shoulder Rumble Strip

40-1.03D(1) General

Construct shoulder rumble strips by rolling or grinding indentations in new concrete pavement.

Do not construct shoulder rumble strips on structures or approach slabs.

Construct rumble strips within 2 inches of the specified alignment. Rumble strip equipment must be equipped with a sighting device enabling the operator to maintain the rumble strip alignment.

Indentations must not vary from the specified dimensions by more than 1/16 inch in depth or more than 10 percent in length and width.

Grind or remove and replace noncompliant rumble strip indentations as determined by the Engineer to bring them to within specified tolerances. Ground surface areas must be neat and uniform in appearance.

Pick up residue from grinding with a vacuum attachment on the grinding machine.

40-1.03D(2) Ground-In Indentations

Concrete pavement must be hardened before grinding rumble strips indentations. Do not construct indentations until the following occurs:

1. 10 days elapse after concrete placement
2. Concrete has developed a modulus of rupture of 550 psi determined under California Test 523,

40-1.03D(3) Rolled-In Indentations

Construct rolled-in indentations before final concrete set. Indentation construction must not displace adjacent concrete.

40-1.03E Joints

40-1.03E(1) General

Concrete pavement joints consist of:

1. Longitudinal and transverse construction joints
2. Longitudinal and transverse contraction joints
3. Isolation joints

Construction joints must be perpendicular to the concrete pavement surface.

Keep joints free from foreign material including soil, gravel, concrete, or asphalt mix until Contract acceptance.

For concrete pavement damaged during joint construction, repair the pavement under section 40-1.03Q(2).

Do not bend tie bars or reinforcement in existing concrete pavement joints.

40-1.03E(2) Construction Joints

Construction joints form where fresh concrete is placed against hardened concrete, existing pavements, or structures.

Before placing concrete at construction joints, apply curing compound no. 1 or 2 to the vertical surface of existing or hardened concrete and allow it to dry.

Use a metal or wooden bulkhead to form transverse construction joints. If dowel bars are specified, the bulkhead must allow dowel bar installation.

If a transition joint between concrete pavement and HMA is specified, apply tack coat between the concrete pavement and HMA.

40-1.03E(3) Contraction Joints

In monolithic concrete pavement, construct longitudinal contraction joints as shown with the sawing method. Construct transverse contraction joints with the sawing method.

Construct transverse contraction joints within 1 foot of their specified spacing. If a slab length of less than 5 feet would be formed, adjust the transverse contraction joint spacing.

Construct transverse contraction joints across the full concrete pavement width regardless of the number or types of longitudinal joints crossed. In areas of converging and diverging pavements, space transverse contraction joints so their alignment is continuous across the full width where converging and diverging pavements are contiguous. Longitudinal contraction joints must be parallel with the concrete pavement centerline. Transverse and longitudinal contraction joints must not deviate by more than 0.1 foot from either side of a 12-foot straight line, except for longitudinal joints parallel to a curving centerline.

If widening existing concrete pavement, do not construct transverse contraction joints to match the existing pavement's joint spacing or skew unless specified.

40-1.03E(4) Isolation Joints

Construct isolation joints by saw cutting a minimum 1/8-inch width to full concrete pavement depth at the existing concrete pavement's edge. Remove the concrete to expose a flat vertical surface. Before placing concrete, secure joint filler material that prevents new concrete from adhering to the existing concrete face.

40-1.03E(5) Sawing Method

Sawing method consists of cutting a groove in the concrete pavement 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. If necessary, the top of the joint must be sawn wider to provide space for joint sealant. Immediately wash slurry from the joint with water at 100 psi maximum pressure.

Saw longitudinal and transverse contraction joints before cracking occurs and after the concrete is hard enough to saw without spalling, raveling, or tearing.

To keep foreign material out of grooves before joint sealant or compression seal installation, you may use a filler in sawed contraction joints. Joint filler material must not react adversely with the concrete or cause concrete pavement damage. After sawing and washing a joint, install joint filler material that keeps moisture in the adjacent concrete during the 72 hours after paving. If you install joint filler material, the specifications for spraying the sawed joint with additional curing compound in section 40-1.03N do not apply. If using absorptive filler material, moisten the filler immediately before or after installation.

40-1.03E(6) Joint Sealant and Compression Seal Installation

40-1.03E(6)(a) General

Do not seal construction joints.

At least 7 days after concrete pavement placement and not more than 4 hours before installing joint sealant or compression seal materials, use dry sandblasting and other methods to clean the joint walls of objectionable material such as soil, asphalt, curing compound, paint, and rust. The maximum sandblasting nozzle diameter must be 1/4 inch. The minimum pressure must be 90 psi. Sandblast each

side of the joint at least once, in at least 2 separate passes. Hold the nozzle at an angle to the joint from 1 to 2 inches from the concrete pavement. Using a vacuum, collect sand, dust, and loose material at least 2 inches on each side of the joint. Remove surface moisture and dampness at the joints with compressed air that may be moderately hot.

Before you install joint sealant or compression seal, the joint wall must be free of moisture, residue, or film.

If grinding or grooving over or adjacent to sealed joints, remove and dispose of joint sealant or compression seal materials. After grinding or grooving, replace the joint sealant or compression seal materials.

40-1.03E(6)(b) Liquid Sealant

Install backer rods when the concrete pavement temperature is above the air dew point and when the air temperature is at least 40 degrees F.

Install liquid sealant immediately after installing the backer rod. Install sealant using a mechanical device with a nozzle shaped to introduce the sealant from inside the joint. Extrude sealant evenly and with continuous contact with the joint walls. Recess the sealant surface after placement. Remove excess sealant from the concrete pavement surface.

Do not allow traffic over sealed joints until the sealant is set.

40-1.03E(6)(c) Preformed Compression Seal

Install preformed compressions seals in isolation joints when specified.

Install longitudinal seals before transverse seals. Longitudinal seals must be continuous except at intersections with transverse seals. Install transverse seals in 1 continuous piece for the entire transverse length of concrete pavement. 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.

Use a machine specifically designed for preformed compression 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. With less than 4 percent stretch

Lay a length of preformed compression seal material cut to the exact length of the pavement joint to be sealed. The Engineer measures this length. After you install the length of preformed compression joint sealant, the Engineer measures the excess amount of material at the joint end. The Engineer divides the excess amount length by the original measured length to determine the percentage of stretch.

40-1.03F Drilled Cores

Drill concrete pavement cores under ASTM C 42/C 42M. Core drilling equipment must use diamond impregnated bits.

Clean, dry, and fill core holes with hydraulic cement grout (nonshrink) or pavement concrete. Coat the core hole walls with epoxy adhesive for bonding new concrete to old concrete under section 95. The backfill must match the adjacent concrete pavement surface elevation and texture.

40-1.03G Test Strips

Section 40-1.03G applies to projects with more than 2,000 cubic yards of JPCP or CRCP.

The first paving activity must be to construct a test strip:

1. 700 to 1,000 feet long
2. Same width as the planned paving
3. With the same equipment used for the planned paving

The Engineer evaluates the test strip for compliance with the specifications for acceptance criteria.

The Engineer selects from 6 to 12 core locations for dowel bars and up to 6 locations for tie bars per 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.

Allow the Engineer 3 business days to evaluate the test strip for:

1. Smoothness
2. Dowel bar and tie bar alignment
3. Thickness
4. Final finishing except coefficient of friction

During the 3 business day evaluation, the Engineer rejects a test strip if any of the following occurs:

1. Surface varies more than 0.02 foot from a 12-foot straightedge's lower edge
2. Wheel path's individual high points are greater than 0.025 foot in 25 feet
3. Dowel bars do not comply with specified placement tolerances
4. Concrete pavement thickness deficiency is greater than 0.05 foot
5. Final finishing does not comply with the specifications except coefficient of friction

Remove the test strip if the Engineer rejects it for noncompliance with the specifications for dowel bar alignment, or thickness. Dispose of rejected test strip material.

If the Engineer rejects the test strip for noncompliance with the smoothness or final finishing specifications except coefficient of friction, you may grind the test strip into compliance if you intend to leave it as part of the paving.

If the Engineer does not reject the test strip during the 3-business-day evaluation, you may begin production paving while the Engineer continues to evaluate the test strip for compliance with the other specifications. If the Engineer rejects the test strip for noncompliance with the other specifications, stop production paving until you construct a test strip the Engineer accepts.

For rejected test strips, submit a plan for changed materials, methods, or equipment before constructing additional test strips. Construct additional test strips until the Engineer accepts one.

Construct additional test strips if you:

1. Propose different paving equipment including:
    1.1. Batch plant
    1.2. Paver
    1.3. Dowel bar inserter
    1.4. Tie bar inserter
    1.5. Tining
    1.6. Curing equipment
2. Change concrete mix proportions

The Engineer may authorize paving to start without a test strip if you use a batch plant mixer, paving equipment, and personnel that completed a Department project of the same type within the preceding 12 months. Submit supporting documents and previous project information.

40-1.03H Placing Concrete

40-1.03H(1) General

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 when concrete placement is interrupted by more than 30 minutes. The transverse construction joint must coincide with the next contraction joint location, or you must remove fresh concrete pavement to the preceding transverse joint location.

Place concrete pavement in full slab widths separated by construction joints or monolithically in multiples of full lane widths with a longitudinal contraction joint at each traffic lane line.

Do not retemper concrete.

If the concrete pavement surface width is constructed as specified, you may construct concrete pavement sides on a batter not flatter than 6:1 (vertical:horizontal).

40-1.03H(2) Concrete Pavement Widening

If concrete pavement is placed adjacent to existing pavement not constructed as part of the contract, grind the existing concrete pavement lane or shoulder adjacent to the new concrete pavement. Perform the grinding before new concrete pavement is placed. The new concrete pavement must match the elevation of the existing concrete pavement after grinding. Grind existing concrete pavement under section 42-3 except profile index must comply with the pavement smoothness specifications in section 40-1.01D.

Use paving equipment with padded crawler tracks or rubber-tired wheels on the existing concrete pavement with enough offset to avoid breaking or cracking the existing concrete pavement's edge.

40-1.03H(3) Concrete Pavement Transition Panel

For concrete pavement placed in a transition panel, texture the surface with a drag strip of burlap, a broom, or a spring steel tine device that produces scoring in the finished surface. The scoring must be either parallel with or transverse to the centerline. For the method you choose, texture at the time that produces the coarsest texture.

40-1.03H(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 attached to the top of metal forms, the attached section must be metal.

The side form's base width must be at least 80 percent of the specified concrete pavement thickness.

Side forms including interlocking connections with adjoining forms must be rigid enough to prevent springing from subgrading and paving equipment and concrete pressure.

Construct subgrade to final grade before placing side forms. Side forms must bear fully on the foundation throughout their length and base width. Place side forms to the specified grade and alignment of the finished concrete pavement's edge. Support side forms during concrete placing, compacting, and finishing.

After subgrade work is complete and immediately before placing concrete, true side forms and set to line and grade for a distance that avoids delays due to form adjustment.

Clean and oil side forms before each use.

Side forms must remain in place for at least 1 day after placing concrete and until the concrete 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 pavement to the specified cross section with minimal hand work.

Consolidate the concrete without segregation. If vibrators are used:

1. The vibration rate must be at least 3,500 cycles per minute for surface vibrators and 5,000 cycles per minute for internal vibrators
2. Amplitude of vibration must cause perceptible concrete surface movement at least 1 foot from the vibrating element
3. Use a calibrated tachometer for measuring frequency of vibration
4. Vibrators must not rest on side forms or new concrete pavement

5. Power to vibrators must automatically cease when forward or backward motion of the paving machine is stopped

Use high-frequency internal vibrators within 15 minutes of depositing concrete on the subgrade to uniformly consolidate the concrete across the paving width including adjacent to forms. Do not use vibrators to shift the mass of concrete.

40-1.03H(5) Slip-Form Construction

If slip-form construction is used, spread, screed, shape, and consolidate concrete to the specified 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 specified concrete pavement alignment by more than 0.1 foot.

Slip-form paving machines must use high frequency internal vibrators to consolidate concrete. You may mount vibrators with their axes parallel or normal to the concrete pavement alignment. If mounted with axes parallel to the concrete pavement alignment, space vibrators no more than 2.5 feet measured center to center. If mounted with axes normal to the concrete pavement alignment, space the 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 frequency of vibration.

40-1.03I Tie Bar Placement

Place tie bars perpendicular to the longitudinal concrete pavement joint and parallel with the concrete pavement surface at mid-slab depth within the following tolerances:

1. Not less than 1/2 inch below the saw cut depth of joints
2. With not less than 2 inches clearance from the concrete pavement's surface and bottom
3. With embedment length tolerance of ±2 inches

Install tie bars at longitudinal joints by one of the following methods:

1. Drill concrete and bond tie bars with chemical adhesive in compliance with the manufacturer's instructions. Clean and dry drilled holes before placing chemical adhesive and tie bars. After inserting tie bars into chemical adhesive, support the bars to prevent movement during curing. If the Engineer rejects a tie bar installation, cut the tie bar flush with the joint face and coat the exposed end of the tie bar with chemical adhesive under section 40-1.02H. Offset new holes 3 inches horizontally from the rejected hole's center.
2. Insert tie bars into plastic slip-formed concrete before finishing. Inserted tie bars must have full contact between the bar and the concrete. If tie bars are inserted through the plastic concrete surface, eliminate evidence of the insertion by reworking the concrete over the tie bars.
3. Use threaded tie bar splice couplers fabricated from deformed bar reinforcement free of external welding or machining.
4. Use tie bar baskets. Anchor baskets at least 200 feet in advance of the concrete placement activity. If you request a waiver, describe the construction limitations or restricted access preventing the advanced anchoring. After the baskets are anchored and before the concrete is placed, cut and remove temporary spacer wires and demonstrate the tie bars do not move from their specified depth and alignment during concrete placement. Use fasteners to anchor tie bar baskets.

If tie bars are not placed correctly, stop paving activities until you demonstrate to the Engineer correction of the cause.

40-1.03J Dowel Bar Placement

Center dowel bars within 2 inches in the longitudinal direction on transverse contraction joints or construction joints.

If using curing compound as lubricant, apply the curing compound to dowels in 2 separate applications. Lubricate each dowel bar entirely before placement. The last application must be applied not more than 8

hours before placing the dowel bars. Apply each curing compound application at a rate of 1 gallon per 150 square feet.

If dowel bars are placed by mechanical insertion, eliminate evidence of the insertion by reworking the concrete over the dowel bars.

If drilling and bonding dowel bars at construction joints, use a grout retention ring.

If using dowel bar baskets, anchor them with fasteners.

Use at least 10 fasteners for basket sections greater than 12 feet and less than or equal to 16 feet. Baskets must be anchored at least 200 feet in advance of the concrete placement activity unless your waiver request is authorized. If requesting a waiver, describe the construction limitations or restricted access preventing the advanced anchoring. After the baskets are anchored and before the concrete is placed, cut and remove temporary spacer wires and demonstrate the dowel bars do not move from their specified depth and alignment during concrete placement.

Place dowel bars to the tolerances shown in the following table:

Dowel Bar Tolerances

Dimension	Tolerance
Horizontal offset	±1 inch
Longitudinal translation	±2 inches
Horizontal skew	3/8 inch, max
Vertical skew	3/8 inch, max
Vertical depth	The minimum distance below the concrete pavement surface must be: DB = d/3 + 1/2 inch where: DB = vertical distance in inches, measured from concrete pavement surface to any point along the top of dowel bar d = concrete pavement thickness in inches The maximum distance below the depth shown must be 0.05 foot.

If dowel bars are not placed correctly, stop paving activities until you demonstrate to the Engineer correction of the cause.

Remove and replace the concrete pavement 3 feet on either side of a joint with a rejected dowel bar.

40-1.03K 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.

40-1.03L Preliminary Finishing

40-1.03L(1) General

Preliminary finishing must produce a smooth and true-to-grade finish. After preliminary finishing, mark each day's concrete pavement with a stamp. The stamp must be authorized before paving starts. The stamp must be approximately 1 by 2 feet in size. 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 each day's start of paving and 1 ± 0.25 foot from the concrete pavement's outside edge. The stamp mark must show the

month, day, and year of placement and the station of the transverse construction joint. Orient the stamp mark so it can be read from the concrete pavement's outside edge.

Do not apply more water to the concrete pavement surface than can evaporate before float finishing and texturing are completed.

Allow enough time to complete finishing activities during daylight. Work may continue after daylight if the Engineer accepts the lighting you provide.

40-1.03L(2) Stationary Side Form Finishing

If stationary side form construction is used, give the concrete a preliminary finish by the machine float method or the hand method.

If using 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 concrete delivery rate. If the time from concrete placement to machine float finishing exceeds 30 minutes, stop concrete delivery . When machine floats are in proper position, you may resume concrete delivery and paving.
3. Run machine floats on side forms or adjacent concrete pavement lanes. If running on adjacent concrete pavement, protect the adjacent concrete pavement surface under section 40-1.03P. Floats must be hardwood, steel, or steel-shod wood. Floats must be equipped with devices that adjust the underside to a true flat surface.

If using the hand method, finish concrete smooth and true to grade with manually operated floats or powered finishing machines.

40-1.03L(3) Slip-Form Finishing

If slip-form construction is used, the slip-form paver must give the concrete pavement a preliminary finish. You may supplement the slip-form paver with machine floats.

Before the concrete hardens, correct concrete pavement edge slump in excess of 0.02 foot exclusive of edge rounding.

40-1.03M Final Finishing

After completing preliminary finishing, round the edges of the initial paving widths to a 0.04-foot radius. Round transverse and longitudinal construction joints to a 0.02-foot radius.

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.

Construct longitudinal grooves with a self-propelled machine designed specifically for grooving and texturing concrete 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, on 3/4-inch centers, and must 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 constant down pressure on the pavement surface during texturing. The machines must not cause ravels.

Construct grooves over the entire pavement width in a single pass except do not construct grooves 3 inches from the concrete pavement edges and longitudinal joints. Final texture must be uniform and smooth. Use a guide to properly align the grooves. Grooves must be parallel and aligned to the pavement edge across the pavement width. Grooves must be from 1/8 to 3/16 inch deep after the concrete has hardened.

For irregular areas and areas inaccessible to the grooving machine, you may hand-construct grooves under section 40-1.03L(2) 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 when tested under California Test 342. Notify the Engineer when the concrete pavement is scheduled to be opened to traffic. Allow at least 25 days for the Department to test for coefficient of friction from the later of:

1. Seven days after concrete placement
2. When the concrete pavement has attained a modulus of rupture of 550 psi

Do not open the concrete pavement to traffic unless the coefficient of friction is at least 0.30.

40-1.03N Curing

Cure the concrete pavement's exposed area under section 90-1.03B using the waterproof membrane method or curing compound method. If using the curing compound method use curing compound no. 1 or 2. When side forms are removed within 72 hours of the start of curing, also cure the concrete pavement edges.

Apply curing compound with mechanical sprayers. Reapply curing compound to saw cuts and disturbed areas.

40-1.03O Early Use of Concrete Pavement

If requesting early use of concrete pavement:

1. Furnish molds and machines for modulus of rupture testing
2. Sample concrete
3. Fabricate beam specimens
4. Test for modulus of rupture under California Test 523

If you request early use, concrete pavement must have a modulus of rupture of at least 350 psi. Protect concrete pavement under section 40-1.03P.

40-1.03P Protecting Concrete Pavement

Protect concrete pavement under section 90-1.03C.

Maintain the concrete pavement temperature at not less than 40 degrees F for the initial 72 hours.

Protect the concrete pavement surface from activities that cause damage and reduce texture and coefficient of friction. Do not allow soil, gravel, petroleum products, concrete, or asphalt mixes on the concrete pavement surface.

Construct crossings for traffic convenience. If authorized, you may use Type III portland cement in the concrete for crossings. Do not open crossings until the Department determines by California Test 523 the concrete pavement's modulus of rupture is at least 550 psi.

Do not open concrete pavement to traffic or use equipment on the concrete pavement for 10 days after paving nor before the concrete has attained a modulus of rupture of 550 psi except:

1. If the equipment is for sawing contraction joints
2. If authorized, one side of paving equipment's tracks may be on the concrete pavement after a modulus of rupture of 350 psi has been attained, provided:

    2.1. Unit pressure exerted on the concrete 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 from the concrete pavement's edge

If concrete pavement damage including visible cracking occurs, stop operating paving equipment on the concrete pavement and repair the damage.

40-1.03Q Repair and Replacement of New Concrete Pavement

40-1.03Q(1) General

Reserved

40-1.03Q(2) Repair of Spalls, Raveling, and Tearing

Before concrete pavement is open to traffic, repair spalls, raveling, and tearing in sawed joints. Make repairs in compliance with the following:

1. Saw a rectangular area with a diamond-impregnated blade at least 2 inches deep.
2. Remove unsound and damaged concrete between the saw cut and the joint and to the saw cut's depth. Do not use a pneumatic hammer heavier than 15 pounds. Do not damage concrete pavement to remain in place.
3. Dispose of removed concrete pavement.
4. Clean the repair area's exposed surfaces with high pressure abrasive water blasting. Further clean and dry the exposed surfaces with compressed air free of moisture and oil.
5. Apply epoxy under section 95 for epoxy resin adhesive for bonding new concrete to old concrete. Apply the epoxy with a stiff bristle brush.
6. Apply a portland cement concrete or mortar patch immediately following the epoxy application. Install joint form board to prevent bonding of the sides of planned joints.

Repair spalls:

1. Deeper than 0.05 foot
2. Wider than 0.04 foot
3. Longer than 0.3 foot

40-1.03Q(3) Repair of Cracks

If cracks form that do not extend to the full depth of a slab, treat the cracks with a high molecular weight methacrylate resin under section 40-6.

Working cracks are full-depth cracks essentially parallel to a planned contraction joint beneath which a contraction crack has not formed. If ordered take 4-inch nominal diameter cores on designated cracks under section 40-1.03F.

Treat working cracks within 0.5 foot of either side of a planned contraction joint in compliance with the following:

1. Route and seal the crack with epoxy resin in compliance with the following:
   1.1. Use a powered rotary router mounted on wheels, with a vertical shaft and a routing spindle that casters as it moves along the crack
   1.2. Form a reservoir 3/4 inch deep by 3/8 inch wide in the crack
   1.3. Use equipment that does not cause raveling or spalling
   1.4. Place liquid sealant
2. Treat the contraction joint adjacent to the working crack in compliance with the following:
   2.1. Use epoxy resin specified in ASTM C 881/C 881M, Type IV, Grade 2 for Type B joints and secondary saw cuts for Type A1 and Type A2 joints
   2.2. Pressure inject epoxy resin specified in ASTM C 881/C881M, Type IV, Grade 1 for narrow saw cuts including initial saw cuts for Type A1 and Type A2 joints

If a working crack intersects a contraction joint, route and seal the working crack and seal the contraction joint as specified for installing liquid sealant in section 40-1.03E(6).

40-1.03Q(4) Removal and Replacement

As specified, remove and replace slabs or partial slabs for:

1. Insufficient thickness
2. Dowel bar misalignment
3. Working cracks more than 0.5 foot from a planned contraction joint

40-1.03Q(5) Smoothness and Friction Corrective Action

Correct concrete pavement not complying with the acceptance criteria specified for smoothness by grinding under section 42-3 and for coefficient of friction by grooving or grinding under section 42.

Do not grind before:

1. Ten days after concrete pavement placement
2. The concrete has developed a modulus of rupture of at least 550 psi

Grind the entire lane width. When completed, the lane width must be uniform in texture and appearance. Square the corrected area's start and end normal to the paved surface's centerline.

Before opening to traffic, retest sections where corrections were made. Allow at least 25 days for the Department to retest sections for coefficient of friction.

40-1.04 PAYMENT

Sealing joints are measured from field measurements for each type of sealed joint.

Transition panels to HMA pavement are measured from dimensions shown.

The Engineer calculates the volume for the payment of concrete pavement based on the plan dimensions.

The Engineer adjusts payment for each primary area for the average thickness deficiency shown in the following table:

Pay Adjustments for Deficient Thickness

Average thickness deficiency (foot)	Deficiency adjustment ($/sq yd)
0.01	0.90
0.02	2.30
0.03	4.10
0.04	6.40
0.05	9.11

If the average thickness deficiency is less than 0.01 foot, the Engineer does not adjust payment for thickness deficiency. If the average thickness deficiency is more than 0.01 foot, the Engineer rounds to the nearest 0.01 foot and uses the adjustment table.

The Department does not pay for the portion of concrete that penetrates treated permeable base.

The material and work necessary for the construction of crossings for public convenience, and their subsequent removal and disposal, will be paid for at the contract prices for the items of work involved and if there are no contract items for the work involved, payment for concrete pavement crossings will be change order work.

Shoulder rumble strips will be measured by the station along each shoulder on which the rumble strips are constructed without deductions for gaps between indentations.

The Department reduces payments by $56.12 per square yard for JPCP slabs allowed to remain in place represented by cores indicating dowel bars placed with their centers from ±2 to ±3 inches from the saw cut of a transverse contraction joint.

The Engineer will calculate the reduced payment using the slab dimensions adjacent to and inclusive of the joints with misplaced dowel bars. This reduced payment is in addition to other specified payment reductions.

The Department reduces payments to the Contractor by $59.56 per square yard for JPCP allowed to remain in place represented by cores indicating either of the following:

1. Tie bars placed outside their specified placement and position tolerances
2. Bar reinforcement placed outside their specified placement and position tolerances

The Engineer calculates the reduced payment using the slab dimensions adjacent to and inclusive of the joints with misplaced tie bars. This reduced payment is in addition to other specified payment reductions.

If the initial cores show that dowel bars or tie bars are within alignment tolerances and the Engineer orders more dowel or tie bar coring, the additional cores will be paid for as change order work.

The Department will not pay for additional coring to check dowel or tie bar alignment you request.

If the Engineer accepts a test strip and it remains as part of the paving surface, the test strip is measured as specified for JPCP or CRCP, seal pavement joint, and seal isolation joint.

If the curvature of a slab affects tie bar spacing and additional tie bars are required, they are included in the payment for jointed plain concrete pavement.

40-2 JOINTED PLAIN CONCRETE PAVEMENT

Reserved

40-3 CONTINUOUSLY REINFORCED CONCRETE PAVEMENT

Reserved

40-4–40-5 RESERVED

40-6 CONCRETE PAVEMENT CRACK TREATMENT

40-6.01 GENERAL

40-6.01A Summary

Section 40-6 includes specifications for applying a high molecular weight methacrylate resin system to concrete pavement surface cracks that do not extend the full slab depth. High molecular weight methacrylate is not to be applied to any cracks in CRCP.

High molecular weight methacrylate resin system consists of:

1. High molecular weight methacrylate resin
2. Promoter
3. Initiator

40-6.01B Definitions

Reserved

40-6.01C Submittals

40-6.01C(1) General

Submit high molecular weight methacrylate samples 20 days before use.

If sealant is to be removed, submit the proposed removal method at least 7 days before sealant removal. Do not remove sealant until the proposed sealant removal method is authorized.

40-6.01C(2) Public Safety Plans

Before starting crack treatment, submit the following plans as shop drawings:

1. Public safety plan for high molecular weight methacrylate resin system
2. Placement plan for the construction activity
3. MSDS for each component of the high molecular weight methacrylate resin system

The public safety plan and the placement plan must identify materials, equipment, and methods to be used.

The public safety plan must include details for:

1. Shipping
2. Storage
3. Handling
4. Disposal of residual high molecular weight methacrylate and the 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 industrial hygienist with current certification in Comprehensive Practice by the American Board of Industrial Hygiene. Submit a copy of the hygienist's certification. The hygienist 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 industrial hygienist with results of the airborne emissions monitoring plan.

The placement plan must include:

1. Crack treatment schedule including coefficient of friction testing
2. Methods and materials including:
   2.1. Equipment description for high molecular weight methacrylate resin system application
   2.2. Equipment description for sand application
   2.3. Gel time range and final cure time for resin

Revise rejected plans and resubmit. With each plan rejection, the Engineer gives revision directions including detailed comments in writing. The Engineer notifies you of a plan's acceptance or rejection within 2 weeks of receiving that plan.

40-6.01D Quality Control and Assurance

40-6.01D(1) General

Reserved

40-6.01D(2) Test Area

Before starting crack treatment, treat a 500-square foot test area within the project limits and at a location accepted by the Engineer. Use test areas outside the traveled way if available. Weather and pavement conditions during the test crack treatment must be similar to those expected during production crack treatment. Use equipment during testing similar to those to be used during crack treatment.

For the test area and during crack treatment, use test tiles for evaluating the high molecular weight methacrylate resin system cure time. Coat at least one 4 by 4 inch smooth glazed tile for each batch of high molecular weight methacrylate resin system. Place the coated tile adjacent to the area being treated. Do not apply sand to the test tiles.

Do not start crack treatment until the Engineer accepts the test area.

The Engineer accepts a treated area if:

1. Corresponding test tiles are dry to the touch
2. Treated surface is tack-free and nonoily
3. Sand cover adheres enough to resist hand brushing
4. Excess sand is removed
5. Coefficient of friction is at least 0.30 determined under California Test 342

40-6.02 MATERIALS

40-6.02A General

Reserved

40-6.02B High Molecular Weight Methacrylate Resin

Promoter and initiator in the high molecular weight methacrylate resin system must be compatible. The high molecular weight methacrylate resin may be a prepromoted resin consisting of promoter and resin mixed together before filling containers. Identify prepromoted resin on the container label.

The resin gel time must be from 40 to 90 minutes at the application temperature. Adjust the gel time to compensate for temperature changes throughout the application.

High molecular weight methacrylate resin must comply with the following requirements:

High Molecular Weight Methacrylate Resin

Property	Requirement	Test method
Viscosity [a]	25 cP, maximum, (Brookfield RVT with UL adapter, 50 RPM at 77 °F	ASTM D 2196
Specific gravity [a]	0.90 minimum, at 77 °F	ASTM D 1475
Flash point [a]	180 °F, minimum	ASTM D 3278
Vapor pressure [a]	1.0 mm Hg, maximum, at 77 °F	ASTM D 323
Tack-free time	400 minutes, maximum, at 77 °F	Specimen prepared under California Test 551
Volatile content [a]	30 percent, maximum	ASTM D 2369
PCC saturated surface-dry bond strength	500 psi, minimum, at 24 hours and 77 ± 2 °F	California Test 551

[a] Test must be performed 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.

40-6.03 CONSTRUCTION

40-6.03A General

Apply high molecular weight methacrylate resin system after any grinding.

Prevent deleterious material such as oil from being deposited on the pavement by equipment with devices such as traps, filters, and drip pans.

Before applying high molecular weight methacrylate resin system, 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 high molecular weight methacrylate resin system, clean the pavement surface by abrasive blasting.

If performing abrasive blasting within 10 feet of a lane occupied by traffic, operate abrasive blasting equipment with a concurrently operating vacuum attachment.

During pavement treatment, protect pavement joints, working cracks, and surfaces not to be treated. Block drains and openings that convey water to water ways.

The machine applying high molecular weight methacrylate resin system 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 high molecular weight methacrylate resin system manually to prevent overspray onto adjacent traffic. If applying resin manually, limit the batch quantity of high molecular weight methacrylate resin system to 5 gallons.

Do not apply high molecular weight methacrylate resin system in more than 90 percent relative humidity. The prepared area must be dry and the surface temperature must be from 50 to 100 degrees F when the high molecular weight methacrylate resin system is applied. Apply high molecular weight methacrylate resin system at a rate of 90 square feet per gallon.

Protect existing facilities from the high molecular weight methacrylate resin system application. Repair or replace existing facilities contaminated with high molecular weight methacrylate resin system at your expense.

Flood the treatment area with high molecular weight methacrylate resin system, penetrating the pavement and cracks. Apply high molecular weight methacrylate resin system within 5 minutes after complete mixing. Mixed high molecular weight methacrylate resin system 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 high molecular weight methacrylate resin system 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 nonoily
2. Sand cover adheres enough to resist hand brushing
3. Excess sand is removed
4. Coefficient of friction is at least 0.35 determined under California Test 342

40-6.04 PAYMENT

Payment for high molecular weight methacrylate crack treatment is included in payment for concrete pavement.

41 CONCRETE PAVEMENT REPAIR

41-1 GENERAL

41-1.01 General

Section 41 includes specifications for pavement subsealing, pavement jacking, repair spalled joints, sealing concrete pavement joints, crack existing concrete pavement, pavement transition taper, dowel bar retrofit and individual slab replacement with rapid strength concrete.

41-2 PAVEMENT SUBSEALING

41-2.01 GENERAL

41-2.01A Summary

Section 41-2 includes specifications for filling voids under existing concrete pavement by drilling holes through the pavement and underlying base, cleaning the holes, injecting grout, and filling the holes with mortar or concrete.

41-2.01B Definitions

Reserved

41-2.01C Submittals

Submit shipping invoices with packaged or bulk fly ash, cement and blended cement.
Before grouting activities begin, submit a proposal for the materials to be used. Include authorized laboratory test data for the grout indicating:

1. Initial set time
2. Compressive strength results at 1, 3, and 7 days for 10, 12, and 14-second efflux times. Use specimen molds and curing conditions specified in ASTM C 109

If requesting a substitution of grout materials, submit a proposal that includes test data.

41-2.01D Quality Control and Assurance

Reserved

41-2.02 MATERIALS

41-2.02A General

Reserved

41-2.02B Grout

Grout must consist of portland cement, fly ash, and water. Proportion portland cement and fly ash by weight. Use from 2.4 to 2.7 parts fly ash to 1 part portland cement. Add enough water to produce a grout efflux time from 10 to 16 seconds determined under California Test 541, part D.

Cement for grout must comply with material specifications for portland cement, Type II.

Your test result for the 7-day compressive strength must be at least 750 psi at 12-second efflux time.

You may use chemical admixtures and calcium chloride in grout.

41-2.02C Chemical Admixtures and Calcium Chloride

Chemical admixtures must comply with the material specifications for concrete admixtures. Calcium chloride must comply with ASTM D 98.

41-2.02D Fly Ash

Fly ash must comply with AASHTO M 295, Class C or Class F. Fly ash sources must be on the Authorized Material List.

41-2.02E Mortar

If mortar is used to fill injection holes, it must be 1 part portland cement to 3 parts fine aggregate by volume. Fine aggregate and aggregate gradings must comply with the material specifications for their use in concrete. Add only enough water to the mortar to produce a consistency that allows for placing and packing into the holes. You may use a commercial-quality premixed fast-setting mortar or concrete.

41-2.03 CONSTRUCTION

Do not inject grout if the atmospheric or subgrade temperature is below 40 degrees F. Do not inject grout in inclement weather. If rainwater is present in the holes, obtain the Engineer's authorization before injecting grout.

Do not inject grout until at least 2 consecutive slabs that require subsealing are drilled ahead of the grouting activities.

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.

Do not leave drilled holes ungrouted for more than 2 business days.

Immediately before grout injection, clean the injection 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.

The grout plant must consist of a positive displacement cement injection pump and a high-speed colloidal mixer. The colloidal mixer must operate from 800 to 2,000 rpm. The injection pump must sustain 150 psi if pumping grout mixed to a 12-second flow time. A pressure gauge must be located immediately adjacent to the supply valve of the grout hose supply valve and positioned for easy monitoring.

Before mixing, weigh dry cement and fly ash if delivered in bulk. If the materials are packaged, each container must weigh the same.

Introduce water to the mixer through a meter or scale.

Dispose of grout not used within 1 hour of mixing.

Inject grout under pressure until the voids under the pavement slab are filled. If a slab raises more than 0.050 inch due to grout injection, stop injecting grout in that hole.

The injection nozzle must not leak. Do not inject grout with the nozzle below bottom of the slab. Inject grout 1 hole at a time. Stop injecting grout in a hole if injected grout rises to the surface at any joint, or crack, or flows into an adjacent hole.

If grout does not flow under a sustained pump gauge pressure of 150 psi after 7 seconds and there is no indication the slab is raising, stop injecting grout at that hole.

Immediately after removing the nozzle, plug the hole with a round and tapered wooden plug. Do not remove plugs until injecting grout in adjacent holes progresses enough so that grout does not surface through previously grouted holes.

After grouting, remove grout from drilled holes at least 4 inches below the pavement surface. Clean holes and fill with mortar or concrete. Finish filled holes flush with the pavement surface.

41-2.04 PAYMENT

Drill hole (subsealing) is measured by actual count of drilled holes. Drilled holes not shown are not counted.

Grout (subsealing) is measured as the dry weight of cement and fly ash. The Engineer measures the fly ash and cement mixed into grout and used in the work. Wasted grout due to leaking is not measured.

41-3 PAVEMENT JACKING

41-3.01 GENERAL

41-3.01A Summary

Section 41-3 includes specifications for filling the voids beneath pavement and raising the pavement to grade by drilling holes through existing pavement, cleaning the holes, injecting grout through the holes, grinding or replacing concrete pavement raised too high, and filling the holes with mortar or concrete.

41-3.01B Definitions

Reserved

41-3.01C Submittals

Submit shipping invoices with packaged or bulk fly ash, cement and blended cement.

Before grouting activities begin, submit a proposal for the materials to be used.
Include authorized laboratory test data for the grout indicating:
1. Initial set time
2. Compressive strength results for 1, 3, and 7 days at 10, 12, and 14-second efflux times Use specimen molds and curing conditions specified in ASTM C 109

If requesting a substitution of grout materials, submit a proposal that includes test data.

41-3.01D Quality Control and Assurance

Reserved

41-3.02 MATERIALS

Materials must comply with the specifications for pavement subsealing in section 41-1.02 with the following exceptions for grout:

1. Add enough water to produce a grout efflux time from 16 to 26 seconds determined under California Test 541, part D.
2. To initiate the pressure injection of grout, you may add additional water to reduce the grout efflux time to not less than 10 seconds.

41-3.03 CONSTRUCTION

Pavement jacking must comply with the specifications for pavement subsealing in section 41-2.03 with the following exceptions:

1. Positive displacement pump for grout injection must provide a sustained gauge pressure of 200 psi. Gauge pressures may be from 200 to 600 psi for brief periods to start slab movement.
2. Raise the slabs uniformly. Use string lines to monitor the pavements movement.
3. Raised pavement final elevation must be within 0.01 foot of the established grade. If the raised pavement final elevation is 0.01 foot higher than the established grade, grind the pavement to within 0.01 foot of the established grade, except remove and replace pavement higher than 0.10 foot. For replacement, use concrete pavement specified in section 40. Grind under section 42-3.
4. Do not move adjacent slabs not specified for grade adjustment. If you move adjacent slabs not specified for grade adjustment, correct the grade of adjacent slabs. If grade correction is greater than 0.1 foot, remove slab and replace with JPCP specified in section 40. If grade correction is less than 0.1 foot, grind under section 42-3.

41-3.04 PAYMENT

Drill hole (jacking) is measured by actual count of drilled holes. Drilled holes not shown are not counted.

Grout (jacking) is the measured weight of dry cement and fly ash. The Engineer measures the fly ash and cement mixed into grout and used in the work. Wasted grout due to leaking is not measured.

The Engineer does not pay for grinding or removing and replacing of concrete pavement due to pavement jacking higher than the tolerances for the established grade.

41-4 REPAIR SPALLED JOINTS

41-4.01 GENERAL

41-4.01A Summary

Section 41-4 includes specifications for repairing spalled joints by removing unsound or damaged concrete and filling the area with a fast-setting grout or polyester grout.

41-4.01B Definitions

Reserved

41-4.01C Submittals

If polyester grout is used, submit a MSDS for each shipment of polyester resin binder before using.

41-4.01D Quality Control and Assurance

If polyester grout is used, allow 14 days for sampling and testing of the polyester resin binder before the proposed use.

If polyester resin binder is stored in containers larger than 55 gallons, notify the Engineer 10 days before the delivery of the resin to the jobsite.

41-4.02 MATERIALS

41-4.02A General

Reserved

41-4.02B Fast-Setting Grout

Fast-setting grout must be one of the following types:

1. One of the following magnesium phosphate grouts:
   1.1. Single component water activated
   1.2. Dual component with a prepackaged liquid activator
2. Modified high alumina based grout
3. Portland cement based grout

Addition of retarders to the fast-setting grout must comply with the grout manufacturer's recommendations.

You may use any accelerating admixtures complying with ASTM C 494/C 494 M, Type C and complying with the material specifications for concrete admixtures. Fast-setting grout must comply with the values for the properties shown in the following table:

Fast-Setting Grout

Property	Test method	Requirements
Compressive strength	--	--
at 3 hours, psi	California Test 551	3,000 min
at 24 hours, psi	California Test 551	5,000 min
Flexural strength	--	--
at 24 hours, psi	California Test 551	500 min
Bond strength at 24 hours	--	--
Saturated surface dry concrete, psi	California Test 551	300 min
Dry concrete, psi	California Test 551	400 min
Water absorption, %	California Test 551	10 max
Abrasion resistance at 24 hours, grams	California Test 550	25 max
Drying shrinkage at 4 days, %	ASTM C 596	0.13 max
Soluble chlorides by weight, %	California Test 422	0.05 max
Water soluble sulfates[a] by weight, %	California Test 417	0.25 max

[a]Test must be performed on a cube specimen, fabricated under CT 551, cured at least 14 days, and then pulverized to 100% passing the no. 50 sieve.

Aggregate filler may be used to extend prepackaged grout. Aggregate filler must be clean, uniformly rounded, and have a moisture content that does not exceed 0.5-percent by weight.

When tested under California Test 202, aggregate filler must comply with the grading requirements for the sieve sizes shown in the following table:

Aggregate Filler Grading

Sieve size	Percentage passing
1/4"	100
No. 16	0–5

Aggregate filler must not exceed 50 percent of the grout volume or the maximum recommended by the manufacturer, whichever is less.

Fast-setting grout must be formulated for a minimum initial set time of 15 minutes and a minimum final set time of 25 minutes at 70 degrees F. Fast-setting grout materials must be stored in a cool and dry environment.

Mix water used with water activated material must be free from oil and not contain more than 2,000 parts per million of chlorides as Cl, or more than 1,500 parts per million of sulfates as SO_4.

Water for curing must not contain enough impurities to cause discoloration of the concrete surface or surface etching.

For magnesium phosphate grout, the quantity of water or liquid activator blended with the dry component must comply with the limits recommended by the manufacturer.

41-4.02C Polyester Grout

Polyester grout consists of polyester resin binder and dry aggregate. The polyester resin binder must be an unsaturated isophthalic polyester-styrene copolymer.

Polyester resin binder must have the required values for the properties shown in the following table:

Polyester Resin Binder

Property	Test method	Requirement
Viscosity[a], Pa·s (RVT, no. 1 Spindle, 20 RPM at 77 °F)	ASTM D 2196	0.075 to 0.200
Specific gravity [a], at 77 °F	ASTM D 1475	1.05–1.10
Elongation, %, Type I at 0.45 inch/min Thickness = 0.25 ± 0.05 inch	ASTM D 638	35 min
	ASTM D 618	Sample conditioning: 18/25/50 + 5/70
Tensile strength, psi, Type I at 0.45 inch/min Thickness = 0.25 ± 0.05 inch	ASTM D 638	2,500 min
	ASTM D 618	Sample conditioning: 18/25/50 + 5/70
Styrene content [a], % (by weight)	ASTM D 2369	40–50
Silane coupler, % (by weight of polyester styrene resin)		1.0 min
PCC saturated surface dry bond strength, psi, at 24 hours and 70 ± 2 °F	California Test 551	500 min
Static volatile emission [a], oz / sq yd, loss,	South Coast Air Quality Management District, Standard Method [b]	2 max

[a]Test must be performed before adding initiator.
[b]SCAQMD Method 309-91, Determination of Static Volatile Emissions.

Silane coupler must be an organosilane ester, gamma-methacryloxypropyltrimethoxysilane. Promoter must be compatible with suitable methyl ethyl ketone peroxide (MEKP) and cumene hydroperoxide (CHP) initiators.

Aggregate for polyester grout must comply with the specifications for concrete aggregate. Use either the 3/8 inch maximum grading or the no. 4 maximum grading. When tested under California Test 202, aggregate must comply with the combined aggregate grading requirements for the sieve sizes shown in the following table:

Combined Aggregate Grading

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

Aggregate retained on the no. 8 sieve must have a maximum of 45 percent crushed particles when tested under California Test 205. Fine aggregate must be natural sand.

Polyester resin binder in grout must be approximately 12 percent by weight of the dry aggregate. The Engineer determines the exact percentage.

The average of coarse and fine aggregate absorption must not exceed 1 percent when tested under California Tests 206 and 207.

At the time of mixing with the resin, the moisture content of the combined aggregate must not exceed 1/2 of the average aggregate absorption when tested under California Test 226.

41-4.02D Joint Form Board

Joint form board must be corrugated cardboard with a 6-mil polyethylene covering or expanded polystyrene material. Do not use polystyrene when polyester grout is used.

41-4.02E Bonding Agent

Bonding agent must be a type recommended by the grout manufacturer.

41-4.03 CONSTRUCTION

41-4.03A General

Reserved

41-4.03B Concrete Removal

Cut along the outlines of rectangular areas marked by the Engineer with a diamond bladed saw. If fast-setting grout is specified, cut to a minimum depth of 2 inches. If polyester grout is used, cut to a minimum depth of 1-1/2 inches but not greater than 1/3 of the depth of pavement

Remove unsound and damaged concrete between the saw cut and the joint to the depth of the saw cut by methods that will not damage the concrete pavement to remain in place. If you damage concrete pavement outside the limits of the designated repair, enlarge the spall repair to encompass the damaged concrete. The Department does not pay for the repair of the added area. Do not use pneumatic hammers that weigh more than 15 lb for concrete removal.

41-4.03C Cleaning

After unsound concrete has been removed from the repair area, clean the exposed faces of the concrete. Clean by sand blasting or high pressure water blasting. Water blasting equipment must be capable of producing a blast pressure from 3,000 to 6,000 psi.

After blasting, clean the exposed concrete area with moisture-free and oil-free compressed air to remove debris. Air compressors must deliver air at a minimum of 120 cu ft/min and develop 90 psi of nozzle pressure.

41-4.03D Joint Form Board Installation

After cleaning, form the joint within the repair area to match the existing joint width and alignment. Place the joint form board full depth along the joint, and extend 1 inch into the joint beyond the edges of the patch.

41-4.03E Bonding Agent Application

Mix bonding agent at the job site in small quantities under the manufacturer's instructions. Before placing grout, apply a thin even coat of bonding agent with a stiff bristle brush scrubbing the entire area, including the patched walls.

41-4.03F Mixing

41-4.03F(1) General

Reserved

41-4.03F(2) Fast-Setting Grout

Mix fast-setting grout in a small mobile drum or paddle mixer under the manufacturer's instructions.

The dual components of prepackaged magnesium phosphate grout with a prepackaged liquid activator must be as supplied by the manufacturer. Use the full amount of each component. Do not add water to dual component magnesium phosphate grout.

Magnesium phosphate grout must not be mixed in containers or worked with tools containing zinc, cadmium, aluminum, or copper. High alumina based grout must not be mixed in containers or worked with tools containing aluminum.

41-4.03F(3) Polyester Grout

Mix polyester grout under the manufacturer's instructions.

41-4.03G Placement

41-4.03G(1) General

Place grout on a dry surface except if a bonding agent is used.

41-4.03G(2) Fast-Setting Grout

Grout other than magnesium phosphate may be placed on a surface that has been dampened and allowed to dry or on a bonding agent recommended by the manufacturer.

41-4.03G(3) Polyester Grout

Place grout on a surface with a bonding agent.

41-4.03H Curing

Cure according to the manufacturer's instructions. If curing compound is recommended by the manufacturer, it must comply with the specifications for the curing compound method, curing compound no. 1 or 2.

41-4.03I Protecting Spall Repairs

Protect fast setting grout from traffic for at least 2 hours after the grout sets. Protect polyester grout from traffic for at least 1 hour after the grout sets.

41-4.04 PAYMENT

Repair spalled joint is measured as the actual area of pavement surface repaired.

41-5 SEALING CONCRETE PAVEMENT JOINT

41-5.01 GENERAL

41-5.01A Summary

Section 41-5 includes specifications for constructing or replacing sealed joints in concrete pavement at existing transverse and longitudinal contraction joints with silicone or asphalt rubber liquid sealant.

Seal concrete pavement joints consists of cutting and cleaning new reservoirs and placing new joint sealant.

Replace concrete pavement joints consists of removing existing joint sealant and backer rod, cleaning existing joint reservoirs, and placing new joint sealant and backer rod.

41-5.01B Definitions

Reserved

41-5.01C Submittals

Before use, submit a certificate of compliance for the joint sealant. With each certificate of compliance, submit a certified test report of the results for the required tests performed within 12 months before the proposed use. Submit the certificate of compliance and accompanying test report for each lot of joint sealant shipped to the job site.

Submit a manufacturer's data sheet verifying that the backer rod is compatible with the silicone joint sealant to be used.

Submit the manufacturer's application instructions and MSDS at least 10 days before beginning sealant placement activities.

Submit one of the following for the facility that you have arranged to receive the concrete saw cutting residue:

1. Copy of the facility's RWQCB or other applicable agency permit
2. RWQCB or other applicable agency's written approval
3. Applicable local, state, or federal agency permits if located outside the State

At least 10 days before beginning removal work, submit the proposed removal method of existing sealant, including backer rods. Do not remove existing sealant until the Engineer authorizes a sealant removal method.

41-5.01D Quality Control and Assurance

Reserved

41-5.02 MATERIALS

41-5.02A General

Reserved

41-5.02B Silicone Joint Sealant

Silicone joint sealant must comply with section 40-1.02I(2).

41-5.02C Asphalt Rubber Joint Sealant

Asphalt rubber joint sealant must comply with section 40-1.02I(3).

41-5.02D Backer Rod

Backer rods must comply with section 40-1.02I(5).

41-5.03 CONSTRUCTION

41-5.03A General

Reserved

41-5.03B Remove Existing Sealant

Remove existing joint sealant materials and backer rods by sawing, plowing, or cutting. Do not damage the existing sealant reservoir or pavement. If the plowing method is used, use rectangular plows.

41-5.03C Construct Joint Sealant Reservoir

Construct a joint sealant reservoir in concrete pavement by the sawing method. The sawing machine must have a vacuum attachment to pick up residue from sawing. Prevent residue from flowing across the pavement or remaining on the pavement surface.

Dispose of removed concrete pavement and residue from sawing at an appropriate disposal facility.

41-5.03D Joint Cleaning

41-5.03D(1) General

Reserved

41-5.03D(2) Debris Removal

Clean dust, dirt, or visible traces of old sealant from the joint. Do not use chemical solvents to wash the joint. Immediately remove slurry or remaining debris after sawing, plowing, cutting, or manual removal. Clean in 1 direction to minimize contamination of surrounding areas.

41-5.03D(3) Reservoir Drying

After debris removal, dry the sealant reservoir with compressed air or moderately hot compressed air, or you may request another means. Drying activities must not leave a residue or film on the reservoir wall.

41-5.03D(4) Sandblasting

After reservoir drying, sandblast the reservoir to remove remaining residue. Do not sandblast straight into the reservoir. Point the sandblasting nozzle close to the surface at an angle to clean each reservoir face. Make at least 1 pass along each reservoir face.

41-5.03D(5) Air Blasting

After sandblasting, air blast the reservoir to remove sand, dirt, and dust. Air blast within 1 hour before placement of sealant. Compressed air used to air blast the reservoir must not introduce oil into the reservoir. If oil is accidentally introduced into the reservoir, redo the joint cleaning sequence until the Engineer determines the reservoir is clean before you continue work on the joint. Compressed air must be delivered at a minimum rate of 120 cubic feet per minute and develop at least 90 psi nozzle pressure.

41-5.03D(6) Vacuuming

After air blasting, use a vacuum sweeper to remove debris or contaminants from the surrounding pavement surfaces.

41-5.03E Backer Rod Installation

Install the backer rod after cleaning the pavement surface and the joints to be sealed have been patched, cleaned, and dried. Install if the temperature of the pavement is above the dew point of the air and if the air temperature is at least 40 degrees F. Backer rod installation must not leave a residue or film on the reservoir walls.

41-5.03F Sealant Installation

Before installing sealant, demonstrate that fresh liquid sealant is ejected from the nozzle free of cooled or cured material.

If asphalt rubber sealant is specified, heat and place asphalt rubber joint sealant under the manufacturer's instructions. Do not place asphalt rubber joint sealant if the pavement surface temperature is below 50 degrees F.

Pump sealant through a nozzle sized for the width of the sealant reservoir so that sealant is placed directly onto the backer rod. The installer must draw the nozzle toward his body.

After pumping the sealant into the joint, tool it to the recessed depth shown. Tool the sealant within 10 minutes of installation or before the sealant begins to form a skin.

After each joint is sealed, remove surplus joint sealer on the pavement surface. Do not allow traffic over the sealed joints until the sealant is tack free and firm enough to prevent embedment of roadway debris into the sealant.

41-5.04 PAYMENT

Seal concrete pavement joint is measured as the actual length of joints installed.

Replace concrete pavement joint is measured as the actual length of joints installed.

41-6 CRACK EXISTING CONCRETE PAVEMENT

41-6.01 GENERAL

41-6.01A Summary

Section 41-6 includes specifications for cracking and seating existing concrete pavement to form discrete segments of pavement, including cleaning loose debris and filling joints, cracks, and spalls.

41-6.01B Definitions

Reserved

41-6.01C Submittals

Submit cores taken to verify cracking equipment and procedure.

41-6.01D Quality Control and Assurance

Before starting cracking operations, the Engineer selects and marks a test section from 3 to 5 existing slabs within the limits of pavement to be cracked.

Demonstrate the ability of the selected equipment and procedure to produce cracks in the concrete pavement as specified.

Immediately before cracking the test section slabs, apply water to the surface of the slabs in sufficient quantity so that cracking can readily be determined. After the application of water, crack the test section pavement using varying impact energy and striking patterns until a proper procedure is established.

To verify that the procedure is producing cracked pavement that complies with the specifications, take at least 2 drilled pavement cores at least 6 inches in diameter. The Engineer orders the exact location where cores are to be taken. Take cores under ASTM C 42. Fill core holes with a fast-setting grout that complies with section 41-3.02B.

41-6.02 MATERIALS

41-6.02A General

Reserved

41-6.02B Hot Mixed Asphalt

Hot mix asphalt (HMA) for filling spalls must comply with section 39, Type B. Aggregate for HMA must comply with section 39-1.02E, no. 4 gradation. Choose asphalt binder Grade PG 64-10, PG 64-16, or PG 70-10. The minimum asphalt binder content must be 6.8 percent.

41-6.03 CONSTRUCTION

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 existing panels are already cracked into segments, crack them further into equal-sized square or rectangular pieces that nominally measure not more than 6 feet transversely and from 3 to 5 feet longitudinally. The pavement cracking equipment must not impact the pavement within 1 foot of another break line, pavement joint, or edge of pavement.

Crack concrete pavement so that vertical cracks are formed completely through the pavement. The vertical cracks must not deviate from vertical by more than 6 inches between the pavement surface and bottom. The cracks must be continuous without surface spalling over 0.10-foot in depth along the crack and without excessive shattering of the pavement or base.

Equipment for cracking concrete pavement must impact the pavement with a variable force and a point of impact that can be controlled. Do not use equipment and procedures that utilize unguided free-falling weights such as "headache balls."

After the equipment and the procedure for cracking pavement have been authorized by the Engineer, use that equipment and procedure to crack the concrete pavement. Take cores of the cracked concrete pavement in the same manner specified for coring test sections. Take cores at intervals of not less than 1 core per lane mile for each machine used. If cores indicate the cracking does not comply with the requirements or if the equipment or procedures are changed, the Engineer orders and marks an

additional test section. Crack the additional test sections and core sample until the cracked pavement complies with the requirements.

Areas of concrete pavement that are covered with 0.10-foot or less of asphalt concrete may be cracked without removal of the asphalt concrete if, after cracking the pavement, a strip of the asphalt concrete surfacing at least 50 feet long is removed for inspection where ordered by the Engineer. If the inspection strip does not comply with the specifications, modify the equipment and procedures, crack another area, and remove another 50-foot strip of asphalt concrete for inspection. If the inspection strip complies with the specifications, use the equipment and procedure to crack the remainder of the concrete pavement covered with 0.10-foot or less of asphalt concrete. Dispose of asphalt concrete surfacing removed from the concrete pavement.

Before opening cracked concrete pavement to traffic, sweep the pavement of loose debris.

Allow public traffic on newly cracked pavement or the first layer of HMA placed for no more than 15 days.

Seat cracked concrete by making not less than 5 passes over the cracked concrete with an oscillating pneumatic-tired roller as specified in section 39-3.03 and weighing not less than 15 tons, or a vibratory sheepsfoot roller exerting a dynamic centrifugal force of at least 10 tons. A pass must be 1 movement of a roller in either direction. The roller speed must not exceed 5 miles per hour.

After all segments have been seated, clean loose debris from joints and cracks using compressed-air.

Fill joints, cracks, and spalls greater than 3/4 inch in width and greater than 1 inch in depth by applying tack coat, filling with HMA, and compacting the HMA, before opening to traffic or before applying tack coat for the 1st layer of HMA.

Within 24 hours of seating any segment of cracked pavement, place the 1st layer of HMA on it.

41-6.04 PAYMENT

Crack existing concrete pavement is measured from the full width and length of the pavement cracked. No deduction is made for existing cracked segments.

41-7 PAVEMENT TRANSITION TAPER

41-7.01 GENERAL

41-7.01A Summary

Section 41-7 includes specifications for constructing pavement transition tapers in existing pavement.

41-7.01B Definitions

Reserved

41-7.01C Submittals

Reserved

41-7.01D Quality Control and Assurance

Reserved

41-7.02 MATERIALS

Reserved

41-7.03 CONSTRUCTION

Use equipment that can construct a pavement transition taper without damaging the concrete pavement to remain in place.

Do not allow flying debris during the construction of tapers.

Existing concrete pavement shown to be tapered may be removed and replaced. If you remove the existing concrete, the replacement concrete must comply with individual slab replacement under section 41-8:

1. Existing base need not be removed

2. Finished surface of the replacement concrete pavement must approximate the planned pavement transition taper surface
3. Replacement concrete pavement surface must be a coarse broom finish

If the final layer of HMA is not placed before opening the lane to public traffic, place temporary HMA in the taper. Temporary HMA must comply with section 39-1.15. Remove temporary HMA before placing the final layer of HMA.

41-7.04 PAYMENT

The Department does not pay for temporary HMA.

Pavement transition tapers are measured from the dimensions shown.

If you choose to remove and replace concrete pavement, the Department does not make additional payment for this work.

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 removing existing pavement and possibly the underlying base and constructing concrete pavement and possibly the underlying base, using RSC.

41-9.01B Definitions

early age: The age less than 10 times the concrete final set time.

final set time: Time a specific penetration resistance of 4,000 psi is achieved, determined under ASTM C 403.

individual slab replacement: Replacement of short segments of single or multiple sequential slabs and possibly the underlying base in the same lane to match the existing concrete thickness.

opening age: Age at which the concrete achieves the specified strength for opening to traffic, including construction traffic.

41-9.01C Submittals

41-9.01C(1) Certificates of Compliance

Submit a certificate of compliance for the following materials:

1. Dowel bars
2. Chemical adhesive for drilling and bonding dowel bars
3. Silicone joint sealant
4. Asphalt rubber joint sealant
5. Preformed compression seal
6. Backer rods, including the manufacturer's statement of compatibility with the sealant to be used.
7. Joint filler material
8. Epoxy powder coating

41-9.01C(2) Manufacturer's Recommendations and Instructions

At least 15 days before delivery to the job site, submit manufacturer's recommendations and instructions for storage and installation of:

1. Chemical adhesive for drilling and bonding dowel bars
2 Silicone liquid sealant
3. Asphalt rubber liquid sealant
4. Preformed compression seals
5. Joint filler material

41-9.01C(3) Protecting Pavement During Cold Weather

Submit a plan for protecting pavement during the initial 72 hours after paving if the average ambient daily temperature is below 40 degrees F and daytime ambient temperature is less than 50 degrees F.

41-9.01C(4) Quality Control Plan

Reserved

41-9.01C(5) Rapid Strength Concrete

At least 45 days before the intended use, submit a sample of cement from each proposed lot and samples of proposed admixtures in the quantities ordered by the Engineer.

During RSC pavement operations, submit uniformity reports for hydraulic cement at least once every 30 days to METS, Attention: Cement Laboratory. Uniformity reports must comply with ASTM C 917, except testing age and water content may be modified to suit the particular material.

At least 10 days before use in a trial slab, 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. Range of ambient temperatures over which the mix design is effective
7. Final set time
8. Any special instructions or conditions such as water temperature requirements

Submit more than 1 mix design to plan for ambient temperature variations anticipated during RSC placement. Each mix design must have a maximum ambient temperature range of 18 degrees F.

Submit modulus of rupture development data for each mix design. You may use modulus of rupture development data from laboratory-prepared samples. The modulus of rupture development data must include tests at 1 hour before opening age, opening age, 1 hour after opening age, 24 hours, 7 days, and 28 days.

41-9.01D Quality Control and Assurance

41-9.01D(1) Just-In-Time-Training

Reserved

41-9.01D(2) Prepaving Conference

Schedule a prepaving conference at a mutually agreed time and place to meet with the Engineer. Make the arrangements for the conference facility. Discuss methods of performing each item of the work.

Prepaving conference attendees must sign an attendance sheet provided by the Engineer. The prepaving conference 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. Concrete plant manager
   - 4.3. Concrete plant operator
   - 4.4. Concrete plant inspectors
   - 4.5. Personnel performing saw cutting and joint sealing
   - 4.6. Paving machine operators
   - 4.7. Inspectors
   - 4.8. Samplers
   - 4.9. Testers

Do not start paving activities, including test strips, until the listed personnel have attended a preconstruction conference.

The purpose of the prepaving conference is to familiarize personnel with the project's specifications. Items to be discussed include the processes for:

1. Production
2. Transportation
3. Placement
4. Replacing pavement
5. Contingency plan
6. Sampling
7. Testing

41-9.01D(3) Quality Control Plan

Reserved

41-9.01D(4) Trial Slabs

Before starting individual slab replacement work, complete 1 trial slab for each mix design. Demonstrate that you are capable of constructing individual slab replacement in compliance with the specifications within the specified time periods including delivery, placement, finishing, and curing times, and under similar atmospheric and temperature conditions expected during replacement operations.

During trial slab construction, sample and split the aggregate for grading, cleanness value, and sand equivalent testing.

Within 20 minutes after rapid strength concrete delivery for trial slabs, fabricate test beams under California Test 524. Use test beams to determine early age and 7-day 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. 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 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 7-day testing under California Test 524 except place them into sand at a time that is from 5 to 10 times the final set time, or 24 hours, whichever is earlier.

Trial slabs must have an early age modulus of rupture of not less than 400 psi and a 7-day modulus of rupture of not less than 600 psi.

41-9.01D(5) Quality Control Testing

Reserved

41-9.01D(6) Acceptance Criteria

41-9.01D(6)(a) General

Reserved

41-9.01D(6)(b) Concrete Pavement Smoothness

The Department tests for smoothness using a 12-foot straightedge placed parallel with and perpendicular to the centerline. Straightedge smoothness specifications do not apply to the pavement surface placed within 12 inches of existing concrete pavement except you must place a straightedge longitudinally with the midpoint coincident with the transverse construction joint. The concrete pavement surface must be within 0.02 foot of the straightedge’s lower edge.

41-9.01D(6)(c) Modulus of Rupture

RSC pavement must develop a minimum modulus of rupture of 400 psi at opening age. RSC pavement must develop a minimum modulus of rupture of 600 psi at 7 days after placement. The Engineer may accept RSC pavement that does not attain the specified modulus of rupture under section 41-9.04B. The Department determines the modulus of rupture by testing 3 beam specimens under California Test 524

except beam specimens may be fabricated using an internal vibrator under ASTM C 31 and averaging the results. No single test represents more than that day's production or 130 cubic yards, whichever is less.

The Engineer determines the modulus of rupture at other ages using beams cured and tested under California Test 524 except the Engineer places them in sand from 5 to 10 times the final set time or 24 hours, whichever is earlier.

41-9.02 MATERIALS

41-9.02A Rapid Strength Concrete

RSC for concrete pavement must comply with section 90-3.

Choose the combined aggregate grading for RSC from either the 1-1/2 inch maximum or the 1-inch maximum combined grading in section 90-1.02C(4)(d).

RSC must develop the specified strength at opening age and 7-day modulus of rupture strengths.

41-9.02B Temporary Roadway Pavement Structure

41-9.02B(1) General

Reserved

41-9.02B(2) Aggregate Base

Aggregate base for temporary roadway pavement structure must be produced from any combination of broken stone, crushed gravel, natural rough-surfaced gravel, reclaimed concrete and sand. Grading of AB must comply with the 3/4-inch maximum grading specified in section 26-1.02B.

41-9.02B(3) Hot Mix Asphalt

For HMA:

1. Choose the 3/8 inch or 1/2 inch HMA Type A or Type B aggregate gradation in section 39-1.02E.
2. Minimum asphalt binder content must be 6.8 percent for 3/8-inch aggregate gradation and 6.0 percent for 1/2 inch aggregate gradation.
3. Choose asphalt binder Grade PG 64-10, PG 64-16, or PG 70-10 in section 92.

41-9.02B(4) Concrete

RSC not conforming to the specifications may serve as temporary roadway and must be replaced during the next paving shift.

41-9.02C Bond Breaker

Bond breaker must be one of the following:

1. White curing paper specified in ASTM C 171
2. White opaque polyethylene film specified in ASTM C 171, except the minimum thickness must be 6 mils
3. Paving asphalt, Grade PG 64-10, under section 92.
4. Curing compound no. 5

41-9.02D Chemical Adhesive for Drill and Bond

Chemical adhesive for drilling and bonding dowels must be on the Authorized Material List available on the Department's METS website. The Authorized Material List indicates the appropriate chemical adhesive system for the concrete temperature and installation conditions.

Each chemical adhesive system must clearly and permanently show the following:

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 (ICBO) Evaluation Report number

7. Directions for use
8. Warnings or precautions required by State and Federal laws and regulations

41-9.03 CONSTRUCTION

41-9.03A General

Contingency plan equipment, materials and personnel for temporary roadway pavement structure must be present at the job site.

41-9.03B Trial Slabs

Trial slabs must be 10 by 20 feet. The trial slab thickness must be at least 10 inches. Place trial slabs near the job site at a mutually-agreed location that is neither on the roadway nor within the project limits.

Dispose of trial slabs and test specimens for trial slabs.

41-9.03C Removing Existing Pavement and Base Materials

The exact limits of individual slab replacement is shown or directed by the Engineer.

Remove existing pavement, and underlying base material if shown, and replace it with base material and concrete pavement. If you are unable to construct, finish, and cure concrete pavement before the specified traffic opening time, construct a temporary roadway pavement structure.

Saw cut the outline of concrete pavement to be removed except where adjacent to an asphalt concrete shoulder with a power-driven saw. Do not saw cut within concrete pavement slabs more than 2 business days before concrete pavement slab removal. If you saw cut in work shifts that are before the actual removal work shift, do not make saw cuts parallel or diagonal to the traveled way. Saw cut such that traffic will not dislodge any pieces or segments.

Saw through any tie bars and dowel bars before concrete pavement slab removal.

Inside the sawed outline, do not impact the surface within 18 inches of pavement to remain in place. Remove the pavement and base without damage to the pavement or base remaining in place.

Dispose of removed materials.

After removing pavement and base to the required depth shown, grade to a uniform plane. Water 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. At your expense, fill areas that were over-excavated during base removal with replacement material in the same operation as the base replacement.

41-9.03D Base Replacement Layer

Replace removed base materials with the specified base material in a separate and distinct operation from replacing concrete pavement.

Finish the replacement base layer to the grade of the original base layer. Do not texture the surface. Finish to a smooth surface, free of voids, porous areas and projections such as mortar ridges.

41-9.03E Bond Breaker

Before application, remove foreign and loose materials.

Place bond breaker between replacement pavement and existing lean-concrete base, cement-treated base, or new base replacement layer.

If you use curing paper or polyethylene film, place it in a wrinkle free manner. Overlap adjacent sheets a minimum of 6 inches in the same direction as the concrete pour.

If you use paving asphalt, do not add water before applying asphalt to the base surface. Apply the paving asphalt in 1 even application at a rate from 0.02 to 0.10 gallon per square yard over the entire base surface area. Do not place concrete pavement until the paving asphalt has cured.

If you use curing compound, apply it in 2 separate applications. Apply each application evenly at a rate from 0.07 to 0.11 gallon per square yard over the entire base surface area.

41-9.03F Spreading, Compacting, and Shaping

Use metal or wood side forms. Wood side forms must not be less than 1-1/2 inches thick. Side forms must be of sufficient rigidity, both in the form and in the connection with adjoining forms, that movement will not occur under forces from subgrading and paving equipment or from the pressure of concrete.

Side forms must remain in place until the pavement edge no longer requires the protection of forms. Clean and oil side forms before each use.

After you deposit the RSC, consolidate RSC with high-frequency internal vibrators. Consolidate 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. Use surface finishing additives as recommended by the manufacturer of the cement after their use is authorized.

41-9.03G Joints

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 joint faces and extend the excavation's full depth. Place the top of the joint filler flush with the top of the pavement. Secure joint filler to the joint face of the existing pavement to prevent the joint filler from moving during the placement of RSC.

Where the existing transverse joint spacing in an adjacent lane exceeds 15 feet, construct an additional transverse contraction joint midway between the existing joints. Complete sawing of contraction joints within 2 hours of completion of final finishing.

Cut contraction joints a minimum of 1/3 the depth of the slab.

41-9.03H Dowel Bar

Drill existing concrete and bond dowel bars with chemical adhesive at transverse construction joints as shown. Do not place dowel bars in transverse contraction joints.

Clean drilled holes in compliance with the chemical adhesive manufacturer's instructions. Holes must be dry at the time of placing the chemical adhesive and dowel bars. Immediately after inserting the dowel bars into the chemical adhesive, support the dowel bars to prevent movement during curing. Leave the supported dowel bars undisturbed until the chemical adhesive has cured a minimum time instructed by the manufacturer. If the Engineer rejects dowel bars, drill new holes adjacent to the rejected holes, place new dowel bars, and securely bond to the concrete.

41-9.03I Final Finishing

After completing preliminary finishing, round the edges of the initial paving widths to a 0.04-foot radius. Round transverse and longitudinal construction joints to a 0.02-foot radius.

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.

The tines must be from 3/32 to 1/8 inch wide, on 3/4-inch centers, and must have enough length, thickness, and resilience to form grooves approximately 3/16 inch deep.

Construct grooves over the entire pavement width except do not construct grooves 3 inches from the concrete pavement edges and longitudinal joints. Final texture must be uniform and smooth. Grooves must be parallel and aligned to the pavement edge across the pavement width. Grooves must be from 1/8 to 3/16 inch deep after concrete has hardened.

If the Engineer determines by visual inspection that the final texturing may not comply with the specifications for coefficient of friction, the Engineer tests to determine the coefficient of friction. Open the pavement to traffic and allow 25 days after concrete placement for the Department to test for the coefficient of friction. If pavement does not comply with the specifications for coefficient of friction, groove or grind the pavement under section 42. Perform grooving or grinding before the installation of any required joint seal or edge drains adjacent to the areas to be grooved or ground.

Protect concrete pavement under section 90-1.03C.

Maintain the concrete pavement temperature at not less than 40 degrees F for the initial 72 hours.

Correct pavement at construction joints not in compliance with straightedge smoothness specifications within 48 hours by grinding.

41-9.03J Temporary Roadway Pavement Structure

Place HMA and aggregate base where existing pavement is replaced for construction of a temporary roadway pavement structure. The quantity must be equal to the quantity of pavement removed during the work shift. If you place temporary roadway pavement structure, it must be maintained and later removed as the 1st order of work if replace concrete pavement activities resume. The temporary roadway pavement structure must consist of 3-1/2 inch thick HMA over aggregate base. Concrete not conforming to the specifications may be used for temporary roadway pavement structure with authorization.

Spread and compact aggregate base and HMA by methods that produce a well-compacted, uniform base, with a surface of uniform smoothness, texture and density. Surfaces must be free from pockets of coarse or fine material. You may spread aggregate base and HMA each in 1 layer. The finished surface of HMA must not vary more than 0.05 foot from the lower edge of a 12-foot long straightedge placed parallel with the centerline and must match the elevation of existing concrete pavement along the joints between the existing pavement and temporary surfacing.

After removing temporary roadway pavement structure, you may stockpile removed aggregate base at the job site and reuse it for temporary roadway pavement structures. If no longer required, dispose of standby material or stockpiled material for temporary roadway pavement structures.

41-9.03K Reserved

41-9.04 PAYMENT

41-9.04A General

Individual slab replacement is measured based on field measurements.

Drill and bond dowel bars are not included in payment for individual slab replacement.

If calibration of volumetric batch-trucks is performed more than 100 miles from the project limits, total payment for RSC is reduced by $1,000 per calibration session.

41-9.04B Pay Factor Adjustment for Low Modulus of Rupture of RSC

The Engineer adjusts payment for RSC for modulus of rupture as follows:

1. Payment for RSC with a modulus of rupture of 400 psi or greater before opening to traffic and 7-day modulus of rupture of 600 psi or greater is not adjusted.
2. Payment for RSC with a 7-day modulus of rupture less than 500 psi is not adjusted and no payment is made. Remove this RSC and replace it at your expense with RSC that complies with the specifications.
3. Payment for RSC with a modulus of rupture less than 300 psi before opening to traffic is not adjusted and no payment is made. Remove this RSC and replace it at your expense with RSC that complies with the specifications.
4. Payment for RSC with a modulus of rupture of 300 psi or greater before opening to traffic and a 7-day modulus of rupture greater than or equal to 500 psi is reduced by the percentage in the following pay table for the quantity represented by the tests.

Percentage Pay Table

Modulus of rupture (psi) at opening to traffic	7-Day modulus of rupture (psi)		
	Greater than or equal to 600	Less than 600 and greater than or equal to 550	Less than 550 and greater than or equal to 500
Greater than or equal to 400	100%	95%	90%
Less than 400 and greater than or equal to 350	95%	95%	90%
Less than 350 and greater than or equal to 300	80%[a]	80%[a]	80%[a]

[a]The Engineer rejects any RSC area that develops 1 or more transverse cracks within 21 days after placement. Remove this RSC at your expense and replace it with RSC that complies with the specifications. A transverse crack is a crack running from one longitudinal edge of the panel to the other.

42 GROOVE AND GRIND CONCRETE

42-1 GENERAL

42-1.01 GENERAL

42-1.01A Summary

Section 42-1 includes general specifications for:

1. Grooving and grinding the surface of pavement and bridge decks
2. Disposing of pavement grooving and grinding residue

42-1.01B Definitions

Reserved

42-1.01C Submittals

Submit one of the following for the facility that you have arranged to receive the concrete residue:

1. Copy of the facility's RWQCB or other applicable agency permit
2. RWQCB's or other agency's written approval
3. Applicable local, state, or federal agency permits if located outside the State

Within 5 business days after completing concrete grooving or grinding activities, submit disposal facility receipts and weight tickets for concrete grooving or grinding residue.

42-1.01D Quality Control and Assurance

Reserved

42-1.02 MATERIALS

Reserved

42-1.03 CONSTRUCTION

42-1.03A General

Reserved

42-1.03B Pavement Grooving and Grinding Residue

Remove grooving and grinding residue with a vacuum attached to the grooving or grinding machine. Prevent residue from flowing across the pavement or remaining on the pavement surface. Dispose of grooving and grinding residue at an appropriate disposal facility.

Do not store concrete pavement grooving or grinding residue within the highway.

If authorized, you may transport liquid grooving or grinding residue to an offsite location for drying. The offsite drying location must be identified and protected under the SWPPP or Water Pollution Control Program.

42-1.04 PAYMENT

Reserved

42-2 GROOVING

42-2.01 GENERAL

42-2.01A Summary

Section 42-2 includes specifications for grooving the surface of pavement and bridge decks.

42-2.01B Definitions

Reserved

42-2.01C Submittals

Reserved

42-2.01D Quality Control and Assurance

The Engineer selects and measures grooved areas for acceptance. Grooved areas are accepted 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. Omitted grooves resulting from a single failed blade are allowed to remain and are measured as grooved. Omitted grooves resulting from more than a single failed blade that is not more than 50 feet in length are allowed to remain and are measured as grooved. Other omitted grooves required to be recut must be grooved before the area is measured for payment.

42-2.02 MATERIALS

Reserved

42-2.03 CONSTRUCTION

42-2.03A General

Reserved

42-2.03B Grooving Equipment

Grooving blades must be 0.095 ± 0.005 inch wide and spaced on 3/4-inch centers.

At the start of each new work shift, grooving machines must be equipped with a full complement of functioning grooving blades.

42-2.03C Grooving

Begin and end grooving at lines normal to the roadway centerline. Center grooving within the lane width. For new pavement or bridge decks, groove the full lane width.

Groove pavement from 1/8 to 1/4 inch deep. Groove bridge decks from 1/8 to 3/16 inch deep. If grooving over inductive loop detectors, groove from 1/16 to 1/8 inch deep.

If a single grooving blade on any grooving machine fails to cut a groove in compliance with the specifications, you may continue to groove for the remainder of the workshift. Do not re-groove because of a single failed blade. If more than a single blade fails, perform either of the following:

1. Discontinue work with that grooving machine within 50 feet of the failure. Do not cut omitted grooves.
2. Continue grooving with that grooving machine until the end of the work shift and cut all the omitted grooves by other means within the same work shift. The Engineer does not accept any grooves in that work shift until you cut all omitted grooves.

42-2.04 PAYMENT

Groove existing concrete pavement and groove existing bridge deck are measured by multiplying the width by the length of the grooved area.

42-3 GRINDING

42-3.01 GENERAL

42-3.01A Summary

Section 42-3 includes specifications for grinding the surface of pavement and bridge decks, and profiling the ground surface to determine smoothness.

You may replace concrete pavement instead of grinding. Smoothness specifications apply to replaced concrete pavement.

42-3.01B Definitions

Reserved

42-3.01C Submittals

Reserved

42-3.01D Quality Control and Assurance

Pavement grinding must result in a finish surface that complies with the quality control and assurance specifications for surface smoothness in section 40-1.01D.

42-3.02 MATERIALS

Reserved

42-3.03 CONSTRUCTION

42-3.03A General

Reserved

42-3.03B Equipment

Grind with abrasive grinding equipment using diamond cutting blades mounted on a self-propelled machine designed for grinding and texturing concrete pavements.

42-3.03C Grinding

Grind bridge decks only when specified. Begin and end grinding at lines perpendicular to the roadway centerline.

Grind in the longitudinal direction of the traveled way and grind the full lane width.

Grinding concrete 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 concrete pavement not constructed as part of the project must comply with the following:

1. Both sides of transverse joints and cracks must have the same depth of texture. The surface must be within 0.01 foot of the lower edge of a 12-foot long straightedge when laid parallel with the centerline with its midpoint at the joint or crack.
2. If necessary, perform additional grinding to achieve the required surface smoothness. Straightedge and profilograph requirements do not apply to areas abnormally depressed from subsidence or other localized causes. End profilograph testing 25 feet before and resume 25 feet after these areas.
3. Cross-slope must be uniform and have positive drainage across the traveled way and shoulder. The surface must be within 0.02 foot of the lower edge of a 12-foot long straightedge when laid perpendicular to the centerline.
4. For weigh-in-motion scales, the profile index specifications do not apply. The surface must be within 0.01 foot of the lower edge of a 12-foot long straightedge laid parallel or perpendicular to the centerline.

The following ground areas must comply with the specifications for smoothness and concrete cover over reinforcing steel in section 51-1.01D(4):

1. Structures
2. Approach slabs
3. Adjacent 50 feet of approach pavement

The coefficient of friction for ground pavements must be at least 0.30 determined under California Test 342.

The coefficient of friction for bridge decks and approach slabs must comply with section 51-1.01D(4).

42-3.03D Pavement Replacement

Instead of grinding, you may replace existing concrete pavement. The new concrete pavement must be the same thickness as the removed pavement. Replace between longitudinal joints or pavement edges and between transverse joints. Do not remove portions of slabs.

Replacement of concrete pavement must comply with individual slab replacement under section 41-9.

For replacement concrete pavement, you may stir pigmented curing compound manually during application. You may apply curing compound with hand-held spraying equipment and the nozzle may be unshielded.

Do not disturb adjacent concrete pavement and subgrade during concrete pavement removal and replacement. Recompact disturbed subgrade to 95 percent relative compaction at your expense.

42-3.04 PAYMENT

Grind existing concrete pavement and grind existing bridge deck are measured by multiplying the width by the length of the actual area ground.

If you begin grinding and change to replacing concrete pavement, the grinding is not paid for.

Replacement concrete pavement constructed instead of grinding is measured by multiplying the width by the length of the area of replaced pavement and is paid for as grind existing concrete pavement.

The Department does not pay for grinding replacement concrete pavement or for additional grinding to comply with smoothness requirements.

43–45 RESERVED

DIVISION VI STRUCTURES

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

Reserved

46-1.01C Submittals

46-1.01C(1) General

Submit a certified calibration chart for each jack and its gage as an informational submittal.

46-1.01C(2) Shop Drawings

Submit shop drawings to OSD, Documents Unit. Notify the Engineer of the submittal. Include in the notification the date and contents of the submittal. Submit 5 sets of shop drawings for initial review. After review, submit from 6 to 12 sets, as requested, for authorization and use during construction.

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

Ground anchor shop drawings must include:

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

Soil nail shop drawings must include:

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

Soil nail shop drawings 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 of soil nail shop drawings.

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 ground water 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 Control and Assurance

46-1.01D(1) General

Stability testing and wall zones must comply with section 19-3.

46-1.01D(2) Load Testing

46-1.01D(2)(a) 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) 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 gage or a load cell to determine the magnitude of applied test loads.

The pressure gage must have an accurately reading, clearly visible dial or display. Dial gages must be graduated in 100 psi increments or less.

Calibrate each jack and its gage as a unit, with the cylinder extension in the approximate position it will have at the final jacking force. Calibrate the jack and gage assembly under the specifications for jacks used to stress tendons permanently anchored at 25 percent or more of the specified ultimate tensile strength in section 50-1.01D(3).

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)(c) 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)(d) 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.

The Department may verify the test loads under California Test 677 using Department-furnished testing equipment. If requested, install and support the equipment during testing and remove the equipment after testing is complete.

46-1.01E Research Investigation

Reserved

46-1.02 MATERIALS

46-1.02A General

Reserved

46-1.02B Sheathing

PVC sheathing must comply with ASTM D 1784, Class 13464-B.

HDPE sheathing must have a density of from 940 to 960 kg/m^3 when measured under ASTM D 792.

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.

46-1.03 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.

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.

46-1.04 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 placed in a cored, formed, or drilled hole, and then grouted and stressed.

Fabrication, installation, and testing of ground anchors must comply with section 50. Interpret "member" in section 50 as "ground anchor."

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

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 Control and Assurance

46-2.01D(1) General

Reserved

46-2.01D(2) Load Testing

46-2.01D(2)(a) General

The Contract describes which ground anchors are to be performance tested. 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.

46-2.01D(2)(b) 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(2)(c) Acceptance Criteria

A performance- or proof-tested ground anchor is acceptable if:

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.

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 bond length after the unacceptable test.

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 51-2.01.

46-2.02B Steel

The anchorage enclosure and the steel tube and bearing plate of the anchorage assembly must be galvanized steel complying with section 55. Section 11-3.02 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 D 792.

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 grout must comply with section 50, except the grout is not required to pass through a screen with 0.07-inch maximum clear openings before being introduced into the grout pump.

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.

Sheath the tendons in the unbonded length with smooth plastic sheathing that extends into the steel tube of the permanent anchorage assembly. Sheath 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 bond 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.

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.

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 C 920.

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 placed in a drilled hole and 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

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)(c), submit revised shop drawings.

If additional verification soil nails are required under section 46-3.01D(2)(c), submit revised shop drawings and a test boring report.

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 Control and Assurance

46-3.01D(1) General

Reserved

46-3.01D(2) Load Testing

46-3.01D(2)(a) 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) Procedure

46-3.01D(2)(b)(i) General

Determine the test load using the following equation:

$$T = Lb \times Qd$$

where:
T = test load, lb
Lb = soil nail bonded length, feet, 10 feet minimum
Qd = design pullout resistance shown, lb/ft

46-3.01D(2)(b)(ii) 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.

46-3.01D(2)(b)(iii) 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.

46-3.01D(2)(b)(iv) 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.

46-3.01D(2)(c) Acceptance Criteria

A soil nail is acceptable if:

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.

Verification test soil nails that fail to comply with the acceptance criteria are rejected. Install and test additional verification test soil nails until they comply with the acceptance criteria. 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.

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.

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 nails that show alternative installation methods, revised production soil nails, or a modified soil nail plan.

46-3.01D(3) 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.

46-3.02 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 and must have a minimum epoxy thickness of 12 mils.

Bar reinforcement for test soil nails is not required to be epoxy coated or encapsulated in grouted plastic sheathing.

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.

46-3.02B Steel

Soil nail anchorage assemblies must comply with section 75-1.02, 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 stud connectors in section 55-1.02.

46-3.02C Bar Reinforcement

Bar reinforcement must comply with section 52.

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.

For bar reinforcement for production soil nails:

1. Grade 60 bar reinforcement must comply with ASTM A 615/A 615M or A 706/A 706M.
2. Grade 75 bar reinforcement must comply with ASTM A 615/A 615M.

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.

Do not splice a test soil nail within the bonded length.

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

Grout must comply with section 50, except testing under California Test 541 is not required and the grout is not required to pass through a screen with 0.07-inch maximum clear openings before being introduced into the grout pump.

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.

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.

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.

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

Soil nails are 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.

For proof test soil nails that fail supplemental testing, the Department deducts $1.00 per linear foot of proof test soil nail.

47 EARTH RETAINING SYSTEMS

47-1 GENERAL

47-1.01 GENERAL

Section 47 includes specifications for constructing earth retaining systems.

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.

Geogrid reinforcement must comply with section 88.

Earthwork must comply with section 19.

47-2.01B Definitions

Reserved

47-2.01C Submittals

Submit results from proposed button-head wire coupler test.

Submit results from each production button-head wire coupler test.

47-2.01D Quality Control and Assurance

Perform tension and slip tests on the proposed button-head wire soil reinforcement and coupler connection. Testing must be performed by an authorized laboratory. Test 6 connection test samples. Test samples must consist of 2 button-head wires each 24 inches long connected by a swaged coupler.

Coupler test samples must comply with minimum tensile specifications for W11 and W20 steel wire in ASTM A 82/A 82M. Total wire slip must be at most 3/16 inch when tested under the specifications for tension testing of round wire test samples in ASTM A 370. Test samples using D-11 and D-20 deformed steel wire must comply with minimum tensile specifications in ASTM A 496/A 496M.

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 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 used in the work. 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 Materials

47-2.02A General

Concrete leveling pads must be minor concrete.

Galvanize soil reinforcement, connecting elements, and other steel components in contact with the earth under section 75-1.05.

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 steel pipe underdrains and underdrain outlets and risers must comply with section 68-2.

Rock for rock slope protection at drain pipe outlets must be no. 3 backing and must comply with section 72-2.

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 D 1752, Type II, with a compressive load of at least 100 psi.

Pipe pins must comply with ASTM A 53/A 53M 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

Concrete panels in freeze-thaw areas must comply with section 90-1.02I and contain at least 675 pounds of cementitious material per cubic yard.

If architectural treatment is not required, finish exposed surfaces of concrete members under the specifications for Class 1 surface finish in section 51-1.03F(3).

47-2.02C Structure Backfill

Structure backfill 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
   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 metallic soil reinforcement, structure backfill must comply with the requirements shown in the following tables:

Gradation Requirements

Sieve size	Percentage passing	California Test
6"	100	202
3"	78-80	202
No. 30	0-60	202
No. 200	0-15	202

Property Requirements

Test	Requirement	California Test
Sand equivalent	12 minimum	217
Plasticity index	6 maximum	204
Minimum resistivity	2000 ohm-cm	643
Chlorides	< 250 ppm	422
Sulfates	< 500 ppm	417
pH	5.5 to 10.0	643

NOTE : If 12 percent or less passes the no. 200 sieve and 50 percent or less passes the no. 4 sieve, the Sand Equivalent and Plasticity Index requirements do not apply.

For geosynthetic soil reinforcement, structure backfill must comply with the requirements shown in the following tables:

Gradation Requirements

Sieve size	Percentage passing	California Test
2"	100	202
No. 4	50-80	202
No. 40	0-30	202
No. 200	0-15	202

Property Requirements

Test	Requirement	California Test
Sand equivalent	30 minimum	217
Plasticity index	6 maximum	204
Durability Index	35 minimum	229
pH	4.5 to 9.0	643

47-2.02D Permeable Material

Permeable material must be Class 1, Type B, complying with section 68-2.02F.

Permeable material for structures with metallic soil reinforcement must comply with the requirements shown in the following table:

Property Requirements

Test	Requirement	California Test
Minimum resistivity	2,000 ohm-cm	643
Chlorides	< 250 ppm	422
Sulfates	< 500 ppm	417
pH	5.5 to 10.0	643

Permeable material for structures with geosynthetic soil reinforcement must comply with the requirements shown in the following table:

Property Requirements

Test	Requirement	California Test
pH	4.5 to 9.0	643

47-2.02E Soil Reinforcement

W11 and W20 steel wire must comply with ASTM A 82/A 82M. Welded wire reinforcement must comply with ASTM A 185/A 185M. You may substitute D11 deformed steel wire for W11 steel wire and D20 deformed steel wire for W20 steel wire. Welded wire reinforcement using deformed steel wire must comply with ASTM A 496/A 496M and A 497/A 497M.

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 with the axis of the wire

Couplers at wire reinforcement connections must be seamless steel sleeves applied over the button-head wires. Swage couplers with a hydraulic press. 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 geogrid reinforcement must comply with ASTM D 4873 and any alternative system details. Protect the geogrid 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 geogrid.

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 section 90-1.02D.

Do not damage the unthreaded portion of the galvanized inspection wire.

47-2.03B Earthwork

47-2.03B(1) General

Grade foundations 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, the embankment must attain at least 95 percent relative compaction 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. 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 soil reinforcement is covered 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.

Construct the 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, the vertical limits of the permeable material must remain unchanged and 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 construction site.

47-2.03B(2) Soil Reinforcement

Place geogrid soil reinforcement in full-length sections.

Cover soil reinforcement with structure backfill during the same work shift that it is placed.

Tension soil reinforcement in the direction perpendicular to the wall face. Use sufficient force to remove slack in the connection and the soil reinforcement. Secure soil reinforcement in place before and during compaction.

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 structure backfill over geogrid 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.

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 be as recommended by the filter fabric manufacturer. 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.

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. Do not operate equipment or vehicles directly on filter fabric.

47-2.03D Concrete

Place concrete for leveling pads at least 24 hours before erecting face panels.

After placing backfill to 2 feet above inspection elements, dry pack voids in face panels with mortar under section 51-1.03E(2) 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.

47-2.04 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 CRIB WALLS

47-3.01 General

47-3.01A General

Section 47-3 includes specifications for constructing crib walls.

47-3.01B Materials

Not Used

47-3.01C Construction

Place 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.

47-3.01D Payment

Not Used

47-3.02 Reinforced Concrete Crib Wall

47-3.02A General

Section 47-3.02 includes specifications for constructing reinforced concrete crib walls.

Reinforced concrete crib walls must comply with section 51.

Concrete crib walls consist of a series of rectangular cells composed of interlocking, precast, reinforced concrete headers, stretchers, and blocks.

47-3.02B Materials

47-3.02B(1) 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(2) Crib Members

47-3.02B(2)(a) General

All members may be manufactured to dimensions 1/8 inch greater in thickness than shown. The thickness of the lowest step must not be less than the dimension shown.

Stretchers may be manufactured 1/2 inch less in length than shown.

When an opening is shown in the face of the wall, special length stretchers and additional headers may be necessary.

For nontangent wall alignments, special length stretchers may be required.

For nontangent wall alignments and at locations where filler blocks are required, special length front face closure members may be required.

47-3.02B(2)(b) Reinforcement

Reinforcing steel must comply with ASTM A 706/A 706M.

Reinforcing wire must comply with ASTM A 496/A 496M.

For hoops or stirrups use either (1) reinforcing wire or (2) deformed steel welded wire reinforcement. The size must be equivalent to the reinforcing steel shown. Deformed steel welded wire reinforcement must comply with ASTM A 497/A 497M.

47-3.02B(2)(c) Concrete

Concrete test cylinders must comply with section 90-1.01D(5), except when 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 the consolidating effort being used to consolidate the concrete in the members.

Cure crib members under section 51-4.02C.

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).

External vibration resulting in adequate consolidation may be used.

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.

Finish concrete-to-concrete bearing surfaces to a smooth plane. Section 51-1.03F does not apply to concrete crib members.

47-3.02C Construction

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.

47-3.02D Payment

The area of reinforced concrete crib wall is measured on the batter at the outer face for the height from the bottom of the bottom stretcher to the top of the top stretcher and for a length measured from end to end of each section of wall.

47-3.03 Steel Crib Wall

47-3.03A General

47-3.03A(1) Summary

Section 47-3.03 includes specifications for constructing steel crib walls.

Steel crib walls consist of a series of rectangular cells composed of steel members.

47-3.03A(2) Definitions

Reserved

47-3.03A(3) Submittals

Submit a certificate of compliance from the manufacturer for the steel products.

47-3.03A(4) Quality Control and Assurance

Reserved

47-3.03B Materials

47-3.03B(1) General

Fabricate crib members with galvanized flat steel sheets complying with AASHTO M 218.

The Engineer may request copies of mill test reports for each heat and thickness.

The nominal thickness of galvanized sheets for crib members must be equal to or greater than that shown.

Fabricate crib members such that:

1. Members of the same nominal size are interchangeable.
2. Bolt holes are not more than 1/8 inch larger than the bolt diameter.
3. Minimum forming radius of 1 inch is maintained.
4. Fabrication is performed without damage to the galvanizing.

Drilling, punching, or drifting bolt holes to correct defects in fabrication is not allowed.

Replace any member that is twisted, bent, or that has improperly located holes.

Load, haul, and handle galvanized material without damaging the galvanizing. Repair abraded or damaged galvanized surfaces under section 75-1.05.

For nontangent wall alignments, special length stringers may be required.

47-3.03B(2) Bolts and Nuts

Comply with ASTM A 307, Grade A. Use either of the following:

1. Heavy hexagon heads and nuts without washers
2. Hexagon heads and nuts with plate washers under the heads and nuts

Washers must be round 1/8-inch-minimum-thickness steel plate, including coating. Holes in washers must not be more than 1/16 inch larger than the diameter of the bolt.

Galvanize bolts, nuts, and washers under section 75.

Torque all bolts from 25 to 75 ft-lb.

47-3.03C Payment

The area of steel crib wall will be measured on the batter at the outer face for the height from the bottom of the base plate to the top stringer and for a length 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.

Type 6 retaining walls consist of concrete footings with either reinforced concrete stems or reinforced concrete masonry unit stems.

Reinforced concrete footings and stems must comply with section 51.

CMU stems must comply with section 58-2.

47-5.02 Materials

Hollow CMUs must comply with ASTM C 90, normal weight, and must be of uniform color and size.

Caulking for sealing expansion joints must be a nonsag polysulfide or polyurethane type complying with ASTM C 920.

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.

Mix mortar fresh as necessary.

CMU construction must be true and plumb.

Provide recesses in the units for horizontal reinforcement.

Provide cleanout openings at the bottoms 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 strength is 1,500 psi or the grout has been in place for 28 days.

47-5.04 Payment

Type 6 retaining walls are measured by the square foot of completed wall stem including cap, measured along the horizontal length and the vertical height from top of footing to top of 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.

Use only 1 type of system at any one location.

47-6.01B Definitions

Reserved

47-6.01C Submittals

Submit shop drawings for the alternative system to OSD, Documents Unit. Submit 5 sets for initial review. Submit from 6 to 12 sets of final shop drawings as requested 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.

For as-built drawings common to more than 1 structure, submit the as-built drawings for each structure.

Submit certificates of compliance for the alternative system stating the supplied material complies with the index criteria for the system at the time of prequalification.

47-6.01D Quality Control And Assurance

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 using data furnished by suppliers or manufacturers of each system. Authorization of additional systems is contingent on the system complying with the prequalification criteria available on the Authorized Material List web site.

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 any remaining installations. The representative must not be your employee.

47-6.02 Materials

Reserved

47-6.03 Construction

Construct the structure to the lines and grades shown. The structure must comply with the authorized system details. 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 elevations shown. Use a minimum height and length of wall adequate for the specified loading and site conditions.

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 concrete gutter behind the coping
3. At least 5 inches below the top edge of the concrete panel

47-6.04 Payment

Reserved

48 TEMPORARY STRUCTURES

48-1 GENERAL

48-1.01 GENERAL

Section 48 includes specifications for constructing temporary structures.

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 loads imposed
4. Produces a finished structure that conforms to the lines and grades shown

48-2.01B Definitions

previously welded splice: Splice made in a falsework member before the member is shipped to the job site.

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 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.

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 field 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 and inspection methods 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

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 sets of falsework drawings and 2 sets of design calculations. Include the following:

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 submittal for each frame.

If you submit multiple submittals at the same time or additional submittals before review of a previous submittal is complete:

1. You must designate a review sequence for submittals
2. Review time for any submittal is 20 days plus 15 days for each submittal of higher priority still under review

You may revise authorized falsework shop drawings if there is sufficient time for the Department's review before construction starts on the revised section. The additional time will not be more than that originally allowed.

For falsework over railways, authorization of falsework drawings is contingent upon the drawings being satisfactory to 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 designate a representative to perform this certification as follows:

1. Where falsework contains openings for railroads, vehicular traffic, or pedestrians, the designated 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 designated 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 designated representative and provide supporting documentation demonstrating the required experience

48-2.01D Quality Control and 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 (1) for previously welded splices and (2) if fillet welds are used where load demands are 1,000 lb or less per inch for each 1/8 inch of fillet weld.

Perform NDT on splices made by field welding at the job site. You may use UT or RT. Each field 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, you must determine and perform all necessary testing and inspection required to certify the ability of the falsework members to sustain the design stresses.

48-2.01D(3) Design Criteria

48-2.01D(3)(a) 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 so 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 or methods.

48-2.01D(3)(b) 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 equal 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 wind pressure values shown in the following table:

Height zone (feet above ground)	Wind pressure value	
	Shores or columns adjacent to traffic	At other locations
	(psf)	(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 equal 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	At other locations
	(psf)	(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

NOTES:

Q = 1 + 0.2W, but not more than 10

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. They are placed more than 5 days before the top slab
2. The 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.

48-2.01D(3)(c) Stresses, Loadings, and Deflections

48-2.01D(3)(c)(i) General

Maximum allowable stresses and loadings specified in section 48-2.01D(3)(c) are based on the use of undamaged high-quality materials. Reduce stresses and loadings for materials of lesser quality.

48-2.01D(3)(c)(ii) Timber

Design timber connections under the Department's *Falsework Manual*.

The maximum allowable stresses, loadings, and deflections for timber are shown in the following table:

Property	Requirement
Compression perpendicular to the grain	450 psi
Compression parallel to the grain	480,000/(L/d)² psi; 1,600 psi maximum
Flexural stress	1,800 psi; 1,500 psi maximum for members with a nominal depth of 8 inches or less.
Horizontal shear	140 psi
Axial tension	1,200 psi
Deflection due to concrete loading only	1/240 of span length[a]
Modulus of elasticity (E)	1.6×10^6 psi
Timber piles	45 tons

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]Do not include deflection compensated for in camber strips

48-2.01D(3)(c)(iii) 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, design stresses for unidentified steel must not exceed those specified for steel complying with ASTM A 36/A 36M in the AISC *Steel Manual* or the following:

Property	Requirement
Tension, axial and flexural	22,000 psi
Compression, axial	$16{,}000 - 0.38(L/r)^2$ psi[a]
Shear on gross section of web of rolled shapes	14,500 psi
Web yielding for rolled shapes	27,000 psi
Modulus of elasticity (E)	30×10^6 psi

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 following:

Property	Requirement
Compression, flexural	12,000,000/[(L x d)/(b x t)] psi[a]
Deflection due to concrete loading only	1/240 of the span[b]
Modulus of elasticity (E)	30 x 10^6 psi

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 A 36/A 36M, or (3) $0.6F_y$ for other identified steel

[b]Do not include deflection compensated for in camber strips

48-2.01D(3)(c)(iv) Manufactured Assemblies

Do not exceed the manufacturer's recommendations 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.

48-2.01D(3)(d) 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 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 48-2.01D(3) 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 48-2.01D(3)(b), 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	Clearances	
	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 railway 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.

48-2.02 MATERIALS

Not Used

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.

Install Type K temporary railing on both sides of vehicular openings through falsework. The Engineer may order you to install temporary railing at other falsework less than 12 feet from the edge of a traffic lane.

Temporary railings for vehicular openings must start 150 feet in advance of the falsework and extend past the falsework in the direction of adjacent traffic flow. For 2-way traffic openings, temporary railing must extend at least 60 feet past the falsework in the direction of adjacent traffic flow.

Install temporary crash cushion modules as shown at the approach end of temporary railings located less than 15 feet from the edge of a traffic lane. For 2-way traffic openings install temporary crash cushion modules at the departing end of temporary railings located less than 6 feet from the edge of a traffic lane.

The Engineer orders the location and length of railing and the type of flare to be used.

Install all temporary railing protecting falsework before erecting falsework. Do not remove temporary railing until authorized.

48-2.03B Foundations

Construct falsework on solid footings capable of supporting falsework loads. Protect footings from softening and undermining. The Engineer may order you to verify 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 at the time 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 employ corrective measures satisfactory to the Engineer. If satisfactory measures are not provided before initial concrete set occurs, stop concrete placement at a location ordered.

48-2.03D Removal

Remove falsework such that portions of falsework not yet removed remain stable at all times.

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 in that span and 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 bridge or a 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.

48-2.04 PAYMENT

Not Used

48-3 TEMPORARY SUPPORTS

Reserved

48-4 TEMPORARY DECKING

Reserved

48-5 JACKING SUPERSTRUCTURE

Reserved

48-6–48-10 RESERVED

49 PILING

49-1 GENERAL

49-1.01 GENERAL

49-1.01A Summary

Section 49-1 includes general specifications for constructing foundation 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.

pile structural capacity design: Design 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*.

49-1.01C Submittals

49-1.01C(1) General

Before handling or installing piles at a location that is closer than the length of the pile being handled or installed to the edge of any traveled way open to public use, submit a work plan of the measures that will 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 sets 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 your submittal. Include in the notification the date and contents of the submittal.

If corrections to the submittal are required, submit 1 set of the corrected test boring report and the log of test borings to OSD, Documents Unit.

49-1.01D Quality Control and 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. The Engineer must authorize locations of additional foundation testing. 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 Engineer does not authorize a revision to:

1. Specified installation methods where 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 where the tip elevation is controlled by liquefaction or scour

Indicator compression pile load testing must comply with ASTM D 1143. 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 D 3689 except do not use the loading apparatus described as "Load Applied to Pile by Hydraulic Jack(s) Acting at One End of Test Beam(s) Anchored to the Pile." 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

Where 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 that is to be used for installation of production piles.

Load test piles must comply with the specifications for piling as described. 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 that are 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 A 722 for uncoated, deformed, Type II, HS steel bars, including all supplementary requirements, except the maximum weight requirement does not apply.
2. Steel plates must comply with ASTM A 709/A 709M, 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.

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 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 will receive dynamic monitoring.

The Department dynamically monitors driven piles using Department-furnished dynamic pile analyzer monitoring instruments.

The 4th paragraph of section 49-2.01A(4)(b) does not apply to driven piles if dynamic monitoring is required.

The Department conducts penetration and bearing analysis of dynamically monitored piles and develops bearing acceptance criteria curves for these piles. Penetration and bearing analyses are based on a wave equation analysis.

Except for load test and anchor piles, do not install 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 be:

1. Available to the Department at least 2 business days before driving.
2. Safely supported at least 6 inches off the ground in a horizontal position on at least 2 support blocks. If requested, rotate the piles on the blocks.
3. Positioned such that the Department has 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 business 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 any damaged cables or instruments in kind 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.

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 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 drill 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 D 1586 for each test boring at 5-foot maximum intervals and terminate when (1) bedrock is encountered, (2) 10 blows with no discernable 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 that are 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 classifying and describing 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.

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

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

Reserved

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.

Reinforced concrete extensions must comply with section 51.

49-1.04 PAYMENT

The payment quantity of load test piles and adjacent anchor piles is the length used in the load testing. Load test piles and adjacent anchor piles are paid for as the type or class of piling shown in the Bid Item List.

The length of the reinforced concrete extension is measured from the plane of pile cutoff to the top of the extension. The extension is paid for as furnish piling or CIDH concrete piling of the type of piling on which it is constructed.

Payment for structure excavation and structure backfill involved in constructing concrete extensions is included in the payment for drive pile or CIDH concrete piling of the type of piling on which the extension is constructed.

49-2 DRIVEN PILING

49-2.01 GENERAL

49-2.01A General

49-2.01A(1) Summary

Section 49-2 includes specifications for constructing driven piles.

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 all 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 vs. blows per foot.
   1.3 Nominal driving resistance vs. 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 all hammer operation parameters assumed in the analysis, including fuel settings, stroke limitations, and hammer efficiency.
4. Copies of all 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 Control and Assurance

49-2.01A(4)(a) General

Reserved

49-2.01A(4)(b) Pile Driving Acceptance Criteria

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.

Where the pile nominal driving resistance is not shown, drive the pile to the nominal resistance shown.

For pile acceptance, use the following formula to determine the required number of hammer blows in the last foot of driving:

$$R_u = (1.83 \times (E_r)^{1/2} \times \log_{10} (0.83 \times N)) - 124$$

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

Reserved

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 the Engineer orders additional lugs be placed on steel piles, furnishing and placing these lugs is change order work. The Department does not pay for the additional work involved in driving piles due to these additional lugs.

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 gage.

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 where 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 where 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.

If you encounter obstructions to driving, provide special driving tips or heavier pile sections, or subexcavate below the bottom of footing, or take other measures to prevent damage to the pile during driving. This is change order work.

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. Rejected piles that do not interfere with the work may be removed or cut off and abandoned in place.

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 all 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.

Furnish piling is measured from the specified tip elevation shown to the plane of pile cutoff.

Payment for furnish piling includes:

1. Furnishing piles to the job site
2. Splicing piles
3. Furnishing and installing pile anchors and lugs

Payment for drive pile 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

49-2.02 STEEL PIPE PILING

49-2.02A General

49-2.02A(1) Summary

Section 49-2.02 includes specifications for constructing steel pipe piles.

49-2.02A(2) Definitions

shop welding: Welding performed at a permanent plant.

field welding: Welding performed at the job site.

49-2.02A(3) Submittals

49-2.02A(3)(a) General

Reserved

49-2.02A(3)(b) 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 all materials and workmanship incorporated in the work and all required tests and inspections of this work have been performed as described.
2. Certified mill test reports for each heat number of steel 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(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) 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(4) Quality Control and Assurance

49-2.02A(4)(a) General

Section 11-3.02 does not apply to longitudinal, skelp end, or spiral seam welds in steel pipe piles.

49-2.02A(4)(b) Plant Audit

Fabricate steel pipe piles at a plant on the Department's Authorized Facility Audit List.

49-2.02A(4)(c) Nondestructive Testing

49-2.02A(4)(c)(1) General

Section 49-2.02A(4)(c) 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)(c)(2) Shop Welds

Section 49-2.02A(4)(c)(2) 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. Where 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)(c)(3) Field Welds

Section 49-2.02A(4)(c)(3) 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 Web site.

Where 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.

49-2.02B 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 0.45 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 A 252 as either ASTM A 572, Grade 50, or ASTM A 709, Grade 50.

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

Circumferential welds must be CJP welds complying with AWS D1.1.

Locate circumferential welds at least 12 inches away from a skelp end weld.

Backing rings must comply with the following:

1. The 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. The gap between the backing ring and the steel pipe wall must not be greater than 5/64 inch. One localized portion of the backing ring fit-up may be offset 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 so 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.

For welding limited to fit-up and attaching backing rings and handling devices, the preheat and interpass temperatures must comply with clause 3.5 and table 3.2, Category C, of AWS D1.1.

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)(e) 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. Marked as 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)(f) 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 A 252, 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 that have been prepared under clause 4.8.4 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 The weighing of individual pipe is not required as specified in ASTM A 252.
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 that 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 A 252, 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 will 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. The weld reinforcement must not exceed 1/8 inch
2.6. The weighing of individual pipe is not required as specified in ASTM A 252
2.7. Each length of pipe must be marked "Caltrans Class R - A 252"

49-2.02C Construction

49-2.02C(1) General

Steel pipe piles may be retapped to prevent pile set-up provided the field welded splice remains at least 3 feet above the work platform until the Engineer authorizes the splice.

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.

The minimum preheat and interpass temperature for splice welding and for making repairs must be 150 degrees F. When field welding is disrupted, preheating to 150 degrees F must occur before welding is resumed.

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 PILES

49-2.03A General

49-2.03A(1) Summary

Section 49-2.03 includes specifications for constructing structural shape steel piles.

49-2.03A(2) Definitions

Reserved

49-2.03A(3) Submittals

Submit a certificate of compliance that includes:

1. Test reports for tensile, chemical, and any specified NDT. Test samples must be taken from the base metal, steel, or from the manufactured or fabricated pile.
2. A statement that all materials and workmanship incorporated in the work and all required tests and inspections of this work have been performed as described.

49-2.03A(4) Quality Control and Assurance

Reserved

49-2.03B Materials

Structural shape steel piles must comply with ASTM A 36 or ASTM A 572.

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 sets 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 Control and Assurance

PC PS concrete piles must comply with section 11-2.

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 75-1.03.

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.

Cure PC PS concrete piles under section 90-4.03 except piles to be placed in a corrosive environment must be steam or water cured.

If piles to be placed in a corrosive environment are steam cured, steam cure the piles under section 90-4.03 except piles must be kept continuously wet for at least 3 days, including the holding and steam curing periods.

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 surface of the concrete. Fill holes with epoxy adhesive before delivering piles to the job site. The epoxy adhesive must comply with section 95-2.01.

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 will 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 A 328/A 328M.

The minimum section modulus per linear foot of wall must be the section modulus shown.

You may install used sheet piles provided 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 includes specifications for constructing CIP concrete piles.

CIP concrete piles include:

1. CIDH concrete piles
2. CIDH concrete pile rock sockets
3. Driven steel shells filled with concrete and reinforcement

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 grading must comply with the 1-inch maximum grading, the 1/2-inch maximum grading, or the 3/8-inch maximum grading 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)
$8 < D \leq 10$	750
$10 < D \leq 14$	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

Construct CIP concrete piles such that the excavation methods and the concrete placement procedures provide for placing the concrete against undisturbed material in a dry or dewatered hole.

Place and secure reinforcement symmetrically about the axis of the pile. Securely block the reinforcement to provide the minimum clearance shown between the reinforcing steel cage and the sides of the drilled hole or steel shell.

Steel shells and dewatered drilled holes must be clean and free of water and debris before reinforcement and concrete are placed.

Provide a suitable light to the Engineer for inspecting the entire length of the steel shell or dewatered 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 pole or overhead sign structures.

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.

49-3.02A(2) Definitions

Reserved

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 the following:

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:
   - 6.1 Depth of concrete
   - 6.2 Theoretical volume of concrete to be placed, including the effects on volume if casings are withdrawn
   - 6.3 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 activities.

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 activity 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 MSDSs.
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 Coupler Log

Where inspection pipes are required, submit a log of the locations of inspection pipe couplers as an informational submittal upon 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 1 business day of completion of concrete placement in the hole.

49-3.02A(3)(e) Coring Logs and Concrete Cores

If coring is performed under section 49-3.02A(4), submit coring logs and concrete cores.

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 the Department 10 days for review and analysis of this report.

49-3.02A(3)(g) Mitigation Plans

For each rejected pile, 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 The proposed mitigation will be performed under the current Department authorized version of *ADSC Standard Mitigation Plan 'A' - Basic Repair* without exception or modification.
   - 2.2 The 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 authorized version of *ADSC Standard Mitigation Plan 'B' - Grouting Repair* without exception or modification.

The most recent version of the *ADSC Standard Mitigation Plan* is available at the following Web site:

http://www.dot.ca.gov/hq/esc/geotech/ft/adscmitplan.htm

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.
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(4) Quality Control and Assurance

49-3.02A(4)(a) General

Reserved

49-3.02A(4)(b) Preconstruction Meeting

Reserved

49-3.02A(4)(c) Concrete Test Batch

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 that is anticipated during the placement of concrete in the piles.

At the job site, place the test batch concrete in an excavated hole 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	Minimum set period before testing[b]	Slump, after set period
T ≤ 2 hours	2T	≥ 7 inches
T > 2 hours	T + 2 hours	≥ 7 inches

[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) Acceptance Testing

49-3.02A(4)(d)(i) General

Section 49-2.03A(4)(d) applies to CIDH concrete piles except for piles (1) less than 24 inches in diameter or (2) constructed in dry holes or holes dewatered without the use of temporary casing to control ground water.

The Department performs acceptance testing using gamma-gamma logging to test the concrete density of the pile for homogeneity.

After notification by the Engineer of pile acceptance, dewater the inspection pipes and cored holes and fill them with grout. Grout must comply 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) Vertical Inspection Pipes

Install vertical inspection pipes for acceptance testing as follows:

1. Inspection pipes must be schedule 40 PVC pipe with a nominal pipe size of 2 inches. Watertight PVC couplers are allowed to facilitate pipe lengths in excess of those commercially available. Log the location of the inspection pipe 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, parallel to the main reinforcement, and securely fastened in place to prevent misalignment during installation of the reinforcement and placing of concrete in the hole. Construct CIDH concrete piles such that the relative distance of inspection pipes to vertical steel reinforcement remains constant.
5. Fill inspection pipes with water upon completion of the concrete placement to prevent debonding of the pipe.
6. Inspection pipes must be completely clean, dry, and unobstructed at the time of testing providing a 2-inch diameter clear opening.
7. Provide safe access to the tops of the tubes.

After placing concrete and before requesting acceptance testing, test each inspection pipe in the presence of the Engineer by passing a 1-1/4-inch-diameter by 4.5-foot-long rigid cylinder through the length of pipe.

If an inspection pipe fails to pass the rigid cylinder:

1. Immediately fill all inspection pipes in the pile with water
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
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

Coring must not damage the pile 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. Preserve cores and identify them with the exact location the core was recovered from the pile.

The coring activity 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*. Coring logs must include core recovery, rock quality designation, 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 core logs. If the Department determines that a pile is anomalous based on the coring logs, the pile is rejected.

49-3.02A(4)(d)(iii) Gamma-Gamma Logging

The Department performs gamma-gamma logging 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 gamma-gamma logging activity.

If the Department determines that a pile is anomalous under California Test 233, part 5C, the pile is rejected.

49-3.02A(4)(d)(iv) Rejected Piles

If a pile is rejected:

1. Suspend concrete placement in the remaining piles
2. Revise the pile installation plan and submit it to the Engineer
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 additional tests to further evaluate a rejected pile. These tests may include crosshole sonic logging and other means of inspection selected by the Department. The pile acceptance test report will indicate if the Department intends to perform any additional testing and when the testing will be performed. Allow the Department 20 additional days for a total of 50 days to perform these tests and to provide supplemental results.

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 Department will deduct the amount shown in the table 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 that it is not feasible to repair the rejected pile, submit a mitigation plan for replacement or supplementation of the rejected pile.

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 not less than 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 not less than 675 pounds of cementitious material per cubic yard.

49-3.02B(3) Aggregate Gradings

For concrete placed under slurry, the combined aggregate grading must comply with the 1/2-inch maximum grading or the 3/8-inch maximum grading specified in section 90-1.02C(4).

49-3.02B(4) Permanent Steel Casings

Permanent steel casings must comply with section 49-2.02.

49-3.02B(5) Grout

Grout used to backfill casings must comply with section 50-1.02C except:

1. Minimum cement content of the grout must not be less than 845 lb/cu yd of grout.
2. Aggregate must be used to extend the grout. The aggregate must comply with the following:
   2.1 Aggregate must consist of at least 70 percent fine aggregate and approximately 30 percent pea gravel, by weight.
   2.2 Fine aggregate must comply with section 90-1.02C.
   2.3 Size of pea gravel must be such that 100 percent passes the 1/2-inch sieve, a minimum 90 percent passes the 3/8-inch sieve, and not more than 5 percent passes the no. 8 sieve.

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 near the bottom of the hole have consistent specified properties. Once consistent properties have been achieved, sample slurry at least twice per shift 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 near 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 near the bottom of the hole. Cleaning of the bottom of the hole and placement of the concrete must not start 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]

Property	Test method	Value
Density Before placement in the drilled hole and during drilling Before final cleaning and immediately before placing concrete	Mud Weight (Density), API 13B-1 section 1	64.3–69.1 pcf[b] 64.3–75.0 pcf[b]
Viscosity Bentonite Attapulgite	Marsh Funnel and Cup. API 13B-1, section 2.2	28–50 sec/qt 28–40 sec/qt
pH	Glass electrode pH meter or pH paper	8–10.5
Sand content Before final cleaning and immediately before placing concrete	Sand, API 13B-1, section 5	≤ 4.0 percent

[a]Slurry temperature must be at least 40 degrees 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.

Remove any caked slurry on the sides or bottom of hole before placing reinforcement.

When 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.

49-3.02B(6)(c) Synthetic Slurry

Synthetic slurry material and property 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.

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

Sample and test synthetic slurries:

1. When the slurry temperature is at least 40 degrees F.
2. At mid-height and near 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 before placing concrete.

49-3.02B(6)(d) Water Slurry

You may use water as slurry if a casing is used for the entire length of the drilled hole.

Water slurry properties must comply with the requirements shown in the following table:

Water Slurry Requirements

Property	Test	Value
Density Before final cleaning and immediately before placing concrete	Mud Weight (Density), API 13B-1 section 1	63.5 pcf [a]
Sand content Before final cleaning and immediately before placing concrete	Sand, API 13B-1, section 5	≤ 0.5 percent

[a]If authorized, you may use salt water slurry. The allowable density of the slurry may be increased by 2 pcf.

49-3.02B(7)–49-3.02B(10) Reserved

49-3.02C Construction

49-3.02C(1) General

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 that 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.

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 soften materials on the borehole walls.

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.

After placing reinforcement and before placing concrete in the hole, if caving occurs or deteriorated foundation material accumulates on the bottom of the hole, clean the bottom of the hole. You must verify that the bottom of the hole is clean.

Remove water that has infiltrated the hole before placing concrete. Do not allow fluvial or drainage water to enter the hole.

Portions of the hole may be enlarged, backfilled with slurry cement backfill, concrete, or other material, and redrilled to the diameter shown to control caving. 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 11-3 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. In a dewatered hole, maintain the concrete in the casing at a level of at least 5 feet above the bottom of the casing or (2) at a level above the bottom of the casing adequate to prevent displacement of the concrete by material from outside the casing, whichever is greater.

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.

49-3.02C(5) Permanent Steel Casing Installation

Section 49-2.01A(4)(b) does not apply to permanent steel casings.

For permanent steel casings placed in a drilled hole:

1. The casings must be watertight and of sufficient strength to prevent damage and to withstand the loads from installation activities, 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(6) Optional Construction Joint

Section 49-3.02C(6) applies to CIDH concrete piles where an optional construction joint is shown.

If you choose to construct the optional construction joint and 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, 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(5).

Section 49-2.01A(4)(b) does not apply to permanent casings.

49-3.02C(7) 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(8) Placing Concrete Under Slurry

Section 49-3.02C(8) applies if placing concrete under slurry.

After placing reinforcement and before placing concrete in the drilled hole, if drill cuttings settle out of the slurry, clean the bottom of 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. Vibrating of concrete is not required.

Placing concrete must be a continuous activity lasting no longer than the time specified for each concrete placing activity at each pile in your pile installation plan.

The delivery tube system must consist of one of the following:

1. A tremie tube or tubes, each of which is at least 10 inches in diameter, fed by one or more concrete pumps
2. One 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 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 activities. 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 will expel 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 10 feet above the piezometric head or within 12 inches of the top of the drilled hole, whichever is higher

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. The log must:

1. Show the pile location, tip 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 Label the graph with the pile location, tip elevation, cutoff elevation, and the dates of excavation and concrete placement.
   - 2.2 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.
   - 2.3 Take readings at each 5 feet of pile depth, and indicate the time of the reading on the graph.

If a temporary casing is used, maintain concrete placed under slurry at a level at least 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.

Dispose of material resulting from using slurry.

49-3.02D Payment

Not Used

49-3.03 DRIVEN STEEL SHELLS FILLED WITH CONCRETE AND REINFORCEMENT

49-3.03A General

49-3.03A(1) Summary

Section 49-3.03 includes specifications for constructing CIP concrete piles consisting of driven steel shells filled with concrete and reinforcement.

49-3.03A(2) Definitions

Reserved

49-3.03A(3) Submittals

Submit a cleanout method for open-ended steel shells as an informational submittal.

49-3.03A(4) Quality Control and 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 any soil, rock, or other material deleterious to the bond between concrete and steel before placing reinforcement and concrete.
4. The bottom 8 feet of the pile must not be cleaned out.

After the steel shell has been cleaned out, construct the pile expeditiously in order 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.

Where conditions render it impossible or inadvisable in the opinion of the Engineer 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

Driven steel shells filled with concrete and reinforcement are paid for as furnish piling and drive pile.

Payment for furnish piling includes:

1. Furnishing steel shells at the job site
2. Furnishing concrete
2. Furnishing reinforcement except for piles with a diameter of 24 inches or greater
3. Splicing steel shells

Payment for drive pile 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-end 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

49-4 STEEL SOLDIER PILING

49-4.01 GENERAL

Section 49-4 includes specifications for drilling holes and installing steel soldier piles in the drilled holes.

49-4.02 MATERIALS

49-4.02A General

Steel soldier piles must comply with section 49-2.03.

49-4.02B Concrete Anchors

Concrete anchors must comply with the specifications for stud connectors in section 55.

Stud connectors must be Type B complying with clause 7 of AWS D1.5.

49-4.03 CONSTRUCTION

49-4.03A General

Clean and prepare piles in heat affected areas before splicing steel piles or welding concrete anchors.

49-4.03B Drilled Holes

Drill holes for steel soldier piles into natural foundation material. Drilled holes must be accurately located, straight, and true.

Plumb and align the pile before placing concrete backfill and lean concrete backfill. The pile must be at least 1 inch 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.

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 activities 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).

Maintain alignment of the pile in the hole while placing backfill material.

49-4.04 PAYMENT

Not Used

49-5 MICROPILING

Reserved

49-6 ALTERNATIVE PILING

Reserved

49-7–49-10 RESERVED

50 PRESTRESSING CONCRETE

50-1.01 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 certifications and test samples to METS.

50-1.01C(2) Certifications

Submit the certifications specified in the following:

1. ASTM A 416/A 416M for uncoated seven-wire steel strand
2. ASTM A 722/A 722M for uncoated HS steel bars
3. ASTM A 882/A 882M 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 prestressing system proposed for use 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 sets for railroad bridges
2. 8 sets for railroad bridges if the project includes a BNSF Railway underpass
3. 4 sets for other structures

After initial review, submit from 6 to 12 sets to OSD, Documents Unit, as 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 must 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 multiframe 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 other structures

For railroad bridges, authorization of the shop drawings is contingent upon the drawings being satisfactory to the railway company involved.

50-1.01C(4) Test Samples

Submit test samples for the materials to be used 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.

Sample under the ASTM specified 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 bar or strand test sample.

Before submitting test samples to METS:

1. Identify each test sample by location and Contract number with weatherproof markings
2. Attach a completed *Sample Identification Card* to each test sample

Allow 45 days for the Department's testing.

Obtain the Department's authorization of the material before incorporating it into the work.

50-1.01D Quality Control and Assurance

50-1.01D(1) General

The following items must be on the Authorized Material List:

1. Post-tensioning prestressing systems
2. Organic zinc-rich primer

For accurate identification, (1) assign an individual lot number and (2) 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 Assurance Testing

The Department tests the 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:

1. Using Department-furnished load cells for post-tensioning of prestressing steel
2. Under California Test 677 for pretensioning prestressing steel

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.

50-1.01D(3) Equipment and Calibration

Equip each hydraulic jack used to tension prestressing steel with 2 pressure gages or 1 pressure gage and a load cell.

Each jack body must be permanently marked with the ram area.

Each pressure gage must be fully functional and have an accurately reading dial at least 6 inches in diameter.

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.

Calibrate jacking equipment as follows:

1. Calibrate each jack and its gage as a unit with the cylinder extension in the approximate position that it will be at the final jacking force.
2. 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:
    1.1. Schedule the calibration of the jacking equipment with METS
    1.2. Verify that the jack and supporting systems are complete, with proper components, and are in good operating condition
    1.3. Mechanically calibrate the gages with a dead weight tester or other authorized means before calibration of the jacking equipment by METS
    1.4. Provide enough labor, equipment, and material to (1) install and support the jacking and calibration equipment and (2) remove the equipment after the calibration is complete
    1.5. Plot the calibration results
3. 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 6 months of use and after each repair.

50-1.02 MATERIALS

50-1.02A General

Reserved

50-1.02B Prestressing Steel

Uncoated strand must comply with ASTM A 416/A 416M.

Epoxy-coated strand must comply with ASTM A 882/A 882M, grit impregnated coating, including Annex A1.

Bars must comply with ASTM A 722/A 722M, Type II, including all supplementary requirements, except the maximum weight requirements do not apply. The reduction of area of the bars with the 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. If the test sample does not meet this requirement, the heat of bars and lot of couplers represented by the sample will be rejected.
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 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 2 months.

The Engineer rejects prestressing steel that has sustained physical damage.

The Engineer may reject prestressing steel that has developed visible rust or other results of corrosion.

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, except admixtures (1) must not contain chloride ions in excess of 0.25 percent by weight and (2) may be dispensed in solid form.

Mix the grout as follows:

1. Add water to the mixer followed by cement and any admixture.
2. Mix the grout with mechanical mixing equipment that produces a uniform and thoroughly mixed grout.
3. Do not exceed 5 gallons of water per 94 lb of cement. Retempering of grout is not allowed.
4. Agitate the grout continuously until the grout is pumped.

The efflux time of grout immediately after mixing must be at least 11 seconds.

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 diameter of at least:
   9.1. 2.5 times the net area of the prestressing steel for multistrand tendons that will be placed by the pull-through method
   9.2. 2.0 times the net area of the prestressing steel for multistrand tendons that will not be placed by the pull-through method
10. Have an inside diameter of at least 3/8 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. Place vents within 6 feet of every high point in the duct profile. 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 must 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 Flushing Water

Water used for flushing ducts must contain 0.1 pound of quicklime (calcium oxide) or slaked lime (calcium hydroxide) per gallon of water. Use only oil-free compressed air to blow out ducts.

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 handling, installation, or cutting of ends, under ASTM A 882/A 882M.

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 to prevent water or debris from entering.

50-1.03B Prestressing

50-1.03B(1) General

Tension the prestressing steel using hydraulic jacks. The force in the prestressing steel must be at least the value shown.

50-1.03B(2) Post-Tensioned Members

50-1.03B(2)(a) General

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 before placing the forms.

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.

The Engineer must witness all demonstrations.

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 strength 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 precast members, do not install prestressing steel for post-tensioning until the steam curing is completed.

If non-epoxy-coated prestressing steel is installed in the ducts after completion of concrete curing, and 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 following installation.

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.

The anchorage system for post-tensioning must:

1. Hold 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

You may omit the 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 unless a greater embedment is shown. 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.

Distribute the anchorage load to the concrete by using a post-tensioning system.

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 must be clean and free from water and deleterious materials that would impair bonding of the grout or interfere with grouting procedures.

Grout must pass through a screen with 0.07-inch maximum clear openings before being introduced into the grout pump.

Prevent the leakage of grout through the anchorage assembly by positive mechanical means.

Pump grout through the duct as follows:

1. Continuously waste grout at the outlet until no visible slugs or other evidence of water or air is ejected and the efflux time of ejected grout is at least 11 seconds
2. Close the outlet valve and hold the pumping pressure momentarily
3. Close the valve at the inlet while maintaining the pressure

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 ducts from damage by freezing.

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 gage having a full-scale reading of not more than 300 psi

Where vents are required, furnish standby flushing equipment capable of developing a pumping pressure of 250 psi and of sufficient capacity to flush out any partially grouted ducts.

Fit grout injection pipes, ejection pipes, and vents with positive mechanical shutoff valves capable of withstanding the pumping pressures. Do not remove or open valves until the grout has set. If authorized, you may substitute mechanical valves with suitable alternatives after demonstrating their effectiveness.

50-1.03B(3) Pretensioned Members

If prestressing steel for pretensioning is placed in the stressing bed and is exposed to the elements for more than 36 hours before encasement in concrete, protect the steel from contamination or 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 for loss of prestress not more than 48 hours before placing concrete for the members, using authorized methods and equipment. 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.

Perform the cutting and releasing of prestressing steel in pretensioned members in such an order that lateral eccentricity of prestress is a minimum.

Anchor the prestressing steel at stresses that will result in the ultimate retention of jacking forces at least equal to those shown.

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 application of organic zinc-rich primer to the surfaces, except apply 2 applications 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.

50-1.04 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, including bridges, approach slabs, culverts, retaining walls, minor structures, and other structures.

Sliding joints, waterstops, and strip waterstops must comply with section 51-2.

Elastomeric bearing pads must comply with section 51-3.

Falsework for constructing concrete structures must comply with section 48-2.

You may use RSC 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.

pier column: Extension of a column or pier into bedrock material.

51-1.01C Submittals

51-1.01C(1) General

If requested, submit concrete form design and materials data for each forming system.

Submit a deck placement work plan for concrete bridge decks.

For colored concrete, submit technical data, manufacturer's specifications, and a work plan for mixing, delivery, placement, finishing, and curing of the concrete.

51-1.01C(2) Permanent Steel Deck Forms

Submit 3 sets 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 grading
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 a certificate of compliance for chemical adhesive stating compliance with ICBO AC 58 and Caltrans Augmentation/Revisions to ICBO AC 58. Revisions to ICBO AC 58 are on the Authorized Material List.

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
5. Current ICBO evaluation report number

51-1.01D Quality Control and Assurance

51-1.01D(1) General

Reserved

51-1.01D(2) Rapid Strength Concrete

Prequalify RSC before use. Prequalification of a RSC mix design includes determining the opening age and attaining the minimum specified 28-day compressive strength.

Prequalify RSC under section 90-1.01D(5)(b).

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 1,200 psi. Not more than 2 test cylinders may have a strength of less than 1,150 psi.

If compressive strength tests performed in the field show that the concrete has attained the specified average 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(3) 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(4) Testing Roadway Surfaces

51-1.01D(4)(a) General

The Engineer tests roadway surfaces for smoothness, coefficient of friction, and crack intensity.

51-1.01D(4)(b) Surface Smoothness

The Engineer tests the surface smoothness of the following:

1. Completed roadway 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

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.

Surface smoothness is tested using a 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.

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

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 reinforcing steel to less than 1-1/2 inches.

Replace portions of decks that cannot be corrected by grinding.

51-1.01D(4)(c) 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.

If portions of completed deck surfaces or approach slabs have a coefficient of friction of less than 0.35, those portions must be ground to produce a coefficient of friction of not less than 0.35 or grooved parallel to the center line. Grinding and grooving must comply with section 42.

51-1.01D(4)(d) 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 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 15-5.05. 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.

51-1.01D(5) Chemical Adhesives

Chemical adhesives for bonding dowels must be on the Authorized Material List. The chemical adhesive must be appropriate for the installation conditions.

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 min, 800 max
Roof sections of exposed top box culverts	675 min, 800 max
Pier columns	675 min, 800 max
Seal courses	675 min
Other portions of structures	590 min, 800 max
Concrete for PC members	590 min, 925 max

Except for minor structures, the minimum required compressive strength for concrete in structures or portions of structures is the strength described or 3,600 psi at 28 days, 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 (water activated) or dual component (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:

Property	Test method	Requirement
Compressive strength at: 3 hours 24 hours	California Test 551	 21 MPa min 35 MPa min
Flexural strength at 24 hours	California Test 551	3.5 MPa min
Bond strength at 24 hours: Saturated surface dry concrete Dry concrete	California Test 551	 2.1 MPa min 2.8 MPa min
Water absorption	California Test 551	10 percent max
Abrasion resistance at 24 hours	California Test 550	25 g max
Drying shrinkage at 4 days	ASTM C 596	0.13 percent max
Soluble chlorides by weight	California Test 422	0.05 percent max
Water soluble sulfates by weight	California Test 417	0.25 percent max

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 amount 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 of iron oxides complying with ASTM C 979. 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 Miscellaneous Metal

Materials for access opening covers for new structures must comply with section 75-1.03.

51-1.02I Miscellaneous Materials

Plastic pipe for deck bleeder drains must be schedule 40 PVC complying with ASTM D 1785.

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.

You may precast structural elements not designated as PC members if authorized. If requested, submit shop drawings for proposed PC members. Include construction joint details, foundation bedding, and other requested information.

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.

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. Payment for additional structure excavation and structure backfill resulting from these changes is made under section 19-3.04.

The Department does not pay for additional costs due to fabricating or performing other related work before the final foundation configuration is determined.

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.

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.

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 A 653/A 653M, Designation SS, Grades 33 through 80, coating designation G165.

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 physical design properties under "Design of Cold-Formed Steel Structural Members" of the AISC *Steel Manual*.

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.

Consolidate concrete using high-frequency vibrators within 15 minutes of placement. Do not use vibrators for pipe culvert headwalls and endwalls, slope paving and aprons, and concrete placed under water. 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.

You may use external vibrators only if consolidation by other means is not possible. Forms must be sufficiently rigid to resist displacement or damage. The use of external vibrators must be authorized.

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.

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.

51-1.03E 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), the drilled hole diameter and depth must comply with the ICBO evaluation report for the size of dowel being installed unless otherwise shown. Increase the drilled hole depth specified in the ICBO evaluation report by 50 percent when dowels are epoxy coated.

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.

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 except that galvanizing is not required.

51-1.03E(11) 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, mud, debris, and loose material.

51-1.03E(12) Diaphragm Bolsters

Reserved

51-1.03E(13) 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 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.

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

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. Use power carborundum stones or disks to remove bulges and other imperfections.

Do not apply Class 1 surface finish until a uniform appearance can be attained.

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.

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

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 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

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.

Complete the smoothness testing and any required grinding before applying seal coats.

Finish bridge decks to be covered with membrane seals to a smooth surface free of mortar ridges and other projections. The coefficient of friction requirements do not apply for these bridge decks.

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.

51-1.03F(5)(b) Bridge Deck Surface Texture

Reserved

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.

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.

Construct a test panel for each type of concrete surface texture shown.

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:

Property	Test	Requirement
Shore A hardness	ASTM D 2240	50–90
Tensile strength	ASTM D 412	1,000 psi min

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 form release agents recommended by the form liner manufacturer. Release agents 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 the following:

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.

When 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 is change order work.

For RSC using portland cement:

1. Cure the concrete using the curing compound method. Fogging of the surface with water after the curing compound has been applied is not required.
2. Immediately repair any damage to the film of the curing compound with additional curing compound. Do not repair damage to the curing compound after the concrete is opened to traffic.
3. Cover the surface with an insulating layer or blanket when the ambient temperature is below 65 degrees F during the curing period. The insulation layer or blanket must have the R-value rating shown in the table below. A heating tent may be used instead of or in combination with the insulating layer or blanket.

Temperature range during curing period (°F)	R-value rating, min
55–65	1
45–55	2
39–45	3

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

If concrete involved in bridge work is not designated by type and is not otherwise paid for under a separate bid item, the concrete is paid for as structural concrete, bridge.

The Department does not deduct the volume of bar reinforcing steel, structural steel, prestressing materials, or piling from the structural concrete quantity.

For seal course concrete, the maximum volume to be paid is the volume contained between vertical planes 1 foot outside the neat lines of the seal course shown. No adjustment to unit price is made for increases or decreases in the quantity of seal course concrete.

Payment for bar reinforcing steel, structure excavation, and structure backfill used in constructing structural concrete for sound walls is included in the payment for structural concrete (sound wall).

Payment for structure excavation and structure backfill used in constructing structural concrete for box culverts is included in the payment for structural concrete, box culvert.

Structural concrete for pier columns is measured as follows:

1. Horizontal limits are vertical planes at the neat lines of the pier column shown.
2. Bottom limit is the bottom of the foundation excavation in the completed work.
3. Upper limit is the top of the pier column concrete as shown.

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 snow plow deflectors.

51-2.01A(4) Quality Control and Assurance

Reserved

51-2.01B Materials

51-2.01B(1) General

Premolded expansion joint filler must comply with ASTM D 1751.

Expanded polystyrene must be commercially available polystyrene board with (1) a flexural strength of at least 35 psi when tested under ASTM C 203 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) Expansion Joint Armor

Fabricate expansion joint armor from steel plates, angles, or other structural shapes under section 75. Shape the armor to the section of the concrete deck and match-mark it in the shop.

51-2.01B(3) Snowplow Deflectors

Snowplow deflectors must consist of ultra-high-molecular-weight polyethylene plates with anchorage devices.

Anchorage devices must comply with ASTM A 276, type UNS S32205 or S31803.

Ultra-high-molecular-weight polyethylene plates must be UV stabilized and comply with ASTM D 4020 and the requirements shown the following table:

Property	Test method	Requirement
Density	ASTM D 792	58 pcf, min
Tensile strength, ultimate	ASTM D 638	5,800 psi, min
Tensile strength, yield	ASTM D 638	2,750 psi, min
Elongation at break	ASTM D 638	290%
Hardness	ASTM D 2240, Shore D	60 min

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 75-1.03.

51-2.01C Construction

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.

Straighten warped sections of expansion joint armor before placing. Use positive methods to hold assemblies in the correct position during concrete placement.

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 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 Control and 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 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 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 Control and Assurance

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:

Property	Test method	Requirement
Modulus at 150 percent elongation	California Test 435	8–75 psi
Recovery	California Test 435	21/32 inch max
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	California Test 435	4.5–12.0 mm

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.

Cut grooves in the concrete using saws having diamond blades with at least a 3/16-inch thickness. The 1st pass depth for groove sides must be at least 2 inches. The top width must be within 1/8 inch of specified width and the bottom width must not vary from the top by more than 1/16 inch for every 2 inches of depth.

Cutting grooves in existing decks includes cutting 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 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 joint seal test samples selected by the Engineer for testing with certificates of compliance at least 30 days before use.

51-2.02C(1)(d) Quality Control and Assurance

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(2) Materials

Preformed elastomeric joint seals must:

1. Comply with ASTM D 2628
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 a 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 locations and methods 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 D 4070.

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 surfaces 1/2 inch from either edge of the groove 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 a MR of 4 inches or less.

Joint seal assemblies with a 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 sets 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 sets, 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 set to OSD, Documents Unit, for each joint seal assembly within 20 days of final authorization.

51-2.02D(1)(d) Quality Control and Assurance

Reserved

51-2.02D(2) Materials

51-2.02D(2)(a) General

Metal parts must comply with section 75-1.03.

Bolts, nuts, and washers must comply with ASTM A 325.

Sheet neoprene must comply with the specifications for neoprene in section 51-2.04. 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 75-1.03, metal parts may comply with ASTM A 572/A 572M.

Elastomer must be neoprene complying with the requirements shown in Table 1 of ASTM D 2628, except recovery and compression-deflection tests are not required, and the requirements shown in the following table:

Property	Test method	Requirement
Hardness, Type A durometer	ASTM D 2240 (modified)	55–70 points
Compression set, 70 hours at 100 °C	ASTM D 395 (modified)	40 percent max

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.

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. Do not damage the installed elastomer during construction activities.

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 a MR over 4 inches.

Joint seal assemblies and seismic joints consist of metal or metal and elastomeric assemblies that are anchored or cast into a recess in the concrete over the joint.

Joint seal assemblies must consist of a metal frame system, supporting rails, and support bars with intervening neoprene glands.

Joint seal assemblies will not be authorized without evidence of 1 year of satisfactory service under similar conditions.

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)(b) Definitions

Reserved

51-2.02E(1)(c) Submittals

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.

After review, submit 6 to 12 sets, 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.

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.

Submit 1 corrected set to OSD, Documents Unit, for each joint seal assembly within 20 days of authorization.

Submit a certificate of compliance for each shipment of joint seal assembly materials.

51-2.02E(1)(d) Quality Control and Assurance

Reserved

51-2.02E(1)(e) 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.

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 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.

The assembly must have CIP anchorage components that form a mechanical connection between the joint components and the concrete deck.

51-2.02E(2) Materials

Neoprene glands must comply with the requirements shown in Table 1 of ASTM D 2628, except recovery and compression-deflection tests are not required, and the requirements shown in the following table:

Property	Test method	Requirement
Hardness, Type A durometer	ASTM D 2240 (modified)	55–70 points
Compression set, 70 hours at 100 °C	ASTM D 395 (modified)	40 percent max

Metal parts of the joint seal assembly must comply with section 75-1.03 or ASTM A 572/A 572M. Bolts, nuts, and washers must comply with the specifications for HS steel fastener assemblies in section 75-1.02.

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 at the fabrication site.

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. Assemblies must be capable of adjustment to the "a" dimension shown.

Deck surfaces must comply with section 51-1.03F(5) before placing joint seal assemblies and anchorages.

The assembly must be completely shop-assembled and placed in 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.

Vertical expansion joints in barriers must be accessible for inspection after recess concrete is placed.

Assemblies must make 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

Submit 5 sets 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 sets, as requested, for final authorization and use during construction.

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.

Submit certificates of compliance for materials used in the joint seals.

Submit a copy of the certified test report for binder material.

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 Control and Assurance

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:

Property	Test method	Requirement
Asphalt compatibility	ASTM D 5329	Pass
Bond, nonimmersed	ASTM D 5329	Pass 3 cycles at -20 °F, 50% Pass 3 cycles at 0 °F, 100%
Cone penetration, nonimmersed	ASTM D 5329 (modified)	1 mm min at 0 ± 2 °F, 200 g total weight, 60 seconds 9 mm max at 77 ± 2 °F, 150 g total weight, 5 seconds
Ductility	ASTM D 113	40 cm min at 77 ± 2 °F
Flexibility	ASTM D 5329[a]	Pass at 10 ± 2 °F
Flow	ASTM D 5329	3 mm max at 140 ± 2 °F, 5 hours
Resilience	ASTM D 5329	40% min at 77 ± 2 °F
Softening point	ASTM D 36	180 °F min
Tensile adhesion	ASTM D 5329	550% min
Safe heating temperature		390–410 °F
Recommended pouring temperature		360–390 °F

[a]Do not oven age specimens. After 24 hours at standard conditions, allow specimens to condition at -10 ± 2 degrees 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 A 36/A 36M.

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. Dispose of removed materials.

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 when 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 feet/second. 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 51-2.04.

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.

Waterstops must comply with the cross section and minimum dimensions shown.

51-2.04A(2) Definitions

Reserved

51-2.04A(3) Submittals

Submit a certificate of compliance for waterstop material stating compliance with paragraph 6 of Army Corps of Engineers CRD-C 572.

51-2.04A(4) Quality Control and 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:

Property	Test method	Requirement
Tensile strength	ASTM D 412	2,000 psi min
Ultimate elongation	ASTM D 412	300 percent min
Compression set, 22 hours at 70 °C	ASTM D 395, Method B	30 percent max
Tear strength	ASTM D 624, Die C	26 kN/m min
Hardness, Type A	ASTM D 2240	55 ± 5
Ozone resistance 20% strain, 100 hours at 100 ± 2.2 °F	ASTM D 1149 except 100 ± 20 parts per 100,000,000	No cracks
Brittleness temperature at -40 °C	ASTM D 746, Procedure B	Pass
Flame propagation	ASTM C 542	Must not propagate flame
Change in volume, IRM 903, immersed 70 hours at 100 °C	ASTM D 471	80 percent max
Change in mass, immersed 7 days at 70 °C	ASTM D 471	15 percent max

After accelerated aging under ASTM D 573 for 70 hours at 100 degrees C, the elastomer must not show property changes greater than those shown in the following table:

Property	Requirement
Tensile strength	-15 percent
Elongation at break	-40 percent
Hardness	+10 points

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. 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.

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.

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

Section 51-3 includes specifications for fabricating and installing bearings.

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) Plain Elastomeric Bearing Pads

For plain elastomeric bearing pads, submit:

1. Certificate of compliance with certified test results for the elastomer
2. Elastomeric bearing pad test samples at least 30 days before use

51-3.02A(3)(c) Steel-Reinforced Elastomeric Bearing Pads

Submit a certificate of compliance with certified test results from the bearing manufacturer for 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(4) Quality Control and Assurance

51-3.02A(4)(a) General

Reserved

51-3.02A(4)(b) 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. Furnish additional pads to replace the pads selected for testing.

The Department takes specimens from the test sample pads, prepares them by cutting and grinding and tests them for tensile strength, elongation, tear strength, and ozone resistance.

51-3.02A(4)(c) Steel-Reinforced Elastomeric Bearing Pads

The Department tests a specimen taken from the test sample steel-reinforced bearing pad under California Test 663. 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 D 4014, Type CR, Grade 3, with a shear modulus of 110 ± 10 psi.

The elastomer must comply with the requirements shown in the following table:

Property	Test method	Requirement
Tensile strength	ASTM D 412	2,250 psi min
Ultimate elongation	ASTM D 412	350 percent min
Compression set, 22 hours at 70 °C	ASTM D 395, Method B	25 percent max
Tear strength	ASTM D 624, Die C	31.5 kN/m min
Hardness, Type A	ASTM D 2240 with 2 kg mass	55 ± 5
Ozone resistance 20% strain, 100 hours at 40 ± 2 °C	ASTM D 1149 except 100 ± 20 parts per 100,000,000	No cracks
Instantaneous thermal stiffening at -40 °C	ASTM D 1043	Not more than 4 times the stiffness measured at 23 °C
Low temperature brittleness at -40 °C	ASTM D 746, Procedure B	Pass

After accelerated aging under ASTM D 573 for 70 hours at 100 degrees C, the elastomer must not show property changes greater than those shown in the following table:

Property	Change
Tensile strength	15 percent loss
Ultimate elongation	40 percent loss; but not less than 300 percent total elongation of the material
Hardness	+10 points

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 D 4014 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 gage). 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

Reserved

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 PC concrete members.

You may construct PC PS concrete bridge members using segmental construction.

51-4.01B Definitions

Reserved

51-4.01C Submittals

51-4.01C(1) General

Submit shop drawings for PC concrete members.

51-4.01C(2) 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 at the time of 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.

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 segmental girder construction, shop drawings must include the following additional information:

1. Details showing construction joints
2. Concrete form and casting details
3. Arrangement of bar reinforcing steel, prestressing tendons, and pressure-grouting pipe
4. Materials and methods for making closures
5. Construction joint keys and surface treatment
6. Other requested information

51-4.01C(3) Closure Wall Panels

Submit 2 sets 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(4) 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.

Submit a certificate of compliance signed by the manufacturer's QC representative for each shipment.

51-4.01D Quality Control and Assurance

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.

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 manufacturer of box culverts must sample and test the concrete for compressive strength at least once every production shift but not less than once daily. Test result records must be available to the Engineer during regular work shifts.

51-4.02 MATERIALS

51-4.02A General

Prestressing must comply with section 50.

Reinforcement must comply with section 52.

In a freeze-thaw area, epoxy coat the reinforcement under section 52-2.02.

Bearing plates, threaded inserts, and other metal fittings must comply with section 75-1.03

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 C 1107.

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.

51-4.02B Fabricating Precast Concrete Members

51-4.02B(1) General

Reserved

51-4.02B(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. Additionally, 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 construction, materials for construction joints at exterior girders must match the color and texture of the adjoining concrete.

51-4.02B(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 6th and 7th paragraphs of section 51-1.01D(4)(b) do not apply.

51-4.02B(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 75-1.03. Bolt holes must comply with section 55-1.02B(6)(b) except holes must not be punched full size.

51-4.02B(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.

51-4.02B(6) Lagging

Concrete for PC concrete lagging in a freeze-thaw area 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.

51-4.02B(7) Deck Panels

Reserved

51-4.02C Curing Precast Concrete Members

Cure PC concrete members under section 90-4.03.

51-4.03 CONSTRUCTION

51-4.03A General

Reserved

51-4.03B Girders, Box Girders, and Double T Girders

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.

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 must be 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 and flush with water. Allow to dry to a surface dry condition immediately before placing the grout.

Do not place equipment or other loads on spans that have been grouted for at least 72 hours after grouting. Do not tension or tighten transverse post-tensioning tendons until 24 hours after grouting the last keyway.

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 a 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 65-2.03D.

Joints must comply with the specifications for cement mortar or resilient material joints in section 65-2.02E. You may use an external sealing band complying with ASTM C 877 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

51-4.04 PAYMENT

Except for piling, furnishing of PC concrete members includes payment for delivery to the job site ready to incorporate into the work.

Erect PC concrete members includes payment for erection into the final position in the work.

Diaphragm dowels and bolts in PC concrete members are paid for as bar reinforcing steel (bridge).

PC concrete lagging is measured based on the gross wall area dimensions shown. No deduction is made for spacing between lagging or openings for drainage piping.

PC concrete box culvert is measured as specified for reinforced concrete pipe in section 65-2.04.

Concrete closure walls are measured on the outside surface of completed panels.

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 systems must comply with section 68-7.

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 Control and 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) 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 operations. 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 D 4355 with 500 hours exposure
3. Comply with the requirements shown in the following table:

Property	Test method	Requirement
Weight	ASTM D 3776	3 oz/sq yd min
Grab breaking load	ASTM D 4632	50 lb min
Apparent elongation	ASTM D 4632	35 percent min
Toughness[a]	--	1,200 lb min

[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 grading must comply with the requirements shown in the following table:

Sieve size	Percentage passing
1/2-inch	100
No. 16	0–5

In freeze-thaw areas, 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. Grading must comply with the 3/4-inch maximum grading 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 75-1.03.

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 75-1.03.

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 section 39. Aggregate grading must be 3/4-inch HMA Types A or B. Asphalt binder must comply with the specifications for liquid asphalt SC-800 in section 93. The quantity of asphalt binder mixed with aggregate must be 0.3 percent less than the OBC as determined under California Test 367.

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 concrete surfaces and thoroughly clean joints immediately before placing seals. Joint surfaces must be dry at the time 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

Construct the treated permeable base under section 29.

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.

Structure excavation and backfill must comply with section 19-3.

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.

51-5.03D(2) Removal of Existing Facilities

Remove portions of existing structures, pavement and base, approach slabs, HMA 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 15-4.

Sawcut 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 HMA, cut the outlines of excavations in HMA 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 HMA over AB.

Keep a standby quantity of HMA and AB at the job site for a temporary roadway structural section.

Spread and compact the AB and HMA. 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 HMA 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.

51-5.04 PAYMENT

The quantity of aggregate base (approach slab) to be paid includes the actual volume used to fill voids below approach slab concrete. No payment is made for AB placed to fill 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 must 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 Control and 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) 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

Not Used

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 system within mass concrete elements. 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. Use a nonshrink grout mix complying with ASTM C 1107 and ASTM C 827 for 0.0 percent shrinkage and 0.0 percent minimum and 4.0 percent maximum expansion. 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.

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.

You may use PC drainage inlets as an alternative to CIP drainage inlets.

Earthwork must comply with section 19-3.

51-7.01B Materials

Concrete for pipe headwalls, endwalls, drainage inlets, and structures identified as minor structures must comply with the specifications for minor concrete.

Bar reinforcing steel must comply with section 52.

Metal frames, covers, grates, and other miscellaneous iron and steel used with minor structures must comply with section 75-1.02.

51-7.01C Construction

PC units for drainage inlets must be round, oval, or rectangular 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.

You may construct forms for drainage inlets using any material that produces the interior dimensions and wall thicknesses shown. Undulations of interior wall surfaces must not exceed 1/2 inch. Extend the outside forms at least 5 inches below the top of the inlet. You may place concrete against excavated earth below this depth except 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.

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 for minor structures designated as final pay on the Bid Item List when the constructed height of the minor structure is within 6 inches of the vertical dimension shown.

Metal frames and covers or frames and grates are not included in the payment for minor structures.

51-7.02 PRECAST DRAINAGE INLETS

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:

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
3. 150 count, or fraction thereof, of headed bar reinforcement for each:
   3.1 Bar size
   3.2 Head size
   3.3 Head type
   3.4 Method of manufacture
   3.5 Heat number of bar material
   3.6 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.

52-1.01C Submittals

52-1.01C(1) General

Reserved

52-1.01C(2) Certificate of Compliance

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

52-1.01C(3) Shop Drawings

52-1.01C(3)(a) General

Shop drawings and calculations must be sealed and signed by an engineer who is registered as a civil engineer in the State.

52-1.01C(3)(b) Temporary Support System

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.

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

52-1.01D Quality Control and 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 A 706/A 706M, except you may use deformed or plain bars complying with ASTM A 615/A 615M, Grade 40 or 60, as reinforcement in the following:

1. Slope and channel paving
2. Minor structures
3. Sign and signal foundations
4. Roadside rest facilities
5. Concrete barrier Type 50 and 60

You may use plain bars complying with ASTM A 706/A 706M 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

Substituted welded wire reinforcement must be on an equivalent area basis and placed as ordered. 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 A 185/A 185M or ASTM A 497/A 497M.

52-1.02D Reinforcing Wire

Reinforcing wire must comply with ASTM A 82/A 82M.

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 strong enough 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 ordered 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.

Unless otherwise shown, anchor each unit of wire spiral reinforcement at both ends by a 135-degree hook with a 6-inch tail hooked around an intersecting longitudinal bar. 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 spiral reinforcement under section 52-6. Lap splices in spiral reinforcement must be lapped at least 80 wire diameters.

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 placed as described.

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 Department considers (1) the cross sectional area of reinforcing wire, in hundredths of square inches, to be equal to its W-size number and (2) the density of reinforcing wire to be 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.

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) 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. 4 ounces
2. Packaged in an airtight container
3. Identified with the manufacturer's name and batch number

52-2.01A(3)(c) 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. 4 ounces
2. Packaged in an airtight container
3. Identified with the manufacturer's name and batch number

52-2.01A(3)(d) Quality Assurance Test Samples

Submit test samples of epoxy-coated reinforcement and epoxy-coated prefabricated reinforcement to METS.

52-2.01A(4) Quality Control and Assurance

The following must be on the Authorized Material List:

1. Epoxy powder
2. Corrosion protection covering for splices

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.

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, when 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

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 A 775/A 775M for bar reinforcement or ASTM A 884/A 884M, Class A, Type 1, for wire reinforcement
2. All certifications specified in ASTM A 775/A 775M for bar reinforcement or ASTM A 884/A 884M for wire reinforcement

Perform qualification testing and certifications required by ASTM A 775/A 775M and ASTM A 884/A 884M at an authorized laboratory.

Submit a certificate of compliance for the patching material that includes 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 Control and Assurance

Furnish two 30-inch test samples of each size from each shipment of epoxy-coated reinforcement to the job site.

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

The Department tests the test samples.

Test samples must comply with the requirements for coating thickness and coating adhesion specified in ASTM A 775/A 775M for bar reinforcement or ASTM A 884/A 884M 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 A 775/A 775M for bar reinforcement
2. ASTM A 884/A 884M, Class A, Type 1, for wire reinforcement

Fabrication and job site handling of epoxy-coated bar reinforcement must comply with ASTM D 3963/D 3963M.

Coating must be light green.

52-2.02C Construction

If damage to the coating occurs during field bending, patch the area immediately.

Job site practices must comply with sections X1.3.1 through X1.3.15 of appendix X1 of ASTM A 884/A 884M for wire reinforcement, except replace the term "should" with the term "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

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 A 934/A 934M for bar reinforcement or ASTM A 884/A 884M Class A, Type 2 for wire reinforcement
2. All certifications specified in ASTM A 934/A 934M for bar reinforcement or ASTM A 884/A 884M for wire reinforcement

Perform qualification testing and certification required by ASTM A 934/A 934M and ASTM A 884/A 884M at an authorized laboratory.

Submit a certificate of compliance for the patching material that includes 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.

52-2.03A(4) Quality Control and Assurance

Furnish two 30-inch-long test samples of each size from each shipment to the job site of epoxy-coated prefabricated 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

The Department tests the test samples.

Test samples must comply with the requirements for coating thickness and coating adhesion specified in ASTM A 934/A 934M for bar reinforcement or ASTM A 884/A 884M 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 A 934/A 934M for bar reinforcement
2. ASTM A 884/A 884M, 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 practices must comply with sections X2.3.1 through X2.3.15 of appendix X2 of ASTM A 934/A 934M for bar reinforcement, except replace the term "should" with the term "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 A 767/A 767M, Class 1, except chromating is not required.

52-3.03 CONSTRUCTION

Job site practices must comply with sections X1.3.1 through X1.3.12 of appendix X1 of ASTM A 767/A 767M for bar reinforcement, except replace the term "should" with the term "must."

52-3.04 PAYMENT

Not Used

52-4 STAINLESS STEEL BAR REINFORCEMENT

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

visible necking: Visible decrease in the test sample's cross sectional area at the point of fracture.

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 for service splices and ultimate butt splices under section 52-6.01C(4).

52-5.01C(2) Certificate of Compliance

Submit a certificate of compliance for each shipment of headed bar reinforcement. Include with the submittal copies of:

1. Mill test reports for the:
   1.1. Bar reinforcement
   1.2. Head material
2. Production test reports
3. Daily production logs

52-5.01C(3) Production Test Report

Submit a production test report prepared by the laboratory performing the testing. The report must be signed by an engineer who represents the laboratory and is registered as a civil engineer in the State.

For each test, the 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

52-5.01D Quality Control and Assurance

52-5.01D(1) General

Headed bar reinforcement must have full size heads and must be on the Authorized Material List.

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).

Section 11-3.02 does not apply to headed bar reinforcement.

Welding, welder qualifications, and inspection of welding must comply with AWS C6.1.

52-5.01D(2) Daily Production Log

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 material and head material used in each production lot
4. Fabrication records, including tracking and production parameters for welds or forgings

52-5.01D(3) Production Testing

A production 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.

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 being notified, the Engineer randomly selects the 4 test samples to be removed from the lot by you and places tamper-proof markings or seals on them.

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.

A test sample will be rejected if the tamper-proof marking or seal is disturbed before testing.

Before transporting test samples to an authorized laboratory:

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

Tensile test headed bar reinforcement test samples:

1. At a laboratory on the Authorized Laboratory List
2. In the condition received
3. Under ASTM A 970/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 rupture, headed bar reinforcement test samples must comply with the requirements specified in section 52-5.02 as follows:

1. If only 1 splice test sample complies with the requirements, the Department rejects all headed bar reinforcement in the lot.
2. If only 2 splice 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 splice 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 attain the specified minimum tensile strength, the Department rejects all headed bar reinforcement in the lot.
3. If 3 or more splice 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 in a way that allows accurate identification at the job site.

52-5.02 MATERIALS

Headed bar reinforcement must comply with ASTM A 970/A970M.

At rupture, headed bar reinforcement must:

1. Comply with the tensile requirements of ASTM A 970/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. The parameters to be recorded include:

1. Friction welding force
2. Forge force
3. Rotational speed
4. Friction upset distance and time
5. Forge upset distance and time

52-5.03 CONSTRUCTION

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 when headed bar reinforcement is to be epoxy coated.

52-5.04 PAYMENT

The payment quantity of headed bar reinforcement is the quantity of heads only.

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

Reserved

52-6.01C Submittals

52-6.01C(1) General

Section 52-6.01C applies if service splices or ultimate butt splices are used in the work.

52-6.01C(2) Certificate of Compliance

Submit a certificate of compliance for each shipment of 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
4. For resistance-butt-welded material:
   - 4.1. Heat number
   - 4.2. Lot number
   - 4.3. Mill certificates

52-6.01C(3) Welder and Welding Procedures Qualifications

Submit welder and welding procedure qualifications as an informational submittal.

52-6.01C(4) Splice Prequalification Report

For each splice type to be used in the work, submit a splice prequalification report for service splices and ultimate butt splices that includes:

1. Copy of the coupler 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

52-6.01C(5) Weld Flash Removal Process

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.

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

52-6.01C(6) Production Test Report

Submit a production test report for each lot prepared by the laboratory performing the testing. The report must be signed by an engineer who represents the laboratory and is registered as a civil engineer in the State.

Allow 3 business days for the Engineer's review.

Each report must include:

1. Lot number and location
2. Bar size
3. Splice type
4. Mechanical splice length
5. Test specimen length
6. Physical condition of splice test sample
7. Notable defects
8. Total measured slip
9. Ultimate tensile strength of each splice
10. For ultimate butt splices:
    10.1. Location of visible necking area
    10.2. Largest measured strain

You may encase splices in concrete:

1. After submitting the production test report for review
2. Before receiving notification from the Engineer that the production test report is authorized
3. Before submitting the production test report for review for splices made vertically at the job site in or above their final positions for bar reinforcement of columns or CIP concrete piles

52-6.01C(7) Quality Assurance Test Samples

Submit test samples for QA testing to METS.

Include copies of the certificates of compliance with the QA test samples for mechanical splices and resistance-butt-welded splices.

52-6.01C(8) Splice Rejection Report

For a rejected lot, submit a splice rejection report.

Allow 3 business days for the Engineer's review.

52-6.01C(9) Radiographic Film Developing Process Records

If requested, submit records of radiographic film developing processes and any chemical changes to the developing processes.

52-6.01D Quality Control and Assurance

52-6.01D(1) General

Section 52-6.01D applies if service splices or ultimate butt splices are used in the work.

Assign a splicing QC manager.

If a lot of splices is rejected, do not use the rejected lot or any subsequent lots until:

1. QC manager performs a complete review of your QC process for these splices
2. You prepare a splice rejection report describing the cause of the failure for the splices in the rejected lot and provisions for preventing similar failures in future lots
3. Engineer has notified you that the splice rejection report is authorized

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.

The following must be on the Authorized Material List:

1. Mechanical couplers
2. Fabricators of resistance-butt-welded splices

You may encase splices in concrete before receiving notification of the QA test results from the Engineer.

If you encase any splices in concrete before receiving notification from the Engineer, you will not be relieved of your responsibility for incorporating material into the work that complies with the Contract.

Section 11-3.02 does not apply to resistance-butt-welded splices.

52-6.01D(2) 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 type to be used, each operator must prepare:

1. 2 prequalification splice test samples
2. 2 additional prequalification splice test samples if using splices dependent on bar deformations

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 production testing requirements specified in section 52-6.01D(4) for the type of splice to be used in the work.

52-6.01D(3) 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(4) Production Testing

52-6.01D(4)(a) General

Production testing includes total slip testing, service splice testing, and ultimate butt splice testing.

Splice test samples must comply with 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 or to 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 and Contract number using weatherproof markings
3. Attach a completed *Sample Identification Card* to each bundle

Test production splice test samples:

1. At a laboratory on the Authorized Laboratory List
2. In the condition received
3. Under California Test 670

Before performing service splice or ultimate butt splice testing, perform total slip testing on the service splice or ultimate but splice test samples as specified in section 52-6.01D(4)(b).

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

If a production 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.

52-6.01D(4)(b) 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, 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)(c) 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 52-6.02C 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)(d) Ultimate Butt Splice Testing

52-6.01D(4)(d)(i) General

An ultimate butt splice test consists of removing and testing 4 splice test samples from each lot of completed splices.

After completing the 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. The Engineer selects splice test samples for hoops at the job site or fabrication plant.

After being notified, the Engineer randomly selects the 4 splice test samples to be removed by you and places tamper-proof markings or seals on them.

If the tamper-proof marking or seal is disturbed before testing, the Department rejects the splice test samples.

At rupture, splice test samples must comply with the requirements specified in section 52-6.02D 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)(c). Test the splice test samples as specified for ultimate butt splice test samples.

52-6.01D(4)(d)(ii) Radiographic Testing

Section 52-6.01D(4)(d)(ii) applies when test samples for CJP butt-welded splices are not removed from a lot of completed splices.

Notify the Engineer 48 hours before performing any RT.

Perform RT of CJP butt-welded splices under AWS D1.4:

1. Before tensile testing the splice test samples
2. On 25 percent of CJP butt-welded splices from a production lot

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.

Radiographic procedures must comply with AWS D1.1 and D1.4.

For field-produced CJP butt welds, do not radiograph more than 1 weld during 1 exposure.

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.

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.

Sufficiently shim penetrameters using a radiographically identical material. Penetrameter image densities must be from 2.0 to 3.6.

Regardless of the reinforcing bar size, radiographic film must be Class 1.

The Department does not allow sight development.

Record the results of radiographic interpretations on a signed certification and keep a copy with the film packet.

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.

52-6.01D(5) Quality Assurance Testing

At the same time you prepare or remove splice test samples for production testing, prepare or remove 4 QA splice test samples for:

1. 1st production test performed
2. 1 of every 5 subsequent production tests, or fraction thereof, randomly selected by the Engineer

QA splice test samples must comply with California Test 670.

Secure, identify, and transport QA splice test samples as specified for splice test samples in section 52-6.01D(4).

The Department tests QA service splices and QA ultimate butt splices as specified for production testing in section 52-6.01D(4).

The Department will notify you of the QA 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 Total Slip Requirements

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

52-6.02C Service Splice Requirements

Service splices must develop a minimum tensile strength of 80,000 psi.

52-6.02D Ultimate Butt Splice Requirements

Ultimate butt splices must do one of the following:

1. Rupture in the reinforcing bar outside of the affected zone and show visible necking as specified in California Test 670, Necking (Option I)
2. Rupture anywhere and neck as specified in California Test 670, Necking (Option II)

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:

1. Lap splices or mechanical lap splices must be the same as the length required for a lap splice in the largest bar
2. Butt splices must be 2 feet measured between the splice midpoints along a line centered between the axes 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 reinforcing bars by lapping where you cannot provide a minimum clear distance of 2 inches between the splice and the nearest adjacent bar.

Do not splice nos. 14 and 18 bars by lapping.

For reinforcing bars complying with ASTM A 615/A 615M, Grade 60, or ASTM A 706/A 706M, 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 reinforcing bars complying with ASTM A 615/A 615M, 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. Same as 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. Do not use split pipe backing.

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. Prestress 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

The types of stray current protection to be installed are shown.

52-7.01B Definitions

Reserved

52-7.01C Submittals

Reserved

52-7.01D Quality Control and Assurance

52-7.01D(1) General

Reserved

52-7.01D(2) Prestress Tendon Connection

Before welding in the work, 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 materials similar to those in the work in 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 Prestress Tendon Connection

For prestress tendon connections, the no. 6 steel wire must comply with ASTM A 82/A 82M, A 510, or A 510M.

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 mold size and shape, and the charge size and alloy mixture for the powder.

The copper cable must comply with section 86-2.08C.

The tape must be commercially available vinyl electrical tape with a thickness of at least 7 mils.

The test box cover and anchorage devices must comply with section 75-1.03. 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 commercial quality, nonconductive, and suitable for adherence to concrete and steel surfaces.

52-7.02F Concrete Insulation Course

Concrete insulation courses 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 nonsag 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 recommended 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 commercial quality, nonconductive, and suitable for adhering to metal surfaces.

Instead of epoxy coating hanger rods, you may use commercial quality neoprene bushings around the pipe at strap supports.

Instead of epoxy coating 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 Prestress Tendon Connection

Do not perform welding on the prestress anchorage devices. Do not perform arc welding on the prestressing strand.

Connect collector wire to the prestressed 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 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 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: Delivering mixed aggregate and cementitious material pneumatically or mechanically to the nozzle body and adding water and mixing the materials in the nozzle body.

wet-mix process: Delivering mixed aggregate, cementitious material, and water pneumatically to the nozzle and adding any admixture at the nozzle.

rebound: Shotcrete material that has ricocheted off the receiving surface, which is recovered and is clean and free of foreign material.

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 not less than 632 pounds of cementitious material per cubic yard.
2. You may substitute a maximum of 30 percent pea gravel for the fine aggregate. The maximum size of pea gravel must be such that 100 percent passes the 1/2-inch screen and at least 90 percent passes the 3/8-inch screen.
3. Admixtures may be added. They must comply 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 shotcrete. 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 gaging wires where 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 manner to minimize 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 gaging 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 surface with a straightedge. Bring to grade any low spots or depressions by placing additional shotcrete. The finished surface must be reasonably 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 the following:

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 Control and Assurance

53-2.01D(1) General

Notify the Engineer at least 24 hours before performing any coring or testing.

Obtain and test all cores for compressive strength at 28 days under ASTM C 42/C 42M at an authorized laboratory. The compressive strength is the average strength of the 3 cores.

Shotcrete must have a minimum compressive strength of 3,600 psi at 28 days.

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 three 3-inch cores from the test panel.
3. Identify each core.
4. Test cores for compressive strength. Discard cores that show evidence of improper coring. The compressive strength is the average strength of the remaining cores.
5. Label and submit test panel and a copy of the test results within 5 days of testing.
6. 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

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) Field Quality Control

53-2.01D(4)(a) General

Obtain at least three 3-inch-diameter test cores from each 50 cu yd, or portion thereof, of shotcrete placed each day. 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(4)(b) Visual Inspection

Each core must:

1. Be dense and be free of laminations and sand pockets
2. 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(4)(c) Compressive Strength Testing

Discard cores that contain bar reinforcement or other obstructions or show evidence of improper coring. The compressive strength is the average strength of the remaining cores.

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 C 42/C42M.

53-2.02 MATERIALS

Mortar must comply with section 51-1.02F.

53-2.03 CONSTRUCTION

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 not less than 45 degrees F for 72 hours after placing and at not less than 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

Reserved

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 D 449, Type I for below ground and Type II for above ground.

The primer must comply with ASTM D 41.

Treated glass fabric must comply with ASTM D 1668, 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 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 from 300 to 350 degrees F.

For waterproofing on steel column casings, apply 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 of 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 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

Not Used

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

Reserved

54-3.01C Submittals

Submit a certificate of compliance for the preformed membrane sheet, including:

1. Type of preformed membrane sheet
2. Conditioner or primer application rates

54-3.01D Quality Control and 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 values shown in the following table:

Membrane Sheet Property Requirements

Property	Test	Value (min)	
		Polyethylene film	Fabric reinforced
Breaking strength[a]	ASTM D 882[b]	20 lb/in[c]	20 lb/in[c]
Percent elongation at break[d]	ASTM D 882[b]	150 percent[c]	25 percent[c]
Pliability	ASTM D 146[e]	No cracks	No cracks
Rubberized asphalt softening point	AASHTO T 53	165 °F	165 °F
Polymer-modified bitumen softening point	AASHTO T 53	210 °F	210 °F

[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 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 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, and remove projections or 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 at the time of membrane application.

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 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

Waterproofing and cover is measured along the slope and includes 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.

For placing HMA on a deck seal, comply with section 39-1.13.

54-5.01B Definitions

Reserved

54-5.01C Submittals

Submit a certificate of compliance for the preformed membrane sheet, including the type of sheet and the conditioner or primer application rates.

54-5.01D Quality Control and 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 Property Requirements

Property	Test	Value (min)
Breaking strength[a]	ASTM D 882[b]	50 lb/in[c]
Percent elongation at break[d]	ASTM D 882[b]	15 percent[c]
Pliability	ASTM D 146[e]	No cracks
Rubberized asphalt softening point	AASHTO T 53	165 °F
Polymer-modified bitumen softening point	AASHTO T 53	210 °F

[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 and HMA 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

Place HMA over the preformed membrane seal within 7 days after installation of the seal and before allowing traffic on the seal.

54-5.04 PAYMENT

Deck seal is measured as the area covered by the seal without a 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

Slurry leveling course is measured as the quantity of undiluted asphaltic emulsion used to produce the slurry, not including any additional water blended into the slurry.

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.

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 the AREMA *Manual for Railway Engineering*.

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 a calibration certificate for each bolt tension measuring device and calibrated wrench before use.

Submit details for methods of straightening material to be fabricated.

Submit a welding QC plan with the steel structures shop drawings. List methods and personnel to satisfy the requirements of AWS D1.5.

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 "Certification," "Report," "Number of Tests and Retests," and "Certification and Test Report" sections of the referenced ASTM standards. For ASTM A 307 anchor bolts, include chemical composition and carbon equivalence for each heat of steel.

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.

Submit certificates of compliance for materials used in the work except for unidentified stock material.

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 sets for highway bridges and 10 sets for railway bridges. Submit 6 to 12 sets, as requested by the Engineer, to OSD, Documents Unit after review for final authorization.

Include the following in the shop drawings:

1. Sequence of shop and field assembly and erection
2. Welding sequences and procedures
3. Layout drawing of the entire structure with locations of butt welded splices
4. Locations of temporary supports
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 in the work
9. Direction of rolling of plates where orientation is specified

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 curved girders
3. Tension hanger plates

Furnish plates, shapes, or bars containing test samples from the mill with extra length to provide for removal of check samples at the fabrication site. Samples may be cut from either end.

You may remove test samples at the rolling mill. Remove samples from the mill plate that will be stripped by the fabricator to produce the designated plate. 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 14 by 18 inches with the long dimension transverse to the direction of rolling. Test samples for other products must be 18 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.

Results of check testing are reported to you no sooner than 20 days after delivery to 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.

55-1.01D Quality Control and Assurance

55-1.01D(1) General

Welder qualification and inspection must comply with AWS D1.5.

The results of the Department's tensile and impact testing of test samples must not vary more than 5 percent below the specified minimum or 5 percent above the specified maximum requirements. If initial test results vary more than 5 percent but less than 10 percent from the specified requirements, a retest may be performed on another test sample from the same heat and thickness.

Each manual torque wrench must have a dial gage 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 laboratory or 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(2) Certifications

Reserved

55-1.01D(3) Source Quality Control

55-1.01D(3)(a) General

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.

In addition to NDT requirements in AWS D1.5, ultrasonically test 25 percent of all main member tension groove welds in material over 1/2 inch thick. The Engineer determines the location of all NDT testing for welding.

55-1.01D(3)(b) Rotational Capacity Testing

55-1.01D(3)(b)(i) 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.

Test procedures specified are for A 325 bolts.

55-1.01D(3)(b)(ii) Long Bolt Test

Use the following equipment for long bolt testing:

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 F 436.
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).
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 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 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	56
1-1/4	71
1-3/8	85
1-1/2	103

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 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 is 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 8 is attained.

Table 4 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	64
1-1/4	82
1-3/8	98
1-1/2	118

55-1.01D(3)(b)(iii) Short Bolt Test

Use the following equipment for short bolt testing:

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 F 436.
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)(ii).

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 A325 Maximum Allowable Torque

Bolt diameter (inches)	Torque (ft-lb)
1/2	145
5/8	285
3/4	500
7/8	820
1	1220
1-1/8	1500
1-1/4	2130
1-3/8	2800
1-1/2	3700

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 is 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(4) Field Quality Control

55-1.01D(4)(a) General

Perform job site HS fastener testing in the Engineer's presence.

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 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(4)(b) Rotational Capacity Testing

Perform rotational capacity testing on each rotational capacity lot under section 55-1.01D(3)(b) before installation.

55-1.01D(4)(c) 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 ASTM A 325 or A 490 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 F 959 except that bolts must be initially tensioned to a value 5 percent greater than the minimum required bolt tension.

55-1.01D(4)(d) Verification Tension Testing

Verify minimum fastener 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.

Check 10 percent of each type of fastener assembly in each HS bolted connection for minimum tension under section 10 of *Specification for Structural Joints Using ASTM A 325 or A 490 Bolts* of the RCSC. Check at least 2 assemblies per connection. For short bolts determine the arbitration 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.

55-1.02 MATERIALS

55-1.02A General

55-1.02A(1) General

Materials must comply with the requirements shown in the following tables:

Structural Steel

Material	Specification
Carbon steel	ASTM A 709/A 709M, Grade 36 or {ASTM A36/A36M}[a]
HS low alloy columbium vanadium steel	ASTM A 709/A 709M, Grade 50 or {ASTM A 572/A 572M, Grade 50}[a]
HS low alloy structural steel	ASTM A 709/A 709M, Grade 50W, Grade HPS 50W, or {ASTM A 588/A 588M}[a]
HS low alloy structural steel plate	ASTM A 709/A 709M, Grade HPS 70W
High-yield strength quenched and tempered alloy steel plate suitable for welding	ASTM A 709/A 709M, Grade 100 and Grade 100W or {ASTM A 514/A 514M}[a]

[a]Grades you may substitute for the equivalent ASTM A 709 steel subject to the modifications and additions specified and to the requirements of ASTM A 709.

Fasteners

Material	Specification
Steel fastener components for general applications:	
Bolts and studs	ASTM A 307
Anchor bolts	ASTM F 1554 or ASTM A 307, Grade C
HS bolts and studs	ASTM A 449, Type 1
HS threaded rods	ASTM A 449, Type 1
HS nonheaded anchor bolts	ASTM F 1554, Grade 105, Class 2A
Nuts	ASTM A 563, including appendix X1[a]
Washers	ASTM F 844
Components of HS steel fastener assemblies for use in structural steel joints:	
Bolts	ASTM A 325, Type 1
Tension control bolts	ASTM F 1852, Type 1
Nuts	ASTM A 563, including appendix X1[a]
Hardened washers	ASTM F 436, Type 1, Circular, including S1 supplementary requirements
Direct tension indicators	ASTM F 959, Type 325, zinc-coated

[a]Zinc-coated nuts tightened beyond snug or wrench tight must be furnished with a dry lubricant complying with supplementary requirement S2 in ASTM A 563.

Other Materials

Material	Specification
Carbon steel for forgings, pins, and rollers	ASTM A 668/A 668M, Class D
Alloy steel for forgings	ASTM A 668/A 668M, Class G
Pin nuts	ASTM A 36/A 36M
Carbon-steel castings	ASTM A 27/A 27M, Grade 65-35, Class 1
Malleable iron castings	ASTM A 47/A 47M, Grade 32510 (Grade 22010)
Gray iron castings	ASTM A 48, Class 30B
Carbon steel structural tubing	ASTM A 500, Grade B or ASTM A 501
Steel pipe[a]	ASTM A 53, Type E or S, Grade B; ASTM A 106, Grade B; or ASTM A 139, Grade B
Stud connectors	AWS D1.5

[a]Hydrostatic testing will not apply.

55-1.02A(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 A 709/A 709M	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

[a]If the material yield point is more than 65,000 psi, reduce the temperature for the CVN impact value 15 degrees F for each increment of 10,000 psi above 65,000 psi.

Determine CVN values under ASTM E 23. Sampling procedures must comply with ASTM A 673. Use the Frequency H (Heat) testing for steels complying with ASTM A 709/A 709M, Grades 36, 50, 50W, and HPS 50W. Use the Frequency P (Piece) testing for steels complying with ASTM A 709/A 709M, Grades HPS 70W, 100, and 100W.

For fracture critical members, minimum CVN impact values are specified in the special provisions.

55-1.02A(3) Structural Steel

Unless otherwise described, structural steel plates, shapes, and bars must comply with ASTM A 709/A 709M, 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 the following items:

1. Flanges or eyebars
2. Hanger plates
3. Splice plates for flanges or eyebars

For members shown, you may substitute rolled shapes for welded sections and welded sections for rolled shapes 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

55-1.02A(4) Bearing Pads

Elastomeric bearing pads must comply with section 51-3.02.

55-1.02A(5) Castings

Steel, gray iron, and malleable iron castings must have adequate 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 1/2 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 be not more than 7.5 percent overweight. Large castings must be suspended and hammered over their entire area. Cracks, flaws, or other defects must not be present after hammering.

55-1.02A(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.

55-1.02A(7) Miscellaneous Materials

Caulking must be polysulfide or polyurethane caulking complying with ASTM C 920, Type S, Grade NS.

55-1.02B Fabrication

55-1.02B(1) General

Rolled material must be straight before being laid out or worked. Subassemblies and completed members must be straight before being incorporated into the work. The Department rejects straightened material showing evidence of damage.

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.

Weld girder stiffeners shown as bearing stiffeners. Ends of 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. Except where stiffeners are cut back, caulk gaps between stiffener ends and the girder flange before painting.

Build 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.

Match-mark connecting parts that are preassembled for setting up for welding or for drilling or reaming holes for field connections.

Where galvanizing is described, galvanize structural steel under section 75-1.05.

Neatly finish exposed parts of the work. Slightly round edges, sharp corners, and edges marred, cut, or roughened during handling or erection.

Clean and paint iron and steel surfaces under section 59.

55-1.02B(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.

You may heat straighten steel slabs not in contact with other metal bearing surfaces if the above tolerances are met.

55-1.02B(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 ASTM A6/A6M
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 shorter radius than specified in ASTM A6/A6M must be bent hot. Hot bent plates must have the direction of bending at right angles to the direction of rolling.

55-1.02B(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 A 563

Threads for pin ends and 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

55-1.02B(5) Pin Connections

Pins must be:

1. Turned to the dimensions shown
2. 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.

Bore holes for pins:

1. True to the diameter specified
2. At right angles to the member axis
3. Except for pins where nonparallel holes are required, holes must be parallel with each other
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.

55-1.02B(6) Bolted Connections

55-1.02B(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

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.

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.

55-1.02B(6)(b) Bolt Holes

55-1.02B(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.

55-1.02B(6)(b)(ii) Punching

Do not punch or subpunch ASTM A 36/A 36M 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.

55-1.02B(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 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

55-1.02B(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.

55-1.02B(6)(c) Installation

Bolted connections using HS fastener assemblies must comply with *Specification for Structural Joints Using ASTM A 325 or A 490 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 and at most 1/4 inch. At least 3 full threads must be located within the grip of the connection. For tension control bolts, measure thread stickout from the outer nut face to the first full thread near the sheared end of the bolt

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.

55-1.02B(7) Welding

55-1.02B(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.

Except for welds to reinforce groove welds, minimum fillet weld size must comply with the sizes shown in the following table:

Base metal thickness of the thicker part joined (inches)	Minimum fillet weld size[a] (inches)
To 3/4 inclusive	1/4
Over 3/4	5/16

[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.

Work complying with sections 56-3 or section 86-2.04 does not need to comply with AWS D1.5.

55-1.02B(7)(b) Backing for Welds

Reserved

55-1.02B(8) Curved Girders

Reserved

55-1.02B(9) Shop Assembly

Prepare and paint contact surfaces of HS bolted connections before assembly. Clean all other metal contact surfaces thoroughly before assembly.

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 long span 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 and adjust abutting sections for line and camber. Drill or ream holes for field connections during preassembly.

Splice joints for welded girders must be preassembled with abutting members, adjusted for line and camber, and prepared for welding.

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 match-marked.

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.

55-1.02C 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.

55-1.03 CONSTRUCTION

55-1.03A General

Reserved

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 are (1) 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

You may erect structural steel girders to provide girder dead load continuity as assumed in design. If erection procedures provide dead load girder continuity, preassemble members with field joints in a no-load condition in a horizontal or an upright position.

You may erect structural steel girders such that dead load girder continuity is not provided. If erection procedures do not provide dead load girder continuity:

1. Submit proposed steel erection procedures with calculations that show girder capacity and geometry will be correct
2. You may increase cross-sectional areas or change grades of steel to provide the specified capacity if authorized
3. After erection, the erected structure must have a load carrying capacity at least equal to the structure shown

55-1.03C(2) Bearings and Anchorages

Set bearing assemblies level. The Engineer provides adjustments to horizontal positions of bearing assemblies due to temperature. Obtain 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 nonmetallic bearing pads using authorized methods.

The embedded end of each anchor bolt must terminate with a head or a nut and washer. Anchor bolts must permit 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(3) Heat Straightening Steel Girders

Reserved

55-1.03C(4)–55-1.03C(10) Reserved

55-1.04 PAYMENT

55-1.04A Measurement

Structural steel and iron is measured by the pound computed from dimensions shown using the following:

1. Density of structural and cast steel is assumed at 0.2833 lb/cu in. The density of cast iron is assumed at 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 assumed 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 A 153/A 153M.
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.

55-1.04B Payment

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.

Structural steel (bridge) includes furnishing and erecting structural steel.

55-2 COLUMN CASINGS

Reserved

55-3 PRESTRESSING STEEL GIRDERS

Reserved

55-4–55-10 RESERVED

56 SIGNS

56-1 GENERAL

Reserved

56-2 FURNISH SIGN PANELS

56-2.01 GENERAL

56-2.01A General

56-2.01A(1) Summary

Section 56-2 includes specifications for fabricating and furnishing sign panels.

Signs must comply with the *California Sign Specifications* and the federal *Standard Highway Signs and Markings* Book. Those publications and related publications are available at the Department's Traffic Operations Web site under signs and work zones.

56-2.01A(2) Definitions

background: Dominant sign color.

legend: All letters, numerals, tildes, bars, arrows, route shields, symbols, logos, borders, artwork, and miscellaneous characters that are intended to convey specific meanings on traffic signs. The style, font, size, and spacing of the legend must comply with the standard alphabets in the federal *Standard Highway Signs and Markings* Book.

56-2.01A(3) 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. Sign panel samples must be at least 12 by 12 inches in size and include background material and legend.

Within 15 days before starting sign fabrication, submit at least 3 copies of your quality control plan for sign panels. Allow 10 days for the Department's review. Do not start fabricating sign panels until the Engineer accepts the quality control plan. The quality control plan must include:

1. Identification of the person responsible for sign quality control
2. Basis of acceptance for incoming raw materials at the fabrication plant
3. Type, method, and frequency of quality control 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. Retroreflective sheeting manufacturer's installation and splicing instructions
7. Recommended cleaning procedure for each product
8. Method of packaging, transporting, and storing signs

Do not submit a quality control plan for construction area signs specified in section 12-3.06.

56-2.01A(4) Quality Control and Assurance

Sign panels must be produced at a fabrication plant.

The Department may inspect signs at the fabrication plant or the job site. The Engineer will reject damaged signs, defective signs, and signs with spelling errors before or after installation.

Whenever instrumental testing under ASTM D4956 is in dispute, the Engineer's visual test will determine the color of the retroreflective sheeting, screened process colors, or film.

Construction area signs and permanent signs must be free from blemishes that could affect serviceability and detract from the general sign color and appearance when viewed during the daytime and nighttime from a distance of 25 feet. The face of completed signs must be uniform, flat, smooth, and free of defects, scratches, wrinkles, gel, hard spots, streaks, extrusion marks, and air bubbles. The front, back, and edges of sign panels must be free of router chatter marks, burns, sharp edges, loose rivets, delaminated skins, excessive adhesive over-spray, and aluminum marks.

Signs must not be chipped or bent.

56-2.01B Materials

56-2.01B(1) General

Reserved

56-2.01B(2) Fabrication

Retroreflective sheeting must be applied to sign panels at the fabrication plant under the retroreflective sheeting manufacturer's instructions without appreciable stretching, tearing, and 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 manufacturing process 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 manufacturing process of the retroreflective sheeting.

Unless the retroreflective sheeting manufacturer's instructions require a different method, splices in the retroreflective sheeting must overlap by a minimum of 1 inch. The retroreflective sheeting on either side of a splice must not exhibit a color difference under incident and reflected light.

For signs composed of multiple panels, the legend must be placed across joints in a way that does not affect the size, shape, spacing, and appearance of the legend on the assembled sign.

For formed panel signs, the retroreflective sheeting for the background and legend must be wrapped around the interior vertical edges of each panel as shown to prevent delamination.

Sign information must be imprinted in 1/4-inch upper case letters and numerals. Locate this information on the back, lower right of each sign panel so that it will not be blocked by a sign post or mounting frame. Sign information must include:

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

Sign information must 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. The information must not be painted, screened, inked, or engraved. The information must be imprinted in a way that does not damage the face of the sign.

Where shown, a sign with 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 must determine 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.

56-2.01B(3) Storage and Handling

Protect, transport, and store sign panels fabricated with screened-process colors under the retroreflective sheeting manufacturer's instructions.

Transport sign panels so that the face of the panels are protected from damage and weather. Ship the panels on pallets, in crates, or in tier racks. Ship the panels vertically on edge. Do not stack the panels

horizontally. Place padding and protective materials between the panels as necessary. Keep the panels dry during transit.

Store sign panels in a dry environment at all times. Store the panels vertically on edge whether indoors or outdoors. Do not store the panels directly on the ground. Do not let the panels get wet during storage. In areas of high heat and humidity, store the panels in enclosed, climate-controlled trailers or containers. Store the panels indoors whenever the storage duration will exceed 30 days.

56-2.01B(4) Sign Panels and Fastening Hardware

Furnish mounting hardware for all types of sign panels, including:

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

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 matches closely the color of the background and legend where it is placed.

56-2.01B(5) Aluminum Sheeting

The alloy and temper of aluminum sheeting must comply with ASTM B209 for the designation specified.

Aluminum sheeting must be pretreated for corrosion resistance under ASTM B449. The surface of the aluminum sheeting must be cleaned, deoxidized, and coated with a light, tightly adherent chromate conversion coating free of powdery residue. The conversion coating must be Class 2 with a weight from 10 milligrams per square foot to 35 milligrams per square foot and an average weight of 25 milligrams per square foot. After the cleaning and coating process, protect the aluminum sheeting from exposure to grease, oils, dust, and contaminants.

Aluminum sheeting must be free of buckles, warps, dents, cockles, burrs, and defects resulting from fabrication.

The base plate for standard route markers must be die cut.

56-2.01B(6) Retroreflective Sheeting

Retroreflective sheeting used for background and legend must comply with ASTM D4956 and must be on the Authorized Material List for signing and delineation materials.

Type II, III, IV, VIII, IX, and XI retroreflective sheeting must have Class 1, 3, or 4 adhesive backing except Type II retroreflective sheeting may have Class 2 adhesive backing. The adhesive backing must be pressure sensitive and fungus resistant.

56-2.01B(7) Process Colors and Film

The type of material used for screened-process colors, nonreflective, opaque, black film, and protective-overlay film must be the type recommended by the retroreflective sheeting manufacturer.

The fabricator must perform all patterns, layouts, and set-ups necessary for the screening process.

The completed surface of the applied screened-process color must be flat and smooth.

Colored retroreflective sheeting must be used for the background. Reverse-screened-process color on white retroreflective sheeting for signs with green, red, blue, and brown backgrounds may be substituted for the background color.

The coefficient of retroreflection for reverse-screened-process colors used on white retroreflective sheeting must be not less than 70 percent of the coefficient of retroreflection specified in ASTM D4956 for the corresponding colored retroreflective sheeting.

The legend must be black, screened-process color or nonreflective, opaque, black film.

Screened-process colors and nonreflective, opaque, black film must have equivalent outdoor weatherability characteristics as the retroreflective sheeting specified in ASTM D4956. Nonreflective, opaque, black film must be vinyl or acrylic material.

Cured, screened-process colors must be able to withstand removal when tested by applying the 3M Company's Scotch brand cellophane tape no. 600 or equivalent tape over the color and removing it with a single, quick motion at a 90 degree angle normal to the surface of the sign's face.

56-2.01C Construction

Do not chip or bend sign panels.

Do not install the legend at the job site.

Immediately replace sign panels exhibiting a significant color difference between daytime and nighttime.

Do not repair sign panels at the job site unless authorized.

56-2.01D Payment

Furnishing sign panels is measured by the dimensions shown.

The Department does not pay for furnishing sign panels until the sign panels are installed.

56-2.02 SINGLE SHEET ALUMINUM PANELS

56-2.02A General

Single sheet aluminum panels must be framed or unframed panels as determined from the sizes shown.

56-2.02B Materials

Aluminum sheeting for framed and unframed panels must be aluminum alloy 6061-T6 or 5052-H38.

Single sheet aluminum panels must not have a vertical splice in the aluminum sheeting. For a panel with a depth greater than 48 inches, 1 horizontal splice is allowed in the aluminum sheeting.

For a framed panel, the framing members must be aluminum channel or rectangular aluminum tubing. The framing members must be within ±1/8 inch of the length shown.

Aluminum channels or rectangular aluminum tubings must be welded together as shown. Weld with the inert gas-shielded arc welding process using E4043 aluminum-electrode filler wires. The filler width must be equal to the wall thickness of the smallest welded channel or tubing.

Attach the aluminum sheeting to the frame with 3/16-inch-diameter rivets at the spacing shown. The rivets must be 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 conversion coating to prevent corrosion.

Completed, single sheet, aluminum panels must be:

1. Within ±1/8 inch of the dimensions shown
2. Flat within a tolerance of ±1/32 in/lf of panel dimension in any direction as measured from a straight line across the plane of the panel to the panel surface

56-2.02C Construction

Not Used

56-2.02D Payment

Not Used

56-2.03 FIBERGLASS-REINFORCED PLASTIC PANELS

56-2.03A General

Fiberglass-reinforced plastic panels must comply with ASTM D3841 and be on the Authorized Material List for signing and delineation materials.

56-2.03B Materials

Fiberglass-reinforced plastic panels must 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 of constituents and releasing agents that could interfere with the bonding of the retroreflective sheeting.

The color of fiberglass-reinforced plastic panels must be uniform gray under Munsell color notation N7.5 to N8.5.

Fiberglass-reinforced plastic panels must be cut from a single piece of laminate. Mounting bolt holes must be predrilled. The predrilled bolt holes, panel edges, and the front and back surfaces of the panels must be true and smooth. The panel surfaces must be free of visible cracks, pinholes, foreign inclusions, warping, and wrinkles that might affect performance and serviceability.

Completed fiberglass-reinforced plastic panels must be:

1. At least 0.135 inch thick
2. Flat within a tolerance of ±1/32 in/lf of panel dimension in any direction as measured from a straight line across the plane of the panel to the panel surface
3. Within ±1/8 inch of the dimensions shown

56-2.03C Construction

Not Used

56-2.03D Payment

Not Used

56-2.04 LAMINATED PANELS

56-2.04A General

Not Used

56-2.04B Materials

56-2.04B(1) General

Laminated panels must consist of a honeycomb core and extruded aluminum frame laminated between 2 sheets of aluminum sheeting to produce flat, rigid panels.

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 with the following properties:

1. Impregnated 18 percent phenolic by weight
2. 1/2-inch honeycomb cell size
3. 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 Department will reject a laminated panel if a 0.010 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.

Laminated panels must be able to resist a wind load of 33 lb/sq ft with a bending safety factor of 1.25 when tested for the following simple span lengths:

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 laminated panels 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 totally immersed in 158 degree F hot water.

All laminated panels must comply with incremental gradations for the various sizes shown.

Individual laminated panels must not exceed 24'-0" in length and 5'-0" in depth. Individual laminated panels must be fabricated as single units without horizontal and vertical joints, splices, and seams.

For signs exceeding 5'-0" in depth, use 2 laminated panels. Each laminated panel must be 5'-0" or less in depth. You may use 3 laminated 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 laminating, 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 conversion coating to prevent corrosion.

Sealant must be placed at the corners of the perimeter frame to prevent water intrusion.

The face of a completed laminated panel must be flat within a tolerance of $\pm$3/32 in/lf of panel dimension in any direction as measured from a straight line across the plane of the panel to the panel surface. Wherever laminated panels adjoin, the gap between the adjoining edges must not deviate by more than 1/32 inch from a straight line placed from corner to corner. Nonadjoining edges must not deviate by more than 1/8 inch from a straight line placed from corner to corner. The face and back sheets must be flush with the perimeter frame. All panel edges must be smooth.

Laminated panels 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.

56-2.04B(2) Roadside Laminated Panels

Laminated panels for roadside signs must be Type B or Type H as determined from the sizes shown.

For Type B panels:

1. Channel edges must be welded together to form the perimeter frame
2. Vertical tube spacers must be welded to the perimeter frame

For Type H panels:

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.

56-2.04B(3) Overhead Laminated Panels

Laminated panels for overhead signs must be Type A.

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.

For signs exceeding 24'-0" in length, the Engineer determines the length of Type A panels if the panel lengths are not shown, except individual panels must not exceed 24'-0" in length or 5'-0" in depth.

56-2.04C Construction

For multiple-panel signs, place a 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 as shown to enclose the H-section closure extrusion for the full length of the panel without gaps.

56-2.04D Payment

Not Used

56-2.05 FORMED PANELS

56-2.05A General

Reserved

56-2.05B Materials

Formed panels 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. Rivet through the sign face at the spacing shown after applying the background material and legend.

Formed edges must be square. Drilled mounting holes must be straight and perpendicular to the front and back surfaces of the formed edges at the spacing shown. The Department rejects formed panel signs with holes that are slanted or incorrectly spaced.

Completed formed-panel signs must be:

1. Flat within a tolerance of ±1/8 in/lf of panel dimension in any direction as measured from a straight line across the plane of the panel to the panel surface
2. Within ±1/16 inch of the dimensions shown

56-2.05C Construction

Not Used

56-2.05D Payment

Not Used

56-3 OVERHEAD SIGN STRUCTURES

56-3.01 GENERAL

56-3.01A Summary

Section 56-3 includes specifications for constructing overhead sign structures.

Furnishing overhead 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 surface finishing as required.

Installation of overhead sign structures includes installing anchor bolt assemblies, removable sign panel frames, sign panels, and performing any welding, and painting or galvanizing required during installation.

The types of sign structures include:

1. Truss
2. Box beam-closed truss
3. Tubular
4. Lightweight
5. Bridge mounted

56-3.01B Definitions

Reserved

56-3.01C Submittals

56-3.01C(1) General

Reserved

56-3.01C(2) Shop Drawings

Before fabricating sign structures, submit 2 sets of shop drawings. Include the following:

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 high-strength bolted connections
7. Details for permanent steel anchor bolt templates
8. Quality control program including:
   - 8.1. Methods
   - 8.2. Equipment
   - 8.3. Personnel
9. Details of clips, eyes, or removable devices for preventing damage to the finished galvanized or painted surfaces used for:
   - 9.1 Securing the sign during shipping
   - 9.2 Lifting and moving during erection

Allow 30 days for the Department's review.

56-3.01D Quality Control and Assurance

56-3.01D(1) General

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

Sign structures must be:

1. Free from kinks, twists, or bends
2. Uniform in appearance

Assemble the completed sections in the shop. Check sections for straightness, alignment, and dimension. Correct any variation.

Select the undercoating for ungalvanized surfaces from the Authorized Material List.

56-3.01D(2) Welding

56-3.01D(2)(a) General

Perform NDT of steel members under AWS D1.1 and the requirements shown in the following table:

Nondestructive Testing for Sign Structures

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, or pole 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

NOTE: t = pole or arm thickness

56-3.01D(2)(b) Ultrasonic Testing

The acceptance criteria for UT must comply with Clause 6.13.3.1 of AWS D1.1, for welded joints of members less than 5/16 inch thick or tubular sections less than 13 inches in diameter.

The acceptance-rejection criteria for UT must comply with Table 6.3 of AWS D1.1 for cyclically loaded nontubular connections for other welded joints.

When performing UT, use an authorized procedure under AWS D1.1, Annex S.

56-3.01D(2)(c) Radiographic Testing

The acceptance criteria for radiographic or real time image testing must comply with AWS D1.1 for tensile stress welds.

56-3.01D(2)(d) Longitudinal Seam Welds

The Engineer selects 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 longitudinal seam.

56-3.01D(2)(e) Circumferential Welds and Base Plate to Post 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.

56-3.01D(3) Charpy V-notch Impact

Reserved

56-3.02 MATERIALS

56-3.02A General

Materials must comply with section 55.

Do not use weathering steel.

56-3.02B Bars, Plates, Shapes, and Structural Tubing

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, Grade B.

Surface flatness after galvanizing must comply with ASTM A 6/A 6M 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

56-3.02C Sheets

Sheets must be carbon-steel complying with ASTM A 1011/A 1011M, Designation SS, Grade 33.

56-3.02D Bolted Connections

Bolts, nuts, and washers must comply with section 55-1.02A(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 55-1.02A(1).

Anchor bolts must comply with ASTM F 1554, 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.

56-3.02E Anchorages

Anchorages for bridge mounted sign structures must comply with the specifications for concrete anchorage devices in section 75-1.03.

56-3.02F Pipe Posts

Pipe posts must be welded or seamless steel pipes. Pipe posts must comply with one of the following:

1. ASTM A 53/A 53M, Grade B
2. ASTM A 106/A 106M, Grade B
3. API Specification 5L PSL2 Grade B, Grade X42R or Grade X42M using nominal pipe sizes for threaded end pipe

You may fabricate posts from structural steel complying with ASTM A 36/A 36M.

Spiral seam welds are not allowed.

56-3.02G 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 A 1011/A 1011M as specified for Designation CS, Type B or Designation SS, Grade36, 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

56-3.02H Elastomeric Bearing Pads

Elastomeric bearing pads must comply with section 51-3.02.

56-3.02I Safety Chain at Walkways

Safety chain at walkways must comply with ASTM A413, Grade 43. The nominal chain size must be 1/4 inch. Use the minimum length that allows lock-up of safety railing.

56-3.02J 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
2. Have a cable breaking strength of at least 10,000 lb
3. Not be prestretched

56-3.02K Fabrication

56-3.02K(1) General

Fabricate sign structures into the largest practical sections before galvanizing.

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

56-3.02K(2) Bolted Connections

Except for HS bolts shown to be snug-tight, HS bolted connections must be HS assemblies complying with section 55-1.02B(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.

Fasten ribbed sheet metal panels for box beam-closed truss sign structures to the truss members with one of the following:

1. Cap screws.
2. Bolts.
3. 3/16-inch stainless steel blind rivets complying with Industrial Fasteners Institute, Standard IFI-114, Grade 51. The outside diameter of the large flange rivet head must be not less than 5/8 inch in diameter. Web splices in ribbed sheet metal panels may be made with a similar type of blind rivets of a size suitable for the thickness of the material being connected.

56-3.02K(3) 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

56-3.02K(4) Walkway

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.

Safety cable at walkways must be continuous between lugs. Before tightening cable clips at the end anchorage, remove the slack in the cable by the full effort of a typical construction worker.

Safety cable at walkways must not be kinked, knotted, deformed, or spliced.

Install clips at safety cables under the manufacturer's instructions.

56-3.02K(5) Handholes

The edges of handholes and other large pole openings must be ground smooth. The roughness of edges must be less than 0.001 inch.

56-3.02L Welding

Welding of steel overhead sign structure members must comply with AWS D1.1.

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. Longitudinal seam welds on structures with telescopic splices connecting pole segments must be CJP groove welds on the female end with a length equal to the designated slip fit splice length plus 6 inches.

Except for welds at posts shown as PJP welds, longitudinal seam welds of fabricated pipe posts must be CJP groove welds.

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.

56-3.02M Surface Finish

56-3.02M(1) General

Galvanize all ferrous metal parts of the following sign structure types:

1. Truss
2. Lightweight
3. Bridge mounted
4. Box-beam-closed truss, clean and paint all ferrous metal parts after galvanizing
5. Tubular, clean and paint all ferrous metal parts after galvanizing

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.

56-3.02M(2) Galvanizing

Galvanizing must comply with section 75-1.05 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 59-10. 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.

56-3.02M(3) Cleaning and Painting

56-3.02M(3)(a) General

Clean and paint sign structures under section 59-5 and section 59-3.

Clean and paint all exterior surfaces of tubular and box beam-closed truss type sign structures, including the areas to be covered by sign panels.

56-3.02M(3)(b) 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, submit the required documentation specified in section 5.6 of AASHTO M 300. Allow 30 days for the Engineer's review.

56-3.02M(3)(c) Testing of Inorganic Zinc Coating

Perform adhesion and hardness testing no sooner than 72 hours after application of the single undercoat of inorganic zinc coating.

56-3.02M(3)(d) Finish Coating

The exposed area of inorganic zinc coating must receive a minimum of 2 finish coats of exterior grade latex paint.

The 2nd finish coat color must match no. 24491 of FED-STD-595. The total dry film thickness of the applications of the 2nd finish coat must be not less than 2 mils.

56-3.03 CONSTRUCTION

56-3.03A General

Do not fasten 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 laminated and formed sign panels on sign structures using fastening hardware of the type and sizes shown.

Install sign panels as shown.

56-3.03B Foundations

Complete the CIDH concrete pile foundation at least 7 days before erecting the sign structure.

56-3.03C Electrical Installation

Electrical installations must comply with section 86.

56-3.04 PAYMENT

The weight of removable sign panel frames and anchorage assemblies is included in the weight for sign structures.

The weight of sign panels is not included in the weight of sign structures.

Extruded aluminum used for steel slot channel for the light fixture mounting channel is measured and paid for on the basis of the computed weight of the steel channel.

Electrical installations are paid under section 86.

The payment for furnishing sign panels is not included in the payment for furnish and install sign structure.

56-4 ROADSIDE SIGNS

56-4.01 GENERAL

56-4.01A Summary

Section 56-4 includes specifications for constructing roadside signs.

Roadside signs include installation of sign panels, fastening hardware, back braces, straps and saddle brackets, and frame assemblies for multiple sign panels.

A roadside sign includes a traffic sign with 1 or more sign panels attached to a supporting structure. A supporting structure is typically 1 or 2 posts, a signal standard, or an electrolier.

56-4.01B Definitions

Reserved

56-4.01C Submittals

Reserved

56-4.01D Quality Control and Assurance

Signs must not be chipped or bent.

56-4.02 MATERIALS

56-4.02A General

Reserved

56-4.02B Metal Posts

Mountings for roadside signs to be installed on barriers or railings must be fabricated from (1) welded or seamless steel pipe under ASTM A53/A53M, Grade B, and (2) structural steel complying with ASTM A36/A36M.

Bolted connections must comply with section 56-3.02D. Concrete anchorage devices must comply with section 75-1.03.

All metal parts for mounting roadside signs must be galvanized after fabrication. Galvanization must comply with section 75-1.05.

56-4.02C Wood Posts

Wood posts must comply with the allowable grades and species for the sizes shown in the following table:

Nominal post size [a]	Allowable grades and species
4 x 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 x 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 x 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

Posts must be graded as specified in section 57-2.01B(2). The sweep must not exceed 0.08 foot in 10 feet.

Before preservative treatment, the moisture content of Douglas fir, Hem-Fir, and Southern yellow pine posts must be not more than 25 percent at the midpoint of the post in the outer 1 inch as measured under ASTM D4444 with an authorized moisture meter.

When delivered to the job site, treated posts must have a moisture content of not more than 25 percent when tested as described above, and must comply with the specified grading requirements.

Douglas Fir and Hem Fir posts must be treated under sections 57-2 and under AWPA U1, Use Category UC4A, Commodity Specification A. Posts must be incised, and the minimum retention of preservative must be as specified in the AWPA requirements.

You may cut the ends of wood posts at the job site. Wherever cutting or boring is performed after treating posts with preservative, manually apply preservative to the cuts and holes under section 57-2.01C(3)(b).

Treat wood block spacers inserted between the post and sign panel on single-post installations with wood preservative under section 57-2.

Unless described otherwise, do not paint wood posts and block spacers.

56-4.02D Laminated Wood Box Posts

The Department furnishes laminated wood box posts with attached metal caps at the top of each post.

If you do not immediately use laminated wood box posts, neatly stack them on dunnage. Handle the posts in a way that does not damage the posts.

56-4.02E Sign Panel Fastening Hardware

Frame assemblies for multiple sign installations must be fabricated from structural steel complying with ASTM A36/A36M or aluminum alloy as shown. Frames fabricated from structural steel must be hot-dip galvanized after fabrication.

Back braces for signs must be commercial quality, mild steel, and hot-dip galvanized after fabrication.

Straps and saddle brackets for mounting sign panels on electroliers, sign structure posts, and traffic signal standards must be stainless steel under ASTM A167, Type 302 or 304. Where shown, theft-proof bolts must be stainless steel with a chromium content of at least 16 percent and a nickel content of at least 8 percent.

Except for theft-proof bolts, the lag screws, bolts, metal washers, and nuts must be commercial quality steel and hot-dip galvanized after fabrication. Fiber washers must be commercial quality.

Galvanizing must comply with section 75-l.05.

56-4.03 CONSTRUCTION

56-4.03A General

Excavate post holes to the depth shown. Place posts in the holes.

Backfill the space around wood posts to the completed ground surface with selected earth or sand that is free of rocks or other deleterious material. Backfill the space around laminated wood box posts to the completed ground surface with granular material. Place the backfill material in layers approximately 1/3 foot thick. Moisten and thoroughly compact each layer.

Drill 2 holes in each wood post to provide the breakaway feature shown.

Backfill material for metal posts must be minor concrete. Minor concrete must contain at least 463 pounds of cementitious material per cubic yard.

Dispose of surplus excavated material uniformly along the adjacent roadway.

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.

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.

Drill holes for bolts, threaded rods, or expansion anchorage devices drilled in existing concrete by a method that will not shatter the concrete adjacent to the holes.

Repair any spalling or chipping of concrete structures at your expense.

Apply standard commercial polyvinyl chloride 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 all 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.

Salvage or remove and dispose of existing sign panels as shown.

56-4.03B Sign Panel Installation

Install sign panels as shown.

Attach sign panels to metal and wood posts, laminated wood box posts, electroliers, sign structure posts, traffic signal standards, and mast arms with fastening hardware of the types and sizes shown.

Install lag screws by turning the lag screw into pilot holes by use of a wrench. Bore the pilot holes with a bit diameter equal to the root diameter of the lag screw thread.

56-4.04 PAYMENT

A roadside sign consisting of 1 post with attached sign panels is paid for as 1 roadside sign - one post. An installed roadside sign consisting of 2 posts with attached sign panels is paid for as 1 roadside sign - two post.

A roadside sign consisting of 1 or 2 laminated wood box posts with attached sign panels is counted as 1 roadside sign and paid for as install roadside sign (laminated wood box post).

A roadside sign mounted on a barrier or railing is measured by scale weighings and paid for as metal (rail mounted sign). Scale weighings include pipe posts, base plates, anchorage assemblies, and other metal parts except sign panels and sign-panel fastening hardware.

Type N (CA), Type P (CA), and Type R (CA) marker panels are paid for as roadside signs.

Payment for furnishing sign panels is not included in the payment for roadside sign.

56-5 INSTALL SIGN PANEL ON EXISTING FRAME

56-5.01 GENERAL

Section 56-5 includes specifications for installing sign panels on existing frames in place.

56-5.02 MATERIALS

Not Used

56-5.03 CONSTRUCTION

Salvage or remove and dispose of existing sign panels as shown.

Install sign panels on existing frames with fastening hardware specified in section 56-2.01B(4).

56-5.04 PAYMENT

Payment for furnishing sign panels is not included in the payment for install sign panel on existing frame.

56-6 INSTALL REMOVABLE SIGN PANEL FRAME

56-6.01 GENERAL

Section 56-6 includes specifications for furnishing and installing removable sign panel frames with sign panels attached on new or existing sign structures.

56-6.02 MATERIALS

Not Used

56-6.03 CONSTRUCTION

Salvage or remove and dispose of existing sign panels and removable sign panel frames as shown.

Install removable sign panel frames as shown.

Install sign panels on removable sign panel frames with fastening hardware specified in section 56-2.01B(4).

56-6.04 PAYMENT

A removable sign panel frame consisting of a single removable sign panel frame with attached sign panels is counted as 1 removable sign panel frame.

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.

56-7 SIGN OVERLAY

56-7.01 GENERAL

Section 56-6 includes specifications for installing sign overlays.

Sign overlay includes furnishing sign overlay.

56-7.02 MATERIALS

Sign overlay materials must comply with section 56-2.01B.

56-7.03 CONSTRUCTION

Install sign overlay as shown.

Self-plugging blind rivets for installing sign overlays must have a 3/16 by 5/8-inch shank. Drill the rivet holes with a no. 10 drill bit. If the overlay is not pre-punched, the maximum rivet spacing must be 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.

56-7.04 PAYMENT

Not Used

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 Control and 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 such 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 75-1.03.

Hot-dip galvanize structural metal under section 75-1.05.

57-1.02C Hardware

Hardware must comply with section 75.

Except for malleable iron washers, hot-dip galvanize hardware under section 75-1.05.

Bolts and nuts must comply with ASTM A 307.

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

Timber and lumber are measured from nominal widths and thicknesses and the actual lengths of the pieces in the completed structure.

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 Control and 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

Inspect and grade mark structural timber and lumber.

Grade the timber and lumber 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 Product Standard PS 56 published by NIST and Standard 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 of timber and lumber is specified, treat the timber, lumber, and piling after millwork is completed.

Preservative-treated timber must be Douglas fir or Hem-Fir.

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.

Chromated copper arsenate must not be used for preservative treatment.

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 D 4444 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 51-2.01C(3) applies to treated timber.

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 the 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 59.

Paint the following items with 1 application of latex-base wood primer and 2 applications of white exterior latex-base 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

57-2.02A(1) Summary

Section 57-2.02 includes specifications for installing timber lagging for soldier pile retaining walls.

57-2.02A(2) Definitions

Reserved

57-2.02A(3) Submittals

Reserved

57-2.02A(4) Quality Control and Assurance

Reserved

57-2.02B Materials

Timber members must be preservative-treated Douglas fir and must be full sawn to the dimensions shown.

57-2.02C Construction

If no concrete facing is shown:

1. Lagging members 4 inches thick or less must be installed with a 3/8-inch gap between members
2. Lagging members greater than 4 inches thick must be installed with a 1/2-inch gap between members

If a concrete facing is shown, install the lagging members with mortar-tight joints.

57-2.02D Payment

Not Used

57-2.03 TIMBER CATWALK

57-2.03A General

57-2.03A(1) Summary

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.

57-2.03A(2) Definitions

Reserved

57-2.03A(3) Submittals

Reserved

57-2.03A(4) Quality Control and Assurance

Reserved

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. Galvanize the cable with a Class A coating under ASTM A 603.

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.

The hardware, turnbuckles, U-bolts, cable clamps, and other fittings must be galvanized under section 75-1.05.

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

Timber catwalk is measured along its length.

57-2.04–57-2.08 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

Submit 5 sets of shop drawings for the plastic lumber for initial review. After review, submit from 6 to 12 sets, 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

Submit the following product data:

1. Manufacturer's material test reports
2. Manufacturer's performance data
3. MSDSs
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 stiffness test results.

57-3.01D Quality Control and Assurance

57-3.01D(1) General

Start a new production lot if any production parameter changes before the maximum production lot size is reached.

57-3.01D(2) 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 D 790, 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) Void Tests

57-3.01D(3)(a) General

Before use in the work, the plastic lumber must be tested for both exterior and interior voids.

Allow 15 days for void testing.

The Engineer selects 2 test samples of each size from each production lot of plastic lumber delivered to the job site.

57-3.01D(3)(b) 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)(c) 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 the cross-sectional dimensions or 1 inch for the length
5. Have total resistance to marine borers and dry rot and must not swell, shrink, or crack
6. Comply with the physical property requirements shown in the following table:

Property	Test	Requirement
Density	ASTM D 792, Test Method A	Skin: 880 kg/m^3 min Core: 680 kg/m^3 min
Water absorption	ASTM D 570	Max increase in weight of 1.0 percent at 2 hours and 3.0 percent at 24 hours
Brittleness	ASTM D 746	Skin: No break at -40 °C
Hardness	ASTM D 2240, Type D	Skin: 45–75
UV deterioration	ASTM D 4587[a] ASTM D 2240, Type D	Skin: After 500 hours of exposure, hardness must not have changed by more than 10 percent
Abrasion	ASTM D 4060 Cycles: 10,000 Wheel: CS17 Load: 1 kg	Skin: Weight loss: < 500 mg Wear index: 2.5–3.0
Chemical resistance	ASTM D 543 Practice A, Procedure 1	Sea water: < 1.5 percent weight increase Gasoline: < 7.5 percent weight increase No. 2 diesel: < 6.0 percent weight increase
Coefficient of thermal expansion	ASTM D 696	0.00009/°C max
Ignition temperature	ASTM D 1929	> 340 °C

[a]ASTM D 4329 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 UV exposure at 60 degrees C and 4 hours of condensate exposure at 40 degrees 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:

Property	Test	Requirement
Flexural strength	ASTM D 790	70,000 psi min
Compression modulus	ASTM D 695	40,000 psi min
Tensile strength	ASTM D 638	70,000 psi min

Fiberglass filaments must comply with the requirements shown in the following table:

Property	Test	Requirement
Density	ASTM D 792	2,560–2,592 kg/m^3
Mechanical, single filament tensile strength	ASTM D 3822	3,450–3,790 MPa
Tensile modulus of elasticity	ASTM D 3822	69–72 MPa

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 property requirements specified for reinforced RPL and the requirements shown in the following table:

Property	Test	Requirement
Density of concrete core	ASTM D 792	1,762 kg/m^3 min
28-day compressive strength of concrete core	ASTM C 579	5,000 psi min
Structural strength of shell Tensile strength, tensile modulus Flexural strength, flexural modulus	 ASTM D 638 ASTM D 790	Less than 10 percent loss after UV deterioration test specified for plastic lumber
Dry film thickness of coating	--	15 mils min
Color change of coating	ASTM D 4587, Test Cycle 2	No visible color change when tested for 800 hours
Initial adhesion of coating	ASTM D 4541	150 psi min
Decrease in initial adhesion of coating	ASTM D 4541 ASTM D 1183, Test Condition D[a]	No more than 10 percent decrease following 2 exposure cycles

[a]Use a low temperature phase at 4 ± 5 degrees F and high temperature phase at 140 ± 5 degrees 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 D 3164 following 2 cycles of exposure under ASTM D 1183, 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.

Each hole for a bolt in the plastic lumber must be bored 1/8 inch larger in diameter than the bolt to be placed. Each hole for a lag screw must be bored to a diameter under the manufacturer's instructions. Bolts and lag screw heads must be recessed 1/2 inch from the surface of the face of plastic lumber fenders.

Coat holes drilled through CPL members with a concrete sealant under the manufacturer's instructions.

Plastic lumber elements that are split, broken, warped, or otherwise damaged are rejected.

57-3.04 PAYMENT

Not Used

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.

Structure excavation and structure backfill must comply with section 19-3.

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 sounds 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 C 90.

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 Control and Assurance

58-2.01D(1) General

Reserved

58-2.01D(2) Concrete Masonry Units

Obtain CMUs of a uniform color and texture from a single source and from a single manufacturer.

58-2.01D(3) Mortar

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.

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(4) Masonry Preconstruction Testing

Perform masonry preconstruction testing at an authorized laboratory. The authorized laboratory must comply with ASTM E 329.

Determine the compressive strength of masonry for each grout mix to be used under one of the following 2007 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 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 C 1019.

58-2.01D(5) Field Quality Control

58-2.01D(5)(a) General

You must employ a special inspector and an authorized laboratory to perform inspections and structural tests of masonry to verify the masonry construction complies with section 1704, "Special Inspections," and section 2105, "Quality Assurance," of the 2007 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(5)(b) Special Inspector

The special inspector must be an ICC certified Structural Masonry Special Inspector. The special inspector must perform the inspections required in section 1704.5, "Masonry Construction," of the 2007 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 2007 CBC.

58-2.01D(5)(c) 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(4).

58-2.02 MATERIALS

58-2.02A General

Reserved

58-2.02B Concrete Masonry Units

CMUs must comply with ASTM C 90 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 C 270 except the cement must comply with section 90-1.02B(2).

Aggregate must comply with ASTM C 144.

Hydrated lime must comply with ASTM C 207, Type S.

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 C 979. 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 C 270.

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 grout with sufficient water to produce a mix consistency suitable for pumping without segregation. Provide grout with a slump from 8 to 11 inches.

58-2.02E Lightweight Aggregate

Reserved

58-2.02F Reinforcement

Bar reinforcing steel must comply with ASTM A 615/A 615 M, Grade 60 or ASTM A 706/A 706 M.

Ladder type joint reinforcement must comply with ASTM A 951, hot-dip galvanized.

58-2.02G Expansion Joint Filler

Expansion joint filler must comply with ASTM D 1751 or ASTM D 2000 M2AA 805.

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 75-1.05.

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 corrugate 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 gage 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

Submit project specific shop drawings to the OSD, Documents Unit. Notify the Engineer of your submittal. For initial review, submit 4 sets of shop drawings. Allow 25 days for the Department's review. After review and correction, submit from 6 to 12 sets, 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 Control and 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 PAINTING

59-1 GENERAL

59-1.01 GENERAL

59-1.01A Summary

Section 59-1 includes general specifications for painting new installations and repainting existing installations.

59-1.01B Definitions

Reserved

59-1.01C Submittals

Submit a certificate of compliance and MSDS for each shipment of blast cleaning material.

59-1.01D Quality Control and Assurance

Measure coating dry film thickness with a calibrated Type 2 magnetic film thickness gage 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 D 4541.

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 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 C 920, 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. Use only the following abrasives unless authorized:

1. Clean dry sand. Do not use unwashed beach sand containing salt or excessive silt.
2. Mineral grit.
3. Steel shot.
4. Steel grit.

Mineral 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 limits specified for the air quality district where the project is located.

59-1.03 CONSTRUCTION

59-1.03A General

Notify the Engineer 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 when the atmospheric or surface temperature is below 36 degrees F or above 100 degrees F or when the relative humidity is more than 85 percent.

Do not apply water-borne paint when the atmospheric or surface temperature is below 51 degrees F or above 100 degrees F or when the relative humidity exceeds 75 percent.

Except for work within enclosures, do not apply paint if:

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 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, rinse cleaned surfaces with fresh 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 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 the same day blast cleaning is performed unless otherwise authorized.

59-1.03D Painting

Each spray pot must have an authorized water trap installed.

Thinning of paint is not allowed 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 are not allowed. 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 to 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 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.

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 nonuniform 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 Summary

Section 59-2 includes specifications for preparing and painting structural steel and other metal, except galvanized or thermal spray coated surfaces.

59-2.01B Definitions

Reserved

59-2.01C Submittals

59-2.01C(1) 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 ASTM A325 or A490 Bolts* of the RCSC.

59-2.01C(2) Mandatory SSPC-QP Certifications

Reserved

59-2.01C(3) 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. Include the following:

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 or qualification statements showing compliance with SSPC-QP certification.

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.

59-2.01D Quality Control and Assurance

59-2.01D(1) General

You must hold following the SSPC certifications in good standing throughout the Contract to perform the following painting activities:

1. For cleaning and painting structural steel in the field, SSPC-QP 1
2. For removing hazardous coatings from structural steel, SSPC-QP 2
3. For cleaning and painting structural steel in a permanent painting facility, SSPC-QP 3 or AISC SPE, Certification P-1 Enclosed

59-2.01D(2) Meetings

Before starting painting activities, conduct a meeting to discuss painting quality work plan requirements. Meeting attendees must include the Engineer and all painting subcontractors.

59-2.01D(3) Field Quality Control

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.

Test the inorganic zinc undercoat before applying final or finish coats. Perform adhesion and hardness testing no sooner than 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, as determined by the Engineer, 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 D 4752 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 D 4752. 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 D 3363. 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.

59-2.02 MATERIALS

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 A325 or A490 Bolts* of the RCSC.

59-2.03 CONSTRUCTION

59-2.03A General

Clean and paint all exposed structural steel and other metal surfaces.

You must provide enclosures for cleaning and painting structural steel. Cleaning and painting of new structural steel must be performed in a Category I Enclosure as defined in SSPC-QP 3. Maintain atmospheric conditions inside enclosures within specified limits.

Except for blast cleaning within closed buildings, perform blast cleaning and painting during daylight hours.

Coatings for new structural steel must comply with the requirements shown in the following table:

Table 1 Coatings for New Structural Steel

Description	Coating	Dry film thickness, mils
All surfaces:		
Undercoat	Inorganic zinc primer, AASHTO M 300 Type I or II	4–8
Finish coat[a]	Exterior grade latex, 2 coats	2 minimum each coat, 4–8 total
Total thickness, all coats		8–14

[a]If no finish coats are described, a final coat of inorganic zinc primer is required

Coatings for existing structural steel must comply with the requirements shown in the following table:

Table 2 Coatings for Existing Structural Steel

Description	Coating	Dry film thickness, (mils)
Connections to new structural steel:[a]		
Undercoat	Inorganic zinc primer, AASHTO M 300 Type I or II	4–8
Finish coat[b]	Exterior grade latex, 2 coats	2 minimum each coat, 4–8 total
Total thickness, all coats		8–14
Other surfaces cleaned to bare metal:		
1st undercoat	State Specification PWB 145	2–3
2nd undercoat	State Specification PWB 146	2–3
1st finish coat	State Specification PWB 171	1.5–3
2nd finish coat	State Specification PWB 172	1.5–3
Total thickness, all coats		7–12
Existing painted surfaces to be topcoated:		
Undercoat	State Specification PWB 146	2–3
1st finish coat	State Specification PWB 171	1.5–3
2nd finish coat	State Specification PWB 172	1.5–3
Total thickness, new coats		5–9

[a]Includes the following locations:

1. New and existing contact surfaces
2. Existing member surfaces under 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

[b]If no finish coats are described, a final coat of inorganic zinc primer is required

59-2.03B Surface Preparation

59-2.03B(1) 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 A 6 or AASHTO M 160 before blast cleaning.

After removing material defects exposed by blast cleaning, restore the blast profile by blast cleaning or using mechanical tools under SSPC-SP 11.

59-2.03B(2) Cleaning

59-2.03B(2)(a) 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. Remove paint that becomes loose, curled, lifted, or that loses its bond after cleaning 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 as determined by the Engineer. When there is no bid item for spot blast cleaning, this is change order work. Spot blast clean surfaces under SSPC-SP 6. 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.

59-2.03B(2)(b) Blast Cleaning

Blast clean steel surfaces to be coated with inorganic zinc under SSPC-SP 10. After blast cleaning, surfaces must have a dense, uniform, angular anchor pattern of from 1.5 to 3.5 mils when measured under ASTM D 4417.

Where shown, spot blast clean existing painted steel surfaces under SSPC-SP 6. After blast cleaning, surfaces must have a dense, uniform, angular anchor pattern of at least 1.5 mils when measured under ASTM D 4417.

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.

59-2.03C Painting

59-2.03C(1) General

Paint new structural steel as follows:

1. Apply the total thickness of undercoats before erection. Apply finish coats 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. Precede each undercoat by 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 and be followed as soon as practical by the undercoat.
2. Apply finish coats after the total dry film thickness of undercoat has been applied.

Caulk contact surfaces of stiffeners, railings, built up members, or open seam more than 6 mils wide with sealing compound or other authorized material. Apply sealing compound no sooner than 72 hours after the last application of undercoat unless authorized. Cure the sealing compound as recommended by the manufacturer 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.

For existing structural steel, apply all undercoats and the 1st finish coat within 30 days of initial cleaning activities.

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.

59-2.03C(2) Zinc Coatings

59-2.03C(2)(a) General

Strain zinc coatings 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 zinc coatings by spray. On areas inaccessible to spray application, you may make limited applications when 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.

59-2.03C(2)(b) Inorganic Zinc Undercoat

59-2.03C(2)(b)(i) General

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.

For damaged areas of the undercoat, the following apply:

1. If the Engineer determines the damaged area is more than 2 percent of the total undercoated surface, blast clean and repaint damaged areas with inorganic zinc.
2. If the Engineer determines the damaged area is 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 A325 or A490 Bolts* of the RCSC.

Complete field testing of the undercoat and correct deficiencies before applying subsequent coats.

59-2.03C(2)(b)(ii) 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. The total thickness of undercoat and final coat must be from 5 to 9 mils.

59-2.03C(2)(b)(iii) Finish Coats

Pressure rinse undercoated surfaces to receive finish coats. Perform pressure rinsing no sooner than 72 hours after the final application of undercoat.

The 1st finish coat must be applied 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 D 1640.

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.

59-2.04 PAYMENT

Not Used

59-3 PAINTING GALVANIZED SURFACES

59-3.01 GENERAL

Section 59-3 includes specifications for 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 not less than 2 applications. Apply the 1st finish coat the same day abrasive blasting is performed unless authorized. Apply the 2nd finish coat after the 1st finish coat has dried 12 hours unless 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 TIMBER

59-4.01 GENERAL

Section 59-4 includes specifications for preparing and painting timber installations.

59-4.02 MATERIALS

Not Used

59-4.03 CONSTRUCTION

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.

You may apply the 1st coat before erection if authorized.

Paint new timber with 3 coats consisting of 1 coat of wood primer and 2 coats of exterior paint.

Paint previously painted timber with 2 coats of exterior paint. Prime bare wood with 1 coat of wood primer.

After timber is in place, putty cracks, checks, nail holes, and other depressions flush with the surface. Let dry before applying the 1st coat of exterior paint.

59-4.04 PAYMENT

Not Used

59-5 PAINTING SIGN STRUCTURES

59-5.01 GENERAL

Section 59-5 includes specifications for preparing and painting sign structures.

59-5.02 MATERIALS

Not Used

59-5.03 CONSTRUCTION

Prepare and paint tubular and box beam-closed truss sign structures under sections 59-2 and 59-3. Do not paint other types of sign structures unless specified in the special provisions.

You may prepare and paint sign structures before or after erection. After erection, repair damaged paint to the satisfaction of the Engineer.

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.

59-5.04 PAYMENT

Not Used

59-6 PAINTING CONCRETE

59-6.01 GENERAL

Section 59-6 includes specifications for painting concrete surfaces.

Submit coating manufacturer's application instructions 7 days before use.

59-6.02 MATERIALS

Coatings must comply with section 91-4.05. Unless otherwise shown, coatings must be white.

59-6.03 CONSTRUCTION

New concrete must be at least 28 days old before painting.

Prepare surfaces under SSPC-SP 13/NACE no. 6.

Pressure rinse prepared surfaces before applying coating. Surfaces must be thoroughly dry at the time of painting. You may use artificial drying methods if authorized.

Apply at least 2 coats under the manufacturer's instructions and SSPC-PA 7.

59-6.04 PAYMENT

Reserved

59-7 ACID STAINING CONCRETE

59-7.01 GENERAL

Section 59-7 includes specifications for preparing and staining concrete surfaces using an acid stain.

Submit stain manufacturer's product data and application instructions 7 days before starting staining activities.

59-7.02 MATERIALS

Concrete stain must:

1. Be a water-based solution of inorganic metallic salts
2. Contain dilute acid that penetrates and etches the concrete surface.
3. Be a commercial quality product designed specifically for exterior applications
4. Produce abrasion resistant color deposits
5. Be authorized before using

59-7.03 CONSTRUCTION

Seal joints between concrete surfaces to be stained and adjacent metal before applying stain.

Test surfaces for acceptance of stain before applying stain. Clean surfaces that resist accepting stain and retest until passing.

Apply stain under the manufacturer's instructions. Apply 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 stained surfaces with water and wet scrub with a stiff bristle nylon brush until the rinse water runs clear. All rinse water must be collected.

Protect adjacent surfaces during staining using an authorized method.

59-7.04 PAYMENT

Reserved

59-8 ANTI-GRAFFITI COATING

59-8.01 GENERAL

Section 59-8 includes specifications for applying a sacrificial anti-graffiti coating.

Submit manufacturer's application and removal instructions 7 days before starting work.

59-8.02 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

59-8.03 CONSTRUCTION

Test surfaces for acceptance of coating before applying. Clean surfaces that resist accepting coating and retest until passing.

Apply anti-graffiti coating under the manufacturer's instructions in at least 2 even coats.

59-8.04 PAYMENT

Not Used

59-9 PAINTING STEEL SOLDIER PILES

59-9.01 GENERAL

Section 59-9 includes specifications for preparing and painting steel soldier piles.

Where shown, prepare and paint steel soldier piles under the specifications for new structural steel in section 59-2.

59-9.02 MATERIALS

Not Used

59-9.03 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 used for the undercoat.

Apply final or finish coats after installation and excavation are complete.

Caulk open joints between concrete and steel solider piles with sealing compound or other authorized material.

59-9.04 PAYMENT

Not Used

59-10 THERMAL SPRAY COAT STRUCTURAL STEEL

59-10.01 GENERAL

59-10.01A Summary

Section 59-10 includes specifications for coating steel surfaces with a thermal spray coating.

Limits for coating are shown.

59-10.01B Definitions

Reserved

59-10.01C Submittals

59-10.01C(1) General

Submit a certificate of compliance for each shipment of wire feedstock.

59-10.01C(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 prejob meeting. Include the following:

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.

59-10.01D Quality Control and Assurance

59-10.01D(1) General

Each thermal spray coating operator must be certified under AWS C2.16/C2.16M.

59-10.01D(2) Meetings

Before starting coating activities, conduct a meeting to discuss coating quality work plan requirements. Meeting attendees must include the Engineer and all coating subcontractors.

59-10.01D(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 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. Coupons must exhibit no cracking with lifting from substrate.

59-10.01D(4) Field Quality Control

The Engineer selects test locations.

If repairs are required, retest rejected areas after completing repairs.

Test the surface profile of blast-cleaned steel under ASTM D 4417, Method C. Perform 3 tests for the first 200 sq ft of blast-cleaned steel and 1 test 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 every 200 sq ft thereafter.

Inspect surfaces for visual cleanliness under SSPC-SP 10 before applying coating.

Test coating thickness under section 6.3 of SSPC-CS 23.00. 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. 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.

59-10.02 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 B 833.

Seal coat paint must be authorized before use.

59-10.03 CONSTRUCTION

Do not apply coating when the steel surface temperature is less than 32 degrees F.

Prepare surfaces under section 59-2.03B(1).

Blast clean surfaces under SSPC-SP 10. 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 under section 59-2. 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 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.

59-10.04 PAYMENT

Not Used

59-11–59-20 RESERVED

60 RESERVED

DIVISION VII DRAINAGE

61 CULVERT AND DRAINAGE PIPE JOINTS

61-1.01 GENERAL

61-1.01A Summary

Section 61 includes specifications for constructing joint systems or couplers for culverts and drainage pipes, testing joints for watertightness, and field leakage testing for pipe systems.

Joint systems or couplers for culverts and drainage pipes are described by classification as "Standard," "Positive," or "Downdrain."

You may use either:

1. Joint systems or couplers complying with the classification shown and as specified in sections 64, 65, 66, and 69 for the type of pipe installed
2. Joint systems or couplers under section 61-1.01D(1)(b) if authorized

The Engineer may require field tests to verify compliance.

61-1.01B Definitions

shear strength: The required joint shear strength is expressed as a percentage of the calculated pipe shear strength at a transverse section remote from the joint. All joints, including any connection, must be capable of transferring the required shear across the joint.

moment strength: The moment strength required of the joint is expressed as a percentage of the calculated moment capacity of the pipe on a transverse section remote from the joint.

tensile strength: The tensile strength is the resistance to the longitudinal force that tends to separate (disjoint) adjacent pipe sections.

integral joint overlap: The integral joint overlap is the projection of 1 pipe barrel into an adjacent pipe barrel.

sleeve joint overlap: The sleeve joint overlap is the minimum sleeve width required to engage abutted pipe barrels.

watertightness: Watertightness is the ability of a joint to hold water under pressure without leaking.

joint: The connection point for 2 or more pipe sections.

61-1.01C Submittals

If joints are described as watertight, submit your analysis or test results performed on representative joints proposed for installation as specified in section 61-1.01D(1)(a) for watertightness.

If using joint systems or couplers under section 61-1.01D(1)(b), submit a certificate of compliance certifying compliance with the table titled "Joint Properties" shown in section 61-1.01D(1)(b).

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 the following information:
   - 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 the repair of joints or pipe sections that fail the field leakage test

61-1.01D Quality Control and Assurance

61-1.01D(1) Source Quality Control

61-1.01D(1)(a) Watertightness

Watertightness must be attained by use of an authorized durable, high-quality, resilient joint material designed to perform the intended function. The material must be neoprene expanded rubber or sheet rubber gaskets, "O" ring rubber gaskets, butyl rubber base joint sealant, or other authorized resilient material.

Assembled joints must pass the following performance tests without joint leakage:

1. Test 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.
2. 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 1 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 1 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.

61-1.01D(1)(b) Performance Specifications for Culvert and Drainage Pipe Joints

If using joint systems or couplers under section 61-1.01D(1)(b), determine the values for joint properties by mathematical analysis or a suitable, 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 joint property values for the joint classifications shown in the following table:

Properties of Joint Classifications

Property	Values		
	Standard	Positive[a]	Downdrain[b]
Shear strength	2%	5%	5%
Moment strength	0%	15%	15%
Tensile strength			
6"–42" dia[c]	0	0	5,000 lb
45"–84" dia[c]	0	0	10,000 lb
Joint overlap[d]			
Integral			
12" and smaller dia[e]	1/4 "min	1/2" min	--
15"–33" dia[e]	1/2" min	3/4" min	--
36" and larger dia[e]	3/4" min	1" min	--
Sleeve min width	10-1/2"	10-1/2"	10-1/2"
Watertightness	If described	If described	Required

Note:
[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 properties.
[b]Joints for downdrains must comply with specified values when tested with joints sealed as proposed 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.

61-1.01D(2) Field Quality Control

61-1.01D(2)(a) Field Leakage Testing for Culvert and Drainage Pipes

61-1.01D(2)(a)(i) General

Where field leakage testing is shown for a pipe system, perform field leakage testing on culverts and drainage structures.

Do not perform field leakage testing if the pipe system is to be fully encased in concrete backfill.

Field leakage testing includes performing field leakage tests for culverts and drainage pipes by:

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

Test all joints for leakage in pipe systems less than 1,500 feet in length.

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 if less than 1 mile in length
2. 30 joints per 100 pipe joints if between 1 mile and 3 miles in length
3. 20 joints per 100 pipe joints if 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 and test each pipe system and appurtenances by the exfiltration, low-pressure air, or negative air pressure method after backfilling. You may use the infiltration test where the groundwater table is low as determined by the Engineer. You may test installed pipe joints using air or water under low pressure.

Clean the pipe and remove debris and sediment before you start testing.

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 the storm drain lines and structures.

Perform each test in the presence of the Engineer.

Prevent joints from drawing 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 will 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.

61-1.01D(2)(a)(ii) Exfiltration and Infiltration Testing

Exfiltration and infiltration tests must comply with ASTM C 969 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 needed.
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 so 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 when 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.

61-1.01D(2)(a)(iii) 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

61-1.01D(2)(a)(iv) Other Allowable Tests

If authorized, you may test:

1. Pipes over 27 inches in nominal diameter 1 joint at a time under ASTM C 1103 instead of the exfiltration test under section 61-1.01D(2)(a)(ii).
2. Plastic pipe 30 inches or less in nominal diameter with the low-pressure air test under ASTM F 1417.
3. Pipes 36 inches or less in nominal diameter with the negative 3.5 psi air pressure (vacuum) test under ASTM C 1214 instead of the exfiltration test or low-pressure air test under section 61-1.01D(2)(a)(ii). 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 under section 61-1.01D(2)(a)(ii)
   - 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

61-1.01D(2)(a)(v) 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 test requirements.

Repair and retest the failed joints or pipe sections as described in the repair procedures submitted under section 61-1.01C. If the same joint fails the leakage test a 2nd time, remove and replace the pipe sections on either side of the joint with new pipes. Whenever a pipe section fails, replace it. Retest the replaced pipe section for leaks. The Department does not pay for repair, replacement, and retesting of failed joints or pipe sections.

61-1.01D(2)(b) Reserved

61-1.02 MATERIALS

Not Used

61-1.03 CONSTRUCTION

Not Used

61-1.04 PAYMENT

Field leakage testing is measured along the invert of the pipe. The payment quantity includes the length through elbows, tees, and other fittings that have passed field leakage tests. Lengths of pipe that need to

be retested are not included in the measured quantities until passing field leakage tests have been attained. Where drainage inlets or similar structures are within the length of the pipe to be tested, the length of pipe is measured to the inside face of the structure.

62 ALTERNATIVE CULVERTS

62-1 GENERAL

62-1.01 GENERAL

Section 62-1 includes general specifications for constructing alternative culverts, alternative slotted pipe, temporary culverts, and for placing concrete backfill for pipe trenches.

Choose from the types of alternative culverts shown. If chosen for alternative culvert:

1. Reinforced concrete pipe and pipe arches must comply with section 65
2. Corrugated steel pipe and pipe arches must comply with section 66
3. Corrugated aluminum pipe and pipe arches must comply with section 66
4. High density polyethylene pipe must comply with section 64
5. Polyvinyl chloride pipe must comply with section 64
6. Structural steel plate pipe, arches, and pipe arches must comply with section 67
7. Structural aluminum plate pipe, arches, and pipe arches must comply with section 67
8. Reinforced concrete box culverts and arch culverts must comply with section 51

62-2 ALTERNATIVE SLOTTED PIPE

62-2.01 GENERAL

Section 62-2 includes specifications for constructing alternative slotted pipe.

Choose from the types of alternative slotted pipe shown. Do not mix types of slotted pipe in the same installation.

If chosen for alternative slotted pipe:

1. Slotted plastic pipe must comply section 64-2
2. Slotted corrugated steel pipe must comply the specifications for slotted corrugated steel pipe in section 66-2

62-2.02 MATERIALS

Not Used

62-2.03 CONSTRUCTION

Not Used

62-2.04 PAYMENT

Not Used

62-3 TEMPORARY CULVERTS

62-3.01 GENERAL

Section 62-3 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.

62-3.02 MATERIALS

You may use used pipe if the pipe complies with the specifications for new pipe. Obtain authorization for used pipe.

62-3.03 CONSTRUCTION

Install a size and type of temporary culvert at each location 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 installation.

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.

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.

Remove and dispose of the culvert when the Engineer determines that the temporary culvert is no longer required for the work.

62-3.04 PAYMENT

Temporary culvert is 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. The payment quantity is the length determined by the Engineer. 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.

Pipe reducers are paid for as pipe of the larger diameter connected to the reducer.

62-4 CONCRETE BACKFILL FOR PIPE TRENCHES

62-4.01 GENERAL

62-4.01A Summary

Section 62-4 includes specifications for placing concrete backfill in pipe trenches.

62-4.01B Submittals

If RSC is used for concrete backfill, 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 500 psi compressive strength when tested under California Test 521.

62-4.02 MATERIALS

Concrete for 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 instead of minor concrete for concrete backfill.

If RSC is used for concrete backfill, the RSC must:

1. Contain at least 505 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

62-4.03 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 achieve 500 psi as specified in section 62-4.01B.

Consolidate concrete backfill using high-frequency internal vibrators.

If HMA is to be placed directly thereon, broom the concrete backfill surface with a heavy broom to produce a uniform rough surface.

62-4.04 PAYMENT

If the limits of concrete backfill for pipe trenches are shown, the volume of concrete backfill is based on the dimensions shown and the length of pipe designated by the Engineer.

If the limits of concrete backfill for pipe trenches are not shown, the volume of concrete backfill is based on the following:

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. Length of pipe designated by the Engineer.
5. Volume occupied by the pipe will not be included in the quantities. Concrete backfill placed outside of these limits will not be included in the quantities paid for unless greater limits are ordered.

If alternative pipe is shown, the volume of concrete backfill is based on the required trench width for the pipe with the smallest outside diameter.

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 constructing plastic pipe.

Plastic pipe includes all necessary elbows, wyes, tees, other branches, fittings, and coupling systems.

64-1.01B Submittals

Submit a certificate of compliance for plastic pipe, including the average pipe stiffness, resin material cell classification and date of manufacture.

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.

64-1.02 MATERIALS

64-1.02A 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 semi-matte 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 a way that protects gaskets from the weather.

Store pipes in unit packages. Protect the bell end of pipes from damage. Support unit packages with racks or dunnage to prevent damage and bending. Take measures to ensure the weight of the upper units does not cause deformation to pipes in the lower units whenever the unit packages are stacked. Do not store pipes adjacent to heat sources. Do not allow pipes to overhang vehicles or storage areas unsupported for 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 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. Do not damage placed pipes. Do not use cracked or chipped pipes and fittings.

64-1.02B 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:

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.

64-1.02C Corrugated Polyethylene Pipe

Corrugated polyethylene pipe must be 60 inches or less in nominal diameter.

Type C and Type S corrugated polyethylene pipe must comply with AASHTO M 294. Corrugated polyethylene pipe must be manufactured from HDPE virgin compounds.

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 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

64-1.02D Corrugated PVC Pipe with Smooth Interior

Corrugated PVC pipe must have a smooth interior.

Corrugated PVC pipe with smooth interior must 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.

64-1.02E Joints

Plastic pipe joints must comply with section 61-1.01D(1)(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 61-1.01D(1)(b) for watertightness.

For corrugated polyethylene pipe:

1. If watertight joints are not shown, Type S corrugated polyethylene pipe must incorporate a closed-cell expanded rubber gasket on each side of the joint complying with ASTM D1056, Grade 2A2. Gaskets must be factory-installed.
2. Corrugated polyethylene pipe joints manufactured to comply with section 61-1.01D(1)(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 porosity, 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 61-1.01D(1)(b) for integral joints except the joint overlap requirements must be 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.

64-1.02F–64-1.02H Reserved

64-1.03 CONSTRUCTION

64-1.03A 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.

64-1.03B 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 19-3.02F or with slurry cement backfill under section 19-3.02D.
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.

64-1.03C Laying Pipe

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.

Connect new plastic pipe to existing or new drainage facilities as shown. 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 pipes. 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 in the direction of 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.

64-1.04 PAYMENT

Plastic pipe 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. The payment quantity is the length designated by the Engineer. 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.

64-2 SLOTTED PLASTIC PIPE

64-2.01 GENERAL

64-2.01A Summary

Section 64-2 includes specifications for fabricating and 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.

64-2.01B Submittals

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.

64-2.02 MATERIALS

64-2.02A General

The interior surface of slotted plastic pipe must be smooth except for the vertical and top wall stiffening ridges. Slotted plastic pipe must be polyethylene.

Slotted plastic pipe must:

1. Be manufactured from polyethylene consisting of virgin polyethylene resin and carbon black
2. Comply with the resin and requirements shown in the following table:

Slotted Plastic Pipe Property Requirements

Property	ASTM test designation	Requirements
Resin Properties:		
Density (g/cm³)	D1505	0.934–0.935
Melt index (g/10 minutes)	D1238	5–10
Performance Properties:		
Flexural modulus (psi)	D790	80,000 (min)
Tensile strength @ yield (psi)	D638	2,400 (min)
Environmental stress crack resistance	D1693	Test condition B, duration 24 hr, 45% failure (max)
Hydrostatic design basis	D2837	Not pressure rated
Color and UV stabilizer	--	C[a]

[a]Resin must not contain less than 2 ± 0.5 percent carbon black UV stabilizer.

The wall thickness of slotted plastic pipe must be at least 0.23 inch. The vertical and top slope walls, except the slot, must be shaped to create external ridges at least 3/8 inch deep and 1-3/8 inches wide at intervals not greater than 10 inches on center when the pipe is manufactured. The ridges must provide enough wall stiffness so that the pipe does not deflect more than 1/16 inch when concrete backfill is placed against the pipe walls.

End caps must be manufactured to the same material requirements as plastic slotted pipe. The end caps and plastic slotted pipe must be made by the same manufacturer. The end caps must prevent concrete backfill from entering the pipe.

Slotted plastic pipe must have tongue-and-groove interlocking ends and clips molded into the sides of the channel to accommodate vertical reinforcing bars for positioning and anchoring purposes. Slots must be at least 1-3/4 inches wide and have hollow throat stiffeners at 5-inch maximum intervals to keep the slot sides apart.

64-2.02B Concrete Backfill for Slotted Plastic Pipe

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

64-2.02C Heel Resistant Grates

Heel resistant grates must comply with ADA requirements. Grate slots must be 1/2 inch wide maximum with an open area of at least 7.43 square inches per square foot area of grate. Grates must be ductile iron.

64-2.02D Bar Reinforcement

Bar reinforcement must comply with ASTM A615/A615M, Grade 60, or ASTM A706/A706M, Grade 60.

64-2.02E Miscellaneous Metal

Ductile iron, nuts, bolts, and washers must comply with section 75.

64-2.02F Grout

Grout must be nonshrink grout complying with ASTM C1107/C1107M.

64-2.02G Reserved

64-2.03 CONSTRUCTION

Wherever minor concrete is used for concrete backfill for slotted plastic pipe, do not allow traffic on top of the concrete backfill within 7 days of placing the concrete backfill.

Wherever RSC is used for concrete backfill for slotted plastic pipe, do not allow traffic on top of the concrete backfill before the required cure time to achieve 2,000 psi as specified in section 64-2.01B.

Excavation must comply with section 19-3.

Pave adjacent traffic lanes before installing slotted plastic pipe.

Lay and join slotted plastic pipe under the pipe manufacturer’s instructions.

Lay slotted plastic pipe to line and grade with sections closely jointed and adequately secured to prevent separation during placement of the backfill. If the plastic slotted pipe does 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 pipe must not extend above the completed surface. Position the pipe so that the completed concrete backfill will be flush with the surrounding grade and 1/8 to 1/4 inch above the top of the grate.

Place channels with the male and female ends facing each other.

Weld slotted plastic pipe at joints with a commercial electric welding tool under the pipe manufacturer's instructions where shown. The constructed welds must not have visible pinholes. The Department may reject transition pieces that have welds with pinholes. Do not reuse the rejected material. Dispose of rejected pieces.

Place lateral support bar reinforcement on both sides of the grate slots where shown. The support bar reinforcement must run the full length of the grate slot.

Anchor heel resistant grates to the concrete backfill with bent 18-inch, no. 3 reinforcement bars threaded through a metal hook or eye attached to the underside edge of the grate where shown. Place the reinforcement bars at 20-inch maximum intervals on each longitudinal edge of the grate. You may use another method to secure the grate to the concrete backfill if authorized 30 days before installation.

Use a transition fitting to connect a slotted plastic pipe to a drainage inlet. The transition fitting must be supplied by the pipe manufacturer.

Fill the gap around the pipe in the structure wall with nonshrink grout where the plastic slotted pipe connects to an existing drainage structure. Install the grout under the pipe manufacturer's instructions.

Cut the pipe as shown after the grout used to seal the transition fitting has cured for at least 24 hours.

Cover slots with heavy-duty tape or other authorized covering during backfilling and paving activities to prevent material from entering the slots.

Place concrete backfill where shown.

Consolidate the concrete backfill with high-frequency internal vibrators.

Texture the concrete surface with a broom or burlap drag to produce a durable skid-resistant surface.

Apply a nonpigmented curing compound to the exposed concrete backfill surface whenever the atmospheric temperature will be 90 degrees F or greater after placing the concrete backfill. The nonpigmented curing compound must comply with ASTM C309 Type 1, Class B.

64-2.04 PAYMENT

Slotted plastic pipe is measured along the centerline of the pipe and parallel with the slope line. The payment quantity is the length designated by the Engineer. 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.

65 CONCRETE PIPE

65-1 GENERAL

65-1.01 GENERAL

Section 65-1 includes general specifications for fabricating and constructing concrete pipe.

Concrete pipe includes all necessary bends, wyes, tees, and other branches.

Excavation, backfill, and culvert beddings must comply with section 19-3.

65-2 REINFORCED CONCRETE PIPE

65-2.01 GENERAL

65-2.01A Summary

Section 65-2 includes specifications for fabricating and constructing reinforced concrete circular pipe, oval shaped pipe, and pipe arches and nonreinforced concrete pipe for culverts, siphons, drains, and conduits.

65-2.01B Definitions

modified designs: Designs that differ from direct designs shown with respect to reinforcement only.

special designs: Designs that differ from direct designs in any respect from those shown.

oval shaped pipe: Pipes having major and minor internal axial dimensions as 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.

65-2.01C Submittals

If you choose to use resilient joint materials, submit the resilient joint materials for testing and authorization.

Submit the following for circular reinforced concrete pipe, direct design method:

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 Culverts and Underground Structures. Submit 6 sets of shop drawings after the initial review for use during construction and by the Office of Culverts and Underground Structures. 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 proposals 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. Copy of the concrete mix design before using the concrete or revising the mix proportions
4. 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) be pipe manufacturer's tests witnessed by State representatives. 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 Control and Assurance

65-2.01D(1) General

Reserved

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.

65-2.02 MATERIALS

65-2.02A General

The cementitious material and aggregate for reinforced concrete pipe must comply with section 90-1.02, except (1) grading 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-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:

$$b = \frac{t - 3/8d}{t - 3/8d - C} \text{ x 0.01 inch}$$

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

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.

65-2.02B Circular Reinforced Concrete Pipe

65-2.02B(1) General

Circular reinforced concrete pipe described by class must comply with section 65-2.02B(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 65-2.02B(2).

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 65-2.02B(2)
2. The wall thickness and reinforcement details under section 65-2.02B(3)

65-2.02B(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 square inch per linear foot 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 Walls 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.

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.

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 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.

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.

65-2.02B(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 and section 65-2.02B(3). Use the backfill method shown for the particular pipe design chosen.

The 3-edge bearing test does not apply to direct design method pipes.

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.

Sample and test the concrete compressive strength at least once every production shift, but not less than once daily.

The circumferential reinforcement for circular reinforced concrete pipe must be smooth or deformed reinforcement with a minimum yield strength of 65,000 psi. Longitudinal reinforcement must be welded to it 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
F_y = specified yield strength of reinforcement

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.

65-2.02C 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 270/M 270 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.

The basis for acceptance of oval shaped reinforced concrete pipe larger in size 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.

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 270
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

Before hydrostatic testing, oval shaped reinforced concrete pipe must be strength tested by 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 207 or to the actual D-load required to produce a 0.01-inch wide crack, whichever is less.

65-2.02D Reinforced Concrete Pipe Arches

Reinforced concrete pipe arches must comply with AASHTO M 206M/M 206.

Reinforced concrete pipe arches must be of the class described.

The basis for acceptance of reinforced concrete pipe arches must be 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 will not be required, except as necessary to obtain samples for the absorption test.

65-2.02E Joints

Joints for culvert and drainage pipes must be standard joints unless the classification is described.

At your choosing, reinforced concrete pipe joints must comply with the details shown or section 61-1.01D(1)(b).

Seal each joint to prevent leakage and infiltration. 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. Sand must be well graded and of such size that it will pass a no. 8 sieve.
   1.2. Materials must be mixed 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. Stored at 70 degrees F or less. Do not expose rubber gaskets to direct sun rays for more than 72 hours.
2.3. 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, or 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 61-1.01D(1)(b) for watertightness.

65-2.03 CONSTRUCTION

65-2.03A General

Reserved

65-2.03B Earthwork

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.

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 Structures

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.

65-2.03D 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.

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. If concrete collars or tee connections are required to connect new reinforced concrete pipe to new or existing pipes, the concrete collars or tee connections must be constructed of minor concrete. The reinforcement for the concrete collars or tee connections must comply with section 52.

Furnish the necessary facilities for lowering and properly placing pipe sections in the trench.

Place circular pipe with elliptical reinforcement with the minor axis of the reinforcement in the vertical position.

Lay pipes to lines and grades with the sections closely jointed. Lay pipes upgrade.

Clean and then seal joints with the type of sealing material necessary to make a tight joint.

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.

Sufficiently protect jointing materials from the air and sun to prevent drying or deterioration.

Keep liquid types of sealing materials in molds or runners. Pour or pump liquid materials into the joint space in a continuous operation and agitate until the joint is completely filled.

Take every precaution to prevent flooding of the pipe trench before backfilling activities start. 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

Reinforced concrete pipe is 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. The payment quantity is the length designated by the Engineer. 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 choose to construct a cast-in-place connection instead of cutting off the pipe to fit the structure, the payment quantity is the length of pipe measured along the centerline of the pipe to the inside face of the structure.

65-3 NONREINFORCED CONCRETE PIPE

Reserved

65-4 RESERVED

66 CORRUGATED METAL PIPE

66-1 GENERAL

66-1.01 GENERAL

66-1.01A Summary

Section 66-1 includes general specifications for fabricating and constructing corrugated metal pipe and pipe arches for culverts, siphons, drains, slotted pipe, and conduits.

Corrugated metal pipe and pipe arches include all necessary bends, wyes, tees, other branches, concrete collars or tees, and reinforcement.

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 Submittals

Submit a certificate of compliance for:

1. Corrugated steel materials
2. Corrugated aluminum materials

66-1.01C Quality Control and Assurance

66-1.01C(1) General

Reserved

66-1.01C(2) 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.

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 Pavings

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. Polymerized asphalt invert coating
3. Polymeric sheet coating
4. Bituminous lining
5. 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.

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.

A bituminous lining must be applied to the inside of the pipe over the bituminous coating wherever bituminous lining is shown.

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.

An asphalt mastic coating may be used instead of the bituminous coating on corrugated steel pipe if linings and pavings 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.

Polymerized asphalt invert coatings must be applied under ASTM A849 for "*Invert Paved Type With Polymer Material (Class P)*," except apply the polymerized asphalt coatings by immersion to a thickness of at least 0.050 inch above the crests and troughs of the corrugations of the interior and exterior inverts including the pipe ends. The polymerized asphalt material must comply with ASTM A742/A742M *Requirements for Polymer Coating* and the following:

1. Polymerized asphalt must be hot-applied thermoplastic material containing a minimum of 7.0 percent styrene-butadiene-styrene block copolymer.
2. Undercutting or delamination from the scribe must not be more than 1/4 inch when a minimum 12-by-12-inch coupon cut from the coated pipe is exposed for 1,000 hours under ASTM B117. The cut edges must be sealed by dipping in a sample of the polymerized asphalt coating heated to the manufacturer's recommended application temperature. The sealed edges must not exhibit corrosion or delamination from the sealed edges following exposure as specified.

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.

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. Repair damaged polymerized asphalt coatings under ASTM A762/A762M, section 11, "Repair of Damaged Coatings."

66-1.02D Coupling Bands

Coupling bands for corrugated metal pipe must comply with either section 66-1.02D or section 61-1.01D(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 61-1.01D(1)(b) 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, except the profile of the sheet on at least 1 side of the lock seam and adjacent to the 180-degree fold must have a minimum retaining offset of 1/2 the sheet thickness as defined under California Test 662.

Sampling and testing for continuous quality control of lock seams must comply with California Test 662.

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 75-1.05.

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.

Quality control testing of the welded seam must comply with California Test 665.

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 75-1.05.

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 75-1.05.

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, except the sheet profile on at least 1 side of the lock seam and adjacent to the 180 degree fold must have a minimum retaining offset of 1/2 the sheet thickness as defined under California Test 662.

Sampling and testing for quality control of continuous lock seams must comply with California Test 662.

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. If concrete collars or tee connections are required, construct the collars or tee connections with minor concrete. Reinforcement must comply with section 52.

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

Corrugated metal pipe is 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. The payment quantity is the length designated by the Engineer. 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.

Pipe reducers are paid for as pipe of the larger diameter connected to the reducer.

66-2 SLOTTED CORRUGATED STEEL PIPE

66-2.01 GENERAL

Section 66-2 includes specifications for fabricating and 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 75-1.02, 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 75-1.05.

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 75-1.05.

Coupling bands for slotted corrugated steel pipe must be galvanized or coated as shown.

Join slotted corrugated steel pipe with coupling bands 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.

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(3) 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 fabricating and constructing spiral rib pipe.

Spiral rib pipe must comply with the specifications for corrugated metal pipe in section 66 except profile and fabrication.

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 61-1.01D(1)(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 fabricating and 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 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 properties must comply with the values in the following table:

Property	ASTM test method	Value
Melt index	D1238	I_2+ 7.5g/10 min ± 1.5
Flow rate ratio	D1238	I_{10}/I_2=7-8
Density	D792	0.902 g/cc ± 0.002
Hardness	D2240	Shore D = 45 ± 5
Ash content	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 polymetric 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 sections 75-1.02 and 75-1.05.

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 61-1.01D(1)(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.

Cover pipes with an opaque sheeting material to provide sun block protection. Do not expose pipes to direct sunlight for periods exceeding 30 days. 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 fabricating and constructing structural plate culverts.

Excavation, backfill, and shaped bedding must comply with section 19-3.

67-2 STRUCTURAL METAL PLATE PIPE

67-2.01 GENERAL

67-2.01A Summary

Section 67-2 includes specifications for fabricating and constructing structural metal plate pipe, arches, and pipe arches.

Structural metal plate pipe, arches, and pipe arches include bends and elbows.

67-2.01B 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.

67-2.02 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 and nuts and bolts for structural steel plate pipe, arches, and pipe arches must comply with AASHTO M 167M/M 167.

Structural plates and 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.

Repair damaged galvanized surfaces under section 75-1.05.

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.

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 2 dissimilar thicknesses are involved in 1 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 1 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.

Tighten plate section bolts within the ranges shown in the following table before backfilling:

Bolt diameter	Torque
3/4 inch	100 ft-lb min to 300 ft-lb max
7/8 inch	150 ft-lb min to 350 ft-lb max

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

Structural metal plate pipe is measured along the centerline of the pipe and parallel with the slope line. The payment quantity includes the length of bends and elbows. The payment quantity is the length designated by the Engineer. 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 1 line of holes is at the pipe crown and 1 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 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.

67-3.02 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 mechanical properties in the following table:

Base metal for liner plates	
Tensile strength, psi	42,000 min
Yield point, psi	28,000 min
Elongation in 2 inches, %	30 min

Prepare and test specimens for tension test under ASTM A283/A283M for plates and ASTM A1011/A1011M for sheets.

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 be not 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 be not 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 in inches^4 per inch of plate width, 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 per foot of pipe length shown in the following table:

Uncoated plate thickness (inches)	Strength (lb/ft)	
	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 are 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 force-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 admixtures 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.

Grouting equipment must be:

1. Capable of grouting at a pressure of at least 100 psi
2. Equipped with a pressure gage having a full-scale reading of not more than 300 psi

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 75-1.05 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.

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

Metal liner plate pipe is measured along the centerline of the pipe and parallel with the slope line. The payment quantity is the length designated by the Engineer.

67-4–67-5 RESERVED

68 SUBSURFACE DRAINS

68-1 GENERAL

68-1.01 GENERAL

Section 68-1 includes general specifications for constructing subsurface drains.

Submit a certificate of compliance for each type of subsurface drain involved.

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.

Repair damaged coatings under section 66-1.02C.

68-1.03 CONSTRUCTION

68-1.03A General

Reserved

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 shown within 72 hours of placing the fabric.

68-2 UNDERDRAINS

68-2.01 GENERAL

Section 68-2 includes specifications for constructing underdrains.

Underdrains include elbows, outlets and risers, wyes, tees, and other branches.

For alternative pipe underdrain, choose one the types shown. Do not mix types of pipe in the same installation.

Excavation and backfill must comply with section 19-3.

Submit a certificate of compliance for each type of pipe, tubing, and fitting.

68-2.02 MATERIALS

68-2.02A General

Reserved

68-2.02B Perforated Steel Pipe

Perforated steel pipe and coupling bands must comply with AASHTO M 36 and AASHTO M218 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.

Repair damaged galvanized surfaces under section 75-1.05.

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. Solvent cementing of joints is not required.

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 75-1.05 after fabrication.

Welding workmanship and technique must be equal to the best practice in modern commercial shops.

Covers must be fitted and bolted into the riser pipe or elbow. Covers must seat uniformly and not be subject to rocking.

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 gradings 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 grading requirements shown in the following table:

Class 1 Permeable Material
Grading Requirements

Sieve sizes	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 grading requirements shown in the following table:

Class 2 Permeable Material
Grading Requirements

Sieve sizes	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 grading requirements shown in the following table:

Class 3 Permeable Material

Grading Requirements

Sieve sizes	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 use with underdrains must comply with section 88-1.02B.

At bridge abutments and wingwalls, filter fabric for underdrains must be Class A.

68-2.02H–68-2.02K 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.

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 under ground.
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

Pipe underdrain is measured along the centerline of the pipe and parallel with the slope line. The payment quantity includes the length 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.

Horizontal drains include furnishing all water required for drilling holes, and necessary tees, plugs, and street ells required for connecting to the collector system.

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 in 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.

At the outlet end of the drilled hole, tightly plug the annular space between the hole and the pipe with earth for a length of at least 2 feet.

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.

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

Horizontal drain is measured along the centerline of perforated, slotted, and nonperforated pipe and along the length of pipe at the outlet end required to connect to the collector system. The payment quantity is the length designated by the Engineer.

Drill hole is 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.

Furnishing and installing a collector system is change order work.

68-4 EDGE DRAINS

68-4.01 GENERAL

Section 68-4 includes specifications for constructing plastic pipe edge drains and edge drain outlets.

Cross drain interceptors at structure approaches, at end anchors or pressure relief joints, and at pavement terminals joining existing pavements are considered edge drains.

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°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°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 to 0.065 inch wide and of such length as 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°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 29-1.02 for treated permeable bases.

Store, proportion, and mix treated permeable material under section 29-1.03C.

68-4.02D Filter Fabric

Filter fabric comply with section 88-1.02B.

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 51-2.04 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 grading, under section 26-1.02B.

HMA for backfilling trenches must comply with section 39-1.15.

Outlet and vent covers must be commercial quality galvanized metal screens or grates approximately 1/2-inch mesh with PVC slip joint nut fittings.

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 compaction of 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 A pavement markers as shown and under section 85 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 when installed 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

Edge drain is measured along the centerline of the pipe. The payment quantity is the slope length of the pipe designated by the Engineer. The quantity for payment includes the length of Y-fittings at cleanout pipes and intermediate outlet connections between the couplings at each end of the straight section of the Y-fitting.

Edge drain outlet is measured along the centerline of the pipe. The quantity for payment includes the length of outlet pipes, vent pipes, cleanouts, and Y-fittings at cleanout pipes and intermediate outlet connections between the couplings at each end of the curved section of the Y-fitting.

The Department does not make a deduction in the length of edge drain for gaps in edge drain pipe at locations of dual outlet, dual vent, or dual outlet and vent connections to the edge drain.

Cross drain interceptors at structure approaches, at end anchors or pressure relief joints, and at pavement terminals joining existing pavements are measured and paid for as edge drain.

68-5 PERMEABLE MATERIAL BLANKET

Reserved

68-6 DRAINAGE WICK

Reserved

68-7 GEOCOMPOSITE DRAIN SYSTEMS

68-7.01 GENERAL

68-7.01A Summary

Section 68-7 includes specifications for constructing geocomposite drain systems.

Structure approach drainage system consists of geocomposite drain, filter fabric, plastic pipe, treated permeable base, and drainage pads.

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.

68-7.02 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

69 OVERSIDE DRAINS

69-1.01 GENERAL

Section 69 includes specifications for constructing overside drains.

Excavation and backfill must comply with section 19-3.

Submit a certificate of compliance for each of the following:

1. Steel materials
2. Aluminum materials
3. Plastic materials

69-1.02 MATERIALS

69-1.02A General

For alternative pipe downdrain, choose one 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.

Joints for overside drains must comply with section 61-1.01D(1)(b) for watertightness.

For pipe downdrains under concrete slope paving, the end of the downdrain must consist of steel pipe or steel conduit.

Do not mix steel pipe 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.

Welding workmanship and technique 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 pipe must be Type I pipe under AASHTO M 36. The nominal thickness of the sheet must be at least 0.064 inch.

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 61-1.01D(1)(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 75-1.05.

69-1.02C Aluminum Pipe Overside Drains

Aluminum entrance tapers, pipe downdrains, reducers, coupling bands, and slip joints must be constructed of aluminum sheets and must comply with AASHTO M 196 and section 66. The pipe must be Type I pipe under AASHTO M 196. The nominal thickness of the sheet must be at least 0.060 inch.

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 61-1.01D(1)(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 61-1.01D(1)(b) for downdrain joints. 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 2 pipe stakes with necessary hardware, bars or coupling bands, and 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 75-1.05.

69-1.02F Cable Anchorage System

Cable anchorage assemblies 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 similar materials in section 56-3.02F for pipe posts.

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 with an anchor assembly wherever the downdrain is not in a trench.

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

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. The length for slip joints is not included in the payment quantity.

For pipe downdrains under concrete slope paving, the length of the pipe downdrain 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.

70 MISCELLANEOUS DRAINAGE FACILITIES

70-1 GENERAL

70-1.01 GENERAL

Section 70-1 includes general specifications for (1) furnishing, placing, and connecting miscellaneous drainage facilities for water drainage and transmission and (2) constructing casings for bridges.

Miscellaneous drainage facilities include corrugated metal pipe drainage facilities, welded steel pipe drainage facilities, precast concrete pipe drainage facilities, drain appurtenances, grated line drains, and casings for bridges.

For a given location, if only one type of pipe riser or pipe inlet is shown, install that type. For a given location, if more than one type of pipe riser or pipe inlet is shown, choose one of the types shown.

70-1.02 MATERIALS

Steps and ladders must be (1) steel where installed in steel or concrete drainage facilities or (2) aluminum where installed in aluminum drainage facilities.

70-1.03 CONSTRUCTION

Excavation and backfill for drains must comply with section 19.

Attach steps and ladders to miscellaneous drainage facilities where described.

Where new drain inlets or manholes are in paved or surfaced areas, do not construct the drain to final grade until the paving or surfacing has been completed immediately adjacent to the drain.

70-1.04 PAYMENT

No payment is made for pipe or casing placed in excess of the length shown.

Pipe drainage facilities are paid for as the type of pipe involved. Pipes are measured along the centerline of the pipe.

If more than one type of pipe riser is shown for a given location, pipe risers are paid for as alternative pipe risers of the types shown in the Bid Item List.

If more than one type of pipe inlet is shown for a given location, pipe inlets are paid for as alternative pipe inlets of the types shown in the Bid Item List.

Pipes for drainage facilities includes pipe components. Payment for pipe components that are not made of pipe is included in payment for the type of pipe involved unless a bid item for the component is shown on the Bid Item List.

Quantities of pipe for energy dissipators, inlets, manholes, and risers are measured to the nearest 0.1 foot of pipe.

Payment for drainage pipe stubs is included in the payment for the type of pipe involved.

Payment for constructing pipe riser connections and bar reinforcement steel riser safety cages is included in the payment for the types of pipe riser shown in the Bid Item List.

Payment for ladders is included in the payment for the type of pipe involved.

Payment for excavation and backfill is included in the payment for the type of miscellaneous drainage facility work involved.

70-2 CORRUGATED METAL PIPE DRAINAGE FACILITIES

70-2.01 GENERAL

Section 70-2 includes specifications for constructing drainage facilities with corrugated metal pipe. Corrugated metal pipe drainage facilities include energy dissipators, inlets, risers, reducers, manholes, and all necessary connections.

70-2.02 MATERIALS

Corrugated metal pipe must be either aluminum or steel aluminum as shown and must have a protective coating if shown. Corrugated metal pipe and coatings must comply with section 66.

70-2.03 CONSTRUCTION

Not Used

70-2.04 PAYMENT

Not Used

70-3 WELDED STEEL PIPE DRAINAGE FACILITIES

70-3.01 GENERAL

Section 70-3 included specifications for constructing drainage facilities with welded steel pipe. Welded steel pipe drainage facilities include energy dissipators, inlets, risers, reducers, and manholes.

70-3.02 MATERIALS

70-3.02A General

Welded steel pipe must comply with one of the following:

1. AWWA C200
2. ASTM A 53/A 53M, 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.

70-3.02B(2) Coal Tar Coating

Coat and wrap the welded steel pipe prior to shipping as follows:

1. Clean, prime, and coat interior and exterior surfaces with coal tar enamel.
2. Wrap the exterior with a bonded felt wrapper under AWWA C203 with section A1.2 of the appendix.

70-3.02B(3) Factory Applied Fusion Bonded Epoxy Coating

If described, coat the interior or exterior surfaces of welded steel pipe. The coating must be a factory applied fusion-bonded epoxy conforming to AWWAC213.

If fusion-bonded epoxy coating is exposed to above grade sunlight, prime and paint the exterior fusion coated wall surfaces. Primer and paint must comply with the type, standard, and coating thickness shown in the following table:

Coatings	Type	Standard	Coating thickness
Primer	Zinc rich	AASHTO M300	2.5–3.5 mil DFT
Finish	Exterior grade latex satin or flat	Meeting State VOC requirements and as recommended by the manufacturer of inorganic zinc-rich primer	2.0–3.0 mil DFT

Submit color options for finish paint. The Engineer selects finish color.

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(4) Asphalt Coating

Reserved

70-3.03 CONSTRUCTION

70-3.03A General

Field welding must be performed under AWWA C206.

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.

Install welded steel pipe so that it is not electrically connected to or in direct physical contact with other metal pipe. If pipe is mechanically connected to public utility lines or other metal pipe, provide electrically insulated connections. Connections to nonmetallic pipe do not require electrically insulated connections. Electrically insulated connections must be placed in welded steel pipe within 5 feet of its ingress into or egress from any building or structure.

If backfill material contains rock or highly expansive clay soils, install a sand shield under AWWA C203 in section A1.3 of the appendix.

Prior to backfilling at the welded joints, pressure test the pipe. Place the pipe under the operating head for a period of 2 hours with no leaks. Correct any leaks or defects and retest if necessary.

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 constructing drainage facilities with precast concrete pipes. Precast concrete drainage facilities include energy dissipators, inlets, risers, reducers, adjustment rings, and manholes.

70-4.02 MATERIALS

Precast concrete drainage facilities must comply with AASHTO M 199M/M 199.

Concrete must comply with section 90-1 except that the grading requirements do not apply to the aggregate.

Reinforcement must comply with section 52.

70-4.03 CONSTRUCTION

Construct mortar joints under section 65.

Inlets may be formed in place as an alternative to using precast 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 includes specifications for constructing items that are appurtenances to drainage facilities. Drain appurtenances include flared end sections, minor concrete drainage appurtenances, miscellaneous metal appurtenances, drainage inlet depressions, drainage inlet markers, redwood covers, and drainage gates.

70-5.01B Materials

Not Used

70-5.01C Construction

Construct concrete under section 51.

70-5.01D Payment

Payment for drainage appurtenances is included in the various items of work involved unless a bid item for the work is shown on the Bid Item List.

70-5.02 FLARED END SECTIONS

70-5.02A General

Fabricate flared end sections as shown. Minor variations may be authorized to permit the use of the manufacturer's fabrication methods.

70-5.02A(1) Precast Concrete Flared End Sections

Precast flared end sections must comply with the specifications for Class III Reinforced Concrete Pipe in AASHTO M 170M and the following:

1. Portland cement and aggregate must comply with section 90-1 except the grading requirements do not apply to the aggregate
2. Area of steel reinforcement per linear foot of flared end section must be at least equal to the minimum steel requirements for circular reinforcement in circular pipe for the internal diameter of the circular portion of the flared end section
3. Basis of acceptance of the precast concrete flared end section is determined under section 5.1.2 of AASHTO M 170

Reinforcement must comply with section 52.

Cutoff walls for precast concrete flared end sections must be minor concrete except the cementitious material content must not be less than 470 lb/cu yd. Construct cutoff walls under section 51.

70-5.02A(1) Metal Flared End Sections

Metal flared end sections must comply with the following:

1. Prefabricated steel flared end sections must comply with AASHTO M 36 and M 218.
2. Prefabricated aluminum flared end sections must comply with AASHTO M 196 and M 197.
3. Metal flared end sections may be used as an alternative to precast concrete flared end sections or plastic flared end sections. Metal flared end sections used on concrete pipe 36 inches in diameter or smaller must be equipped with toe plates.

Mortar used to connect metal flared end sections to precast concrete pipe must comply with section 51-1.

Welded wire fabric must be commercial quality.

70-5.02A(2) Plastic Flared End Sections

Plastic flared end sections must comply with ASTM D 1248.

70-5.02A(3) Alternative Flared End Sections

For a given location, if only one type of flared end section is shown, install that type. For a given location, if more than one type of flared end section is shown, choose one of the types shown.

Alternative flared end sections must be the same material type as the drainage facility to which it is attached. Comply with the material specifications in section 62. Metal flared end sections may be used as an alternative to precast concrete flared end sections or plastic flared end sections. Comply with section 70-5.02A(1).

If more than one type of flared end section is shown for a given location, flared end sections are paid for as alternative flared end section of the types shown in the Bid Item List.

70-5.03 MINOR CONCRETE DRAINAGE APPURTENANCES

Minor concrete drainage appurtenances must comply with section 51-7. Minor concrete drainage appurtenances include concrete foundations, bases, basin floors, and reinforced concrete pipe risers.

70-5.04 MISCELLANEOUS METAL DRAINAGE APPURETENANCES

Miscellaneous iron and steel items used for drains must comply with section 75.

The following items are not included in the payment for miscellaneous drainage facilities:

1. Steel cover
2. Frame and grate
3. Frame and cover
4. Manhole frame and cover
5. Manhole frame and grate
6. Manhole frame and cover (pressure)

70.5.05 DRAINAGE GATES

70-5.05A General

Reserved

70-5.05B Automatic Drainage Gates

70-5.05B(1) General

Reserved

70-5.05B(2) Drainage Gates for Low Head Pressure

Reserved

70-5.05B(3) Drainage Gates for High Head Pressure

Reserved

70-5.05C Slide Headgates

Reserved

70-5.06 INLET DEPRESSIONS

70-5.06A General

Construct inlet depressions for drainage as shown.

70-5.06B Inlet Depressions, HMA

HMA concrete drainage inlet depressions must comply with section 39 and the following:

1. In shoulder areas of roadways, provide the asphalt type that matches the roadway construction.
2. In locations outside the shoulder areas, provide the asphalt type that is specified for miscellaneous areas.

If necessary, place and finish HMA by hand so that the drainage inlet depressions match the grade of the surrounding material.

70-5.06C Inlet Depressions, Concrete

Concrete drainage inlet depressions must comply with specifications for minor concrete except (1) the cement content must be at least 463 lb/cu yd and (2) placement must comply with the following:

1. If concrete pavement is placed near an inlet depression, place the pavement before constructing the inlet depression.
2. If concrete inlet depressions are constructed in shoulder areas, concrete must be placed on prepared base material compacted to at least 95 percent relative compaction. Finish the concrete as follows:
   2.1. After 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.
   2.2. 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.

2.3. If use of water is necessary, apply the water immediately before brooming the surface.
2.4 Cure the concrete under section 40-1.03N.

70-5.07 DRAINAGE INLET MARKERS

Provide the size and type of drainage inlet marker shown. If a specific type is not shown, choose one type from the table titled "Drainage Inlet Markers." Markers must comply with the requirements shown in the following table:

Drainage Inlet Markers

Type	Property	Requirements	Test method
Thermoplastic	Composition	Thermoplastic free of lead and chromium	--
	Thickness	0.080–0.160 inch	--
	Legend color (nonreflective)	Blue or green	--
	Background color (nonreflective)	White	AASHTO M 249
	Skid resistance	60 BPN	ASTM E 303
Metal medallion	Composition	Commercial-grade stainless steel, aluminum, brass, or bronze sheet metal or cast.	--
	Thickness of metal, inches	0.055-0.138	--
	Height of marker, inches	0.055-0.138	--
	Legend color (nonreflective)	Blue or green	--
	Background color (nonreflective)	White or bare metal	--
	Skid resistance	60 BPN	ASTM E 303
Plastic medallion	Composition	Plastic that contains ultraviolet inhibitors	--
	Thickness, inches	0.025-0.060	--
	Thickness (with dome), inches	0.055-0.120	--
	Legend color (nonreflective) [a]	Blue or green	--
	Background color (nonreflective) [a]	White	--
	Weathering resistance	1 year without yellowing, fogging, or pitting	ASTM D1435
Stamped concrete	Composition	Authorized concrete stamp	--

[a] Requirements if metal marker is colored.

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

70-5.08 REDWOOD COVERS

Boards for redwood covers must be no. 1 heart structural grade, S4S redwood.

70-6 GRATED LINE DRAINS

Reserved

70-7 CASINGS FOR BRIDGES

70-7.01 GENERAL

Section 70-7 includes specifications for constructing welded steel pipe casings through bridges and under approach slabs.

Submit shop drawings for temporary supports of casings at abutments.

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 casing must be cleaned, primed, and coated to comply with ANSI/AWWA C213.

Wrapping tape for the casing must be a pressure sensitive PVC or polyethylene tape with a minimum thickness of 50 mils, 2 inches wide.

Repair damaged coating on the casing with pipe wrapping. Wrap field joints and fittings with pipe wrapping. Apply pipe wrapping as follows:

1. Pipe casing, joints, and fittings to be wrapped must be thoroughly cleaned and primed as recommended by the tape manufacturer.
2. Tape must be tightly applied 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. Adequate tension must be applied so tape will conform closely to contours of the joint.

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 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 concrete or CIP minor concrete pipe cradle, galvanized steel pipe clamp, and 2 anchor bolts. The protection shield must be Type 316 stainless steel pipe protection shield. Provide commercial quality wire mesh and reinforcement. Moist cure the concrete casing support for not less than 3 days.

Anchor concrete casing supports with epoxy. Epoxy 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

Unless otherwise shown, 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-pound asphalt-felt building paper, securely taped or wired in place.

If a blockout is provided 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 2 pipe sizes larger than the casing.

70-7.04 PAYMENT

Welded steel pipe casing is measured along the centerline of the casing.

71 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, concrete lining, slope paving, and gabions.

72-1.02 MATERIALS

Concrete shown for slope protection or slope paving must comply with the specifications for minor concrete.

Unless otherwise specified, fabric must be Class 8 RSP fabric.

72-1.03 CONSTRUCTION

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 fabric in compliance with the manufacturer's instructions. Place the fabric loosely on the slope so that the fabric conforms to the surface without damage when the cover material is placed.

Join edges of the fabric with either overlapped joints or stitched seams.

If the fabric is joined with overlapped joints, 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

Payment is not made for the additional fabric used for overlaps.

72-2 ROCK SLOPE PROTECTION

72-2.01 GENERAL

Section 72-2 includes specifications for constructing RSP. RSP includes:

1. Excavating and backfilling the footing trench
2. Placing RSP fabric where shown
3. Placing revetment type rock courses on the slope

Use the class of rock and the method for placement described.

72-2.02 MATERIALS

72-2.02A Rock

For method A placement and the class of RSP described, comply with the rock grading shown in the following table:

Rock Grading for Method A Placement

Rock size	Percentage larger than[a]				
	Class				
	8T	4T	2T	1T	1/2 T
16 Ton	0–5	--	--	--	--
8 Ton	50–100	0–5	--	--	--
4 Ton	95–100	50–100	0–5	--	--
2 Ton	--	95–100	50–100	0–5	--
1 Ton	--	--	95–100	50–1	0–5
1/2 Ton	--	--	--	95–100	50–100
1/4 Ton	--	--	--	--	95–100

[a]For any class, the percentage of rock smaller than the smallest rock size must be determined on the basis of weight. For all other rock sizes within a class, the percentage must be determined on the basis of the ratio of the number of individual rocks larger than the smallest size shown for that class compared to the total number of rocks.

For method B placement and the class of RSP described, comply with the rock grading shown in the following table:

Rock Grading for Method B Placement

Rock size	Percentage larger than[a]							
	Class							
	1 T	1/2 T	1/4 T	Light	Facing	No. 1	No. 2	No. 3
2 ton	0–5	--	--	--	--	--	--	--
1 ton	50–100	0–5	--	--	--	--	--	--
1/2 ton	--	50–100	0–5	--	--	--	--	--
1/4 ton	95–100	--	50–100	0–5	--	--	--	--
200 lb	--	95–100	--	50–100	0–5	0–5	--	--
75 lb	--	--	95–100	--	50–100	50–100	0–5	--
25 lb	--	--	--	95–100	90–100	90–100	25–75	0–5
5 lb	--	--	--	--	--	--	90–100	25–75
1 lb	--	--	--	--	--	--	--	90–100

[a]For any class, the percentage of rock smaller than the smallest rock size must be determined on the basis of weight. For all other rock sizes within a class, the percentage must be determined on the basis of the ratio of the number of individual rocks larger than the smallest size shown for that class compared to the total number of rocks.

Rock must have the values for the material properties shown in the following table:

Rock Material Properties

Property	California Test	Value
Apparent specific gravity	206	2.5 minimum
Absorption	206	4.2% maximum[a]
Durability index	229	52 minimum[b]

Select rock so that 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.

72-2.02B Fabric

Fabric must be RSP fabric that complies with the class shown in the following table:

Fabric Class

Class	Largest rock grading class used in slope protection
8	1 ton or smaller
10	Larger than 1 ton

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 so that their longitudinal axis is normal to the face of the embankment.

Place foundation course rocks so that they are in contact with the ground surface.

For rocks above the foundation course, place them so 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 so 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 quantity is determined by weighing with a scale.

If RSP is paid by the cubic yard, the quantity is based on 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. Concreted-rock slope protection includes:

1. Excavating and backfilling the footing trench
2. Placing fabric and weep tubes where shown
3. Placing revetment type rock courses on the slope
4. Concreting the rock

Use the class of rock and the method for placement described.

72-3.02 MATERIALS

72-3.02A 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 comply with color no. 30450 (tan) of FED-STD-595.

Use 1-inch combined aggregate gradings in the concrete.

The water content of the concrete must permit gravity flow into the interstices with limited spading and brooming.

72-3.02B Rock

Rocks for concreted-rock slope protection must comply with the grading shown in the following table:

Concreted-Rock Grading

Rock size	Percentage larger than[a]				
	Class				
	1/2 ton	1/4 ton	Light	Facing	Cobble
1 ton	0–5	--	--	--	--
1/2 ton	50–100	0–5	--	--	--
1/4 ton	--	50–100	0–5	--	--
200 lb	90–100	--	50–100	0–5	--
75 lb	--	90–100	90–100	50–100	0–5
25 lb	--	--	--	90–100	95–100

[a]For any class, the percentage of rock smaller than the smallest rock size must be determined on the basis of weight. For all other rock sizes within a class, the percentage must be determined on the basis of the ratio of the number of individual rocks larger than the smallest size shown for that class compared to the total number of rocks.

Rocks for concreted-rock slope protection must have the values for the material properties shown in the following table:

Rock Material Properties

Property	California Test	Value
Apparent specific gravity	206	2.5 minimum
Absorption	206	4.2% maximum[a]
Durability index	229	52 minimum[b]

Select rocks so that the shape provides 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 individual rock thickness is greater than 0.33 times the length.

72-3.02C Weep Tubes

Weep tubes must:

1. Be schedule 80, perforated PVC pipe
2. Have a 2-inch nominal diameter
3. Comply with section 68-2.02D

72-3.03 CONSTRUCTION

72-3.03A General

Excavate a footing trench along the toe of the slope.

The coloring agent must be uniformly and homogeneously mixed with the concrete.

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.

72-3.03B Placement Method A

Method A must comply with section 72-2.03B.

72-3.03C Placement Method B

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 so 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 acceptable means. Comply with the concrete penetration shown in the following table:

Minimum Concrete Penetration

	Rock class				
	1/2 ton	1/4 ton	Light	Facing	Cobble
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 to 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 concreted-rock slope protection by any one of the methods specified in section 90-1.03B. 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 quantity is determined by weighing with a scale.

If concreted-rock slope protection is paid by the cubic yard, the quantity is based on 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. Small-rock slope protection includes:

1. Excavating and backfilling the footing trench
2. Placing RSP fabric where shown
3. Placing small rocks on the slope

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 grading shown in the following table:

Rock Grading for 7-inch-Thick Layer

Sieve sizes	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 grading shown in the following table:

Rock Grading for 5-inch-Thick Layer

Sieve sizes	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 grading shown in the following table:

Rock Grading for 4-inch Thick Layer

Sieve sizes	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 RSP 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 quantity of small-rock slope protection is based on 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 using minor concrete or shotcrete.

72-5.02 MATERIALS

Pervious backfill material must comply with section 19-3.02C.

Expansion joint filler must comply with section 51-2.01B(1).

Reinforcement must comply with section 52.

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 comply with color no. 30450 (tan) of FED-STD-595.

Weep tubes must:

1. Be schedule 80, perforated PVC pipe
2. Have a 2-inch nominal diameter
3. Comply with section 68-2.02D

At each weep tube and drain hole, place a securely tied sack that contains one cubic foot of pervious backfill. The sack material must comply with the specifications for filter fabric.

72-5.03 CONSTRUCTION

The foundation, which includes all surfaces where concrete is to be placed, must be evenly graded so that no point on the graded surface is above the designated plane.

Earthwork must comply with section 19.

Wrap each weep tube in filter fabric.

Place weep tubes as shown or ordered.

Place reinforcement under section 52.

Concrete must comply with section 51.

The coloring agent must be uniformly and homogeneously mixed 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 permit the use of concrete sufficiently wet 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 fine texture hair push broom to produce a uniform surface. Brooming must be done when the surface is sufficiently set to prevent deep scarring and must be accomplished by drawing the broom down the slope, leaving marks parallel to the edge of the panel. 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 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.

Curing concrete slope protection, gutter lining, ditch lining, and channel lining must comply with one of the methods specified in section 90-1.03B. If colored concrete is described and you use the curing compound method, apply curing compound no. 6.

Construct, finish, and cure shotcrete slope paving under section 53.

72-5.04 PAYMENT

Quantities of minor concrete or shotcrete will be calculated by multiplying the following:

1. Area measured along the slope lines of the completed concrete slope protection
2. Thickness shown for the concrete slope protection

No additional payment is made for additional concrete placed by reason of low foundation.

72-6 BROKEN-CONCRETE SLOPE PROTECTION

Reserved

72-7–72-10 RESERVED

72-11 SLOPE PAVING

72-11.01 GENERAL

72-11.01A General

Section 72-11.01 includes general specifications for constructing slope paving.

Construct slope paving using minor concrete or shotcrete.

72-11.01B Materials

Shotcrete must comply with section 53.

The maximum aggregate size used in minor concrete must not be larger than 1 inch or smaller than 3/4 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 coloring agent must be uniformly and homogeneously mixed with the concrete. The color of the completed concrete after curing and when air dry must comply with color no. 30450 of FED-STD-595.

Reinforcement must comply with section 52.

Timber spacers must be construction heart redwood or better and graded under section 57-2.01B(2).

Nails used to fasten the timber spacers must be hot-dip galvanized.

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.

Schedule the construction of the slope paving so that the work, including placing, finishing, and application of curing compound, is completed in any section bordered by timber spacers on the same day that the work is started in that section. There must be no construction joints between timber spacers.

Earthwork for slope paving must comply with section 19.

Before applying concrete, evenly grade foundations so 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.

Place reinforcement under section 52.

Securely hold timber spacers in place with anchor bars consisting of commercial quality bar reinforcing steel.

If there are no timber spacers or whenever the Engineer determines that the size of a panel between spacers is too large to be constructed without an intermediate construction joint, place a joint at an

authorized location. Complete any section of concrete 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 51-7.

Spread and tamp the concrete until it is thoroughly compacted and mortar flushes to the surface. If the slope is too steep to permit the use of concrete sufficiently wet 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 fine texture hair push broom to produce a uniform surface. Brooming must be done when the surface is sufficiently set to prevent deep scarring and must be accomplished by drawing the broom down the slope, leaving marks parallel to the edge of the panel. The Engineer may order 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.

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

Quantities of minor concrete or shotcrete will be calculated by multiplying the following:

1. Area computed from measurements along the slope of the actual areas constructed
2. Thickness shown for the concrete slope paving

No payment is made for additional concrete placed by reason of low foundation.

No deduction is made for timber spacers.

72-11.02 EXPOSED AGGREGATE SLOPE PAVING

72-11.02A General

Section 72-11.02 includes specification for constructing slope paving with an exposed aggregate finish.

72-11.02B Materials

Shotcrete must not be used to construct exposed aggregate slope paving.

Coarse aggregate must comply with the 1 inch x No. 4 primary size coarse aggregate specified in section 90-1.02C(4)(b).

Concrete set retarders must be commercial quality, manufactured specifically for use on the top surface of concrete. The retarder must effectively slow down the setting time and depth of the cement and fine aggregate matrix to permit exposing the aggregates.

72-11.02C Construction

The coloring agent must be uniformly and homogeneously mixed with the concrete.

Place and consolidate the concrete so 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 sufficiently set to permit 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 a depth of approximately 3/16 to 3/8 inch. Exposed aggregate surfaces must be uniform in appearance.

Immediately after the cement mortar has hardened sufficiently 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, cure the concrete. 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

Reserved

72-12–72-15 RESERVED

72-16 GABIONS

72-16.01 GENERAL

Section 72-16 includes specifications for constructing gabion structures. Gabions consist of wire mesh baskets that are placed and then filled with rock. The wire baskets must be standard sized.

Gabions must be divided by diaphragm panels so that baskets are 36-inch long cells.

Empty gabion baskets must be assembled individually and joined successively. The individual mesh panels (base, front, ends, back, diaphragms, and lid) and successive gabions must be assembled so that the strength and flexibility along the joints is comparable to a single panel.

Submit a certificate of compliance for each shipment of gabion baskets to the job site.

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.

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 ASTM A641 and the requirements in the following tables:

Wire Size with PVC Coating

Gabion basket style	USA wire gage	Mesh type
Cubical	12	twisted
	11 min to 9 max	welded
Mattress	12	twisted
	11	welded

Wire Size without PVC Coating

Gabion basket style	USA wire gage	Mesh type
Cubical	11	twisted
	11 min to 9 max	welded
Mattress	11	twisted
	11	welded

Wire material properties must have the values shown in the following table:

Wire Material Properties

Property	ASTM tests	Value
Min tensile strength	A 370	60 ksi
12-gage wire:		
Diameter	A641	0.106 inch with 0.102 min
Zinc coating	A641 Class 3 and A90	0.75 oz/sq ft
11-gage wire:		
Diameter	A641	0.120 inch with 0.116 min
Zinc coating	A641 Class 3 and A90	0.80 oz/sq ft
9-gage wire:		
Diameter	A641	0.148 inch with 0.144 min
Zinc coating	A641 Class 3 and A90	0.85 oz/sq ft

Twisted-mesh wire must be formed with a nonraveling twist and into a uniform hexagonal pattern. For PVC-coated wire, use 10-gage size for the selvage wires. For wire without PVC coating, use 9-gage 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 A185 except weld shears must be:
   3.1. 600 lb minimum for 11-gage wire
   3.2. 800 lb minimum for 9-gage 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.

PVC coating must be UV resistant. A suitable UV resistance additive must be blended with the PVC. Identify the additive on the certificate of compliance. 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 products 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 material properties must have the values shown in the following table.

Tie Wire and Spiral Binder Wire Material Properties

Property	Test method	Value
Min tensile strength	ASTM A 370	60 ksi
Tie wire		
Wire size	USA wire gage	13.5
Min diameter	ASTM A641	0.086 inch
Max diameter	ASTM A641	0.082 inch
Zinc coating	A641 Class 3 and ASTM A90	0.70 oz/sq ft
Spiral binder wire		
Wire size	USA wire gage	9
Min diameter	ASTM A641	0.148 inch
Max diameter	ASTM A641	0.144 inch
Zinc coating	ASTM A641 Class 3 and ASTM A90	0.85 oz/sq ft

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, 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-gage. 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 per the manufacturer's instructions.

72-16.02F Fabric

If gabions are shown for downdrains, use woven tape fabric instead of RSP 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 72-2.02A.

Rocks for gabion baskets equal to or greater than 18 inches in height must vary in size and comply with the gradation shown in the following table:

Rock Grading for 18-Inch or Larger Baskets

Screen size (inches)	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 shown in the following table.

Rock Grading for 12-Inch Baskets

Screen size (inches)	Percentage passing
8	100
4	0–5

The unit weight of a rock-filled gabion must be at least 110 lb/ cu ft. Whenever requested by the Engineer, verify the unit weight. Verification must be performed 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.

72-16.03 CONSTRUCTION

72-16.03A General

Areas where gabions are to be placed must be constructed to the lines and grades shown. Excavation and backfill must comply with section 19.

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 fabric on top of the gabions before placing the earth fill.

72-16.03B Assembly

Assemble the gabions as empty units. Each gabion must be manufactured with the necessary panels that are properly spaced and secured so that the panels can be rotated into position without additional tying of the rotation joint. 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 (locked loops) made at 4-inch nominal spacing. Use 13.5-gage standard tie wire. Do not construct joints with simple spiraling (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 (locked loops) in every mesh opening along the joint
2. Spiral binders that are 9-gage and such that the spiral binder passes through every mesh opening along the joint. Crimp both ends of the spiral binder and secure it in place.

Temporary fasteners may be used to hold panels at gabion-to-gabion joints, and they 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-gage tie wire or 9-gage standard spiral binder before filling the basket with rock. In one 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 one 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.

Multi-layered gabion configurations must be stepped and staggered. Join each layer of gabion to the underlying layer along the front, back, and ends.

Join shear key and counterfort gabions to underlying gabions along the front, back, and ends.

For transitional gabions, fold, cut, and fasten gabion baskets as shown or as accepted by the Engineer.

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.

Whenever filling 36-inch-high gabions, place rock in 12-inch-deep layers. Whenever filling 18-inch-high gabions, place 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 so 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-gage tie wire or 9-gage standard spiral binder. In one 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 one alternative fastener at each mesh opening. The alternative fastener must contain and secure all wires along the lid.

72-16.04 PAYMENT

Gabions are measured based on the dimensions shown or ordered

73 CONCRETE CURBS AND SIDEWALKS

73-1 GENERAL

73-1.01 GENERAL

73-1.01A Summary

Section 73-1 includes general specifications for constructing minor concrete items including, concrete curbs, sidewalks, gutter depressions, driveways, island paving, curbs ramps, detectable warning surfaces, and textured and colored concrete surfaces.

73-1.01B Definitions

Reserved

73-1.01C Submittals

Reserved

73-1.01D Quality Control and Assurance

The Engineer uses test panels as the standard of comparison for accepting textured and colored concrete surfaces.

Construct and finish test panels at the job site with materials, tools, equipment, and methods you will use in the work. If a test panel is rejected, construct an additional test panel the same size as the original.

Do not place concrete that requires a test panel until the Engineer accepts the test panel.

73-1.02 MATERIALS

73-1.02A General

The cementitious material content of concrete must be at least 463 lb/cu yd.

For extruded or slip-form curb construction the aggregate size may range from 3/8 to 1 inch. If you use 3/8 inch maximum size aggregate, cementitious material content must be at least 505 lb/cu yd.

Steel dowels, reinforcing steel, and welded wire reinforcement must comply with section 52.

Preformed expansion joint filler must comply with ASTM D 1751.

Mortar must comply with section 51-1.02F.

Form oil must be commercial quality or other equivalent coating which allows ready release of forms and does not discolor the concrete.

Adhesive must comply with section 95-2.03.

73-1.02B Detectable Warning Surface

Detectable warning surface must be shown on the Authorized Material List for detectable warning surface and must comply with yellow color no. 33538 of FED-STD-595.

73-1.03 CONSTRUCTION

73-1.03A General

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 inch deep before concrete removal.

To add a detectable warning surface to an existing curb ramp, install a prefabricated detectable warning surface under manufacturer's recommendations.

73-1.03B Subgrade Preparation

Prepare subgrade to required grade and cross section. Remove soft or spongy basement material 6 inches below subgrade elevation for curbs, gutter depressions, island paving, and driveways and 3 inches below subgrade elevation for sidewalks and curb ramps. Backfill with earth, sand, or gravel to produce a stable foundation.

Apply water to subgrade under section 17-3 and thoroughly compact before placing concrete.

Verify the finished surface of the subgrade does not project into concrete cross section at any point by:

1. Means of a template supported on the side forms for fixed form method
2. Measuring from the offset guide line or survey marks for extruded or slip form methods.

73-1.03C Fixed Form

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 in advance of placing concrete.

Place and compact concrete in the forms without segregation.

73-1.03D Extruded or Slip Form

Wet the subgrade immediately in advance of placing 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 concrete surface with a brush application of grout.

If using a slip form machine control alignment, grade, and cross slope automatically by one of the following:

1. Sensing of preset string lines.
2. Sensing of preset string line for control of alignment and grade and cross slope control.

The slip form machine must be equipped with traveling forms rigid enough to produce the required cross section. The slip form machine must produce a dense homogeneous concrete true to grade and cross section requiring minimum handwork. Consolidate concrete with internal vibrators or other authorized method.

If the extruded or slip form machine fails to produce concrete with web marks of water on the surface or has surface pits larger than 3/16 inch in diameter, aggregate grading limits are further restricted.

73-1.03E Expansion and Contraction Joints

Construct contraction joints by scoring concrete with a grooving tool and rounding corners with an edger tool or saw cutting hardened concrete to a depth of at least 1 inch. Apply curing compound immediately to the exposed surfaces of sawcut joints.

Construct expansion joints at each side of a structure and at each end of a curb return using 1/4 inch thick preformed joint filler. Finish concrete adjacent to expansion joints with an edger tool. Do not construct expansion joints closer than 20 feet to an island nose. Shape preformed joint filler to match surface contour of concrete.

You may construct expansion joints by saw cutting through the full depth of the concrete cross section. The width of the sawcut must provide for a tight fit of the preformed joint filler.

If joint is cut before concrete has hardened:

1. Protect adjacent surfaces with close fitting, firmly supported shields.
2. Complete sawcut and insertion of the preformed joint filler before curing concrete.

If joint is cut after concrete has hardened:

1. Mortar preformed joint filler in place using heavy trowel pressure.
2. Cover exposed portions of concrete in the vicinity of sawcut with an additional application of curing compound.

After concrete has cured, check joint filler for tight fit. If any loose joints are found, mortar joint in place and check after mortar has cured. Repeat as necessary to achieve a tight fit.

73-1.03F Curing

Cure concrete with pigmented curing compound under section 90-1.03B(3).

Apply curing compound to provide complete coating of all exposed faces of the concrete surface.

73-1.04 PAYMENT

Items for minor concrete are measured based on the dimensions shown.

Detectable warning surface is measured based on the dimensions shown.

73-2 CURBS

73-2.01 GENERAL

73-2.01A Summary

Section 73-2 includes specifications for constructing curbs.

73-2.01B Definitions

Reserved

73-2.01C Submittals

Reserved

73-2.01D Quality Control and Assurance

Reserved

73-2.02 MATERIALS

Reserved

73-2.03 CONSTRUCTION

73-2.03A General

Provide entrances for driveways and curb ramps.

If curbs are constructed over existing pavement use steel dowels and reinforcing steel or adhesive to anchor the curb to the existing pavement.

If steel dowels and reinforcing are used, anchor steel dowels in drilled holes with mortar made from equal parts in volume of portland cement and sand. 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 under section 73-1.03E at right angles to the line of curbs. Space contraction joints at 20 foot intervals. For curbs adjacent to existing concrete, align curb joints with existing concrete 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. Check the top and face of curbs and surface of gutter for flatness with a 10-foot straightedge. No gaps greater than 0.01 feet are allowed except at grade changes or curves.

Clean any discolored concrete at your expense by abrasive blast cleaning or other authorized method.

73-2.03B Fixed Form

Fixed forms must comply with section 73-1.03C.

Set forms the full depth of the back and face of curbs.

Back bender forms may be constructed with 1/2-inch-thick benders.

Cleat back bender forms together as required to obtain the full depth of the curb.

Use form clamps to prevent interference with finishing operations.

Place preformed joint filler in position at expansion joints before placing concrete.

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 forms from face of curb 1 to 6 hours after placing concrete. Do not remove forms if concrete is plastic enough to slump.

Immediately after removing forms from face of curb, use a steel trowel to obtain a smooth finish. The smooth finish must extend to within 0.17 foot of the flow line or to the flow line of a curb with integral gutter. After smoothing curb face, apply a fine brush finish parallel to the line of the curb.

73-2.03C Extruded or Slip Form

Extruded or slip form must comply with section 73-1.03D.

If using an extrusion machine, determine the offset guide line used to set grade for top of the curb from survey marks established by the Engineer. The extrusion machine must be equipped with a grade line gage or pointer that allows for continual comparison between curb placement and offset guide line.

The extrusion 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 uniform depth below the established grade of the top of curb.

You may place curbs that are not on a structure with an extrusion machine or slip form paver if:

1. Concrete complies with section 73-1.02.
2. Finished curb is true to line and grade.
3. Concrete contains maximum amount of water that maintains curb shape without support.
4. Required surface texture is obtained.

73-2.04 PAYMENT

Reserved

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, gutters, gutter depressions, island paving, curb ramps, and driveways.

73-3.01B Definitions

Reserved

73-3.01C Submittals

For a prefabricated detectable warning surface, submit a 5-year manufacturer's warranty of replacement for 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 Quality Control and Assurance

For a prefabricated detectable warning surface provide a 24-by-24-inch test panel.

73-3.02 MATERIALS

Reserved

73-3.03 CONSTRUCTION

Construct expansion joints at:

1. All returns and opposite of expansion joints in adjacent curb
2. Sixty foot maximum intervals when no adjacent curb is present

Construct contraction joints to create 12-to-20-square foot rectangular patterns into the surface of sidewalks.

Install prefabricated detectable warning surface under manufacturer’s recommendations.

Broom finish surface of sidewalk, gutter depression, curb ramp and driveway. For surfaces used by pedestrians, apply broom finish perpendicular to the path of travel. 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 miscellaneous structures (i.e. manholes, pipe inlets, or other miscellaneous structures), 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 with a float to grade and cross section and trowel smooth.

Leave forms in place for sidewalk, gutter depression, island paving, curb ramp and driveway for a minimum of 12 hours after surface finishing.

If using extruded or slip form method, comply with section 73-1.03D.

Clean any discolored concrete at your expense by abrasive blast cleaning or other authorized method.

73-3.04 PAYMENT

Reserved

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 obtain the pattern or impressions shown.

73-4.01B Submittals

For each color of a dry-shake method colored concrete surface, submit manufacturer's data for color hardener, and curing and finishing compounds.

73-4.01C Quality Control and Assurance

For a textured or colored concrete surface, construct a 48-by-48-inch test panel for each type of texture and color.

73-4.02 MATERIALS

For textured and colored concrete surfaces, aggregate must comply with the grading requirements for fine aggregate in section 90-1.02C(4)(c).

Aggregate used in grout for textured and colored concrete surfaces must comply with the grading requirements in the following table:

Aggregate Grading for Grout

Sieve sizes	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 dry-shake method must comply with ASTM C 979.

73-4.03 CONSTRUCTION

Protect surrounding exposed surfaces during the placement, finishing, and curing operations of colored concrete.

If shown, place welded wire reinforcement.

Screed concrete to the grade and cross section shown. Strike-off and compact until a layer of mortar is brought to the surface. Wood float to a uniform surface.

For dry-shake method apply surface color hardener in 2 applications while the concrete surface is in the plastic stage. Use at least 60 lb of hardener per 100 sq ft of concrete surface. Wood float surface after each application of hardener. Trowel only after final floating.

Texture while concrete is in the plastic stage. For textures that require concrete stamps, use stamp under manufacturer's recommendations.

Do not texture or grout grooved area and detectable warning surface on a curb ramp.

If textured concrete surface is grouted, place grout after initial curing of textured concrete. Remove curing seal and other deleterious substances before applying grout. Removal method must not stain or discolor area of textured concrete to remain exposed after grouting. Spread and consolidate grout over the textured concrete area under manufacturer recommendations. Remove excess grout from textured concrete area with a squeegee and damp burlap rags or other authorized method. Apply curing seal.

73-4.04 PAYMENT

Textured and colored concrete surfaces are measured parallel to the concrete surface.

73-5–73-6 RESERVED

74 PUMPING EQUIPMENT AND CONTROLS

74-1 GENERAL

74-1.01 GENERAL

74-1.01A Summary

Section 74-1 includes general specifications for pumping equipment and their control systems.

The arrangement and general location of pumping equipment and control systems are shown.

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 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.

Shop drawings for pumping equipment must include:

1. System layout
2. Piping connections
3. Appurtenances
4. Other materials required for the equipment installation
5. Mounting details and anchorage details

Shop drawings for electrical equipment must include:

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 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 drainage pump and pumping plant electrical equipment require changes to pump plant metal work or other construction details, submit revised shop drawings. The Department does not adjust payment for these changes.

74-1.01C(3) Product Data

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.

Product data includes catalog cuts, performance data, installation instructions, and additional documentation.

Catalog cuts must include:

1. Manufacturer's name
2. Catalog or part number
3. Size

4. Capacity
5. Electrical ratings
6. Finish
7. Maintenance and adjustment requirements
8. Identification symbols described
9. Installation instructions

74-1.01C(4) Samples

The Engineer may request material samples of submitted equipment. If requested, send samples to OSD, Documents Unit.

74-1.01C(5) Work Plans

74-1.01C(5)(a) 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. Operational test, including pump controller operation
5. Supplying water
6. Water disposal

74-1.01C(5)(b) Maintain Pumping Capacity and Maintenance Requirements Plan

Submit a work plan for maintaining the pumping plant 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. Total pumping capacity alternative specified in section 74-1.03E.
3. 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) Closeout Submittals

Submit closeout submittals as 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 accepted 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 pumping plant equipment to the Engineer.

74-1.01D Quality Control and 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) Operational Tests

Perform the operational tests in the Engineer's presence. The Engineer confirms the pump nameplates before testing.

Fill the pump sump and storage boxes with water. Fill boxes as required until operational tests and performance tests are accepted. 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

Repeat the operational tests until the requirements have been met.

74-1.01D(3) Performance Tests

After acceptance of the operational tests, the Engineer will run performance tests on the installed pumping plant equipment. Perform testing under section 74-1.01C(5)(a). Performance tests include two 5-minute tests for each pump.

Performance tests must show that each installed drainage pump meets 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.

The Engineer repeats performance tests until the requirements have been met.

Remove bulkheads and blocking from pipes after performance testing is complete.

74-1.01D(4) Drainage Pump Final Inspection

Section 74-1.01D(4) applies if you use the drainage pumps installed under the Contract to maintain total pumping capacity for the pumping plant drainage area before Contract acceptance.

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 drainage pumps used before Contract acceptance under section 74-1.01C(5)(a) 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 75-1.03C.

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 using means and methods that comply with the manufacturer's written instructions and prevent damage, deterioration, or loss, and maintain warrantee requirements.

74-1.03 CONSTRUCTION

74-1.03A General

Reserved

74-1.03B Painting

Painting must comply with section 59-1.

Paint uncoated drainage pump equipment, including metal work, as machinery under section 59-2.03C(1).

Before installing, paint wood on all surfaces under section 59-4.

Paint the pump number on each drainage pump motor and on each discharge pipe 5 feet above every landing. Numbers must be stenciled and at least 1-1/2 inches tall. Use 2 applications of commercial quality white gloss enamel.

Paint an arrow showing the direction of drainage pump rotation on each discharge pipe 4-1/2 feet above every landing. 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. Push buttons
4. Operating handles
5. Electrical cover plates
6. Plastic parts
7. Locks

Repair exposed nongalvanized threads or damaged galvanizing under section 75-1.05.

Clean, prime, and touch up damaged areas of painted surfaces. Use the same type 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 installed equipment from damage.

Clean equipment, enclosures, galvanized and noncorrodible metal surfaces, and wood surfaces in the pumping plant after installation under section 59-1.03C.

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 the maintenance instructions in a galvanized sheet-metal frame. Install the frame on an interior pump house wall.

Supply an 11- by 17 inch fused-laminate copy of the control system schematic diagram. Install 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 for the pumping plant.

For existing pumping plants:

1. Stage removal activities such that total pumping capacity is maintained
2. Provide pump plant maintenance

Upon completion of new pumping plants:

1. Maintain total pumping capacity
2. Provide pump plant maintenance

Furnish electrical energy necessary for maintaining total pumping capacity and maintenance requirements.

Pumping plant maintenance must include:

1. Removing dirt and debris from 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 maintenance dates, work performed, and the name of employee doing the work.

Maintain total pumping capacity at the corresponding dynamic head shown. Use 1 of the following alternatives to maintain 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 for the pumping plant drainage area before Contract acceptance.

The pumping plant must be complete. The Engineer inspects the storage box, screens, pump sump, and pumping plant equipment before authorizing its 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, and checks and weirs. Safeguards must:

1. Intercept 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

The Department does not pay for failed tests.

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

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

Submit certificates 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 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 motor nameplate power at the point the pump requires maximum power.
3. Motor rpm.
4. Impeller final diameter.

74-2.01D Quality Control and Assurance

74-2.01D(1) General

Reserved

74-2.01D(2) Regulatory Requirements

Drainage pumps must be factory certified under ANSI/HI 11.6. Each pump certification must be of the actual motor, pump, and trimmed impeller combination delivered to the job site.

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

Use the size and type of pipe and fittings shown.

74-2.02B Drainage Pumps and Pumping Apparatus

74-2.02B(1) General

Reserved

74-2.02B(2) Drainage Pumps

Drainage pumps must be factory assembled, tested, and must be a submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal wastewater pump complying with ANSI/HI 1.1-1.2 and ANSI/HI 1.3. 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 meet the design pump rates and dynamic heads shown.

Drainage pumps must have cast iron (1) casings, (2) brackets, (3) volutes with open inlet, and (4) horizontal pump discharges.

Drainage pumps must have a base support engineered to permit 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 at least 3-inch solids handling
4. Trimmed to develop from 97 to 100 percent of motor nameplate power at point of maximum load and still deliver at least the design pump rates and dynamic heads shown
5. Keyed and secured to the shaft. 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 "G" or smaller, 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, and a cast iron casing with lifting eyes or lugs.

The cables must be listed for "Extra Hard Service" in 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 junction box.

Install a motor nameplate and pump identification nameplate on each drainage pump. 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 of 30 inches Hg vacuum to 30 psi unless otherwise shown
5. Gauge guard and gauge cock. Gauge guard must be 1/2 by 1/4 inch, PVC or CPVC body, PTFE or Viton diaphragm, and rated for 0 to 250 psi. Gauge cock must be 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 A 1008/A 1008M with at least an A60 metallic coating complying with ASTM A 653/A 653M.

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 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 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 spaces between 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 inch 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 nonhanded steel lock chassis and self aligning trim with concealed through bolts. Locksets must be Function F75 with knobs, chromium roses, and 1/2-inch steel square corner latchbolt.

Weatherstripping must have a polyurethane seal. Overhead door drips must have a 2-1/2-inch projection and be full width. Door shoe with rain drips must be mill finished aluminum with 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 the frame fabricated from 18-gauge electro-galvanized steel
2. Have dual 12 gauge security grilles with through bolted screws on the inside
3. Have bronze insect and bird screen in 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 A 53/A 53M. 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 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 75-1.05.

Gaskets must be 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. 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. Slot holes 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 75-1.05.

Pumping plant metal work must comply with section 75-1.04.

74-2.02F Storage Cabinets

Storage cabinets must:

1. Be wall mounted, steel, and bolted or welded construction
2. Have double doors with single locking handle or magnet catch, and padlock staples
3. Have 2 adjustable shelves
4. Be 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 assembly or adjustment of equipment. Mount 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 square, alignment, twist, and plumb before and after installation and adjust if necessary. Tolerances are ±1/16 inch.

Check the door frame as follows:

1. Squareness at door rabbet on a line 90 degrees from jamb perpendicular to frame head
2. Alignment at jambs on a horizontal line parallel to plane of wall
3. Twist at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall
4. Plumbness at jambs on a perpendicular line from head to floor

Fill 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 door in frame and shim as necessary. Install weatherstripping on the top and sides of frame. Install door shoe on door. Install overhead door drip over door. Use weatherproof silicone sealant and adhesive as the threshold bedding sealant.

Install the pump house door lock cover as shown.

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.

Drainage pump automatic operation must be controlled by the water level monitoring system and the pump controller.

74-3.01B Definitions

DPDT: double pole, double throw.

SPDT: single pole, double throw.

74-3.01C Submittals

74-3.01C(1) General

Submit a toll free telephone service of the designated service organization for manufacturers 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 Control and Assurance

74-3.01D(1) General

Reserved

74-3.01D(2) Regulatory Requirements

Electrical equipment must comply with section 86-1.02 and be NRTL listed.

Materials and workmanship must comply with section 86-1.02 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.

74-3.02 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 volts, and must have:

1. 2-pole, 50-ampere 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 volts
2. 1/2-inch-diameter thru-hole
3. Low range current sensing level from 1 to 15 amperes

4. High-range current sensing level from 15 to 300 amperes

Time meters must be 120-volt and nonresettable from 0 to 99,999.9 hours.

Selector switches must:

1. Be single-pole, 2-position maintained, 10-ampere, 120-volt rotary types
2. Have contacts rated at 120 volts and 35 percent power factor
3. Have an inductive pilot duty rating of:
   3.1. 60 amperes make
   3.2. 6 amperes break
   3.3. 10 amperes continuous

Pilot lights must be panel mounted, 120-volt, high-visibility LEDs with colored plastic lens and screw cap.

Control relays must be 120-volt, 3-pole, double-throw general purpose relays with clear plastic case and 11-pin plug base with 10-ampere contacts. Control relays must include a matching barrier type, 11-contact relay socket with 10-ampere contacts and screw terminals.

Time delay relays must:

1. Be 120-volt, electronic "ON-DELAY" types
2. Have DPDT, double-break 10-ampere contacts, having a range of 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-volt with SPDT, 0.3-ampere contact with:
   3.1. Maximum turn-on time of 5 milliseconds
   3.2. Maximum output current of 100 microamperes at 28 volts, DC

Push buttons must:

1. Be heavy duty, general purpose types
2. Have 1 normally open, momentary contact rated at 120 volts and 35 percent power factor
3. Have an inductive pilot duty rating of:
   3.1. 60 amperes make
   3.2. 6 amperes break
   3.3. 10 amperes continuous

Terminal blocks must be comply with NEMA ICS 4 and be:

1. DIN rail mounted or attached to the enclosure
2. Rated for 30 amperes at 600 volts
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

Reserved

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. Trapped air level monitoring system

must include an air compressor, three-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-volt, ±1/20 hp shaded pole motor with integral overload protection
2. Include an aluminum piston with Teflon-sleeved cylinder
3. Have a capacity of at least 0.65 cu ft/min at 50 psi
4. Be capable of initializing against 250 psi head

The solenoid valve must be a 120-volt, 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.

Polyethylene air tube must be 0.04-inch-thick wall type complying with ASTM D 1248, 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-volt, solid state, industrial grade with software stored in nonvolatile memory. You may use proprietary software.

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, then energize the lag pump ten seconds later

The controller must output a 120-volt 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 an LED display with 1/2-inch-high letters that computes to 1 decimal place and 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-volt, 10-ampere rated contacts
2. LED indicators mounted on plug-in bases
3. Test pushbutton 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-volt AC input with DC voltage and current outputs to suit 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 comply with section 86-2.05A, Type 1.

Flexible conduit and fittings must comply with section 86-2.05A, Type 4.

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 86-2.08, 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. Pre-printed, 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 labels 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 D 178 and be rated for at least 20,000 volts dielectric strength, when tested under ASTM D 149. Floor covering must be at least 1/4 inch thick.

Float switches must:

1. Be 120-volt, 8-ampere, SPDT, 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 a impact and heat resistant colored polycarbonate threaded globe with neoprene gasket. Globe color must be as shown.
4. Have a threaded, die-cast-aluminum guard.
5. Include a twin tube, 18-watt, 120-volt, compact fluorescent lamp with integral ballast.

Light switches must:

1. Be NRTL listed, specification grade
2. Have 20-ampere, 120/277-volt, 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-ampere, 120-volt rotary switches
2. Have contacts rated at 120 volts and 35 percent power factor
3. Have an inductive pilot duty rating of:
    3.1. 60 amperes make
    3.2. 6 amperes break
    3.3. 10 amperes 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 volts. Seal failure relays must have individual pump leak-indicator lights.

Pull boxes must be concrete-type complying with section 86-2.06.

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 cable under section 86-2.09B and the following:

1. Pull conductors to prevent damage to 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:

Conductor Color-Coding

System	Color code
120/240V-Single phase	Black, blue
120/240V-Three phase	Black, orange, blue
120/208V-Three phase	Black, red, blue
480/277V-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 alter performance.

Install current switches in the starter compartments. Loop power conductors around the sensing coil multiple times.

The Department does not adjust payment for disassembly, assembly, or modifications to the motor control center for installation.

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.

74-3.03D Training

Train 6 Department personnel in programming, connection, operation, troubleshooting, and maintenance of the pump controller. Training must be for at least 4 hours and be at the job site.

The training instructor must be a factory-authorized representative of the pump controller manufacturer.

Training must:

1. Supply Department personnel with books, manuals, and other training material
2. Include equipment required for pump controller training
3. Include hands-on experience in programming techniques and operation

74-3.04 PAYMENT

Not Used

74-4 BOOSTER PUMP

74-4.01 GENERAL

74-4.01A Summary

Section 74-4 includes specifications for installing booster pumps.

The booster pump must be a factory assembled, skid-mounted system.

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 manual copies as PDF files on CDs or DVDs. Submit 1 manual 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 Control And 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.

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) 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)(b) 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)(c) 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)(d) 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 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 volts AC, with 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 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)(e) 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)(f) 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 unless otherwise shown

74-4.02B(2)(g) 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. Locate the inlet and outlet valves inside the booster pump enclosure.
2. Use threaded or flanged fittings on the pump inlet and outlet connections.
3. The pump must be 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 will supply a lock upon 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

75-1.01 GENERAL

75-1.01A Summary

Section 75 includes specifications for fabricating and installing miscellaneous metal materials.

75-1.01B Quality Control and Assurance

Miscellaneous metal 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

75-1.02 MISCELLANEOUS IRON AND STEEL

75-1.02A General

Welding must comply with AWS D1.1.

Remove burrs, rough and sharp edges, and other flaws.

Straighten warped pieces after fabricating and galvanizing.

Steel fastener components for general applications, components of HS steel fastener assemblies for structural steel joints, carbon-steel castings, and malleable iron castings must comply with section 55-1.02A(1); other miscellaneous iron and steel materials must comply with the corresponding specifications shown in the following table:

Miscellaneous Iron and Steel Materials

Material	Specification
Steel bars, plates, and shapes	ASTM A 36/A 36M, A 575, or A 576 (AISI or M Grades 1016–1030)
Stainless steel fasteners, alloys 304 & 316, for general applications:	
Bolts, screws, studs, threaded rods, and nonheaded anchor bolts	ASTM F 593 or F 738M
Nuts	ASTM F 594 or F836M
Washers	ASTM A 240/A 240M 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 A 536, Grade 80-55-06
Cast iron pipe	Commercial quality
Steel pipe	Commercial quality, welded or extruded
Other parts for general applications	Commercial quality

Raised pattern plates must be commercial quality.

Galvanize steel parts and cast iron manhole frames and covers for sidewalks under section 75-1.05. Galvanize 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.

75-1.02B 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 A 36/A 36M
   1.2. A 576, 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.

Drainage inlet frames and grates except those on bridges need not be galvanized or coated with asphalt.

Matchmark frames and grates and frames and covers in pairs before delivery to the job site; the grates and covers must fit into their frames without rocking.

75-1.02C Metal Cattle Guard

Reserved

75-1.02D–75-1.02G Reserved

75-1.03 MISCELLANEOUS BRIDGE METAL

75-1.03A General

Miscellaneous bridge metal must comply with section 75-1.02.

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

Produce the parts shown in the table below from the corresponding materials shown:

Miscellaneous Metal Parts

Part	Material
Bearing assemblies	ASTM A 36/A36M
Access opening covers	Commercial-quality sheet steel
Access doors	Galvanized sheet steel complying with ASTM A 653/A 653M, Coating Designation G210 [Z600]
Springs for deck drain grating latches[a]	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

[a]Test spring latches and other mechanical devices before delivery to the job site; they must operate smoothly and properly.

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 C 920, Type S, Grade NS, Class 25, Use O.

75-1.03B 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 A 722/A 722M, including supplementary requirements. Nuts must comply with the 1st and 2nd paragraphs of section 50-1.03B(2)(c).

Where cleaning is described, clean nuts, bolts, threaded bars, and plate washers under SSPC-SP 6 or SSPC-SP 2. Abrasives used for blast cleaning must comply with section 59-1.02B.

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 D 4417. 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 except threads engaged by nuts with 2 applications of organic zinc-rich primer. Do not use aerosol cans. Apply the 2nd application to the nuts and threads after installation. Organic zinc-rich primer must be on the Authorized Material List

Thread locking systems must be on the Authorized Material List for anaerobic thread locking systems and must comply with the requirements thereon.

75-1.03C Anchorage Devices

75-1.03C(1) General

Concrete anchorage devices must be mechanical expansion anchors or resin capsule anchors installed in drilled holes or CIP concrete inserts.

Concrete anchorage devices must be on the Authorized Material List.

Submit a certificate of compliance for anchorage devices.

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 A 563.

Except for mechanical expansion anchors and iron castings for CIP inserts, metal parts of anchorage devices must be hot-dip or mechanically galvanized.

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 B 663.

Iron castings must be mechanically galvanized.

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 values shown in the following table:

Torque Requirements

Stud diameter (inches)	Installation torque values (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.

75-1.03C(2) Mechanical Expansion Anchors

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

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 to equipment or fixture, demonstrate to the Engineer that the expansion anchors are firmly seated within these tolerances.

75-1.03C(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

75-1.03C(4) Cast-In-Place Concrete Inserts

CIP concrete inserts must be ferrule loop or cast iron.

When tested under California Test 682, CIP inserts must withstand the minimum ultimate test loads shown in the following table:

CIP Insert Sustained 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

75-1.03D Bridge Deck Drainage System

75-1.03D(1) General

Bridge deck drainage system consists of the drainage components specified in the special provisions.

Securely cover deck drain grates and other grating openings to prevent intrusion of debris until after final cleanup of the deck and drainage areas.

After 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.

75-1.03D(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 A 276, Type 304, for a project in a non-freeze-thaw area
4. Comply with ASTM A 276, 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

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.

75-1.03D(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.

Submit a certificate of compliance for fiberglass pipe and fittings; include laboratory test results.

Fiberglass pipe and fittings must:

1. Comply with ASTM D 2996
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 a at least 2,500 hours of accelerated weathering when tested under ASTM G 154 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.

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.

75-1.03D(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 as shown instead of welded pipe.

The PVC pipe and fittings must be Schedule 40, complying with ASTM D 1785. Pipe support spacing must be at most 6 feet.

75-1.03E Bridge Joint Restrainers

75-1.03E(1) General

Bridge joint restrainers include various combinations of the following: structural steel parts, bolts, bearing plates, cable drum units, pipe sleeves, PVC pipe, elastomeric pads, expansion joint filler, expanded neoprene, expanded polystyrene, sheet neoprene, hardboard, and incidentals.

Place new concrete adjacent to restrainers before installing restrainers.

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.

75-1.03E(2) Cable Type

75-1.03E(2)(a) General

Cable-type restrainers consist of cables, swaged fittings, studs, nuts, cable yield indicators, disc springs, and if shown, turnbuckles.

You are responsible for determining the required lengths of the cable-type restrainers.

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 consist of a cable fitted with a swaged fitting and right hand thread stud at both ends and must 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.

Submit 2 certified copies of mill test reports of each manufactured length of cable.

Submit 2 certified copies of the mill test and heat treating reports of each heat of bars used for cable yield indicators.

75-1.03E(2)(b) Materials

Each swaged fitting, turnbuckle, stud, and nut assembly must develop the specified breaking strength of the cable.

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.

Securely wrap each free end of restrainer-unit cables to prevent separation.

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 and keep the stud in proper position.

Each stud must comply with ASTM A 449 after galvanizing. Before galvanizing, mill a 3/8-inch slot for the locking pin in the stud end.

Nuts must comply with ASTM A 563, 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

Machine the wall of the reduced section of the cable yield indicator so that the indicator yields at a load from 36,000 to 38,000 lb when tested in compression along the major axis at a test speed of at most 1/2 inch/minute.

Disc springs must be made from steel complying with ASTM A 684/A 684M, Grade 1075. Do not galvanize disc springs; clean and paint them with a paint recommended by the manufacturer and color shown.

Turnbuckles must be steel pipe type. Pulls for turnbuckles must consist of a swaged fitting and stud assembly.

Steel parts must comply with ASTM A 36/ A36M or A 576, Grade 1030, (AISI 1030) and must not be rimmed or capped steel.

You may drill holes in steel parts after galvanizing if you repair the holes as specified for repairing damaged galvanized surfaces in section 75-1.05.

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

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 D 1056 for Class SC, Grade SCE43 material or firmer.

Ship cable-type restrainers as complete units.

75-1.03E(2)(c) Installation

Notify the Engineer at least 2 days before tightening and setting cable-type restrainer units.

Repair existing structural steel paint areas that you damage and holes you drill through existing steel members as specified for repairing damaged galvanized surfaces in section 75-1.05.

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 except dirt and dust; this cleaning and painting is change order work.

75-1.03E(2)(d) Corrosion Protection

75-1.03E(2)(d)(i) General

Section 75-1.03E(2)(d)(i) applies if corrosion protection on cable-type restrainers is specified in the special provisions.

Submit a test sample of grease from the lot to be used and test results at least 40 days before use.

For the locknuts, submit a certificate of compliance with a copy of each required test report.

75-1.03E(2)(d)(ii) Materials

The corrosion protection system must be on the Authorized Material List and comply with the requirements thereon.

The grease must comply with the corrosion-inhibiting grease specifications in section 46-2.02D.

The sheathing must have:

1. Density of 940 kg/m^3 to 960 kg/m^3 as measured under ASTM D 792, Test Method B
2. Minimum wall thickness of 80 mils

The sheathing must be:

1. Sufficiently strong to prevent damage during construction
2. Watertight
3. Chemically stable without embrittlement or softening
4. Nonreactive with concrete, steel, or corrosion inhibiting grease

The Department rejects burned or damaged HDPE sheathing.

The nuts must be mechanically zinc-coated nylon insert locknuts complying with ASTM A 536, Grade DH, and ASME B18.22.2 except that the thickness must be greater than that specified in ASME B18.2.2. The nuts must maintain complete locking effectiveness at 100 percent relative humidity. Do not use thread locking systems. The mechanical and thermal properties of the nylon resin used in the locknut insert must have the values shown in the following table:

Nylon Insert Requirements

Property	Test method	Value
Mechanical:		
Tensile strength	ASTM D 638	12,000 psi min
Tensile strength at yield	ASTM D 638	12,000 psi min
Elongation at yield	ASTM D 638	5 percent max
Elongation at break	ASTM D 638	60 percent max
Flexural modulus	ASTM D 790	410 ksi
Izod impact	ASTM D 256	53 J/m
Thermal:		
Heat deflection temperature		
at 66 psi	ASTM D 648	210 °C
at 264 psi	ASTM D 648	65 °C
Melting point	ASTM D 3418	260 °C

The pigment composition and physical properties of the penetrant must have the values shown in the following table:

Penetrant Pigment Composition and Property Requirements

Pigment composition or property	Test method	Value
Total pigment content	ASTM D 2371	24–28 percent
Pigment component:		
Synthetic red iron oxide	ASTM D 3721	19–23 percent
Zinc hydroxy phosphite	ASTM D 4462	33–37 percent
Barium sulfate	ASTM D 602	40–48 percent
Nonvolatile content	ASTM D 2369	60 percent min
Consistency, KU	ASTM D 562	50–75
Density	ASTM D 1475	1.018 g/mL
Drying time, dry to recoat, 4 mils wet film	ASTM D 1640	2–4 hours
Flash point	ASTM D 3278	40 °C min
Salt fog performance, 1–2 mils dry film on abrasive blast cleaned panel under SSPC-SP 5, white metal blast cleaning	ASTM B 117	500 hours, no rust or creepage at scribe

The penetrant vehicle must consist of 75 to 79 percent overbased crystalline calcium sulphonate alkyd resin and 21 to 25 percent driers, UV absorbers, and aliphatic hydrocarbons. The properties of the resin solution must have the values shown in the following table:

Resin Solution Property Requirements

Property	Test method	Value
Density	ASTM D 1475	0.935 g/mL
Flash point	ASTM D 3278	40 °C min
Nonvolatile content	ASTM D 2369	70 percent min
Viscosity	ASTM D 2196, no. 6 spindle at 25 °C, 10 rpm	9,000 cP min

The pigment composition and physical properties of the finish coat must have the values shown in the following table:

Finish Coat Pigment Composition and Property Requirements

Pigment composition or property	Test method	Value
Total pigment content	ASTM D 2371	22–28 percent
Pigment component:		
Titanium dioxide	ASTM D 476, Type III or IV	40–43 percent
Carbon black	ASTM D 561	0.04–1.00 percent
Zinc hydroxy phosphite	ASTM D 4462	28–32 percent
Barium sulfate	ASTM D 602	26–30 percent
Nonvolatile content	ASTM D 2369	70 percent min
Consistency, KU	ASTM D 562	90–120
Density	ASTM D 1475	1.139 g/mL
Drying time, dry to recoat, 4 mils wet film	ASTM D 1640	
Dust free		1–4 hours
Tack free		5–12 hours
Dry hard		24–48 hours
Flash point	ASTM D 3278	40 °C
Sag resistance	ASTM D 4400	16 mils min
Salt fog performance, 100 µm dry film on SSPC-SP 5 blasted cold-rolled steel panel	ASTM B 117	1,000 hours, no more than 1 percent undercutting, blistering, or peeling

The finish coat vehicle must consist of 77 to 81 percent overbased crystalline calcium sulphonate alkyd resin, 12 to 16 percent modified alkyd, and 7 to 9 percent driers, UV absorbers, and aliphatic hydrocarbons. The properties of the resin solution must have the values shown in the table titled "Resin Solution Property Requirements" above.

The finish coat must match color no. 26373 of FED-STD-595.

75-1.03E(2)(d)(iii) Applying Corrosion Protection

Fully coat the galvanized cable-type restrainer with corrosion-inhibiting grease and encapsulate it in a smooth HDPE sheath.

The sheath must be hot melt extruded onto the strand or must be shop applied by a method that ensures all spaces between the sheath and the strand and between the strand wires are filled with corrosion-inhibiting grease.

The ends of the sheathing must be flush with the ends of the galvanized swaged fittings.

Cover the swaged fitting and a portion of the adjacent sheathed cable and threaded stud with a corrosion protection system.

After final installation, the corrosion protection system must extend 2 inches onto both the sheathed cable and the threaded stud.

Clean the cable yield indicator, washers, disc spring, nut, and threaded stud under section 59-1.03C(4) and apply a prime coat of red calcium sulphonate penetrant.

Apply the prime coat to the specified dry film thickness in 1 or more applications. The total dry thickness of the prime coat must be at least 1 mil.

Color code the disc springs after the application of the prime coat.

Coat the cable yield indicator, washers, disc spring, nut, and the portion of threaded stud from the outer face of the nut to and including the ends of the stud with a finish coat of gray calcium sulphate alkyd resin.

Apply the finish coat to the specified dry film thickness in 1 or more applications. The total dry thickness of the finish coat must be at least 8 mils.

Apply the grease, sheathing, corrosion protection system, prime coat, and finish coat at the manufacturer's plant except do not apply the finish coat to any portion of the stud within 1-1/2 inches from

the exposed end of the stud. After the cable restrainer installation is completed, recoat the parts specified in the 9th paragraph of section 75-1.03E(2)(d)(iii) that are accessible with the finish coat.

The items specified in section 75-1.03E(2)(a) to be submitted at the manufacturer's plant must be submitted with all manufacturer's plant-applied coatings.

75-1.03E(3) Pipe Type

Pipe-type restrainers consist of double extra strong steel pipe and associated hardware.

Submit shop drawings showing the method of grouting pipe-type restrainers.

Double extra strong steel pipe must comply with ASTM A 53/A 53M, Grade B.

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. Grout must comply with section 50-1.02C. 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.

75-1.03E(4) Bar Type

Bar-type restrainers consist of HS bars, bearing plates, couplers, anchorage devices, and incidentals.

Bar-type restrainers must comply with the material and sampling specifications for bar prestressing steel in section 50.

Clean and paint new metal surfaces of bar-type restrainer units after fabrication under the specifications for new structural steel in section 59-2, except SSPC-QP 1, SSPC-QP 2, and SSPC-QP 3 certifications are not required.

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.

You must determine the required length of each bar-type restrainer.

Bearing plates must comply with ASTM A 36/A 36M.

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.

75-1.03E(5)–75-1.03E(6) Reserved

75-1.03F Nonskid Surface

Where a nonskid surface is shown on steel plates, apply an epoxy mixed with grit.

Submit a work plan for the nonskid surface showing:

1. Application method
2. Spread rate of epoxy and grit
3. Number of coats

Epoxy must comply with section 95-2.01, 95-2.03, or 95-2.09.

Grit must be:

1. Commercial-quality aluminum oxide, silicon carbide, or almandite garnet grit particles
2. Screen size no. 12 to 30 or no. 14 to 35
3. Applied uniformly at a rate of at least 0.3 psf of surface area.

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.

Before applying any nonskid material, prepare a 1 sq ft test sample applied on hardboard at least 1/4 inch thick. The nonskid surface must have a total thickness from 1/8 to 3/16 inch.

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 in section 75-1.03F.

75-1.03G Bearing Devices

Bearing assemblies or masonry plates placed on mortar pads must comply with section 55-1.03C(2).

Set bearing plates level. Set rockers and expansion devices to comply with the temperature at the time of erection or to the specified setting.

75-1.03H–75-1.03J Reserved

75-1.04 PUMPING PLANT METAL WORK

Pumping plant metal work must comply with section 75-1.02.

Pumping plant metal work consists of fabricated and cast metal parts used for constructing pumping plants:

1. Including metal parts in the pumphouse, outside stairway, storage box, and discharge box and the roadway-type inlet frames and grates at the pumping plant site
2. Excluding bar reinforcing steel and metal parts installed under section 74
3. Excluding roadway-type inlet frames and grates paid for as miscellaneous iron and steel

Pipe handrailing must comply with section 83-1.02G(3).

Anchorage devices must comply with the specifications for concrete anchorage devices in section 74-2.02E.

Except in walkway areas, cast iron manhole covers and frames and cast iron grates and frames must be dipped in commercial-quality asphaltum.

Manhole covers and frames for pumping plant discharge boxes must be watertight and certified by the manufacturer to be rated to the pressure shown.

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

75-1.05 GALVANIZING

Galvanizing must comply with the schedules and specifications shown in the following table except that galvanizing of miscellaneous bridge metal is not required for (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; and (3) items described to receive other finishes.

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 A 123/A123M
Steel <1/8 inch thick	Galvanize before or after fabrication	If galvanized before fabrication, ASTM A 653/A 653M, Coating Designation G210. If galvanized after fabrication, ASTM A 123/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 A 53/A 53M 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 A 307, A 325, A 449, A 563, F 436, or F 1554[b]	Galvanize after fabrication.	ASTM A 153/A 153M
Rail elements, backup plates, terminal sections, and end and return caps of metal beam guard railing	--	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 A 307, A 325, A 449, A 563, F 436, or F 1554, galvanize under their ASTMs.

Galvanizing is not required for stainless steel, monel metal, and similar corrosion-resistant parts.

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 be performed after galvanizing and must comply with thread dimensions and overtapping allowances in ASTM A 563.

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. Do not use aerosol cans.

75-1.06 PAYMENT

Except for final-pay-item miscellaneous metal materials, miscellaneous metal materials are determined from scale weighings.

A frame and cover pair is 1 unit. A frame and grate pair is 1 unit.

The weight of nonmetallic materials for restrainer units are not included in the weight of miscellaneous metal for restrainers.

The weight of epoxy and grit for a nonskid surface is not included in the weight of miscellaneous metal materials.

76 WELLS

76-1 GENERAL

Reserved

76-2 WATER WELLS

Reserved

76-3 EXPLORATION HOLES

Reserved

76-4 REHABILITATE EXISTING WATER WELLS

Reserved

76-5 MONITOR WELLS

Reserved

76-6–77-10 RESERVED

77 LOCAL INFRASTRUCTURE

Reserved

78–79 RESERVED

80 FENCES

80-1 GENERAL

80-1.01 GENERAL

Section 80-1 includes general specifications for constructing fences except Type ESA temporary fences.

80-1.02 CLEARING

Remove earth, trees, brush, and other obstructions that interfere with fence construction.

80-1.03 CONNECTIONS

Connect new fences to existing fences.

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.

80-1.04 FOOTINGS AND DEADMEN

For concrete for metal post and brace footings and for deadmen, use:

1. Commercial quality aggregates and cementitious material
2. At least 470 pounds of cementitious material per cubic yard

Crown each concrete footing to shed water.

80-1.05 POST PLACEMENT

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.

80-1.06 SURPLUS EXCAVATED MATERIAL

After constructing a fence, uniformly spread the surplus excavated material along the adjacent roadway where designated by the Engineer.

80-1.07 TEMPORARY FENCES

A temporary fence must comply with the Contract for a permanent fence of the same type except:

1. You may use used materials if the used materials are good, sound, and suitable for the purpose intended
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 on the plans or specified in section 80.
3. Posts 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

80-1.08–80-1.09 RESERVED

80-1.10 PAYMENT

The fence payment quantity does not include the width of openings.

The fence is measured:

1. Parallel to the ground slope
2. Along the fence

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 Control and Assurance

Reserved

80-2.02 MATERIALS

80-2.02A General

Reserved

80-2.02B Metal Posts and Braces

Line posts must comply with ASTM A 702 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 purpose intended

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-section 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 purpose intended

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 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 A 121
2. Have 2 point barbs
3. Be one of the following:
   - 3.1. 12-1/2 gage, Class 1
   - 3.2. 13-1/2 gage, Class 3
   - 3.3. 15-1/2 gage, Class 3

80-2.02E Wire Mesh

Wire mesh must:

1. Comply with ASTM A 116, 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 gage.

The intermediate wires and vertical stays must be 12-1/2 gage.

80-2.02F Tension Wires, Hardware, and Grounding Materials

Tension wire must be 8-gage galvanized wire.

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 be:

1. At least 1-3/4 inches long
2. Manufactured from 9-gage galvanized wire

Wire used to fasten barbed wire and wire mesh to metal posts must be galvanized and at least 11 gage. Clips and hog rings used for metal posts must be at least 9 gage.

Wire used to tie the lower line of barbed wire to the top wire of wire mesh must be 12-gage 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 length, end bars must comply with the line post specifications and plans.

Vertical stays for gateways must be:

1. Pretwisted
2. 9.5-gage galvanized wire
3. Evenly spaced between end bars at 66-inch maximum intervals

Wire loops must be 6-gage 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 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 installed in a drilled hole butt end down.

Securely fasten tension wires to wood posts. Make an extra loop around each post at each attachment point and staple the wire to the post.

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 post.

Attach barbed wire and wire mesh fabric to the private property side of posts.

On wire mesh fence, tie the lower line of barbed wire to the top wire of the wire mesh with wire at 4-foot intervals between posts. Attach the wire mesh fabric to each post by fastening the top and bottom wires and alternate longitudinal wires with at least 5 fasteners.

At each grade depression, snub or guy the fencing by means of a double 8-gage or a double 9-gage galvanized wire connected to:

1. Each horizontal line of barbed wire or to the top and bottom of wire mesh fabric
2. A deadman weighing about 100 lb and buried in the ground at least 2 feet

Stretch and fasten the fencing before snubbing or guying.

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 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 powerline 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 Engineer-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.

resisting moment: Product of a member's section modulus about the designated axis and its yield strength.

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.

80-3.01D Quality Control and Assurance

Under California Test 674, test:

1. 1 post from each lot of 1,500 or fewer chain link fence posts
2. 1 brace from each lot of 500 or fewer chain link fence braces

If the post or brace fails, test 2 additional posts or braces from the same lot. If 1 of these posts or braces fails, the Department rejects the lot.

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.

Galvanize posts and braces under section 75-1.05 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 followed by 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 1000 hours of exposure to salt fog with a maximum of 5 percent red rust when tested under ASTM B 117.
   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 G 152, cycles 1, or 3 Carbon Arc artificial weathering device.
      1.5.2. ASTM G 155, 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 D 2247.
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 B 117.

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.

Line, end, latch, and corner posts must have the following minimum resisting moments:

Minimum Resisting Moments of Line, End, Latch, and Corner Posts

	Minimum resisting moments (ft-lb)		
	Line posts		End, latch, and corner posts
Fence height	Perpendicular to fence line	Parallel to fence line	Any direction
≤ 6	800	400	1,400
> 6 feet	1,400	700	2,400

Each brace must have a minimum resisting moment of 400 ft-lb about the center of the major axis and 300 ft-lb about the minor axis.

Each end, latch, and corner post must have a midpoint deflection about either axis of at most 0.25 inch. Each post and brace must have a permanent set about either axis at most 0.01 inch when tested under California Test 674.

Before galvanizing and manufacturing, the nominal thickness of the material of each:

1. Post must be at least 0.105 inch
2. Brace must be at least 0.075 inch

A line post having a resisting moment about the weaker axis:

1. Less than 75 percent of the required minimum resisting moment perpendicular to the fence line must not be used at an angle point in the fence line where the deflection angle exceeds 10 degrees.
2. Not less than 75 percent of the required minimum resisting moment perpendicular to the fence line may be used at an angle point in the fence line up to a deflection angle of 30 degrees.

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 75-1.05

80-3.02C Fabric

Chain link fabric must comply with AASHTO M 181 for Type I fabric with a Class C coating 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 gage for fence 84 inches or less in height
2. 9 gage for fence over 84 inches in height and for 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 3-1/4-inch-vertical and 5-1/4-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-gage coil spring steel.

Tie wires and hog rings must be at least 9-gage steel.

Post clips must be at least 6-gage steel.

Galvanize tension and tie wires, hog rings, and post clips under ASTM A 116, coating Class 3.

Turnbuckles and truss tighteners must be:

1. Commercial quality steel, malleable iron, or wrought iron
2. Galvanized under section 75-1.05
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 high density polyethylene with ultraviolet 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 properties must have at least the values shown in the following table:

Plastic Slat Material Property Requirements

Property	Test method	Value
Melt index	ASTM D 1238	0.24
Density	ASTM D 1505	0.951
Low temperature brittleness	ASTM D 746	-76 °F
Tensile strength	ASTM D 638	3,700 psi

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 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 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 barbed wire supporting arms are shown, extend each upwards 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

80-4–80-9 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 Control and Assurance

Reserved

80-10.02 MATERIALS

Each drive gate for a chain link fence must be the length 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 length must have vertical stays such that no panel exceeds 8 feet in length.

A gate frame must be made with pipe at least 1-1/2 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 75-1.05.

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, 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 stops to hold gates open and a center rest with catch.

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.

80-11–80-15 RESERVED

81 MONUMENTS

81-1.01 GENERAL

Section 81 includes specifications for constructing cast-in-place concrete survey monuments.

81-1.02 MATERIALS

Concrete must be minor concrete with 1-inch maximum aggregate.

The Department furnishes survey marker disks.

For Type B and Type D survey monuments, the frame and cover must be fabricated from cast steel or gray cast iron. The frame, cover, and hardware must comply with the specifications in section 55-1.02.

Covers must fit into frames without rocking.

Granular material for Type B and Type D survey monuments must be gravel, crushed gravel, crushed rock, or any combination of these. Granular material must not exceed 1-1/2 inches in the greatest dimension.

81-1.03 CONSTRUCTION

For Type D survey monuments, you may use either Alternative 1 or Alternative 2 as shown.

Locate the survey monument so that the point referenced falls within 1/2 inch from the center of the disk when the disk is placed in the center of the monument.

Survey monuments must be cast-in-place in neat holes without the use of forms, unless forms are shown.

Consolidate the concrete and cure it using the water method under section 90-1.03B(2).

Place the survey marker disk in the survey monument before the concrete reaches its initial set. Press firmly to embed the disk in the concrete.

Fill the resulting space around the monument with earth free from rock or with base and surfacing material. Earth material must be watered and tamped into place.

Place surplus excavated material uniformly along the adjacent roadway as ordered.

81-1.04 PAYMENT

Not Used

DIVISION IX TRAFFIC CONTROL FACILITIES

82 MARKERS AND DELINEATORS

82-1.01 GENERAL

82-1.01A Summary

Section 82-1 includes specifications for fabricating and installing markers and delineators, including highway post markers.

Except for highway post markers, markers and delineators must comply with the *California MUTCD*.

82-1.01B Submittals

Submit a certificate of compliance for:

1. Metal target plates
2. Enamel coating
3. Retroreflective sheeting

82-1.01C Quality Control and Assurance

Finished metal target plates must be free of dents and defects. The maximum edge-to-edge surface deviation from a horizontal plane must not exceed 1/8 inch.

The enamel coating on metal target plates must be the product of a commercial manufacturer. The coating must be smooth, substantially free of flow lines, paint washout, streaks, blisters, and other defects that might impair serviceability or detract from the general appearance.

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 as received and after 1,000 hours in an artificial weathering device under ASTM G155, Table X3.1, Cycle 1, and a daylight luminous directional reflectance (Y value) of 70 minimum

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[a]	10 target plates
Flat sheet stock	10,000 sq ft or less[b]	Five 12 by 24 inch specimens
Coil stock	5,000 lb or less[c]	Two 12 by 12 inch specimens or one 12 by 24 inch specimen

[a]Lot size must not exceed 10,000 target plates.
[b]Lot size must not exceed 10,000 sq ft. Flat sheet stock must be identifiable with parent coil stock.
[c]Coil weight must not exceed 5,000 lb.

If any sample does not comply with section 82, the Department rejects the entire lot. If the Department chooses to resample, the sample quantity may be twice the number shown in the table titled "Metal Target Plate Sampling."

82-1.02 MATERIALS

82-1.02A General

Markers and delineators must be on the Authorized Material List for signing and delineation materials.

82-1.02B Wood Posts

Wood posts must comply with section 56-4.02C.

82-1.02C Metal Posts

The steel for metal posts must comply with ASTM A36/A 36M.

Metal posts must be galvanized under section 75-1.05.

82-1.02D Flexible Posts

Flexible posts must be white, except where shown as yellow.

Flexible posts must be free of burns, discoloration, contamination, and other objectionable marks or defects that affect appearance or serviceability.

82-1.02E Target Plates

Target plates for Type K-1 (CA) and Type K-2 (CA) object markers must be the same color and material as the flexible post.

Target plates for highway post markers and Type L-1 (CA) and Type L-2 (CA) object markers installed on metal posts must be manufactured from aluminum sheets or zinc-coated steel sheets.

Galvanize steel sheets under section 75-1.05. The zinc-coated steel sheets must comply with ASTM A653/A 653M, Commercial Steel (CS 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. Any evidence of damage to or removal of the zinc coating is cause for rejection of the entire lot.

Aluminum target plates 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 the uniform application of an acid-chromate-fluoride, acid-chromate-fluoride phosphate, or equivalent chemical anti-corrosion conversion coating.

Cut the target plates to size and shape and punch mounting bolt holes as shown. The surfaces and edges of the target plates must be free from fabrication defects.

Coat the pretreated metal target plates with an opaque white coating on both sides with 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 the zinc-coated steel target plates, including shearing, cutting, and punching, before starting the enameling process.

Apply the enamel coating by spray, dip, roller, or continuous roller coating. Use other methods if authorized.

82-1.02F Reserved

82-1.02G Reflectors

Reflectors for markers and delineators must consist of Type III or higher grade retroreflective sheeting on the Authorized Material List for signing and delineation materials.

82-1.02H Hardware

Attach target plates with either (1) 1/4-inch galvanized steel or aluminum nuts and bolts or (2) 3/16-inch blind aluminum rivets and washers.

Attach marker panels to posts with 5/16-inch galvanized steel bolts, nuts, and washers.

82-1.02I Highway Post Markers

Letters and numerals on highway post markers must be made with opaque black paint or film. Paint and film must have equivalent outdoor weatherability characteristics as the retroreflective sheeting specified in ASTM D4956. Nonreflective opaque black film must be vinyl or acrylic material.

Use stencils to apply painted letters and numerals on highway post markers.

Film for letters and numerals must have pressure sensitive adhesive and must be computer cut.

82-1.03 CONSTRUCTION

Drive posts in place where soil conditions permit if the method of driving does not damage the posts. Drill pilot holes if ground conditions are such that the posts cannot be driven without damaging the posts. Install target plates and marker panels after the posts have been set in place.

After setting the posts in position, fill any space around them with rock-free earth. During placement, thoroughly tamp and water the fill material in a way that holds the post securely in position.

After installing the posts, place surplus excavated material uniformly along the adjacent roadway unless otherwise specified in section 14-11.

Before Contract acceptance, apply a spot application of paint to all exposed areas where the paint has been damaged and clean all exposed areas that have become soiled.

82-1.04 PAYMENT

A delineator post with 2 target plates is counted as a single delineator.

A highway post marker is paid for as a milepost marker.

83 RAILINGS AND BARRIERS

83-1 RAILINGS

83-1.01 GENERAL

Section 83-1 includes specifications for constructing railing.

83-1.02 MATERIALS AND CONSTRUCTION

83-1.02A General

Materials and construction for the various types of railings must comply with section 83-1.02.

At locations where traffic is adjacent to metal beam guard railing work, all materials required to complete the guard railing work at any 1 location must be available before work starts at that location.

At locations exposed to traffic, schedule activities so that at the end of each day no post holes are open and no railing posts are installed without the blocks and rail elements assembled and mounted.

Welding must comply with AWS D1.1. Welds on exposed surfaces must be ground flush with the adjacent surfaces.

Galvanize completed steel parts and hardware for railings under section 75-1.05.

After galvanizing, railing elements must (1) be free of fins, abrasions, rough or sharp edges, and other surface defects and (2) not be kinked, twisted, or bent. If straightening is necessary, the method used must be authorized. Railing elements with kinks, twists, or bends may be rejected.

Clean and regalvanize (1) abraded or damaged galvanized surfaces of steel railing and posts and (2) ends of steel railing cut after galvanizing, except if allowed by the Engineer, you may make repairs to the surfaces under section 75-1.05.

Mortar must comply with the specifications for mortar in section 51-1 and consist of 1 part by volume of cement and 3 parts by volume of clean sand.

Cure mortar by either the water method or the curing compound method using curing compound no. 6.

Excavation and backfill must comply with section 19.

Steel bridge railing, concrete railing, and tubular metal railing must present a smooth, uniform appearance in its final position, conforming closely to the horizontal and vertical lines shown or ordered.

After constructing the railing, dispose of surplus excavated material uniformly along the adjacent roadway, except as specified in section 14-11.

83-1.02B Metal Beam Guard Railing

Rail elements, backup plates, terminal sections, end and return caps, bolts, nuts, and other fittings for metal beam guard railing must comply with AASHTO M 180, except as modified in section 83-1.02B. The rail elements, backup plates, terminal sections, and end and return caps must comply with AASHTO M 180 for Class A, Type I W-beam guard railing, except within 0.5 miles of the coast the components must comply with AASHTO M 180 for Class A, Type II W-beam guard railing. The edges and center of the rail elements must contact each post block. Rail element joints must be lapped not less than 12-1/2 inches and bolted. The rail metal must withstand a cold bend, without cracking, of 180 degrees around a mandrel of a diameter equal to 2.5 times the thickness of the plate.

Workmanship must be equivalent to good commercial practice and all edges, bolt holes, and surfaces must be free of torn metal, burrs, sharp edges, and protrusions.

Submit 2 certified copies of mill test reports of each heat from which the rail elements are formed.

Bolts must have shoulders of a shape that will prevent the bolts from turning. Holes in the rail elements must be of a similar shape to the bolt shoulder.

Splice rail elements at intervals not to exceed 12.5 feet and make splices at posts, unless otherwise shown.

Rail elements at joints must have full bearing. If the radius of curvature is 150 feet or less, the rail elements must be shaped in the shop. Stencil the radius of curvature on the back of each rail element in numerals of 2-1/2-inch height.

Construct metal beam guard railing using:

1. Wood or steel posts
2. Wood blocks for line posts
3. 1 type of post and block for any 1 continuous length of guard railing

Fabricate steel posts from steel that complies with ASTM A 36/A 36M.

Submit 2 certified copies of mill test reports of each heat of steel from which the steel posts are formed or fabricated.

Plastic blocks must be listed on the Authorized Material List.

The grades 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. Grade wood posts and blocks 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 fabricating, pressure treat wood posts and blocks under section 57-2.01 and AWPA U1, Use Category UC4A, Commodity Specification A.

If copper naphthenate, ammoniacal copper arsenate, chromated copper arsenate, ammoniacal copper zinc arsenate, ammoniacal copper quat, or copper azole is used to treat the wood posts and blocks, fill bolt holes with a grease recommended by the manufacturer for corrosion protection. The grease must not melt or run at a temperature of 149 degrees F. Fill the bolt holes with the grease before the bolts are inserted.

Breakaway wood guard rail terminal posts may be field bored to provide the 2-3/8-inch-diameter hole shown.

Where field cutting or boring is performed after treatment, thoroughly swab, spray, or brush cuts and holes with 2 applications of the same type of preservative as initially used or treat with copper naphthenate under AWPA Standard M4. Preservative application in the field must comply with the 7th paragraph in section 57-2.01B(3).

Drive wood posts, with or without pilot holes, or place the posts in drilled holes. Backfill any space around wood posts with selected earth, free of rock, placed in layers approximately 4 inches thick. Moisten and thoroughly compact each layer.

Drive steel posts. If ground conditions are such that pilot holes are necessary to prevent damage to posts during driving, fill 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 the tubes in drilled holes. Backfill any space around the tubes with selected earth, free of rock, placed in layers approximately 4 inches thick. Moisten and thoroughly compact each layer. Insert wood terminal posts into the tubes by hand. Before the posts are inserted, coat the inside surfaces of the tubes with a grease that will not melt or run at a temperature of 149 degrees F or less. The edges of the posts may be slightly rounded to facilitate insertion of the posts into the tubes.

Place posts at equal intervals. If authorized, you may space end posts closer to the adjacent posts.

The bolted connection of the rail element to the post must withstand a 5,000-pound pull at right angles to the line of the railing.

Fabricate the metal work in the shop. No punching, cutting, or welding is allowed in the field. Lap rail elements such that the exposed ends do not face approaching traffic.

Install terminal sections under the manufacturer's instruction.

Components built from structural steel plates welded together may be substituted for the rolled steel components if:

1. Depth, width, and average thicknesses are at least equal to those of the rolled section
2. For the welded section, the steel plates comply with ASTM A 36/A 36M and the flanges are welded to the web with continuous fillet welds on each side of the web

Metal beam guard railing must be connected to bridge railings, barriers, retaining walls, abutments, and other flat concrete surfaces as follows:

1. Metal rail posts, box spacers, and plate washers must be fabricated of steel under ASTM A 36/A 36M.
2. Metal box spacer must be fabricated from separate plates and welded or press-formed and welded.
3. HS bolts must comply with ASTM A 325, A 325M, or A 449 or the bolts may be fabricated from steel rod under ASTM A 449. The bolts or rods must comply with the mechanical requirements specified in ASTM A 325 or A 325M after galvanizing. Nuts and washers must comply with ASTM A 325 or A 325M.
4. For the connection of guard railing to new bridge railing or barriers, anchor bolt holes must be formed in the concrete parapet using metal sleeves.
5. For the connection of guard railing to existing bridge railing or barriers, anchor bolt holes must be drilled in the concrete parapet. Areas around the holes that are spalled or otherwise damaged during drilling must be repaired with a mixture of commercial quality epoxy adhesive and sand. The proportions of epoxy adhesive to sand must be from 1:4 to 1:6. The cementing agent must consist of a 2-component epoxy adhesive manufactured especially for the making of epoxy-sand mortar. The 2 components and the epoxy-sand mixture must be mixed under the manufacturer's instructions.
6. Footings for railing posts must be constructed of minor concrete. Reinforcement must comply with section 52.
7. Concrete must be placed against undisturbed material of the excavated holes for footings.

End anchor assemblies and rail tensioning assemblies for metal beam guard railing must comply with the following:

1. Type SFT end anchor assembly must consist of an anchor cable, an anchor plate, a wood post, a steel foundation tube, a steel soil plate, and hardware.
2. Type CA end anchor assembly must consist of an anchor cable, an anchor plate, a single anchor rod or double anchor rods, hardware, and 1 concrete anchor.
3. Rail tensioning assembly must consist of an anchor cable, an anchor plate, and hardware.
4. Anchor plate, metal plates, steel foundation tubes, and steel soil plate must be fabricated of steel under ASTM A 36/A 36M.
5. Anchor rods must be fabricated of steel under ASTM A 36/A 36M, A 441, or A 572, or ASTM A 576, Grade 1018, 1019, 1021, or 1026. The eyes must be hot forged or formed with full penetration welds. After fabricating and before galvanizing, anchor rods with eyes that have been formed with any part of the eye below 1,600 degrees F during the forming operation or with eyes that have been closed by welding must be thermally stress relieved. The completed anchor rod after galvanizing must develop a strength of 50,000 lb.
6. Instead of built-up fabrication, anchor plates may be press-formed from steel plate, with or without welded seams.
7. Bolts and nuts must comply with ASTM A 307, unless otherwise described.
8. Anchor cable 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 of improved plow steel with a minimum breaking strength of 23 tons. Submit 2 certified copies of mill test reports of each manufactured length of cable used. The overall length of each cable anchor assembly must be a minimum of 6.5 feet.
9. Cable clips and a cable thimble must be used to attach cable to the anchor rod where shown. Thimbles must be commercial quality, galvanized steel. Cable clips must be commercial quality, drop-forged, galvanized steel.
10. Swaged fitting must be machined from hot-rolled bars of steel under AISI C 1035 and annealed suitable for cold swaging. The swaged fitting must be galvanized before swaging. A lock pin hole to

accommodate a 1/4-inch plated spring steel pin must be drilled through the head of the swaged fitting to keep the stud in the proper position. The manufacturer's identifying mark must be stamped on the body of the swaged fitting.

11. 1-inch nominal diameter stud must comply with ASTM A 449 after galvanizing. Before galvanizing, a 3/8-inch slot for the locking pin must be milled in the stud end.
12. Swaged fittings, stud, and nut assembly must develop the specified breaking strength of the cable.
13. Cable assemblies must be shipped as a complete unit, including stud and nut.
14. Clevises must be drop-forged galvanized steel and must develop the specified breaking strength of the cable.
15. Submit 1 sample of cable properly fitted with swaged fitting and right hand thread stud at both ends, as specified above, including a clevis if shown, 39 inches in total length for testing.
16. Portion of the anchor rod to be buried in earth must be coated with a minimum 20-mil thickness of one of the following:
    16.1. Coal tar enamel under AWWA C 203.
    16.2. Coal tar epoxy under either of the following:
        16.2.1. SSPC-Paint 16, *Coal Tar Epoxy-Polyamide Black Paint*
        16.2.2. U.S. Army Corps of Engineers Specifications, Formula C-200a, Coal Tar-Epoxy (Black) Paint.
17. Metal components of the anchor assembly must be fabricated under good shop practice and hot-dip galvanized under section 75-1.05.
18. Anchor cables must be tightened after the concrete anchor has cured for at least 5 days.
19. Concrete used to construct anchors for end anchor assemblies must be minor concrete.
20. Concrete must be placed against undisturbed material of the excavated holes for end anchors. the top 12 inches of the holes must be formed if ordered.
21. Reinforcing steel in concrete anchors for end anchor assemblies must comply with section 52.

Place anchor bolts to be set with epoxy in holes filled with the 2-component epoxy mixture specified in section 95-2.01.

Railing parts must be interchangeable with similar parts, regardless of source.

83-1.02B(1) Minor Concrete Vegetation Control

Reserved

83-1.02B(2) Type WB Transition Railing

Type WB transition railing is used if metal beam guard railing is used to connect to concrete barrier railing.

Ten-gage metal elements must comply with AASHTO M 180 for Class B, Type I thrie beam element, except within 0.5 miles of the coast the metal elements must comply with AASHTO M 180 for Class B, Type II thrie beam element. Other metal 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 metal elements and end caps must comply with AASHTO M 180 for Class A, Type II thrie beam element.

83-1.02B(3) Temporary Metal Beam Guard Railing

Temporary metal beam guard railing must comply with the Contract for a permanent metal beam guard railing of the same type except:

1. You may use used materials if the used materials are good, sound, and suitable for the purpose intended
2. Steel posts, plates, foundation tubes, soil plates, hardware, threaded rods, and anchor bolts, except HS bolts, may be commercial quality
3. The Department does not require:
    3.1. Galvanizing of steel elements
    3.2. Treating wood with a wood preservative

Removed temporary metal beam guard railing materials not damaged may be reused in the permanent work provided the materials comply with the specifications for the permanent work and the materials are new when used for the temporary metal beam guard railing.

83-1.02C Terminal System

83-1.02C(1) General

Reserved

83-1.02C(2)–83-1.02C(4) Reserved

83-1.02D Steel Bridge Railing

83-1.02D(1) General

Steel bridge railing consists of steel railing fabricated from structural shapes, pipe, formed sections, tubing, plates, and bars.

Structural shapes, tubing, plates, bars, bolts, nuts, and washers must comply with section 55-1.02. Other fittings must be commercial quality.

Pipe sections must be standard steel pipe.

Formed sections must be:

1. Formed from mild steel and true to dimensions
2. Free from kinks, twists, and bends
3. Uniform in appearance

Closed sections must be made of 1-piece tubing or of 2 bent plates welded together at the longitudinal joints.

Seams in the posts must be in the faces of the posts normal to the plane of the railing.

Mechanical expansion anchors for attaching the railing to the supporting concrete members must comply with the specifications for concrete anchorage devices in section 75-1.03A.

Railings must conform to the curvature by means of a series of short chords, from center to center of rail posts, except that railing described as conforming to the curvature must be shop bent to fit the curvature. Joints must be matchmarked.

Railings must be carefully erected true to line and grade. Posts and balusters must be vertical within a tolerance not to exceed 0.02 foot in 10 feet. Adjacent railing panels must align with each other within 1/16 inch.

Posts must be mortared in sockets, set on mortar pads, or set on steel or concrete supporting members as shown.

83-1.02D(2) California Bridge Railing

Reserved

83-1.02E Cable Railing

Cable railing must consist of cables supported by pipe posts set in either concrete footings or post pockets in the tops of retaining walls or other structures.

Pipe for posts and braces must be standard steel pipe or pipe that complies with section 80-2.02.

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 color of the cable

Cable 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

Galvanize cable under Federal Specification RR-W-410.

Tension cable to provide taut railings between posts.

Construct post footings of minor concrete.

83-1.02F Concrete Railing

Concrete railing consists of either an all-reinforced concrete section or the reinforced concrete portion of composite railing sections with end and intermediate posts.

Concrete railing must comply with sections 51 and 52.

If ordered, adjust the height of the concrete railing to allow for the camber and dead load deflection of the superstructure. The amount of adjustment will be ordered before the concrete is placed.

83-1.02G Metal Railing

83-1.02G(1) General

Metal railing consists of metal elements mounted on concrete members.

83-1.02G(2) Tubular Metal Railing

Tubular metal railing and tubular hand railing consists of tubular metal rails supported by metal posts, anchor bolts, hardware, and fittings.

Materials for tubular rails, posts, rods, bolts, and nuts must comply with the requirements shown in the following table:

Material	ASTM
Tubular steel rails and tubular handrailing	A 500, Grade B
Steel posts, rolled bars, and plate washers	A 36/A 36M
Steel sleeves for tubular rails	A 36/A 36M
HS bolts	A 325, A 325M, or A 449
HS threaded rods	A 449
Nuts and washers for HS bolts and rods	A 325 or A 325M

Stud bolts must comply with the specifications for stud connectors in section 55-1.02.

HS bolts or threaded rods furnished under ASTM A 449 must comply with the mechanical requirements specified in ASTM A 449 after galvanizing.

The metal railing posts to which the chain link railing attaches must fit the mounting brackets, pipe sleeves, and other connection fittings.

Install shims at posts and railings, where necessary, 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.

For tubular hand railing mounted on Type 80 SW concrete barrier railing:

1. Resin capsule anchors and threaded rods must comply with section 75-1.03A.
2. Drilling and bonding threaded rods must comply with the specifications for drilling and bonding dowels in section 51-1.

If the horizontal radius of the railing is 30 feet or less, that portion of the tubular railing must be either shop bent or built up from 1/4-inch-thick structural steel plates. Structural steel plates must comply with ASTM A 36/A 36M. Built up tubular railing must match the seamless tubing in appearance.

The difference between out-to-out rail sleeve dimensions and the clear inside dimensions of the tubular steel rails must not exceed 3/16 inch after galvanizing.

Submit 2 sets of anchor bolt layouts before placing parapet or other structural support reinforcement.

Carefully handle materials to avoid bending, braking, abrading, or otherwise damaging the parts. Do not use manufacturing, handling, or installation methods that damage or distort the members or damage the galvanizing.

Before the railing parts are assembled, clean bearing surfaces and surfaces to be in permanent contact. The bases of posts must be true and flat to provide uniform bearing on the concrete portions of the railing.

Adjust the vertical position of the metal railing to allow for camber and dead load deflection of the superstructure. The amount of adjustment will be ordered before the metal railing is installed.

83-1.02G(3) Pipe Handrailing

Pipe handrailing consists of handrailing elements supported by metal brackets or tubular steel posts.

Handrailing elements must be either structural tubing for tubular steel posts or commercial quality standard steel pipe. Tubular steel posts must be round, seamless or welded structural tubing complying with ASTM A 501 and have a wall thickness not less than that of standard steel pipe of the same nominal size.

Brackets, bolts, threaded studs, nuts, washers, and other fittings must be commercial quality structural steel, except that standard steel pipe fittings may be used where shown.

Mechanical expansion anchors for attaching the railing to supporting concrete members must comply with the specifications for concrete anchorage devices in section 75-1.03A.

Railing must be carefully erected true to line and grade. Posts must be vertical within a tolerance not to exceed 0.02 foot in 10 feet and set in sockets or on mortar pads.

83-1.02G(4) Ornamental Railing

Reserved

83-1.02H Reserved

83-1.02I Chain Link Railing

Chain link railing consists of a metal frame covered with chain link fabric, including posts, horizontal members, post anchorages, stretcher bars, truss rods, tension wires, and other required hardware and fittings.

Posts and horizontal members must be standard steel pipe, structural steel tubing, or structural shapes, except where metal conduit is specified. Structural tubing steel must comply with ASTM A 500 or A 501.

Structural shapes, plates, bars, and bolts must comply with section 55-1.02.

Stretcher bars, 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 color of the cable

Frame members carrying electrical conductors must be rigid metal conduit manufactured of mild steel complying with UL 6, *Electrical Rigid Metal Conduit - Steel*. Zinc coat the interior and exterior surfaces of the rigid metallic conduit by hot-dip galvanizing.

Tension wires must be at least 7-gage coil spring steel.

Post clips must be at least 9-gage steel.

Wire ties or hog rings must be 9-gage, commercial quality, steel wire. Wire ties must be given at least 1 complete turn.

Galvanize tension wires, post clips, wire ties, and hog rings under ASTM A 116, Coating Type Z, Class 3.

Six-gage (0.192-inch minimum diameter) aluminum wire ties complying with ASTM B 211 or B 211M, Alloy 1100-H18, or 6-gage (0.192-inch minimum diameter) aluminum hog rings complying with ASTM B 211 or B 211M, Alloy 6061-T94 or Alloy 5052-H38 may be substituted for steel wire ties or hog rings.

Bend ends of wire ties away from pedestrian traffic.

Chain link fabric must be 11 gage 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 F 1345, Class 2

The color of vinyl-coated chain link fabric must be either medium green or dark green.

The railings pertaining to a structure must all be the same color.

Chain link fabric must be woven into approximately 1-inch mesh.

Tighten truss rods and cables with turnbuckles or other fittings.

Stretch and fasten the fabric securely to the posts, other members, and tension wires. Stretch tension wires tightly.

Wherever necessary to conform to curvature, either horizontal or vertical, rework and fit the fabric to present a smooth, neat, and workmanlike appearance.

Provide openings in the fabric as required by other facilities. Reinforce openings with not less than 1 turn of 6-gage wire.

Attach pipe handrailing to chain link railing where shown. Handrailing must comply with section 83-1.02G(3).

83-1.02J Pedestrian Barricade

Install pedestrian barricade as shown.

83-1.03 PAYMENT

Metal beam guard railing is measured along the face of the rail element from end post to end post of the completed railing. The point of measurement at the end post is the center of the bolt attaching the rail element to the end post. If metal beam guard railing is connected to a structure, barrier, wall, or abutment, where the railing connects is considered the end post and the point of measurement is the midpoint between the 2 bolts attaching the rail element at the connection.

Double metal beam guard railing is measured from end post to end post along the center line of the installed barrier.

All other railing is measured along the face of the railing, including end and intermediate posts, and with no deductions for gaps in the railing for lighting and sign supports.

Railing is measured without allowance for overlap at rail splices.

Payment for excavation and backfill is included in the railing work that requires it.

Payment for drilling anchor plate bolt holes in rail elements and driving steel foundation tubes is included in the payment for end anchor or rail tensioning assembly.

An end anchor assembly (Type CA) with 2 cables attached to 1 concrete anchor is measured as 1 end anchor assembly (Type CA).

The length of metal beam guard railing includes buried post anchors.

Temporary metal beam guard railing, temporary terminal system end treatments, temporary Type SFT and Type CA end anchor assemblies, and temporary return and end caps are measured as specified for the corresponding items for permanent metal beam guard railing work.

83-2 BARRIERS

83-2.01 GENERAL

Section 83-2 includes specifications for constructing barrier.

Trim existing median planting to clear the work area for median barrier construction. Dispose of trimmings.

Do not remove an existing median barrier more than 500 feet in advance of the construction of the new barrier being constructed.

At locations exposed to traffic, schedule activities so that at the end of each day no post holes are open and no barrier posts are installed without the blocks and rail elements assembled and mounted.

At the end of each day's activities, reset the existing median barrier without mesh or glare screen and anchor as authorized so that no gap is left between the reset barrier and the barrier being installed. You may place Type K temporary railing instead of resetting the existing barrier.

83-2.02 MATERIALS AND CONSTRUCTION

83-2.02A General

Reserved

83-2.02B Thrie Beam Barrier

Thrie beam barrier must comply with section 83-1.02B.

Rail elements, backup plates, terminal connectors, terminal sections, and return caps must comply with AASHTO M 180 for Class A, Type I thrie beam guard railing, except within 0.5 miles of coast the components must comply with AASHTO M 180 for Type II thrie beam guard railing.

Posts for thrie beam barrier on bridges must be steel. Posts for approach barrier transitions to connect to concrete structures and posts set in steel foundation tubes at trailing end anchors must be wood. At all other locations, posts for thrie beam barrier must be wood or steel, however, only 1 type of post must be selected in any 1 continuous length of barrier.

Use wood or plastic blocks with wood and steel posts.

Plastic blocks must be listed on the Authorized Material List.

Toenailing wood blocks to wood posts is not required.

Unless otherwise specified, anchor bolts and threaded rods must comply with ASTM A 307.

Plates must comply with section 55.

If a barrier is to be installed on existing structures, anchor the posts to the deck as shown.

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.

Mortar under base plates must comply with section 83-1.02.

Drilling of anchor bolt holes and bonding of bolts must comply with section 51-1.03E(3).

If the spacing between the posts must be varied from the standard spacing, you may modify the metal railing at the job site, if authorized. Repair damaged galvanizing under section 75-1.05.

Install terminal sections and return caps under the manufacturer's instruction.

83-2.02B(1) Minor Concrete Vegetation Control

Minor concrete vegetation control must comply with section 83-1.02B(1).

83-2.02B(2) Transition Railing

Types STB transition railing is used to connect concrete barrier or railing to single thrie beam barrier.

Types DTB transition railing is used to connect concrete barrier or railing to double thrie beam barrier.

Ten-gage metal elements must comply with AASHTO M 180 for Class B, Type I thrie beam element, except within 0.5 miles of the coast the metal elements must comply with AASHTO M 180 for Class B, Type II thrie beam element. Other metal 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 metal elements and end caps must comply with AASHTO M 180 for Class A, Type II thrie beam element.

After constructing the transition railing, dispose of surplus excavated material uniformly along the adjacent roadway, except as specified in section 14-11.

83-2.02C Reserved

83-2.02D Concrete Barrier

83-2.02D(1) General

Concrete barrier must comply with sections 51 and 52.

If a gap is left in the concrete barrier for equipment or special drainage features during construction on highways open to traffic, close the gap by temporary or permanent means when work is not actively in progress at the location of the gap.

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.

The top and exposed faces of the barrier must comply with the following requirements when tested with a 10-foot straightedge laid on the surfaces:

1. For Type 50 and 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 50 and 60 series, both the top and faces must not vary more than 0.02 foot from the edge of the straightedge.

If a concrete barrier is to be constructed on a recently completed bridge, adjust the height of the barrier to allow for the camber and dead load deflection of the superstructure. The amount of adjustment will be ordered before the concrete is placed. Place the barrier after the falsework has been released and as long after the superstructure construction as the progress of the work will allow, unless otherwise ordered.

If a concrete barrier is to be constructed on existing pavement or an existing structure, adjust the height of the barrier to allow for irregularities in the existing grade. The amount of adjustment will be ordered before the concrete is placed.

If a concrete barrier is to be constructed on an existing structure, bond the dowels in drilled holes in the existing concrete. Drilling of the holes and bonding of the dowels must comply with section 51.

If a concrete barrier is to be constructed to the face of an existing concrete structure, match the existing weep holes.

Locate expansion joints in the barrier at deck, pavement, and principal wall joints. Expansion joint filler material must be the same size as the joint or 1/2 inch minimum.

Cement concrete barrier markers to the barrier under the manufacturer's instruction. Match the spacing of the markers to the spacing of the raised pavement markers on the adjacent median edgeline pavement delineation.

Excavation and backfill must comply with section 19-3.

The portion of barrier below finished grade may be placed to the neat lines of the excavation.

For Type 50E, 60F, 60GE, and 60SF concrete barriers, 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
3. Be placed without compaction

At connections to structures, apply a uniform film of grease to the upper surface of the neoprene strip before placing the sheet metal.

The tubular lower railing for Type 80SW concrete barrier must comply with the specifications for tubular handrailing in section 83-1.02G(2).

Forms for Type 80 series concrete barrier railing must remain in place for a minimum of 36 hours after the concrete is placed.

If the project is in a freeze-thaw area, the barrier must comply with the following requirements:

1. Concrete must contain not less than 675 pounds of cementitious material per cubic yard.
2. Bar reinforcing steel must comply with section 52-2.02.
3. Concrete barriers on bridges or walls must be cured by the water method.

83-2.02D(2) Materials

Construct Type 50 and 60 series concrete barriers of minor concrete, except as follows:

1. Maximum size of aggregate used for extruded or slip formed concrete barrier 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 grading is used to construct extruded or slip formed concrete barrier, the concrete must contain not less than 675 pounds of cementitious material per cubic yard.

Concrete for concrete barriers other than Type 50 and 60 series must contain not less than 590 pounds of cementitious material per cubic yard.

For Type 50E, 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 be constructed of minor concrete.

Structural steel plates and hardware required to join the concrete barrier at gaps caused by foundations of overhead signs, electroliers, drainage structures, and at other locations must comply with sections 75-1.03A and 75-1.05.

Polystyrene at connections to structures and transitions to bridge columns must comply with section 51-2.01B(1).

Sheet metal, neoprene strip, and grease required at connections to structures must comply with the following:

1. Sheet metal must be commercial quality galvanized sheet steel, 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 section 51-2.04.
3. Grease must comply with Society of Automotive Engineers AS 8660. A uniform film of grease must be applied to the upper surface of the neoprene strip before placing the sheet metal.

83-2.02D(3) Construction Methods

Type 50 and Type 60 series concrete barriers must be constructed by one of the following:

1. Cast-in-place-with-fixed-forms method
2. Extrusion or slip form method
3. Combination of both methods

Concrete barriers other than Type 50 and Type 60 series must be constructed by the cast-in-place-with-fixed-forms method.

83-2.02D(3)(a) Cast-In-Place with Fixed Forms

Concrete barriers constructed by the cast-in-place-with-fixed-forms method must comply with section 51.

Precast mortar blocks must not be used to support the reinforcing steel on the traffic side of barriers.

83-2.02D(3)(b) Extrusion or Slip Form

Concrete barriers constructed by using an extrusion or slip form machine or other similar type of equipment must be of well-compacted, dense concrete, and the exposed surfaces must comply with section 51. You may be required to furnish evidence of successful operation of the extrusion or slip form machine or other equipment.

The combined aggregate grading for the minor concrete must be of grading to produce concrete of the shape and surface texture specified.

Concrete may be made with the materials continuously batched by volume and mixed in a continuous mixer under the batching and mixing requirements in ASTM C 685.

Concrete must be fed to the extrusion or slip form machine at a uniform rate. Operate the machine under enough uniform restraint to forward motion to produce a well-compacted mass of concrete free from surface pits larger than 1 inch in diameter and requiring no further finishing other than that under section 83-2.02D(4).

Concrete must be of a consistency such that after extrusion or slip forming it will maintain the shape of the barrier without support.

The grade for the top of the concrete barrier 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 gage 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 uniform depth below the predetermined finished top of the barrier grade or on existing pavement or bridge decks.

You may construct expansion joints by sawing through the barrier section to its full depth. Insertion of joint filler is not required.

If expansion joints are not constructed by sawing, construct the expansion joints under section 51.

If sawing or forming the joints is performed before the concrete has hardened, firmly support the adjacent portions of the barrier with close fitting shields.

If sawing or forming the joints is performed after the application of curing compound, treat the exposed faces of the barrier in the vicinity of the joint with curing compound after sawing or forming the joints.

If extrusion or slip forming methods of placement are used, the horizontal reinforcing bars must be placed continuously.

83-2.02D(4) Finishing

The surface finish of Type 50 and Type 60 series concrete barriers, before the application of the curing compound, must be free from surface pits larger than 1 inch in diameter and must be given a final soft brush finish with strokes parallel to the line of the barriers. Finishing with a brush application of grout is not allowed.

To facilitate finishing, remove fixed forms for CIP Type 50 and Type 60 series concrete barriers as soon as possible after the concrete has set enough to maintain the shape of the barrier without support.

Not less than 7 days after placing Type 50 and Type 60 series concrete barriers, exposed surfaces must receive a light abrasive blast finish to achieve a uniform appearance.

The final surface finish of concrete barriers other than Type 50 and Type 60 series must be Class 1 surface finish under section 51-1.03F(3). Alternative final surface finish methods must be submitted in writing and must not be used unless authorized.

83-2.02D(5) Curing

Cure exposed surfaces of concrete barriers with curing compound no. 6. The formed surfaces of the concrete barriers on bridges or walls that do not support sound walls may be cured under section 90-1.03B(5) except keep the forms in place for a minimum of 12 hours after the concrete is placed. For Type 50 and Type 60 series concrete barriers, apply curing compound by 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.

83-2.02E Crash Cushion

83-2.02E(1) General

Reserved

83-2.02E(2)–83-2.02E(6) Reserved

83-2.02F Wildlife Passage Way

Reserved

83-2.02G Reserved

83-2.03 PAYMENT

The division point for computing the length for payment of double thrie beam barrier (bridge) and double thrie beam barrier is the face of the paving notch of the bridge.

The point of measurement at 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. Where single barriers are constructed on each side of a median obstruction and the single barriers merge into a double barrier, the post with 2 blocks attached is regarded as an end post for measuring the length of single and double barrier. Transition sections are paid for as single thrie beam barrier.

Single thrie beam barrier constructed on each side of piers underneath structures or other obstructions is measured along each line of the installed barrier.

Double thrie beam barrier is measured from end post to end post along the center line of the installed barrier.

Within the pay limits of transition railing shown, drilling holes for wood posts and driving posts is included in the payment for transition railing.

Payment for drilling holes for wood posts, driving posts, backfilling the space around posts, excavating and backfilling end anchor assembly holes, and connecting thrie beam barrier to concrete surfaces is included in the payment for the barrier.

Concrete barriers, except Types 50E, 60F, 60GE, and 60SF, are measured along the top of the barrier.

Type 50E, 60F, 60GE, and 60SF concrete barriers are measured once along the centerline between the 2 walls of the barrier.

Payment for (1) bar reinforcing steel, (2) drilling and bonding dowels in structures, (3) hardware for steel plate barrier, (4) miscellaneous metal, (5) excavation, and (6) backfill, including concrete paving and granular material or concrete slab used as backfill in Type 50E, 60F, 60GE, and 60SF concrete barrier, is included in the payment for the concrete barrier.

Steel plate barrier attached to concrete barrier at overhead sign foundations, electroliers, drainage structures, and other locations shown is paid for as the type of concrete barrier to which the steel plate barrier attaches.

84 TRAFFIC STRIPES AND PAVEMENT MARKINGS

84-1 GENERAL

84-1.01 GENERAL

84-1.01A Summary

Section 84-1 includes general specifications for applying traffic stripes and pavement markings.

84-1.01B Definitions

traffic stripe: A longitudinal centerline or a longitudinal 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 a traffic line as shown.

pavement marking: A 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.

84-1.01C Quality Control and Assurance

Within 14 days of applying a traffic stripe or a pavement marking, the retroreflectivity of the traffic stripe or the pavement marking must be a minimum of 250 millicandelas per square meter per lux for white and 150 millicandelas per square meter per lux for yellow. Test the retroreflectivity under ASTM E 1710.

84-1.02 MATERIALS

Glass beads applied to paint and molten thermoplastic material must comply with State Specification 8010-004.

84-1.03 CONSTRUCTION

84-1.03A General

Establish alignment for traffic stripes and all layout for pavement markings with a device or method that will not damage the pavement or conflict with other traffic control devices.

84-1.03B Protection from Damage

Protect existing retroreflective pavement markers during work activities.

Remove any existing pavement marker that is coated or damaged by work activities and replace it with an equivalent marker on the Authorized Material List for signing and delineation materials.

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.

84-1.03C Tolerances and Appearance

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:

1. Not deviate by more than 2 inches from the lengths shown
2. Be uniform throughout the entire length of each broken traffic stripe so that a normal striping machine will be able to repeat the pattern and superimpose successive coats on the applied traffic stripe

A completed pavement marking must comply with the dimensions shown and have well-defined edges without running or deformation.

A completed thermoplastic traffic stripe or thermoplastic pavement marking must be free of runs, bubbles, craters, drag marks, stretch marks, and debris.

84-1.03D 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.

Where a new traffic stripe joins an existing traffic stripe, allow enough distance between the new and existing striping patterns to ensure continuity at the beginning and end of the transition.

84-1.03E Application of Stripes and Markings

Apply thermoplastic for a pavement marking with a stencil or a preformed marking.

Apply paint for a pavement marking with a stencil and hand 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. If permanent tape is used for a traffic stripe or a pavement marking, apply the tape under the manufacturer's instructions.

Immediately remove drips, overspray, improper markings, paint, and thermoplastic tracked by traffic using an authorized method.

Apply a traffic stripe or a pavement marking 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 glass beads application by stabbing the glass bead tank with a calibrated rod.

84-1.03F–84-1.03H RESERVED

84-1.04 PAYMENT

Traffic stripe is measured along the line of the traffic stripe without deductions for gaps in the broken traffic stripe.

Pavement marking is measured by the area covered.

84-2 THERMOPLASTIC TRAFFIC STRIPES AND PAVEMENT MARKINGS

84-2.01 GENERAL

84-2.01A Summary

Section 84-2 includes specifications for applying thermoplastic traffic stripes and pavement markings.

84-2.01B Submittals

For each batch of thermoplastic material, submit:

1. Certificate of compliance
2. METS notification letter stating that the material is authorized for use
3. MSDS

84-2.02 MATERIALS

Thermoplastic must comply with State Specification PTH-02SPRAY, PTH-02HYDRO, or PTH-02ALKYD.

Primer must comply with the thermoplastic manufacturer's recommendations. Do not thin the primer.

84-2.03 CONSTRUCTION

84-2.03A General

Apply the primer:

1. To asphaltic surfaces over 6 months old and to all concrete surfaces
2. Immediately before and concurrently with the application of the thermoplastic
3. At the manufacturer's instructed rate

Use preheaters with mixers having 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.

84-2.03B Extruded Thermoplastic

Apply extruded thermoplastic at a temperature from 400 to 425 degrees F, unless a different temperature is instructed by the manufacturer.

Apply extruded thermoplastic for a traffic stripe at a rate of at least 0.20 lb/ft of 4-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/100 sq ft.

84-2.03C Sprayable Thermoplastic

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 0.13 lb/ft of 4-inch wide solid stripe.

The applied sprayable thermoplastic material must be at least 0.040 inch thick.

84-2.04 PAYMENT

A double thermoplastic traffic stripe consisting of two 4-inch-wide yellow stripes is measured as 2 traffic stripes.

84-3 PAINTED TRAFFIC STRIPES AND PAVEMENT MARKINGS

84-3.01 GENERAL

84-3.01A Summary

Section 84-3 includes specifications for applying painted traffic stripes and pavement markings.

84-3.01B Submittals

For each batch of paint, submit:

1. Certificate of compliance
2. METS notification letter stating that the material is authorized for use
3. MSDS

84-3.02 MATERIALS

84-3.02A General

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 D 6628.

Do not thin the paint.

84-3.02B Mixing

Mix the paint by mechanical means until it is homogeneous. Thoroughly agitate the paint during its application.

84-3.02C Application Equipment

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 upon 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 gage 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 If pneumatically operated, pressure regulators and gages that are in full view of the operator
   - 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.

84-3.03 CONSTRUCTION

For existing surfaces, apply traffic stripes and pavement markings in 1 coat.

For a new surface, except 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 4-inch-wide yellow stripes of a double traffic stripe.

If the two 4-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. When the 1st coat of the centerline stripe is applied in the same direction as post miles increase, 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. When the 1st coat of the centerline stripe is applied in the same direction as post miles decrease, 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 1 gallon per 107 square feet.

Apply 2-coat paint at the approximate rate shown in the following table:

Two-Coat Paint Application Rates

Paint type	Square foot coverage per gallon	
	1st coat	2nd coat
Waterborne paint	215	215
Acetone-based paint	360	150

Apply glass beads at an approximate rate of 5 lb/gal 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 is provided with paint gages, the Engineer may measure the volume of paint using the gages instead of stabbing the paint tank with a calibrated rod.

84-3.04 PAYMENT

A double traffic stripe consisting of two 4-inch-wide yellow stripes separated by a 3-inch-wide black stripe is measured as a single traffic stripe.

84-4 TWO-COMPONENT PAINT TRAFFIC STRIPES AND PAVEMENT MARKINGS

Reserved

84-5 RECESSED THERMOPLASTIC TRAFFIC STRIPES

Reserved

85 PAVEMENT MARKERS

85-1 GENERAL

85-1.01 GENERAL

85-1.01A Summary

Section 85-1 includes general specifications for placing pavement markers.

85-1.01B Submittals

Submit a certificate of compliance for each type of pavement marker used.

85-1.01C Quality Control and Assurance

Pavement markers must be on the Authorized Material List for signing and delineation materials.

85-1.02 MATERIALS

85-1.02A General

Package pavement markers in a way that prevents damage.

Mark each package with the manufacturer's name, type, color, quantity, lot number, and date of manufacture.

Replace damaged shipments.

Protect pavement markers from moisture during shipment to the job site and when stored at the job site.

85-1.02B Nonreflective Pavement Markers

85-1.02B(1) General

Use ceramic or plastic nonreflective pavement markers.

Nonreflective pavement markers must be free from defects that affect adhesion, appearance, performance, or any combination thereof. The top, bottom, and sides of nonreflective pavement markers must be free from objectionable marks or discoloration.

The top surface of nonreflective pavement markers must be convex with a gradual change in curvature.

The bottom of nonreflective pavement markers must have areas of integrally formed protrusions or indentations. The bottom surface of the markers must not deviate more than 0.05 inch from a flat surface. The protrusion areas must have faces parallel to the bottom of the marker and must project approximately 0.04 inch from the bottom.

85-1.02B(2) Plastic

Plastic nonreflective pavement markers Types A and AY must be polypropylene or ABS plastic type.

Plastic nonreflective pavement markers must comply with the testing requirements specified in section 85-1.02B(3) for tests d, e, f, g, and i.

Do not coat plastic nonreflective pavement markers with any substance that interferes with the adhesive bond.

85-1.02B(3) Ceramic

When tested under California Test 669, properties of ceramic nonreflective pavement markers must comply with the requirements shown in the following table:

Test	Properties	Requirement
a	Bond strength	700 psi, min
b	Glaze thickness	0.007 in., min
c	Hardness	6 Moh, min
d	Luminance factor, Type A, white markers only, glazed surface	75, min
e	Yellowness index, Type A, white markers only, glazed surface	7, max
f	Color-yellow, Type AY, yellow markers only. The chromaticity coordinates must be within a color box defined in California Test 669	Pass
g	Compressive strength	1,500 lb, min
h	Water absorption	2.0%, max
i	Artificial weathering, 500 hours exposure, yellowness index	20, max

85-1.02C Retroreflective Pavement Markers

The exterior surface of a retroreflective pavement marker shell must be smooth and contain 1 or 2 retroreflective faces of the specified color.

The base of a retroreflective pavement marker must be flat, rough textured, and free from gloss and substances that could reduce the adhesive bond. The deviation of the base from a flat surface must not exceed 0.05 inch.

When tested under California Test 669, retroreflective pavement markers must comply with the requirements shown in the following 2 tables:

Property	Requirement
Bond strength[a]	500 psi, min
Compressive strength[b]	2,000 lb, min
Compressive strength, recessed markers	1,200 lb, min
Abrasion resistance, marker must meet the respective specific intensity minimum requirements after abrasion.	Pass
Water soak resistance	No delamination of the body or lens system of the marker nor loss of reflectance

The Department rejects the entire lot of markers if:
[a]1. Marker body or filler material fails before reaching 500 psi under the bond strength test
[b]2. Deformation is more than 0.125 inch at a load of less than 2,000 lb or if delamination of the shell and filler material is more than 0.125 inch regardless of the load required to break a marker

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
After 1 year field evaluation	0.30	0.15	0.08

85-1.02D Hot Melt Bituminous Adhesive

Bituminous adhesive must comply with the values shown in the following table:

Property	Test	Value
Penetration, dmm, 100 g, 5 seconds, 77 °F	ASTM D 5	10–20
Softening point, °F	ASTM D 36	200 min
Flash point, COC, °F	ASTM D 92	550 min
Filler content, percent by weight (insoluble in 1,1,1 trichloroethane)	ASTM D 2371	65–75
Brookfield thermosel viscosity, centipoise, no. 27 spindle, 20 rpm, 400 °F	ASTM D 4402	3,000–6,000

Flexible bituminous adhesive must comply with the requirements shown in the following table:

Property	Test	Requirement
Penetration, dmm, 100 g, 5 seconds, 77 °F	ASTM D 5	30 max
Softening point, °F	ASTM D 36	200 min
Ductility, in, 2 in/min, 77 °F	ASTM D 113	6 min
Ductility, in, 0.4 in/min, 39 °F	ASTM D 113	2 min
Flexibility	California Test 440	No breaks or cracks
Brookfield thermosel viscosity, centipoise, no. 27 spindle, 20 rpm, 375 °F	ASTM D 4402	2,500–6,000
Bond strength to concrete, psi	California Test 440	100 min
Bond strength to retroreflective pavement marker, psi	California Test 440	120 min

The filler material must be ASTM D 1199, Type PC, Grade III, calcium carbonate. The fineness of the filler material must comply with the gradation requirements shown in the following table:

Sieve sizes	Percentage passing
No. 100	100
No. 200	95
No. 325	75

85-1.02E Epoxy Adhesive

Epoxy adhesive must be either rapid set or standard set.

Automatic mixing equipment for the epoxy adhesive must use positive displacement pumps and must properly meter the 2 components in the specified ratio, ±5 percent by volume of either component. At the start of each day, check the ratio of the 2 components of the epoxy adhesive in the presence of the Engineer. Make the check by disconnecting the mixing heads or 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.

The voids in an undisturbed sample of cured, mixed epoxy adhesive obtained from the extrusion nozzle must not exceed 4 percent.

85-1.03 CONSTRUCTION

85-1.03A 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.

Remove undesirable material from the pavement surface, including dirt, curing compound, grease, oil, loose or unsound layers, and paint.

Regardless of the pavement age or type, clean the pavement surface by abrasive blast cleaning, except where hot melt bituminous adhesive is applied on clean, new HMA and seal coat surfaces, abrasive blast cleaning is not required.

Apply pavement markers to the pavement with bituminous adhesive, flexible bituminous adhesive, standard set epoxy, or rapid set epoxy adhesive, except:

1. Apply pavement markers in pavement recesses with flexible bituminous adhesive
2. Do not use epoxy adhesive to apply plastic nonreflective pavement markers

Comply with the manufacturer's installation instructions for the type of adhesive used.

Completely cover the pavement surface or bottom of the pavement marker with the adhesive without leaving any voids. Place the pavement marker into position and firmly apply pressure until contact is made with the pavement. Apply enough adhesive so that it protrudes around the pavement marker edges after pressing it into place.

Place retroreflective pavement markers so 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.

85-1.03B Hot Melt Bituminous Adhesive

If using hot melt bituminous adhesive, place pavement markers on new HMA or seal coat surfaces after the surface or seal coat has been open to public traffic for at least 7 days when the pavement temperature and air temperature 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 recommended solvent.

85-1.03C Epoxy Adhesive

If using epoxy adhesive, place pavement markers on new HMA or seal coat surfaces after the surface or seal coat has been open to public traffic for at least 14 days.

Place pavement markers at the pavement temperature and air temperature recommended by the epoxy adhesive manufacturer.

Apply epoxy adhesive and place pavement markers before the epoxy starts to thicken. Stop using the epoxy when it does not protrude around the pavement marker edges upon application of slight pressure.

85-1.03D Pavement Recesses

Locate pavement recesses along the line or lines of new or existing stripes.

Do not construct recesses on existing structures.

Equipment 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.

Dispose of all removed material.

85-1.04 PAYMENT

Not Used

86 ELECTRICAL SYSTEMS

86-1 GENERAL

86-1.01 SUMMARY

Section 86 includes specifications for installing, modifying, and removing electrical systems.

Comply with part 4 of the *California MUTCD*. Nothing in section 86 is to be construed as to reduce the minimum standards in this manual.

The locations of electrical system elements shown are approximate; the Engineer determines the final location.

86-1.015 DEFINITIONS

actuation: As defined in the *California MUTCD*.

channel: Discrete information path.

controller assembly: Controller unit and auxiliary equipment housed in a rainproof cabinet to control a system's operations.

controller unit: Part of the controller assembly performing the basic timing and logic functions.

detector: As defined in the *California MUTCD*.

electrolier: Complete assembly of lighting standard and luminaire.

flasher: Device to open and close signal circuits at a repetitive rate.

flashing beacon control assembly: Switches, circuit breakers, terminal blocks, flasher, wiring, and necessary electrical components all housed in a single enclosure to properly operate a beacon.

inductive loop detector: Detector capable of being actuated by inductance change caused by vehicle passing or standing over the loop.

lighting standard: Pole and mast arm supporting the luminaire.

luminaire: Assembly that houses the light source and controls the light emitted from the light source.

magnetic detector: Detector capable of being actuated by induced voltage caused by vehicle passing through the earth's magnetic field.

powder coating: A coating applied electrostatically using UV-stable polymer exterior grade powder.

pre-timed controller assembly: Operates traffic signals under a predetermined cycle length.

signal face: As defined in the *California MUTCD*.

signal head: As defined in the *California MUTCD*.

signal indication: As defined in the *California MUTCD*.

signal section: As defined in the *California MUTCD*.

signal standard: Pole and mast arm supporting 1 or more signal faces with or without a luminaire mast arm.

traffic-actuated controller assembly: Operates traffic signals under the varying demands of traffic as registered by detector actuation.

traffic phase: Signal phase as defined in the *California MUTCD*.

vehicle: As defined in the *California Vehicle Code*.

86-1.02 REGULATIONS AND CODE

Electrical equipment must comply with 1 or more of the following:

1. ANSI
2. ASTM
3. 8 CA Code of Regs § 2299 et seq.
4. EIA
5. NEMA
6. NETA
7. UL

Materials and workmanship must comply with:

1. FCC
2. ITE
3. NEC
4. NRTL
5. Public Utilities Commission, General Order No. 95, "Rules for Overhead Electrical Line Construction"
6. Public Utilities Commission, General Order No. 128, "Rules for Construction of Underground Electric Supply and Communication Systems"

86-1.03 SCHEDULE OF VALUES

Determine quantities required to complete work. Submit the quantities as part of the schedule of values.

Provide a schedule of values for each lump sum bid item.

Do not include costs for traffic control system in the schedule of values.

The schedule of values must include type, size, and installation method for:

1. Foundations
2. Standards and poles
3. Conduit
4. Pull boxes
5. Conductors and cables
6. Service equipment enclosures
7. Telephone demarcation cabinet
8. Signal heads and hardware
9. Pedestrian signal heads and hardware
10. Pedestrian push buttons
11. Loop detectors
12. Luminaires and lighting fixtures

86-1.04 EQUIPMENT LIST AND DRAWINGS

Within 15 days of Contract approval, submit for review a list of equipment and materials that you propose to install. The list must include:

1. Name of manufacturer
2. Dimensions
3. Item identification number
4. List of components

The list must be supplemented by 2 copies of data, including:

1. Schematic wiring diagrams
2. Scale drawings of cabinets showing location and spacing of shelves, terminal blocks, and equipment, including dimensions
3. Operation manual

Electrical equipment constructed as shown will not require detailed drawings and diagrams.

Furnish 3 sets of computer-generated cabinet schematic wiring diagrams.

The cabinet schematic wiring diagram must be placed in a heavy duty plastic envelope and attached to the inside of the door of each cabinet.

Prepare diagrams, plans, and drawings using graphic symbols in IEEE 315, "Graphic Symbols for Electrical and Electronic Diagrams."

86-1.05 CERTIFICATE OF COMPLIANCE

Submit a certificate of compliance for all electrical material and equipment.

86-1.06 MAINTAINING EXISTING AND TEMPORARY ELECTRICAL SYSTEMS

86-1.06A General

Keep existing electrical system or authorized temporary replacement in working order during the progress of the work. Shutdown is allowed for alteration or removal of the system. Traffic signal shutdown must be limited to normal working hours. Lighting system shutdown must not interfere with the regular lighting schedule. Notify the Engineer before performing work on the existing system.

Notify the local traffic enforcement agency before traffic signal shutdown.

If lane closures are specified, traffic signal system shutdowns must be limited to the hours allowed for lane closures.

Where an existing or temporary system is being modified and the work is not described but the Engineer considers it necessary to keep the system in working order, the work is change order work.

The Department or local agency will:

1. Continue the operation and maintenance of existing electrical facilities
2. Continue to provide electrical energy to operate existing electrical facilities
3. Repair or replace existing facilities damaged by traffic
4. Pay for electrical energy to operate existing or new facilities undergoing the functional tests specified in section 86-2.14C.

Verify location and depth of existing detectors, conduits, pull boxes, and other electrical facilities before using tools or equipment that may damage those facilities or interfere with an electrical system.

Notify the Engineer immediately if existing facility is damaged by your activities. Repair or replace damaged facility promptly. If you fail to complete the repair or replacement, promptly, the Department will repair or replace and deduct the costs.

Replace damaged detectors within 24 hours at your expense. If you fail to complete the repair within 24 hours, the Department will repair and deduct the repair costs.

If the roadway remains open to traffic while an existing lighting system is modified:

1. Keep the existing system in working order
2. Make the final connection so the modified circuit is in operation by nightfall

Keep temporary electrical installations in working order until no longer required. Remove temporary installations under section 86-7.

During traffic signal system shutdown, place W3-1, "Stop Ahead," and R1-1, "Stop," signs in each direction to direct traffic through the intersection. For 2-lane approaches, place 2 R1-1 signs.

Use a minimum size of 30 inches for the R1-1 sign.

Cover signal faces when the system is shut down overnight. Cover temporary W3-1 and R1-1 signs when the system is turned on.

86-1.06B Maintaining Existing Traffic Management System Elements During Construction

Reserved

86-1.07 SCHEDULING OF WORK

The first order of work must be to place the order for the electrical equipment. Furnish the Engineer a statement from the vendor that the order for the electrical equipment has been received and accepted by the vendor. Submit the statement as an informational submittal.

Except service installation and service equipment enclosure, do not work above ground until all materials are on hand to complete the electrical work at each location. Schedule work to allow each system to be completed and ready for operation before opening the corresponding section of the roadway to traffic.

If street lighting exists or is installed in conjunction with traffic signals, do not turn on the signals until the street lighting is energized.

Traffic signals will not be placed in operation until the roadways to be controlled are open to traffic.

Lighting and traffic signals, including flashing operation, will not be placed in operation before starting the functional test period specified in section 86-2.14.

Do not pull conductors into conduit until:

1. Pull boxes are set to grade
2. Metallic conduit is bonded and grounded

In vehicular undercrossings, soffit lights must be in operation as soon as practicable after falsework has been removed from the structure. Lighting for pedestrian structures must be in operation before opening the structure to pedestrian traffic.

If the Engineer orders soffit lights or lighting for pedestrian structures to be activated before permanent power service is available, installing and removing the temporary power service is change order work.

The initial traffic signal turn on must be made between 9:00 a.m. and 2:00 p.m. Before the initial turn on, all equipment, including pedestrian signals, pedestrian push buttons, vehicle detectors, lighting, signs, and pavement delineation must be installed and in working order. Direct louvers, visors, and signal faces to maximize visibility.

Start functional tests on any working day except Friday or the day before a holiday. Notify the Engineer 48 hours before the start of a functional test.

86-2 MATERIALS AND INSTALLATION

86-2.01 EXCAVATING AND BACKFILLING

Dispose of surplus excavated material.

Backfill under section 19-3. Backfill placed in conduit trenches outside the hinge point of slopes and not under pavement must be compacted to a minimum relative compaction of 90 percent. Compact backfill within hinge points and in areas where pavement is to be constructed to a minimum relative compaction of 95 percent.

Backfill trenches and restore sidewalk, pavement, and landscaping at 1 intersection before starting excavation at another intersection.

Unless otherwise specified in section 12, restrict closure for excavation on a street or highway to 1 lane at a time.

86-2.02 REMOVING AND REPLACING IMPROVEMENTS

Replace or reconstruct underlying material damaged by your activities. Replacement material must be of equal or better quality than the material replaced.

If a part of a square or slab of concrete sidewalk, curb, gutter, or driveway is broken or damaged, the entire square or slab must be removed and reconstructed.

Cut the outline of concrete sidewalk or driveway to be removed:

1. Using a power-driven saw
2. On a neat line

3. To a 0.17-foot minimum depth

86-2.03 FOUNDATIONS

86-2.03A 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 post, standard, and pedestal 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 for posts and standards 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 75-1.05.

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 for posts, standards, and pedestals 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 posts, poles, standards, pedestals, or cabinets until the concrete foundation has cured for at least 7 days.

The Engineer will choose either the plumbing or raking technique for posts, standards, and pedestals. 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 post, standard, and pedestal 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, an additional 1/6th of a turn.

In unpaved areas, construct a raised concrete pad in front of each controller cabinet.

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 removed.

86-2.03B 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 under section 86-2.01
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.

86-2.04 STANDARDS, POLES, STEEL PEDESTALS, AND POSTS

86-2.04A General

Except for Type 1 standards, 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 depressed or raised, 1/4 inch tall, legible, and include the following information:

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
   - 5.3. Readable after the support structure is coated and installed

Change in the mast arm configuration is allowed as long as the mounting height and stability are maintained.

Configure the mast arm as a smooth curving arm.

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

86-2.04B Steel Standards, Poles, Pedestals, and Posts

86-2.04B(1) General

Welding must comply with AWS D1.1.

Handhole reinforcement rings for standards, steel pedestals, poles, and posts must be continuous around the handholes.

Type 1 standards and steel pedestals for controller cabinets must be manufactured of one of the following:

1. At least 0.12-inch-thick galvanized steel
2. 4-inch standard weight galvanized steel pipe complying with ASTM A 53/A 53M
3. 4-inch Type 1 conduit with the top designed for post-top slip fitter

Push button posts, pedestrian barricades, and guard posts must comply with ASTM A 53.

Standards, poles, pedestals, posts, fasteners, and other ferrous materials must be galvanized under section 75-1.05.

86-2.04B(2) Bolted Connections

Anchor bolts must comply with ASTM F 1554, Grade 55 for weldable steel.

HS anchor bolts, nuts, and washers must comply with section 55-1.02A(1).

Bolts, nuts, and washers for general applications must comply with section 55-1.02A(1).

HS bolts shown to be snug tight must comply with section 55-1.02A(1) for general applications.

HS bolts, nuts, and flat washers used to connect slip base plates must comply with ASTM A 325.

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
30	150
31	200
36-20A	165

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, 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. 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 A 325 or A 449, and the mechanical requirements in ASTM A 325 after galvanizing. Coat threads of cap screws with a colored lubricant, clean and dry to the touch. Lubricant color must contrast the zinc-coating color on the cap screw such that the presence of the lubricant is visually obvious. Lubricant must be insoluble in water or the fastener components must be shipped to the job site in a sealed container.

Bolted connections attaching signal or luminaire arm to the pole must be considered slip critical. Galvanized faying surfaces of plates on luminaire arm, signal arm, and pole must be roughened by hand using a wire brush before assembly and must comply with requirements for Class C surface conditions for slip-critical connections in "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts," a specification approved by the RCSC. Paint for faying surfaces must comply with the RCSC specification for Class B coating.

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 on the arm plate to avoid interference with the cap screw heads.

The Engineer will randomly take test samples of fastener components from each production lot and submit to these test samples to METS with test reports specified in ASTM fastener specifications for QA testing and evaluation. The Engineer will determine sample sizes for each fastener component.

86-2.04B(3) Standards and Poles

Standards and poles with shaft lengths of 15 feet or longer must comply with section 55-1.02 and the following:

1. Tapered tubes must be manufactured from sheet steel of weldable grade having a minimum yield strength of 55,000 psi after manufacturing.
2. Certified test reports verifying compliance with minimum yield strength requirements must be submitted. Test report may be the mill test report for the as-received steel or 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 tensile properties of the steel to meet the specified minimum yield strength. Test data must include tensile properties of the steel after cold forming for specific heats and thicknesses.
3. If a single-ply 5/16-inch-thick pole is specified, a 2-ply pole with equivalent section modulus may be substituted.
4. Standard 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.
5. 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 steel in 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.
6. Welds must be continuous.
7. Weld metal at the transverse joints must extend to the sleeve, making the sleeve an integral part of the joint.
8. During manufacturing, longitudinal seams on vertical tubular members of cantilevered support structures must be centered on and along the side of the pole that the pole plate is located. Longitudinal seams on horizontal tubular members, including signal and luminaire arms, must be within ±45 degrees of the bottom of the arm.
9. Longitudinal seam welds in steel tubular sections may be made by the electric resistance welding process.
10. Longitudinal seam welds must have a 60 percent minimum penetration, except:
    10.1. Within 6 inches of a circumferential weld, the longitudinal seam weld must be a CJP groove weld.
    10.2. 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.
11. Exposed circumferential welds, except fillet and fatigue-resistant welds, must be ground flush with the base metal before galvanizing or painting. Ground flush is specified as -0, +0.08-inch.
12. Circumferential welds and base plate-to-pole welds may be repaired only 1 time.
13. Exposed edges of the plates that make up the base assembly must be finished smooth and exposed corners of the plates must be broken. Provide shafts with slip-fitter shaft caps.
14. Surface flatness requirements specified in ASTM A 6 apply to plates:
    14.1. In contact with concrete, grout, or washers and leveling nuts
    14.2. In HS bolted connections
    14.3. In joints, where cap screws are used to secure luminaire and signal arms
    14.4. Used for breakaway slip base assemblies
15. Standards and poles must be straight with a maximum variation of:
    15.1. 1 inch measured at the midpoint of a 30-foot to 35-foot standard
    15.2. 3/4 inch measured at the midpoint of a 17-foot to 20-foot standard

15.3. 1 inch measured 15 feet above the base plate for Type 35 and Type 36 standards

16. Do not make additional holes in structural members.
17. Standards with an outside diameter of 12 inches or less must be round. Standards with an outside diameter greater than 12 inches must be round or multisided. Multi-sided standards must be convex with a minimum of 12 sides and have a minimum bend radius of 4 inches.
18. Manufacture mast arms from material specified for the standard.
19. Manufacture the cast steel option for slip bases from material of Grade 70-40 complying with ASTM A 27/A 27M. Other comparable material may be used if authorized. The casting tolerances must comply with the Steel Founders' Society of America's recommendations for green sand molding.
20. One casting from each lot of a maximum of 50 castings must be radiographed under ASTM E 94. Castings must comply with the acceptance criteria for severity level 3 or better for the types and categories of discontinuities specified in ASTM E 186 and E 446. If the casting fails the inspection, 2 additional castings must be radiographed. If the 2 additional castings fail the inspection, the lot will be rejected.

86-2.04C Fiberglass Highway Advisory Radio Poles

Reserved

86-2.04D Aluminum Lighting Standards

Reserved

86-2.05 CONDUIT

Use conduits to run the conductors except for overhead and where conductors are run inside poles.

You may use a larger size conduit than specified as long as you use it for the entire length between outlets. Do not use reducing coupling.

New conduit must not pass through existing foundations for standards.

86-2.05A Material

Conduit and conduit fitting must be UL or NRTL listed and comply with the requirements shown in the following table:

Conduit and Conduit Fitting Requirements

Type 1	Hot-dip galvanized rigid steel conduit and conduit couplings must comply with UL 6 and ANSI C80.1. Zinc coating testing must comply with copper sulfate test requirements in UL 6. Conduit couplings for rigid steel conduit must be electrogalvanized.
Type 2	Hot-dip galvanized rigid steel conduit must comply with requirements for Type 1 conduit and be coated with PVC or polyethylene. Exterior thermoplastic coating must have a minimum thickness of 35 mils. Internal coating must have a minimum thickness of 2 mils. Coated conduit must comply with UL 6; NEMA RN 1; or NRTL PVC-001.
Type 3	Rigid nonmetallic PVC conduit must comply with UL 651. Type A extruded rigid PVC conduit and extruded rigid HDPE conduit must comply with UL 651A. Coilable, smooth-wall, continuous length HDPE conduits must comply with UL 651B. Install at underground locations only.
Type 4	Waterproof flexible metal conduit must consist of conduit with a waterproof nonmetallic sunlight-resistant jacket over an inner flexible metal core. Type 4 conduit must be UL listed for use as the grounding conductor.
Type 5	Intermediate steel conduit and conduit couplings must comply with UL 1242 and ANSI C80.6. Zinc coating testing must comply with copper sulfate test requirements in UL 1242. Conduit couplings for intermediate rigid steel conduit must be electrogalvanized. Type 5 conduit must only be used if specified.

Bonding bushings to be installed on metal conduit must be insulated and either galvanized or zinc alloy type.

Fittings for steel conduit and for watertight flexible metal conduit must be UL listed at UL 514B.

86-2.05B Use

Install Type 1 conduit on all exposed surfaces and at the following locations:

1. In concrete structures
2. Between a structure and nearest pull box

Exposed conduit installed on painted structure must be painted the same color as the structure.

Change or extend existing conduit runs using the same material. Install pull box if an underground conduit changes from the metallic type to Type 3.

Minimum trade size of conduit must be:

1. 1-1/2 inches from electrolier to adjacent pull box
2. 1 inch from pedestrian push button post to adjacent pull box
3. 2 inches from signal standard to adjacent pull box
4. 3 inches from controller cabinet to adjacent pull box
5. 2 inches from overhead sign to adjacent pull box
6. 2 inches from service equipment enclosure to adjacent pull box
7. 1-1/2 inches if unspecified

Two conduits must be installed between a controller cabinet and the adjacent pull box.

86-2.05C Installation

Whether shop or field cut, ream ends of conduit to remove burrs and rough edges. Make cuts square and true. Slip joints and running threads are not allowed for coupling conduit. If a standard coupling cannot be

used for coupling metal type conduit, use a threaded union coupling that is UL or NRTL listed. Tighten couplings for metal conduit to maintain a good electrical connection through conduit run.

Cut Type 3 conduit with tools that will not deform the conduit. Use solvent weld for connections.

Cut Type 2 conduit with pipe cutters; do not use hacksaws. Coated conduit must be threaded with standard conduit-threading dies. Tighten conduit into couplings or fittings using strap wrenches or approved groove joint pliers.

Protect shop-cut threads from corrosion under the standards shown in the following table:

Shop-Cut Thread Protection

Steel conduit and conduit couplings	ANSI C80.1
Electrical intermediate metal conduit and conduit couplings	ANSI C80.6

Paint conduits. Apply 2 coats of authorized unthinned zinc-rich primer of organic vehicle type. Do not use aerosol cans. Paint the following parts of conduits:

1. All exposed threads
2. Field-cut threads before installing conduit couplings to steel conduit
3. Damaged surfaces on metal conduit

Do not remove shop-installed conduit couplings.

Damaged Type 2 conduit or conduit coupling must be wrapped with at least 1 layer of 2-inch-wide, 20-mil-minimum-thickness PVC tape as specified in ASTM D 1000, with a minimum tape overlap of 1/2 inch. Before applying the tape, conduit or fitting must be cleaned and painted with 1 coat of rubber-resin based adhesive as recommended by the tape manufacturer. You may repair damaged spots in the thermoplastic coating by painting over with a brushing type compound supplied by the conduit manufacturer instead of the tape wrap.

The ends of Types 1, 2, or 5 conduit must be threaded and capped with standard pipe caps until wiring is started. The ends of Types 3 and 4 conduit must be capped until wiring is started. If caps are removed, replace with conduit bushings. Fit insulated bonding bushings on the end of metal conduit ending in pull box or foundation. Bell or end bushings for Type 3 conduit must be nonmetallic type.

Conduit bends, except factory bends, must have a radius of not less than 6 times the inside diameter of the conduit. If factory bends are not used, bend the conduit without crimping or flattening using the longest radius practicable. Bend conduits as shown in the following table:

Conduit-Bending Requirements

Type 1	By equipment and methods recommended by the conduit manufacturer.
Type 2	Use standard bending tool designed for use on thermoplastic coated conduit. Conduit must be free of burrs and pits.
Type 3	By equipment and methods recommended by the conduit manufacturer. Do not expose conduit to direct flame.
Type 5	By equipment and methods recommended by the conduit manufacturer.

Install pull tape in conduit that is to receive future conductors. The pull tape must be a flat woven lubricated soft fiber polyester tape with a minimum tensile strength of 1,800 lb and have printed sequential measurement markings every 3 feet. At least 2 feet of pull tape must be doubled back into the conduit at each end.

Existing underground conduit to be incorporated into a new system must be cleaned with a mandrel or cylindrical wire brush and blown out with compressed air.

Install conduit to a depth of not less than 30 inches below finished grade, except in sidewalk and curbed paved median areas, where it must be at least 18 inches below grade. You may lay conduit on existing pavement within new curbed median.

Conduit coupling must be a minimum of 6 inches from the face of the foundation.

Place a minimum of 2 inches of sand bedding in the trench before installing Type 2 or Type 3 conduit. Place a minimum of 4 inches of same material over conduit before placing additional backfill material.

Conduit runs located behind curbs may be installed in the street, within 3 feet of, and parallel with the face of the curb by the trenching in pavement method as specified in section 86-2.05C. Pull boxes must be located behind the curb or at the locations shown.

Obtain authorization before disturbing pavement. If an obstruction is encountered, obtain authorization to cut small holes in the pavement to locate or remove the obstruction. If jacking or drilling method is used, keep jacking or drilling pit 2 feet away from edge of pavement. Pavement must not be weakened or subgrade softened from excess water use.

Conduit used for drilling or jacking must be removed; install new conduit for completed work. If a hole larger than the conduit is pre-drilled and you install conduit by hand or by equipment and method recommended by the conduit manufacturer, you may install Type 2 or Type 3 conduit under the pavement.

If trenching in pavement method is specified, conduit installation under pavement that is not a freeway lane or freeway to freeway connector ramp, must comply with the following:

1. Use Type 3 conduit. Place conduit under pavement in a trench approximately 2 inches wider than the outside diameter of conduit, but not exceeding 6 inches in width. Trench depth must not exceed the greater of 12 inches or conduit trade size plus 10 inches, except that at pull boxes the trench may be hand dug to required depth. The top of the installed conduit must be a minimum of 9 inches below finished grade.
2. Trenching installation must be completed before placing final pavement layer.
3. Cut pavement to be removed with a rock cutting excavator. Minimize shatter outside the removal area.
4. Place conduit in the bottom of the trench and backfill with minor concrete. Minor concrete must contain a minimum of 590 lb of cementitious material per cubic yard. If the trench is in asphalt concrete pavement and pavement overlay is not placed, backfill the top 0.10 foot of the trench with minor HMA.
5. Backfill trenches, except for the top 0.10 foot, by the end of each day. The top 0.10 foot must be filled within 3 days after trenching.

Conduit installed beneath railroad tracks must be:

1. Type 1 or 2
2. 1-1/2-inch minimum diameter
3. Placed a minimum depth of 42 inches below the bottom of the rail.

If jacking or drilling method is used, construct jacking pit to a minimum of 13 feet from the centerline of track at the near side of jacking pit. Cover jacking pit with substantial planking if left overnight.

Conduit ending in a standard or pedestal must not extend more than 3 inches vertically above the foundation and must be sloped toward the handhole opening. Conduit entering through the side of a nonmetallic pull box must end inside the box within 2 inches of the wall and 2 inches above the bottom and be sloped toward the top of the box to facilitate pulling of conductors. Conduit entering through the bottom of a pull box must end 2 inches above the bottom and be located near the end walls to leave the major portion of the box clear. At the outlet, the conduit must enter from the direction of the run.

Underground conduit runs, including under sidewalks, that are adjacent to gasoline service stations or other underground gasoline or diesel storage, piping, or pumps and that lead to a controller cabinet, circuit breaker panel, service, or enclosure where an arc may occur during normal operations must be sealed if the conduit is within the limits specified in the NEC for Class 1, division 1. Use Type 1 or Type 2 conduit for these runs.

Conduit for future use in structures must be threaded and capped. Conduit leading to soffit, wall, or other lights or fixtures below pull box grade must be sealed and made watertight, except where conduit ends in a No. 9 or No. 9A pull box.

Support for conduit in or on a wall or bridge superstructure must comply with the following:

1. Steel hangers, steel brackets, and other fittings must comply with section 75-1.03.
2. Construct precast concrete conduit cradles using minor concrete and commercial quality welded wire fabric. 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. Bond precast concrete cradles to the structure with one of the following epoxy adhesives:
   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 pipe sleeve or form an opening for conduit through the bridge superstructure concrete. Sleeve or opening through either prestressed member or conventionally reinforced precast member must be:
   3.1. Transverse to the member.
   3.2. Through the web.
   3.3. Not more than 3 inches maximum gross opening in concrete.
4. Where conduits pass through the abutment concrete, wrap conduit with 2 layers of asphalt-felt building paper securely taped or wired in place. Fill the space around the conduit that runs through the bridge abutment wall 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 that run through the abutments after prestressing is completed.
5. Run surface-mounted conduit straight and true, horizontal or vertical on the wall, and parallel to walls on ceilings or other similar surfaces. Support conduit at a maximum of 5-foot intervals or closer where necessary to prevent vibration or unsightly deflection. The supports must include galvanized malleable iron conduit clamps and clamp backs secured with expansion anchorage devices as specified for concrete anchorage devices in section 75-1.03. Threaded studs must be galvanized and be of the largest diameter that will pass through the mounting hole in conduit clamp.
6. Where pull boxes are placed in conduit runs, the conduit must be fitted with threaded bushings and bonded.
7. Mark the location of conduit end in structure, curb, or wall with a "Y" that is a minimum of 3 inches tall, directly above conduit.

86-2.05D Expansion Fittings

Install expansion fitting where the conduit crosses an expansion joint in a structure. Each expansion fitting for metal conduit must include a copper bonding jumper having the ampacity specified in NEC.

Each expansion-deflection fitting for expansion joints of 1-1/2-inch movement rating must be watertight and include a molded neoprene sleeve, a bonding jumper, and 2 silicon bronze or zinc-plated iron hubs. Each fitting must allow a minimum of 3/4-inch expansion, contraction, and lateral deflection.

86-2.06 PULL BOXES

You may use a larger standard size pull box than that described.

86-2.06A Materials

Pull box, cover, and extension for installation in ground or sidewalk area must be precast reinforced concrete or nonconcrete material. Nonconcrete material must:

1. Be fire resistant with a burn rate no greater than 0.3 inch per minute per 0.1 inch of thickness when tested under ASTM D 635
2. Show no significant change in physical properties with exposure to weather
3. Be dense, free of voids or porosity, and gray or brown in color

Nonconcrete pull box must comply with the following:

1. Top dimensions must not exceed the bottom dimensions by more than 1 inch.
2. Extension must be of the same material as the pull box and attached to the pull box to maintain the minimum combined depths as shown.
3. Cover must not fail and must not deflect more than 1/4 inch when a vertical force of 1,500 lb is applied through a 1/2-by-3-by-6-inch steel plate to a nonconcrete cover on the pull box. Center the steel plate on the cover with its longitudinal axis coinciding with the longitudinal axis of the cover.

Nonconcrete pull boxes must be of sufficient rigidity that when a designated concentrated force is applied perpendicularly to the midpoint of one of the long sides at the top while the opposite long side is supported by a rigid surface, it must be possible to remove the cover without the use of tools. The designated concentrated force must be 150 lb for a No. 3-1/2 pull box and must be 100 lb for a No. 5 or No. 6 pull box.

If a transformer or other device must be placed in a nonmetallic pull box, include recesses for a hanger.

Secure cover, except ceiling pull box cover, with 3/8-inch hold down bolts, cap screws, or studs, washers, and brass stainless steel or other noncorroding metal nut. Stainless steel hardware must have an 18 percent chromium content and an 8 percent nickel content.

Galvanize ferrous metal parts under section 75-1.05.

Traffic pull box must be provided with steel cover and special concrete footing. Steel cover must have an embossed nonskid pattern.

Traffic pull box and cover must have a vertical proof-load strength of 25,000 lb. Comply with Federal Specification RR-F-621 and distribute the 25,000 lb load through a 9-by-9-by-2-inch steel plate. You must be able to place the load anywhere on the box and cover for 1 minute without causing cracks or permanent deformations.

No. 3-1/2(T) and No. 5(T) traffic pull box must be reinforced with a galvanized Z bar welded frame and cover similar to that shown for No. 6(T) pull box. Frame must be anchored to the box with 1/4 by 2-1/4 inch concrete anchors. Four concrete anchors must be included for No. 3-1/2(T) pull box; one placed in each corner. Six concrete anchors must be included for No. 5(T) and No. 6(T) pull boxes; one placed in each corner and one near the middle of each of the longer sides.

Hold down screws must be 3/8-inch hex flange cap screws of Type 316 stainless steel. Nut must be zinc-plated carbon steel, vibration resistant, and have a wedge ramp at the root of the thread. Nut must be spot welded to the underside or fabricated with galvanized Z-bar pull box frame.

Steel cover must be countersunk approximately 1/4 inch to accommodate the bolt head. When tightened, the bolt head must not exceed more than 1/8 inch above the top of the cover. A 1/4-inch tapped hole and brass bonding screw must be included.

Concrete placed around and under traffic pull boxes must be minor concrete.

86-2.06B Cover Marking

Marking must be clearly defined, uniform in depth, and parallel to either the long or short sides of the cover.

Marking letters must be between 1 to 3 inches high.

Before galvanizing steel or cast iron cover, apply marking by one of the following methods:

1. Use cast iron strip at least 1/4 inch thick with letters raised a minimum of 1/16 inch. Fasten strip to cover with 1/4-inch flathead stainless steel machine bolts and nuts. Peen bolts after tightening.
2. Use sheet steel strip at least 0.027 inch thick with letters raised a minimum of 1/16 inch. Fasten strip to 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 bolts after tightening.
3. Bead weld the letters on cover such that the letters are raised a minimum of 3/32 inch.

86-2.06C Installation and Use

Space pull boxes no more than 200 feet apart. You may install additional pull boxes to facilitate the work.

Pull box in ground or sidewalk area must be installed as follows:

1. Embed bottom of the pull box in crushed rock.
2. Place a layer of roofing paper on the crushed rock.
3. Place grout over the layer of roofing paper. Grout must be 0.50 to 1 inch thick and be sloped toward the drain hole.
4. Make a 1-inch drain hole in the center of the pull box through the grout and roofing paper.

5. Place grout between the pull box and the pull box extension, and around conduits.

Reconstruct the sump of an existing pull box if disturbed by your activities. Remove old grout and replace with new if the sump was grouted.

After installation of traffic pull box, install the steel cover and keep it bolted down when your activities are not in progress at the pull box. When the steel cover is placed for the final time, the cover and Z bar frame must be cleaned of debris and tightened securely.

86-2.07 RESERVED

86-2.08 CONDUCTORS AND CABLES

86-2.08A General

Conductor must be copper wire that complies with ASTM B 3 and B 8.

Wire size must comply with the requirements shown in the following table:

Wire Size Requirements

Conductor usage	Requirement
In loop detector lead-in cable	ASTM B 286
Everywhere except in loop detector lead-in cable	AWG[a]

[a]Except conductor diameter must not be less than 98 percent of specified AWG diameter.

Single conductor and cable, except detector lead-in cable, must have clear, distinctive, and permanent markings on the outer surface throughout its length. The markings must include the manufacturer's name or trademark, insulation type letter designation, conductor size, voltage, and temperature rating, and for cables, it must also include number of conductors.

86-2.08B Conductor Identification

Conductor insulation must be a solid color with a permanent stripe as specified below. The solid color must be homogeneous through the full depth of insulation. Identification stripe must be continuous throughout the length of conductor. For conductor sizes No. 2 and larger, the insulation may be black and the ends of the conductors must be taped for a minimum length of 20 inches with electrical insulating tape of the required color. Conductor identification must comply with the requirements in the following table:

Conductor Identification

Circuit	Signal phase or function	Identification			Size
		Insulation color[i]			
		Base	Stripe[a]	Band symbols[f]	
Vehicle signals[a, b, d]	2, 6	Red, Yel, Brn	Blk	2, 6	14
	4, 8	Red, Yel, Brn	Ora	4, 8	14
	1, 5	Red, Yel, Brn	None	1, 5	14
	3, 7	Red, Yel, Brn	Pur	3, 7	14
	Ramp meter 1	Red, Yel, Brn	None	NBR	14
	Ramp meter 2	Red, Yel, Brn	Blk	NBR	14
Pedestrian signals[d]	2p, 6p	Red, Brn	Blk	2p, 6p	14
	4p, 8p	Red, Brn	Ora	4p, 8p	14
	1p, 5p	Red, Brn	None	1p, 5p	14
	3p, 7p	Red, Brn	Pur	3p, 7p	14
Pedestrian push buttons[d]	2p, 6p	Blu	Blk	P-2, P-6	14
	4p, 8p	Blu	Ora	P-4, P-8	14
	1p, 5p	Blu	None	P-1, P-5	14
	3p, 7p	Blu	Pur	P-3, P-7	14
Traffic signal controller cabinet	Ungrounded circuit conductor	Blk	None	CON-1	6
	Grounded circuit conductor	Wht	None	CON-2	6
Highway lighting pull box to luminaire	Ungrounded-line 1	Blk	None	NBR	14
	Ungrounded-line 2	Red	None	NBR	14
	Grounded	Wht	None	NBR	14
Multiple highway lighting	Ungrounded-line 1	Blk	None	ML1	10
	Ungrounded-line 2	Red	None	ML2	10
Lighting control	Ungrounded to PEU	Blk	None	C1	14
	Switching leg from PEU unit or SM transformer	Red	None	C2	14
Service	Ungrounded-line 1 (signals)	Blk	None	NBR[e]	6
	Ungrounded-line 2 (lighting)	Red[h]	None	NBR[e]	8
Sign lighting	Ungrounded-line 1	Blk	None	SL-1	10
	Ungrounded-line 2	Red	None	SL-2	10
Flashing beacons[g]	Ungrounded between flasher and beacons	Red or Yel	None	F-Loc.[c]	14
Grounded and common	Pedestrian push buttons	Wht	Blk	NBR	14
	Signals and multiple lighting	Wht	None	NBR	10
	Flashing beacons and sign lighting	Wht	None	NBR	12
	Lighting control	Wht	None	C-3	14
	Service	Wht	None	NBR	14
Railroad preemption		Blk	None	R	14
Spares		Blk	None	NBR	14

NBR = No band required PEU=Photoelectric unit
[a]On overlaps, insulation is striped for 1st phase in 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.
[d]These requirements do not apply to signal cable.
[e]"S" if circuit is switched on line side of service equipment by utility.
[f]Band conductors in each pull box and near ends of termination points. On signal light circuits, a single band may be placed around 2 or 3 ungrounded conductors comprising a phase.
[g]Ungrounded conductors between service switch and flasher mechanism must be black and banded.
[h]Black acceptable for size No. 2 and larger. Tape ends for 20 inches with indicated color.
[i]Color Code: Yel-Yellow, Brn-Brown, Blu-Blue, Blk-Black, Wht-White, Ora-Orange, Pur-Purple.

86-2.08C Circuit Conductors

Circuit conductors must be UL or NRTL listed and rated for 600 V(ac) operation. Insulation for No. 14 to No. 4 conductors must be one of the following:

1. Type TW PVC as specified in ASTM D 2219
2. Type THW PVC
3. Type USE, RHH, or RHW cross-linked polyethylene

Minimum insulation thickness for the insulation types shown must comply with the following table:

Insulation Thickness

Insulation type	Conductor size	Insulation thickness (mils)
USE, RHH, or RHW	No. 14 to No. 10	39
	No. 8 to No. 2	51
THW or TW	No. 14 to No. 10	27
	No. 8	40
	No. 6 to No. 2	54

Insulation for No. 2 and larger conductor must be one of the types listed above or Type THWN.

Conductor for wiring wall and soffit luminaire must be stranded copper with insulation rated for use at temperatures up to 125 degrees C.

86-2.08D Signal Cable

Signal cable, except for the 28-conductor type, must:

1. Not be spliced
2. Be marked in each pull box with the signal standard information it is connecting to

Signal cable must comply with the following:

1. Cable jacket must be:
   1.1. Black polyethylene with an inner polyester binder sheath
   1.2. Rated for 600 V(ac) and 75 degrees C
2. Filler material, if used, must be polyethylene material.
3. Conductor must be solid copper with Type THWN insulation as specified in section 86-2.08 and ASTM B 286. The minimum thickness of Type THWN insulation must be 12 mils for conductor sizes No. 14 to No. 12 and 16 mils for conductor size No. 10. The minimum thickness of nylon jacket must be 4 mils.

Conductor Signal Cable Requirements

Cable type[a]	Conductor quantity and type	Cable jacket thickness (mils)		Maximum nominal outside diameter (inch)	Conductor color code	Remarks
		Average	Minimum			
3CSC	3 - No. 14	44	36	0.40	blue/black, blue/orange, white/black stripe	Use for pedestrian push buttons and spare
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 - see "12CSC Color Code and Functional Connection" table	Use for vehicle signals, pedestrian signals, spares, and signal common
28CSC	27 - No. 14 1 - No. 10	80	64	0.90	No. 10 - white No. 14 - see "28CSC Color Code and Functional Connection" table	Keep signal commons in each cable separate except at the signal controller. Label each cable as "C1" or "C2" in pull box. Use "C1" for signal phases 1, 2, 3, and 4. Use "C2" for phases 5, 6, 7, and 8.

[a]Conductor signal cable description starts with the number of conductors, followed by "CSC". (e.g., a signal cable with 3 conductors is labeled "3CSC.")

12CSC Color Code and Functional Connection

Color code	Termination	Phase
Red	Vehicle signal red	2, 4, 6, or 8
Yellow	Vehicle signal yellow	2, 4, 6, or 8
Brown	Vehicle signal green	2, 4, 6, or 8
Red/black stripe	Vehicle signal red	1, 3, 5, or 7
Yellow/black stripe	Vehicle signal yellow	1, 3, 5, or 7
Brown/black stripe	Vehicle signal green	1, 3, 5, or 7
Black/red stripe	Spare, or use as required for red or DONT WALK	
Black/white stripe	Spare, or use as required for yellow	
Black	Spare, or use as required for green or WALK	
Red/white stripe	Ped signal DONT WALK	
Brown/white stripe	Ped signal WALK	

28CSC Color Code and Functional Connection

Color code	Termination	Phase
Red/black stripe	Vehicle signal red	2 or 6
Yellow/black stripe	Vehicle signal yellow	2 or 6
Brown/black stripe	Vehicle signal green	2 or 6
Red/orange stripe	Vehicle signal red	4 or 8
Yellow/orange stripe	Vehicle signal yellow	4 or 8
Brown/orange stripe	Vehicle signal green	4 or 8
Red/silver stripe	Vehicle signal red	1 or 5
Yellow/silver stripe	Vehicle signal yellow	1 or 5
Brown/silver stripe	Vehicle signal green	1 or 5
Red/purple stripe	Vehicle signal red	3 or 7
Yellow/purple stripe	Vehicle signal yellow	3 or 7
Brown/purple stripe	Vehicle signal green	3 or 7
Red/2 black stripes	Ped signal DONT WALK	2 or 6
Brown/2 black stripes	Ped signal WALK	2 or 6
Red/2 orange stripes	Ped signal DONT WALK	4 or 8
Brown/2 orange stripes	Ped signal WALK	4 or 8
Red/2 silver stripes	Overlap A, C red	OLA, OLC
Brown/2 silver stripes	Overlap A, C green	OLA, OLC
Red/2 purple stripes	Overlap B, D red	OLB, OLD
Brown/2 purple stripes	Overlap B, D green	OLB, OLD
Blue/black stripe	Ped push button	2 or 6
Blue/orange stripe	Ped push button	4 or 8
Blue/silver stripe	Overlap A, C yellow	OLA(y), OLC(y)
Blue/purple stripe	Overlap B, D yellow	OLB(y), OLD(y)
White/black stripe	Ped push button common	
Black/red stripe	Railroad preemption	
Black	Spare	

86-2.08E Signal Interconnect Cable (SIC)

Signal interconnect cable must be a 3-pair or 6-pair type with stranded tinned copper No. 20 conductors. Each conductor insulation must be 13 mils minimum nominal thickness, color-coded, polypropylene material. Conductors must be in twisted pairs. Color coding distinguishes each pair. Each pair must be wrapped with an aluminum polyester shield and must have a No. 22 or larger stranded tinned copper drain wire inside the shielded pair.

Cable jacket must be black, HDPE, rated for a minimum of 300 V(ac) and 60 degrees C, and must have a minimum nominal wall thickness of 40 mils. Cable jacket or moisture-resistant tape directly under the outer jacket must be marked as specified in section 86-2.08.

You must have a minimum of 6 feet of slack at each controller cabinet. Splicing is allowed only if shown.

Insulate conductor splice with heat-shrink tubing and overlap at least 0.6 inch. Cover overall cable splice with heat-shrink tubing and overlap the cable jacket at least 1-1/2 inch.

86-2.09 WIRING

Solder conductors by hot iron, pouring, or dipping method, connectors and terminal lugs for conductor sizes No. 8 and smaller. Do not perform open-flame soldering.

86-2.09A Circuitry

Do not run traffic signal indication conductors to a terminal block on a standard unless connected to a mounted signal head.

Use only 1 conductor to connect to each terminal of a pedestrian push button.

The common for pedestrian push button circuit must be separate from the traffic signal circuit grounded conductor.

86-2.09B Installation

Use a UL- or NRTL-listed inert lubricant for placing conductors in conduit.

Pull conductors into conduit by hand, using pull tape specified in section 86-2.05C. Do not use winches or other power-actuated pulling equipment.

If adding new conductors or removing existing conductors, remove all conductors, clean the conduit under section 86-2.05C, and pull all conductors in the conduit as 1 unit.

If traffic signal conductors are run in a lighting standard containing street lighting conductors from a different service point, you must encase the traffic signal conductors or the lighting conductors with a flexible or rigid metal conduit for a length until the 2 types of conductors are no longer in the same raceway.

If less than 10 feet above grade, enclose temporary conductors in flexible or rigid metal conduit.

Leave slack for each conductor as 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

After conductors are installed, seal ends of conduits with an authorized sealing compound.

To form a watertight seal, tape the ends of spare conductors and conductors ending in pull boxes.

Conductors and cables inside a fixture or cabinet must be neatly arranged and tied together by function with self-clinching nylon cable ties or enclosed in a plastic tubing or raceway.

Identify conductors for signal overlap phase as specified for vehicle signals in the table titled "Conductor Identification."

Permanently identify conductors by function. Place identification on each conductor or each group of conductors forming a signal phase at each pull box and near the end of the conductors.

Label, tag, or band conductors by mechanical methods. Identification must not move along the conductors.

86-2.09C Connectors and Terminals

Connectors and terminals must be UL- or NRTL-listed crimp type. Use a manufacturer-recommended tool for connectors and terminals to join conductors. Comply with MIL-T-7928.

Terminate stranded conductors smaller than No. 14 in crimp style terminal lugs.

86-2.09D Splicing and Terminations

Splices are allowed for:

1. Grounded conductors in a pull box.
2. Pedestrian push button conductors in a pull box.
3. Conductors in a pull box adjacent to each electrolier or luminaire.
4. Ungrounded traffic signal conductors in a pull box, if traffic signals are modified.
5. Ungrounded traffic 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.
6. Ungrounded lighting circuit conductors in a pull box, if lighting circuits are modified.

86-2.09E Splice Insulation

You may use "Heat-shrink tubing" or "Method B" to insulate splices.

Splice must function under continuous submersion in water.

Multi-conductor cable must be spliced and insulated to form a watertight joint and to prevent moisture absorption by the cable.

Low-voltage tape must be:

1. UL or NRTL listed
2. Self fusing, oil and flame-resistant, synthetic rubber
3. PVC, pressure-sensitive adhesive of 6 mils minimum thickness

Insulating pad must be a combination of an 80-mils thick electrical grade PVC laminate and a 120-mils thick butyl splicing compound with removable liner.

Heat-shrink tubing must comply with the following:

1. Be medium or heavy wall thickness, irradiated polyolefin tubing with an adhesive mastic inner wall.
2. Before contraction, minimum wall thickness must be 40 mils.
3. Comply with requirements for extruded insulated tubing at 600 V(ac) in UL Standard 468D and ANSI C119.1, and the requirements shown in the following table:

Heat-Shrink Tubing Requirements

Shrinkage ratio	33 percent, maximum, of supplied diameter when heated to 125 °C and allowed to cool to 25 °C
Dielectric strength	350 kV per inch, minimum
Resistivity	25^{13} Ω per inch, minimum
Tensile strength	2,000 psi, minimum
Operating temperature	-40 °C to 90 °C (135 °C in emergency)
Water absorption	0.5 percent, maximum

Insulate splices using "Heat-shrink tubing" by performing the following:

1. Completely cover the splice area with electrical insulating coating and allow to dry.
2. Heat as recommended by the manufacturer. Do not perform open-flame heating.
3. When heated, the inner wall must melt and fill crevices and interstices of the covered object and the outer wall must shrink to form a waterproof insulation.
4. After contraction, each end of the heat-shrink tubing or the open end of end cap of heat-shrink tubing must overlap the conductor insulation at least 1-1/2 inches.
5. If 3 or more conductors are to be enclosed in 1 splice, place mastic around each conductor before placing inside tubing. Use mastic type recommended by heat-shrink tubing manufacturer.
6. Cover entire splice with electrical insulating coating and allow to dry.

Insulate splices using "Method B" by performing the following:

1. Completely cover the splice area with electrical insulating coating and allow to dry.
2. Apply 2 layers of electrical insulating pad with a minimum thickness of 1/8 inch each layer or 2 layers of half lapped low voltage tape.
3. Apply 3 layers of half lapped polyvinyl chloride tape.
4. Cover entire splice with electrical insulating coating and allow to dry.

Use at least 2 thicknesses of electrical insulating pad. Apply pad to splice as recommended by the manufacturer.

86-2.09F Fused Splice Connectors

Install a fused disconnect splice connector in each ungrounded conductor, between the line and the ballast, in the pull box adjacent to each luminaire. Connector must be accessible in the pull box.

For 240 and 480 V(ac) circuits, each connector must simultaneously disconnect both ungrounded conductors. Connector must not have exposed metal parts except for the head of the stainless steel assembly screw. Recess the head of the stainless steel assembly screw a minimum of 1/32 inch below the top of the plastic boss that surrounds the head.

Splice connector must protect the fuse from water or weather damage. Contact between the fuse and fuseholder must be spring loaded. Splice connector terminals must be:

1. Rigidly crimped, using a tool recommended by the manufacturer of the fused splice connector, onto ungrounded conductors
2. Insulated
3. Watertight

Fuses must be standard midget ferrule type, with "Non-Time-Delay" feature, and 13/32 by 1-1/2 inches.

86-2.10 BONDING AND GROUNDING

Secure all metallic components, mechanically and electrically, to form a continuous system that is effectively grounded.

Bonding jumper must be copper wire or copper braid of the same cross sectional area as a No. 8 or larger to match the load. Equipment grounding conductors must be color coded as specified in NEC or be bare.

Attach bonding jumper to the standard as shown in the following table:

Bonding Jumper Attachment

Standard type	Requirements
Standard with handhole and traffic pull box lid cover	Use UL-listed lug and 3/16-inch diameter or larger brass or bronze bolt. Run a jumper to the conduit or bonding wire in adjacent pull box. Grounding jumper must be visible after the standard is installed and mortar pad is placed on foundation.
Standard without handhole	Use UL-listed ground clamp on each anchor bolt.
Slip base standard	Use UL-listed ground clamp on each anchor bolt or attach UL-listed lug to bottom slip base plate with 3/16-inch diameter or larger brass or bronze bolt.

Ground 1 side of the secondary circuit of step-down transformer.

Ground metal conduit, service equipment, and grounded conductor at the service point as specified by NEC and service utility, except grounding electrode conductor must be No. 6 or larger.

Equipment bonding and grounding conductors are required in conduits. Run a No. 8 minimum bare copper wire continuously in a conduit system. The bonding wire must be sized as specified in the NEC.

Ground electrode must be:

1. 1 piece
2. 10-foot minimum 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
3. Installed as specified in NEC
4. Bonded to service equipment using one of the following:
   4.1. Ground clamp
   4.2. Exothermic weld

4.3. No. 6 or larger copper conductor

On wood pole, metallic equipment mounted less than 8 feet above ground surface must be grounded.

Bond metallic conduit in nonmetallic pull box using bonding bushing or bonding jumper.

Bond metallic conduit in metal pull box using bonding bushings and bonding jumpers connected to bonding wire running in the conduit system.

86-2.11 SERVICE

86-2.11A General

Electrical service installation and materials must comply with service utility requirements.

If service equipment is to be installed on a utility-owned pole, you must furnish and install conduit, conductors, and other necessary material to complete the service installation. The service utility will decide the riser and equipment position.

Install service equipment early on to allow service utility to schedule its work before project completion.

Furnish each service with a circuit breaker that simultaneously disconnects all ungrounded service entrance conductors.

Circuit breakers must:

1. Be quick-break on either automatic or manual operation
2. Have operating mechanism that is enclosed and tripfree from operating handle on overload
3. Be trip indicating
4. Have frame size plainly marked
5. Have trip rating clearly marked on operating handle
6. Have overload tripping of breakers not influenced by ambient temperature range of -18 to 50 degrees C
7. Be internal trip type
8. Be UL or NRTL listed and comply with UL 489 or equal
9. Have minimum interrupting capacity of 10,000 A, rms, if used as service disconnect

Service equipment enclosure must be a NEMA 3R enclosure with a dead-front panel and a hasp with a 7/16-inch hole for a padlock. Enclosure must be field marked as specified in the NEC to warn qualified persons of potential electric arc flash hazards.

Service equipment enclosure, except Types II and III, must be galvanized or have a factory-applied rust-resistant prime coat and finish coat.

Types II and III service equipment enclosures must be manufactured from one of the following:

1. Galvanized sheet steel
2. Sheet steel plated with zinc or cadmium after manufacturing
3. Aluminum

Manufacture service equipment enclosure as specified in section 86-3.04A. Overlapping exterior seams and doors must comply with requirements for NEMA 3R enclosures in the NEMA Enclosure Standards.

If an alternative design is proposed for Type II or III service equipment enclosure, submit plans and shop drawings to the Engineer for authorization before manufacturing.

Except for falsework lighting and power for your activities, when you submit a written request, the Engineer will arrange:

1. With the service utility to complete service connections for permanent installations and the Department will pay all costs and fees required by the service utility. Submit request at least 15 days before service connections are required.
2. For furnishing electrical energy. Energy used before Contract completion will be charged to you, except cost of energy used for public benefit as ordered will be paid by the Department or local authorities.

Payment for furnishing and installing Department-owned or permanent service poles, service equipment, conduit, conductors, and pull boxes, including equipment, conduit, and conductors placed on utility-owned poles, is included in the payment for the of electrical work involved.

If the service point is indeterminate and is shown as "approximate location" or "service point not yet established," the labor and materials required for making the connection between the service point, when established, and the nearest pull box shown is change order work.

86-2.11B Electric Service for Irrigation

Reserved

86-2.11C Booster Pump Electrical System

Reserved

86-2.12 WOOD POLES

Wood poles must comply with the following:

1. Class 5 or larger as specified in ANSI O 5.1
2. Less than 180-degree twist in grain over the full length
3. 4-inch or less sweep
4. Beveled top
5. Placed in ground at least 6 feet
6. Length must be:
    6.1. 25 feet for service pole
    6.2. 35 feet for others

After fabrication, pressure-treat pole under section 57-2.01B(3) and AWPA U1, Use Category UC4B, Commodity Specification D.

Treat pole with waterborne wood preservative if specified.

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.

Manufacture 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.

Mount mast arm for luminaire to provide a 34-foot mounting height for a 200 W high-pressure sodium luminaire and a 40-foot mounting height for a 310 W high-pressure sodium 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.

86-2.13 LIGHTING AND SIGN ILLUMINATION CONTROL

Enclosure for the circuit breaker for lighting and sign illumination control must:

1. Be NEMA 3R
2. Be galvanized, cadmium plated, or powder coated
3. Include dead front panel and a hasp with a 7/16-inch-diameter hole for padlock

86-2.14 TESTING

86-2.14A Materials Testing

Deliver material and equipment to be tested to either the METS or a testing location as ordered.

Allow 30 days for acceptance testing from the time material or equipment is delivered to test site. You must pay for all shipping, handling, and related transportation costs associated with testing. If equipment is rejected, you must allow 30 days for retesting. Retesting period starts when corrected equipment is delivered to test site. You must pay for all retesting costs.

If equipment submitted for testing does not comply with specifications, remove the equipment within 5 business days after notification that the equipment is rejected. If equipment is not removed within that period, it may be shipped to you at your expense.

When testing is complete, you will be notified. You must pick up the equipment at the test site and deliver it to the job site.

Testing and quality control procedures for all other traffic signal controller assemblies must comply with NEMA TS Standards for Traffic Control Systems.

86-2.14B Field Testing

Before starting functional testing, perform the following tests in the presence of the Engineer:

86-2.14B(1) Continuity

Test each circuit for continuity.

86-2.14B(2) Ground

Test each circuit for grounds.

86-2.14B(3) Insulation Resistance

Perform insulation resistance test at 500 V(dc) on each circuit between the circuit and a ground. Insulation resistance must be 10 MΩ minimum on all circuits, except for inductive loop detector circuits that must have an insulation resistance value at least 100 MΩ.

86-2.14C Functional Testing

Test periods must comply with section 86-1.07.

Acceptance of new or modified traffic signal will be made only after all traffic signal circuits have been thoroughly tested.

Perform functional test to show that each part of the system functions as specified.

Functional test for each new or modified system must include at least 5 business days of continuous, satisfactory operation. If unsatisfactory performance of the system occurs, the condition must be corrected and the system retested until the 5 business days of continuous, satisfactory operation is obtained.

Except for new or modified parts of existing lighting circuit and sign illumination system, the Department or local agency will maintain the system during test period and pay the electrical energy cost. Except for electrical energy, you must pay the cost of necessary maintenance performed by the Department or local agency on new circuits or on the portions of existing circuits modified under the Contract.

Shutdown of electrical system caused by traffic, a power interruption, or unsatisfactory performance of Department-furnished materials does not constitute discontinuity of the functional test.

86-2.15 GALVANIZING

Galvanize under section 75-1.05. Cabinet material may be galvanized before fabrication as specified in ASTM A 653/653M, Coating Designation G 90.

Steel pipe standard and mast arm must be hot-dip galvanized after manufacturing and must comply with section 75-1.05. Remove spikes from galvanized surfaces.

A minimum of 10 inches of upper end of anchor bolts, anchor bars or studs, and nuts and washers must be galvanized as specified in section 75-1.05.

After galvanizing, bolt threads must accept galvanized standard nuts without requiring tools or causing removal of protective coatings.

Galvanizing existing materials in an electrical installation will not be required.

86-2.16 PAINTING

Paint electrical equipment and material and comply with the following:

1. Use paint material specified in section 91.
2. Factory or shop cleaning methods for metals are acceptable if equal to the methods specified.
3. Instead of the temperature and seasonal restrictions for painting as specified in section 59, for electrical installations, paint may be applied to equipment and materials at any time the Engineer allows.
4. Ungalvanized ferrous surface to be painted must be cleaned before applying the prime coat. Blast cleaning is not required.
5. If an authorized prime coat is applied by the manufacturer, and in good condition, the 1st primer application is not required.
6. Existing equipment to be painted in the field, including Department-furnished equipment, must be washed with a stiff bristle brush using a solution of water containing 2 tablespoons of heavy duty detergent powder per gallon. After rinsing, surface must be wire brushed with a coarse, cup-shaped, power-driven brush to remove badly bonded paint, rust, scale, corrosion, grease, or dirt. Dust or residue remaining after wire brushing must be removed before priming.
7. Do not paint galvanized metal guard post, galvanized equipment, Department-furnished controller cabinet, and wood pole for traffic signal or flashing beacon.
8. New galvanized metal surface to be painted in the field must be cleaned as specified for existing equipment before applying the prime coat. Do not wire brush new galvanized surface.
9. After erection, examine exterior surface for damaged primer, clean, and spot coat with primer.
10. Paint Types II and III steel service equipment enclosures with a polymeric or an enamel coating system matching color no. 14672, of FED-STD-595. Coating must be commercially smooth and free of flow lines, paint washout, streaks, blisters, and other defects that would impair serviceability or detract from general appearance. Coating must comply with the requirements shown in the following table:

Property	Requirements
Coating hardness	Finish must have pencil lead hardness of HB, minimum, when tested under ASTM D 3363.
Salt spray resistance	Undercutting coating system's film must not exceed 1/8 inch average, from lines scored diagonally and deep enough to expose the base metal, after 336 hours of exposure in a salt spray cabinet complying with ASTM B 117.
Adherence	Must not have coating loss when tested under California Test 645. Perform testing by applying coating to 4" x 8" x 0.024" test specimens of the same material as the cabinet, using the same application method.

11. Finish interior of metal signal visor, louver, and front face of backplates with 2 applications of lusterless black exterior grade latex paint formulated for application to properly prepared metal surface. Good condition factory finish will be acceptable.
12. Finish metal signal section, signal head mounting, brackets and fittings, outside of visor, pedestrian push button housing, pedestrian signal section and visor, and back face of back plate with 2 applications of lusterless black or dark olive green exterior grade latex paint formulated for application to properly prepared metal surface. Match color to color chip no. 68 filed at METS.
13. Prepare and finish conduit and conduit fitting above ground the same as adjacent standard or post.
14. Relocated, reset, or modified equipment previously finished under this section, except for previously-finished galvanized standard with traffic signal yellow enamel, must be given a spot finishing application on newly primed areas and 1 finishing application over the entire surface. If the signal face or mounting brackets are required to be painted under this section, all signal faces and mounting brackets on the same mounting must be repainted.
15. Small rusted or repaired areas of relocated or reset galvanized equipment must be cleaned and painted as specified in section 75-1.05 for repairing damaged galvanized surfaces.
16. Stencil equipment number neatly on the standard or adjacent structure. Obtain number from the Engineer.
17. Perform painting neatly. The Engineer reserves the right to require use of brushes if the work performed by a paint spraying machine is unsatisfactory.

86-2.17 RESERVED

86-2.18 NUMBERING ELECTRICAL EQUIPMENT

Place numbers and edge sealers on the equipment as ordered.

Wherever new numbers are to be placed on existing or relocated equipment, remove the existing numbers.

Apply reflective numbers to a clean surface. Only treat the edges of the numbers with an edge sealer.

Place 5-digit, self-adhesive equipment numbers on all electroliers, soffit lighting, sign lighting, and service pedestals as shown. On service pedestals, place the numbers on the front door.

Place numbers for illuminated signs mounted on overcrossings or for soffit luminaires on the nearest adjacent bent or abutment at approximately the same station as the sign or soffit luminaire. Where no bent or abutment exists near the sign or soffit luminaire, place the number on the underside of the structure adjacent to the sign or soffit luminaire. Arrangement of numbers must be the same as those used for electroliers.

Place the numbers for overhead sign bridges on both posts.

Numbers for wood poles must be 3-inch embossed aluminum fastened to the pole with 1-1/4-inch aluminum nails.

86-3 CONTROLLER ASSEMBLIES

86-3.01 CONTROLLER ASSEMBLIES

86-3.01A General

Model 170E and Model 2070 controller assemblies, specified as a Model 170E/2070 controller assembly, consists of a Model 170E or 2070 controller unit, a wired cabinet, and all auxiliary equipment required to control the system.

86-3.01B Department-Furnished Controller Assemblies

The Model 170E/ 2070 controller assembly, excluding anchor bolts, is Department furnished.

Construct controller cabinet foundation as shown for Model 332L and 334L cabinets, including furnishing and installing anchor bolts, install the controller cabinet on the foundation, and make field wiring connections to the terminal block in the controller cabinet.

A listing of field conductor terminations for each Department-furnished controller cabinet will be provided to you at the job site.

The Department will maintain the controller assemblies.

86-3.02 BATTERY BACKUP SYSTEM

86-3.02A General

86-3.02A(1) Summary

This work includes assembling and installing a BBS. Comply with TEES.

The Department will furnish the BBS components listed in section 6-2.03.

86-3.02A(2) Submittals

Before shipping external cabinets to the job site, submit a material list including Contract number, cabinet serial numbers, and contact information to METS.

Submit a certificate of compliance for each external cabinet and batteries.

86-3.02A(3) Quality Control and Assurance

The Department may test the external cabinets.

After complete installation, perform BBS functional testing. Test for 30 minutes of continuous, satisfactory operation with utility power turned off. Perform the test in the presence of the Engineer.

Batteries must be warranted by the manufacturer for 2 years to operate within a temperature range of -25 to +60 degrees C.

86-3.02B Materials

Batteries must:

1. Be deep cycle, sealed, prismatic, lead-calcium based, absorbed glass mat, valve-regulated lead-acid type
2. Have a 12 V voltage rating
3. Be group size 24
4. Be commercially available and stocked locally
5. Have a carrying handle
6. Be marked with a date code, maximum recharge data, and recharge cycles
7. Have 2 top-mounted threaded-stud posts that include all washers and nuts required for attaching 3/8-inch ring lugs of a Department-furnished BBS battery harness
8. Include rubber insulating protective covers for protecting the lugs, posts, and wiring: red for positive terminal and black for negative terminal
9. Be new and fully charged when furnished
10. Be free from damage or deformities

External cabinet must be one listed on the Authorized Material List.

Dimensions and details for the external cabinet, for attaching the external cabinet to the Model 332L cabinet, and for wiring the Department-furnished equipment will be available in an *Information Handout* as specified in section 2-1.06B or as shown.

The following details must comply with section 86-3.04 and TEES:

1. Door construction, including material, thickness, coating, and welds
2. Frame
3. Door seals
4. Continuous stainless steel piano hinge or 4 leaves with 2 bolts on each side of each leaf used to connect the door to the external cabinet
5. Padlock clasp or latch and lock mechanism

The external cabinet must be ventilated by using louvered vents, a filter, and a thermostatically controlled fan. Fan must be AC operated from the same line output as the Model 332L cabinet. A 2-position terminal block must be provided on the fan panel along with 10 feet of connected hookup wire.

The external cabinet surface must be anodized aluminum. Do not use anti-graffiti paint.

The external cabinet must include all bolts, washers, nuts, and cabinet-to-cabinet coupler fittings necessary for mounting it to the Model 332L cabinet.

Fasteners for the external cabinet must include:

1. Four 18-8 stainless steel hex head, fully-threaded, 3/8" – 16 x 1" cabinet mounting bolts
2. 2 washers per bolt designed for 18-8 stainless steel, 1-inch OD round, 3/8-inch flat-type bolt
3. K-lock nut per bolt consisting of 18-8 stainless steel K-lock washer and a hex-nut

External cabinet to Model 332L cabinet couplings must include a conduit for power connections between the 2 cabinets. Couplings must include:

1. 2-inch nylon-insulated steel chase nipple, T & B 1947 or equivalent
2. 2-inch sealing, steel locknut, T & B 146SL or equivalent
3. 2-inch nylon-insulated steel bushing, T & B 1227 or equivalent

86-3.02C Construction

Mount external cabinet to the right side of the Model 332L cabinet. The typical side-mounting location of the external cabinet is flush with the bottom of the Model 332L cabinet and approximately equidistant from the front and rear door edges.

86-3.02D Payment

Reserved

86-3.03 RESERVED

86-3.04 CONTROLLER CABINETS

Controller assembly models other than Model 170E/2070 must comply with section 86-3.04.

86-3.04A Cabinet Construction

Cabinet must be watertight and the top crowned 1/2 inch or slanted toward the back to prevent standing water.

Cabinet and door must be manufactured from one of the following:

1. 0.073-inch-minimum-thickness cold-rolled steel with continuously-welded exterior seams
2. 0.073-inch-minimum-thickness stainless steel with overlapping exterior seams complying with Type 4 enclosures of the NEMA Enclosure Standards
3. 0.125-inch minimum thickness aluminum with continuously-welded exterior seams

Exterior welds must be ground smooth and edges filed to a radius of at least 0.03 inch.

Cabinet manufactured from cold-rolled steel must comply with section 86-2.16 and the following:

1. Cabinet must be finished with a polymeric or an enamel coating system matching color no. 14672 of FED-STD-595.
2. Cabinet must not have a coating loss when two 4-by-8-inch test specimens of the same material and coating as the cabinet are tested. Two 9-inch diagonal scratches exposing bare metal will be made on the specimen. Soak the specimen in demineralized water for 192 hours. Tightly affix a 1-inch wide strip of masking tape to the surface and remove with one quick motion. Specimen showing evidence of blistering, softening, or peeling of paint or coating from the base metal will be rejected. Testing must comply with California Test 645, except the 180-degree bend test is not required.
3. Metal must be prepared by the 3-step, iron-phosphate conversion coating bonderizing technique.
4. Inside walls, doors, and ceiling of the housing must be the same as the outside finish.

Cabinet manufactured from stainless steel must comply with the following:

1. Use annealed or quarter-hard stainless steel specified in ASTM A 666, Type 304, Grades A or B.
2. Use the gas tungsten arc welding process with bare stainless steel welding electrodes. Electrodes must comply with AWS A5.9 for ER308/ER308H.
3. Procedures, welder, and welding operator must comply with requirements and practices recommended in AWS C5.5.
4. Ground or brush exposed exterior surfaces of stainless steel cabinet to a 25 to 50-microinch finish using iron-free abrasives or stainless steel brushes.
5. After grinding or brushing, cabinet must not show rust discoloration when:
   5.1. Exposed for 48 hours in a salt spray cabinet as specified in ASTM B 117.
   5.2. Exposed for 24 hours in a tap water spray cabinet with the water temperature between 38 and 45 degrees C.
6. After the test, cabinet showing rust discoloration anywhere on its surface will be rejected. Rejected cabinets may be cleaned, passivated, and resubmitted for testing.

Cabinet manufactured from aluminum sheet must comply with ASTM B 209 or B 209M for 5052-H32 aluminum sheet and the following:

1. Use the gas metal arc welding process with bare aluminum welding electrodes. Electrodes must comply with AWS A5.10 Class ER5356.
2. Procedures, welder, and welding operator for welding must comply with the requirements in AWS B3.0, "Welding Procedure and Performance Qualification," and to practices recommended in AWS C5.6.
3. Surface finish of each aluminum cabinet must comply with MIL-A-8625 for a Type II, Class I coating except anodic coating must have a minimum thickness of 0.0007 inch and a minimum coating weight of 0.001 ounce per square inch. The anodic coating must be sealed in a 5 percent aqueous solution

of nickel acetate, pH 5.0 to 6.5, for 15 minutes at 97 degrees C. Before applying anodic coating, clean and etch cabinets using the steps below:

3.1. Clean by immersing into an inhibited alkaline cleaner such as Oakite 61A, Diversey 909, or equal, at 71 degrees C for 5 minutes. Use 6 to 8 ounces of cleaner per gallon of distilled water.
3.2. Rinse in cold water.
3.3. Etch in a solution of 1-1/2 ounce of sodium fluoride and 4 to 6 ounces of sodium hydroxide per gallon of distilled water at 60 to 65 degrees C for 5 minutes.
3.4. Rinse in cold water.
3.5. Immerse in 50 percent by volume nitric acid solution at room temperature for 2 minutes.
3.6. Rinse in cold water.

Cabinet must have:

1. Single front door with:
   1.1. 44-inch maximum door width.
   1.2. Lock, when closed and latched, is locked.
   1.3. Police panel mounted on the door, equipped with a keyed lock and 2 police keys. Each police key must have a shaft at least 1-3/4 inch in length.
2. Dust-tight gasketing on all door openings, permanently bonded to the metal. Mating surface of the gasketing must be covered with silicone lubricant to prevent sticking.
3. Handle that:
   3.1. Allows padlocking in closed position
   3.2. Has a minimum length of 7 inches
   3.3. Has a 5/8-inch, minimum, steel shank
   3.4. Is manufactured of cast aluminum or zinc- or cadmium-plated steel
4. Cabinet door frame with:
   4.1. Latching mechanism that:
      4.1.1. Holds tension on and forms a firm seal between the door gasketing and frame.
      4.1.2. Is a 3-point cabinet latch with nylon rollers that have a minimum diameter of 3/4 inch and equipped with ball bearings.
      4.1.3. Has a center catch and a pushrod made of zinc- or cadmium-plated steel. Pushrod must be at least 1/4 by 3/4 inch and turned edgewise at the outer supports. Cadmium plating must comply with MIL-QQ-416. Zinc plating must comply with MIL-QQ-325.
   4.2. Hinging that:
      4.2.1. Has 3-bolt butt hinges, each having a stainless steel fixed pin. Hinges must be stainless steel or may be aluminum for an aluminum cabinet.
      4.2.2. Is bolted or welded to the cabinet. Hinge pins and bolts must not be accessible when the door is closed.
      4.2.3. Has a catch to hold the door open at 90 and 180 degrees, ± 10 degrees, if a door is larger than 22 inches in width or 6 square feet in area. Catch must be at least a 3/8-inch-diameter, stainless-steel-plated rod capable of holding the door open at 90 degrees in a 60 mph wind at an angle perpendicular to the plane of the door.
5. Lock that:
   5.1. Is solid brass, 6-pin tumbler, rim type
   5.2. Has rectangular, spring-loaded bolts
   5.3. Is left hand and rigidly mounted with stainless steel machine screws approximately 2 inches apart
   5.4. Extends 1/8 to 3/8 inch beyond the outside surface of door
6. 2 keys removable in the locked and unlocked positions.

Submit alternative design details for review and approval before manufacturing a cabinet.

Use metal shelves or brackets that will support controller unit and auxiliary equipment.

Machine screws and bolts must not protrude outside the cabinet wall.

86-3.04B Cabinet Ventilation

Each controller cabinet must have:

1. 8 screened, 1/2 inch diameter or larger, raintight vent holes in the lower side or bottom of the cabinet. You may use louvered vents with a permanent metal mesh or a 4-ply woven polypropylene air filter held firmly in place, instead.
2. Electric fan with ball or roller bearings and a capacity of at least 100 cubic feet per minute. Fan must be thermostatically controlled and manually adjustable to turn on between 32 and 65 degrees C with a differential of not more than 6 degrees C between automatic turn on and turn off. The fan circuit must be fused at 125 percent of the ampacity of the installed fan motor.

Fan and cabinet vent holes must be positioned to direct the bulk of the airflow over the controller unit or through the ventilating holes of the controller unit.

86-3.04C Cabinet Wiring

Conductors used in the controller cabinet wiring must:

1. Be neatly arranged and laced or enclosed in a plastic tubing or raceway.
2. End with a properly-sized captive- or spring-spade terminal or be soldered to a through-panel solder lug on the back side of the terminal block. Apply a crimp-style connector with the proper tool to prevent opening of the handle until the crimp is completed.

Controller cabinet must have an equipment-grounding bus bonded to the cabinet and is connected to the system equipment grounding conductor with a No. 8 or larger grounding conductor.

With all cabinet equipment in place and connected, the resistance between the grounded terminal bus and the equipment grounding bus must be 50 MΩ, minimum, when measured with an applied voltage of 150 V(dc).

If direct current is to be grounded, connect to equipment ground only.

Use 2 or more terminal blocks for field connection. Install field terminal within 22 inches from the front of the cabinet and orient it for screwdriver operation. Terminal must be a minimum of 5 inches above the foundation.

No more than 3 conductors per terminal are allowed. Two flat metal jumpers, straight or U shaped, may be placed under a terminal screw. At least 2 full threads of terminal screws must be fully engaged when screw is tightened. Live parts must not extend beyond the barrier.

86-3.04D Cabinet Accessories

86-3.04D(1) Labels

Include permanently printed, engraved, or silk-screened label for equipment and removable items of equipment.

Labeling must match the cabinet wiring diagram. The label for a shelf-mounted equipment must be on the shelf face below the item. The label for a wall-mounted equipment must be below the item.

86-3.04D(2) Convenience Receptacle

Mount convenience receptacle in a readily accessible location inside the cabinet.

Convenience receptacle must be a duplex, 3-prong, NEMA 5-15R grounding-type outlet that complies with UL Standard 943.

86-3.04D(3) Surge Arrestor

Surge arrestor must reduce effects of power line voltage transients and comply with the rating requirements shown in the following table:

Surge Arrestor Requirements

Recurrent peak voltage	184 V(ac)
Energy rating, maximum	20 J
Power dissipation, average	0.85 W
Peak current for pulses less than 7 µs	1,250 A

Standby current must be 1 mA or less for a 120 V(ac), 60 Hz sinusoidal input.

86-3.04D(4) Terminal Blocks

Terminal block must be rated 600 V(ac), minimum, and have a nickel-, silver-, or cadmium-plated brass-binder head-screw terminal.

Heavy duty terminal block must be rated at 20 A and have 12 positions with No. 10 by 5/16-inch nickel-plated brass-binder head screws and nickel-plated brass inserts. Each position must have 2 screw-type terminals. Terminal block must be barrier type with shorting bars in each of the 12 positions and must have integral type marking strips.

Light-duty terminal block must be 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.

86-3.04E Components

86-3.04E(1) Toggle Switches

Toggle switch must:

1. Have poles as required
2. Be rated at 200 percent of the circuit current for circuits of 10 A or less and 125 percent of the circuit current for circuits over 10 A

86-3.04E(2) Cartridge Fuses

Install cartridge fuse in panel-mounted fuseholder. Fuse type and rating must be as recommended by the fuse manufacturer for the type of load being protected.

86-3.04E(3) Circuit Breakers

Circuit breaker must comply with section 86-2.11 except the breaker must have a minimum interrupting capacity of 5,000 A, rms.

86-3.04E(4) Connectors

Connectors used for interconnecting various parts of circuits together must be designed and constructed for the application involved. Design connector to provide positive connection of all circuits and easy insertion and removal of mating contacts. Connector must be permanently keyed to prevent improper connection of circuit.

Connector, or device plugging into connector, must have positive connection to prevent a circuit from breaking due to vibration, a pull on connecting cable, or similar disruptive force.

86-4 TRAFFIC SIGNAL FACES AND FITTINGS

86-4.01 VEHICLE SIGNAL FACES

Each vehicle signal face must:

1. Be adjustable and allow for 360-degree rotation about the vertical axis
2. Comply with ITE publication ST-017B, "Vehicle Traffic Control Signal Heads"
3. Comply with California Test 604, except for arrow and "X" faces
4. Have 3 sections arranged vertically: red at top, yellow at center, and green at bottom
5. Be of the same manufacturer and material, if more than 1 is installed at an intersection, except for programmed visibility type
6. Be sealed with neoprene gasket at top opening

86-4.01A Signal Sections

Each signal section must comply with the following:

1. Maximum height must be 10-1/4 inches for an 8-inch section and 14-3/4 inches for a 12-inch section.
2. Housing must:
   2.1. Be either die-cast or permanent mold-cast aluminum, or if specified, be structural plastic.
   2.2. Comply with ITE publication ST-017B if die-cast or permanent mold-cast aluminum is used.

2.3. Have a 1-piece, hinged, square-shaped door designed to allow access for relamping without the use of tools. Door must be secured to hold the door closed during loading tests. Module or lens must be watertight and mounted in the door.

3. Hinge pins, door latching devices, and other exposed hardware must be Type 304/304L or 305 stainless steel. Interior screws and fittings must be stainless steel or steel with a corrosion resistant plating or coating.
4. Opening must be placed on the top and bottom to receive 1-1/2-inch pipe. The 8- and 12-inch sections of an individual manufacturer must be capable of joining to form a signal face in any combination. This interchangeability is not required between metal and plastic sections.
5. Gaskets must be made of a material not affected if installed in a section with metal or plastic housing that is continuously operated for 336 hours.
6. Use LED modules.

Description of structural failure and the requirements for signal sections are shown in the following table:

Signal Section Structural Failure

Signal section type	Requirements	Description of structural failure
Metal	California Test 666	Fracture within housing assembly or deflection of more than half the lens diameter of signal section during wind load test
Plastic	California Test 605	Fracture within housing assembly or deflection of more than 10 degrees in either the vertical or horizontal plane after wind load has been removed from front of signal face, or deflection of more than 6 degrees in either the vertical or horizontal plane after wind load has been removed from back of signal face

86-4.01A(1) Metal Signal Sections

Each metal signal section must have a metal visor. Metal signal faces requiring backplates must have metal backplates.

86-4.01A(2) Plastic Signal Sections

Housing must be molded in 1 piece or fabricated from 2 or more pieces and joined into a single piece. Plastic must have ultraviolet stability and be self extinguishing. Housing and door must be colored throughout and be black matching color no. 17038, 27038, or 37038 of FED-STD-595.

Each face section must be joined to 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 front and back of housing. Each screw must be a No. 10 and have a nut, flat washer, and lock washer.
2. Two machine screws, each with a nut, flat washer, and lock washer, installed through holes near the front of the housing, and a fastening through the 1-1/2-inch pipe opening. Fastening must have 2 large flat washers to distribute the load around the pipe opening and 3 carriage bolts, each with a nut and lock washer. Minimum screw size must be No. 10. Minimum carriage bolt size must be 1/4 inch.

Supporting section of each signal face supported only at the top or bottom must have reinforcement.

Reinforcement plate must be either sheet aluminum, galvanized steel, or cast aluminum. Each plate must be a minimum of 0.11 inch thick and have a hole concentric with a 1-1/2-inch pipe-mounting hole in the housing. Place reinforcement plate as shown in the following table:

Reinforcement Plate Placement

Type of reinforcement plate	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 3 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 lock washer.

If signal face is supported by a Type MAS side attachment slip fitter inserted between 2 sections, place spacers between the 2 sections. Vertical dimension of spacers must allow proper seating of serrations between the slip fitter and the 2 sections. In addition to the fastening through the large openings in the housing, the 2 sections must join with at least 2 machine screws through holes near the front of the housing and the spacers and through matching holes in a reinforcing plate installed in the housing. Machine screws must be No. 10 minimum size. Spacers must be made of the same material as the signal housing.

If reinforcing webs are used to connect the back of the housing to the top, bottom, and sides, reinforcing plates are not required.

Holes for machine screws must be either cast or drilled during signal section fabrication. Surround each hole with a 1/8-inch-minimum-width boss to allow contact between signal sections about the axis of the hole.

Each plastic signal section must have a plastic or metal visor. Plastic signal faces requiring backplates must have plastic backplates.

Serrated nylon washer must be inserted between each plastic signal section and metal mounting assembly. Each washer must be between 3/16 and 1/4 inch thick. Serrations must match those on the signal section and the mounting assembly.

86-4.01B Electrical Components

Conductors must be connected to a terminal block mounted inside, at the back of housing. Terminal block must have enough screw type terminals or NEMA type tab connectors to end all field and module or lamp conductors independently. Permanently identify terminal with field conductors attached or color code conductors to facilitate field wiring.

86-4.01C Visors

Include a removable visor with each signal section. Comply with ITE publication ST-017B. Visors are classified by lens enclosure as (1) full circle, (2) tunnel, or (3) cap type. The bottom opens for tunnel type and both, the bottom and the lower sides open for cap type. Unless specified, visors must be tunnel type.

Visor must have a downward tilt between 3 and 7 degrees with a length of:

1. 9-1/2-inch minimum for nominal 12-inch round lenses
2. 7 inch for nominal 8-inch round lenses

Metal visor must be formed from 0.050-inch minimum thickness aluminum-alloy sheet.

Plastic visor must be either formed from sheet plastic or assembled from 1 or more injection, rotational, or blow-molded plastic sections. Material must be of a black homogeneous color with lusterless finish. Sections must be joined using thermal, chemical, or ultrasonic bonding, or with aluminum rivets and washers permanently colored to match the visor.

Secure each visor to its door and prevent removal or permanent deformation when the specified wind load in California Tests 605 for plastic visors or 666 for metal visors is applied to its side for 24 hours.

If directional louvers are used, fit louvers snuggly into full-circular signal visors. Outside cylinder must be constructed of 0.030-inch nominal thickness, or thicker, sheet steel and vanes must be constructed of 0.016-inch nominal thickness, or thicker, sheet steel, or the cylinder and vanes must be constructed of 5052-H32 aluminum alloy of equal thickness.

86-4.01D Light Emitting Diode Signal Module

86-4.01D(1) General

86-4.01D(1)(a) Summary

This work includes installing LED signal module.

Use LED signal module as the light source for the following traffic signal sections:

1. 8-inch section
2. 12-inch section
3. 12-inch arrow section
4. 12-inch U-turn section
5. 12-inch bicycle section
6. 12-inch PV section
7. 12-inch lane control section

86-4.01D(1)(b) Submittals

Before shipping LED signal modules to the job site, submit the following to METS:

1. Delivery form including Contract number and contact information
2. List containing all LED signal module serial numbers anticipated for use
3. LED signal modules

86-4.01D(1)(c) Quality Control and Assurance

86-4.01D(1)(c)(i) General

Module must be one listed on the Authorized Material List for LED traffic signals.

The Department will test LED signal module shipments as specified in ANSI/ASQ Z1.4. Testing will be completed within 30 days of delivery to METS. LED signal modules tested or submitted for testing must be representative of typical production units. LEDs must be spread evenly across the module. LED arrow indication must provide the minimum initial luminous intensity listed.

LED and circular LED signal modules will be tested as specified in California Test 604. Arrow, U-turn, and bicycle LED signal modules will be tested as specified in California Test 3001. All parameters of the specification may be tested on the modules. Measurements will be performed at the rated operating voltage of 120 V(ac).

Delays resulting from submittal of noncompliant materials do not relieve you from executing the Contract within the allotted time. Noncompliant materials will be rejected. Resubmit new LED for retesting and pick up the failed units within 7 days of notification. Provide new LED signal modules and allow a minimum of 30 days for retesting.

After testing, pick up the tested LED signal modules from METS and deliver to the job site.

86-4.01D(1)(c)(ii) Reserved

86-4.01D(2) Materials

86-4.01D(2)(a) General

LED signal module must:

1. Have an operational lifecycle rating of 48 months. During the operational lifecycle, LED signal module must comply with all parameters of this specification.
2. Be a single, self-contained device, designed to be sealed in the door frame of a standard traffic signal housing and comply with ITE publication, Equipment and Material Standards, chapter 2, "Vehicle Traffic Control Signal Heads."
3. Be 4 lb maximum weight.
4. Be from the same manufacturer.
5. Be the same model for each size and type.
6. Be sealed units with:
    - 6.1. 2 color-coded conductors for power connection, except for lane control LED signal modules use 3 color-coded conductors.
    - 6.2. Printed circuit board and power supply contained inside and complying with chapter 1, section 6 of TEES.
    - 6.3. Lens that is:
        - 6.3.1. Integral to the units.
        - 6.3.2. Convex or flat with a smooth outer surface.
        - 6.3.3. Made of UV-stabilized plastic or glass and withstands UV exposure from direct sunlight for 48 months without exhibiting evidence of deterioration.
    - 6.4. 1-piece EPDM gasket.

7. Include 3-foot-long conductors with quick disconnect terminals attached.
8. Be weather tight and connect directly to electrical wiring.
9. Be capable of optical unit replacement.
10. Have manufacturer's name, trademark, model number, serial number, lot number, month and year of manufacture, and required operating characteristics, including rated voltage, power consumption, and volt-ampere, permanently marked on the back of the module.
11. Have a symbol of the module type and color. The symbol must be an inch in diameter. The color must be written out in 0.50-inch-high letters next to the symbol.
12. Be AlInGaP technology for red and yellow indications and gallium nitride technology for green indications.
13. Be ultra bright type rated for 100,000 hours of continuous operation from -40 to +74 degrees C.

Individual LEDs must be wired so catastrophic loss or failure of 1 LED will not result in loss of more than 5 percent of the signal module light output. Failure of an individual LED in a string must not result in loss of an entire string or other indication.

No special tools for installation are allowed.

The symbol for a 12-inch U-turn section is an inverted "U" with an arrow on the left end and is 15/16 inch wide. Approximate shape and size for the U-turn face is as shown.

Approximate shape and size for the 12-inch bicycle section face is as shown.

Lane control section is a combination module with a red X and green arrow. Approximate shape and size for lane control signal face is as shown. Conductor function and color code requirements are shown in the following table:

Conductor Function and Color Code

Function	Color
Neutral	White
Red X	Red
Green arrow	Brown

Minimum power consumption for LED signal module must be 5 W.

Maximum power consumption for LED signal module must be as shown in the following table:

Power Consumption Requirements

LED signal module type	Power consumption (Watts)					
	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

Lens may be tinted or may use transparent film or materials with similar characteristics to enhance "On/Off" contrasts. Tinting or other materials to enhance "On/Off" contrast must not affect chromaticity and must be uniform across the face of the lens.

If polymeric lens is used, surface coating or chemical surface treatment must be applied for front surface abrasion resistance.

The power supply must be integral to the module.

Internal components must be adequately supported to withstand mechanical shock and vibration from high winds and other sources.

Lens and LED signal module material must comply with the ASTM specifications for that material.

Enclosures containing either the power supply or electronic components of LED signal module, except lenses, must be made of UL94VO flame-retardant material.

If a specific mounting orientation is required, the LED signal module must have prominent and permanent vertical markings for accurate indexing and orientation within the signal housing. Markings must include an up arrow, or the word "Up" or "Top."

When operating at 25 degrees C, the LED signal module must meet or exceed the illumination values shown in the following tables:

Minimum Initial Intensities for Circular Indications (cd)

	8-inch			12-inch		
Angle (v,h)	Red	Yellow	Green	Red	Yellow	Green
2.5, ±2.5	157	314	314	399	798	798
2.5, ±7.5	114	228	228	295	589	589
2.5, ±12.5	67	133	133	166	333	333
2.5, ±17.5	29	57	57	90	181	181
7.5, ±2.5	119	238	238	266	532	532
7.5, ±7.5	105	209	209	238	475	475
7.5, ±12.5	76	152	152	171	342	342
7.5, ±17.5	48	95	95	105	209	209
7.5, ±22.5	21	43	43	45	90	90
7.5, ±27.5	12	24	24	19	38	38
12.5, ±2.5	43	86	86	59	119	119
12.5, ±7.5	38	76	76	57	114	114
12.5, ±12.5	33	67	67	52	105	105
12.5, ±17.5	24	48	48	40	81	81
12.5, ±22.5	14	29	29	26	52	52
12.5, ±27.5	10	19	19	19	38	38
17.5, ±2.5	19	38	38	26	52	52
17.5, ±7.5	17	33	33	26	52	52
17.5, ±12.5	12	24	24	26	52	52
17.5, ±17.5	10	19	19	26	52	52
17.5, ±22.5	7	14	14	24	48	48
17.5, ±27.5	5	10	10	19	38	38

Minimum Luminance for [Arrows, U-turn, Bicycle, Lane Control](FL), and Programmed Visibility Indications (cd)

	Red	Yellow	Green
Arrow indication	1,605	3,210	3,210
U-turn indication	1,605	3,210	3,210
Bicycle indication	1,605	1,605	1,605
Lane control indication (X)	1,605	--	--
Lane control indication (Arrow)	--	--	1,605
PV indication at angle v=2.5, h=±2.5	91	91	91

When operating over a temperature range of -40 to +74 degrees C, the LED signal module, except yellow, must meet or exceed the following illumination values for 48 months. When operating at 25 degrees C, the yellow LED signal module must meet or exceed the following illumination values for 48 months:

Minimum Maintained Intensities for Circular Indications (cd)

	8-inch			12-inch		
Angle (v,h)	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 [Arrow, U-turn, Bicycle, Lane Control](FL), and Programmed Visibility Indications (cd)

	Red	Yellow	Green
Arrow indication	1,610	3,210	3,210
U-turn indication	1,610	3,210	3,210
Bicycle indication	1,610	1,610	1,610
Lane control indication (X)	1,610	--	--
Lane control indication (Arrow)	--	--	1,610
PV indication at angle v=2.5, h=±2.5	314	314	314

LED signal module must comply with the chromaticity requirements for 48 months when operating over a temperature range of -40 to +74 degrees C shown in the following table:

Chromaticity Standards (CIE Chart)

Red	Y: not greater than 0.308 or less than 0.998 - X
Yellow	Y: not less than 0.411 nor less than 0.995 - X nor greater than 0.452
Green	Y: not less than 0.506 - 0.519(X) nor less than 0.150 + 1.068(X) nor more than 0.730 - X

LED signal module must operate:

1. At a frequency of 60 ± 3 Hz, over a voltage range from 95 to 135 V(ac), without perceptible flicker to the unaided eye. Fluctuations of line voltage must have no visible effect on luminous intensity of the indications. Rated voltage for measurements must be 120 V(ac).

2. Compatible with currently used controller assemblies, including solid state load switches, flashers, and conflict monitors. Comply with TEES chapters 3 and 6. If a 20 mA alternating current or less is applied to the unit, the voltage read across the 2 leads must be 15 V(ac) or less.

Wiring and terminal block must comply with section 13.02 of ITE publication, Equipment and Material Standards, chapter 2, "Vehicle Traffic Control Signal Heads." Electrical connection for each Type 1 LED signal module must be 2 secured, color-coded, 3-foot-long, 600 V(ac), 20 AWG minimum stranded jacketed copper wires. Wires must comply with NEC, rated for service at +105 degrees C. Three wires must be used for lane control LED signal module.

LED signal module on-board circuitry must:

1. Include voltage surge protection to withstand high-repetition noise transients. The voltage surge protection must comply with NEMA Standard TS2, section 2.1.6.
2. Comply with FCC, title 47, subpart B, section 15 regulations for Class A emission limits for electronic noise.

LED signal module must provide a power factor of 0.90 or greater.

Total harmonic distortion from current and voltage induced into an alternating current power line by LED signal module must not exceed 20 percent at an operating temperature of 25 degrees C.

When power is applied to LED signal module, light emission must occur within 90 ms.

86-4.01D(2)(b) Red and Yellow Flashing Light Emitting Diode Signal Module

No external circuitry to flash the LED signal module is allowed. Use 12 V(dc) or 120 V(ac).

Flashing LED signal module circuitry must prevent perceptible light emission to the unaided eye when a voltage, 50 V(ac) or less for alternating current or 5 V(dc) for 12 V(dc) flasher units is applied to the unit.

Electrical connection for each flashing LED signal module must be 4 secured, color-coded, 600 V(ac), 20 AWG minimum-stranded jacketed copper wires. Wire must comply with NEC, rated for service at +105 degrees C. Conductors for flashing LED signal module must be 3 feet in length with quick disconnect terminals attached. The color code must comply with the requirements in the following table:

Color Code Requirements

Function	Color
Neutral/DC common	White
Steady on	Red
Flash on	Brown
Flash off	Orange

Flashing LED signal module must include all necessary electronics to:

1. Operate in a "steady on" mode
2. Perform, in "flash on" mode, 50 to 60 flashes per minute with a 50 ± 5 percent duty cycle
3. Allow alternating flashing operation, wig wag, if the "steady on" input of another flashing LED signal module is connected

When power is applied to the "flash on" control conductor, the control output must allow a 12 V(dc) or 120 V(ac) signal that is switched opposite of the flash state of the module. Output must be able to the source a maximum of 2.5 A for 12 V(dc) or 0.3 A for 120 V(ac).

Do not use the power consumption from "flash out" output of the flashing LED signal module when determining maximum power consumption.

The flashing LED signal module must be clearly marked on the back, as "DC Flasher" or "AC Flasher", in 0.50-inch letters.

86-4.01E Backplates

Background light must not be visible between the backplate and the signal face or between sections.

Plastic backplates must be either formed from sheet plastic or assembled from extruded, molded, or cast 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 backplate
3. No. 10 machine screws with washers, lock washers, and nuts, painted to match backplate

Backplate material must be of black homogeneous color with a lusterless finish. Secure each plastic backplate to the plastic signal face in a manner that prevents its removal or permanent deformation when the wind-load test is applied to either the front or back of the signal face. Permanent deformation of any portion of the backplate must not exceed 5 degrees forward or backward after wind loading is applied for 24 hours.

If plastic backplate requires field assembly, join with at least 4 No. 10 machine screws at each field-assembled joint. Each machine screw must have an integral or captive flat washer, a hexagonal head slotted for a standard screwdriver, and either a locking nut or a nut and lockwasher. 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 sections with rivets or aluminum bolts peened after assembly to avoid loosening.

Instead of the screws shown, you may use self-threading No. 10 steel screws to fasten plastic backplates to plastic signal face. Each screw must have an integral or captive flat washer, a hexagonal head slotted for a standard screwdriver, and is stainless steel or steel with a zinc or black-oxide finish.

86-4.01F Terminal Blocks

Reserved

86-4.02 PROGRAMMED VISIBILITY VEHICLE SIGNAL FACES

Programmed visibility signal face and its installation must comply with sections 86-4.01 and 86-4.04.

Each programmed visibility signal section must:

1. Have a nominal 12-inch-diameter circular or arrow indication
2. Comply with ITE publication ST-017B for color and arrow configuration
3. Have a cap visor
4. Have an adjustable connection that provides incremental tilting from 0 to 10 degrees above or below the horizontal while maintaining a common vertical axis through couplers and mountings

Terminal connection must allow external adjustment about the mounting axis in 5-degree increments.

Signal must be mountable with ordinary tools and capable of servicing without tools. Preset adjustment at 4 degrees below the horizontal.

Visibility of each programmed visibility signal face must be capable of adjustment or programming, within the face. When programmed, each signal face's indication must be visible only in those areas or lanes to be controlled except that during dusk and darkness a faint glow to each side is allowed.

A signal technician qualified to program the programmed visibility signal heads must be present when signal heads are placed in operation.

Program the head as recommended by the manufacturer.

86-4.03 PEDESTRIAN SIGNAL FACES

Message symbols for pedestrian signal faces must be white "Walking Person" and portland orange "Upraised Hand." Comply with ITE Standards: "Pedestrian Traffic Control Signal Indications" and the *California MUTCD*. Each symbol's height must be at least 10 inches and width must be at least 6-1/2 inches.

Luminance of the "Upraised Hand " symbol must be 1,100 foot-lamberts, minimum, and the luminance of the " Walking Person " symbol must be 1,550 foot-lamberts, minimum, when tested under California Test 606.

Uniformity ratio of an illuminated symbol must not exceed 4 to 1 between the highest luminance area and the lowest luminance area.

Luminance difference between a nonilluminated symbol and the background around the symbol must be less than 30 percent when viewed with the front screen in place and at a low sun angle.

Each housing, including front screen, must have maximum overall dimensions of 18-1/2 inches in width, 19 inches in height, and 11-1/2 inches in depth.

All new pedestrian signal faces installed at an intersection must be the same make and type.

86-4.03A Type A

Each Type A pedestrian signal face must include a housing, 1 LED pedestrian signal combo module, and a front screen.

86-4.03B Front Screen

Front screen installation for each Type A signal must comply with one of the following:

1. Install, tilting downward at an angle of 15 ± 2 degrees out from the top, an aluminum honeycomb screen with 0.2-inch cells, 3/8 inch thick, or a plastic screen of 3/8-inch squares, 1/2 inch thick with a wall thickness of 1/16 inch. Completely cover message plate. Include a clear front cover of 1/8-inch-minimum-thickness acrylic plastic sheet or 1/16-inch-minimum-thickness polycarbonate plastic. Hold screen and cover firmly in place with stainless steel or aluminum clips or stainless steel metal screws.
2. Install a 1-1/2-inch-deep eggcrate or Z-crate type screen of 1/32-inch-nominal-thickness polycarbonate. Mount screening in a frame constructed of 0.040-inch minimum thickness aluminum alloy or polycarbonate. Install screen parallel to the face of the message plate and hold in place with stainless steel screws. A visor is not required.

The Department will test screens in a horizontal position with its edges supported. When a 3-inch-diameter, 4-lb steel ball is dropped on the screen from a height of 4 feet above, the front screen must not fracture, separate at the welds, or compress more than 1/8 inch. When pedestrian housing is used to support the front screen during the test, remove the message plate from the pedestrian signal housing so as to prevent back support for the screen.

Screen and frame must be one of the following:

1. Aluminum anodized flat black or finished with lusterless black exterior grade latex paint formulated for application to properly prepared metal surfaces
2. Flat black plastic

86-4.03C Housing

Pedestrian signal housing must comply with section 86-4.01A.

86-4.03D Reserved

86-4.03E Finish

Paint exterior of each housing as specified in section 86-2.16.

86-4.03F Control

Pedestrian signals must be controllable by solid-state switching devices specified for traffic signal controller assemblies.

86-4.03G Terminal Blocks

Include light duty terminal block as specified in section 86-4.01B with each pedestrian signal face.

86-4.03H Reserved

86-4.03I Light Emitting Diode Pedestrian Signal Modules

86-4.03I(1) General

86-4.03I(1)(a) Summary

This work includes installing LED PSF module into standard Type A pedestrian signal housing.

86-4.03I(1)(b) Submittals

Before shipping LED PSF modules to the job site, submit the following to METS:

1. Delivery form including Contract number and contact information
2. List containing all LED PSF module serial numbers anticipated for use
3. LED PSF modules
4. Manufacturer's name, trademark, model number, lot number, and month and year of manufacture

86-4.03I(1)(c) Quality Control and Assurance

86-4.03I(1)(c)(i) General

Module must be one listed on the Authorized Material List for LED traffic signals.

The Department will test LED PSF module shipments as specified in ANSI/ASQ Z1.4. Testing will be completed within 30 days of delivery to METS. LED PSF modules tested or submitted for testing must be representative of typical production units.

LED PSF modules will be tested as specified in California Test 606. All parameters of the specification may be tested on the modules.

Delays resulting from submittal of noncompliant materials do not relieve you from executing the Contract within the allotted time. Noncompliant materials will be rejected. Resubmit new LED for retesting and pick up the failed units within 7 days of notification. Provide new LED PSF modules and allow a minimum of 30 days for retesting. You must pay for all shipping and handling costs related to testing and retesting. Delays resulting from resubmittal and retesting are your responsibility and no extra time will be allowed.

After testing, pick up the tested LED PSF modules from METS and deliver to the job site.

86-4.03I(1)(c)(ii) Reserved

86-4.03I(2) Materials

LED PSF module must:

1. Be installed in standard Type A pedestrian signal housing. Do not include reflectors.
2. Use LED as the light source.
3. Be designed to mount behind or replace the face plates of standard Type A housing as specified in ITE publication, Equipment and Material Standards, chapter 3, "Pedestrian Traffic Control Signal Indications" and the *California MUTCD*.
4. Have a minimum power consumption of 5 W.
5. Use required color and be ultra bright type rated for 100,000 hours of continuous operation from -40 to +74 degrees C.
6. Be able to replace signal lamp optical units and pedestrian signal faces with both LED and incandescent light sources.
7. Fit into pedestrian signal housings without modifications to the housing.
8. Be a single, self-contained device, not requiring on-site assembly for installation into standard Type A housing.
9. Have the following information permanently marked on the back of the module:
    9.1. Manufacturer's name
    9.2. Trademark
    9.3. Model number
    9.4. Serial number
    9.5. Lot number
    9.6. Month and year of manufacture
    9.7. Required operating characteristics, as follows:
        9.7.1. Rated voltage
        9.7.2. Power consumption
        9.7.3. Volt-ampere (VA)
        9.7.4. Power factor
10. Have prominent and permanent vertical markings for accurate indexing and orientation within the signal housing if a specific mounting orientation is required. Markings must include an up arrow, or the word "Up" or "Top." Marking must be a minimum of 1-inch diameter.

All LED PSF modules must be from the same manufacturer.

Circuit board and power supply must be contained inside the LED PSF modules. Circuit board must comply with Chapter 1, Section 6 of TEES.

Individual LEDs must be wired so catastrophic loss or failure of 1 LED will not result in a loss of more than 5 percent of the PSF module light output. Failure of an individual LED in a string must not result in the loss of an entire string or other indication.

LEDs must be evenly distributed in each indication. Do not use outline forms.

No special tools for installation are allowed.

The power supply for LED PSF module must be integral to the module. The power supply for each symbol must be isolated to avoid turn-on conflict.

Assembly and manufacturing processes for LED PSF module must assure that all internal components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.

Material used for LED PSF module must comply with ASTM D 3935.

Enclosures containing either the power supply or electronic components of LED PSF module, except lenses, must be made of UL94VO flame-retardant material.

The color of the "Upraised Hand" symbol must be portland orange.

The color of the "Walking Person" symbol must be lunar white.

Each symbol must not be less than 10 inches high and 6.5 inches wide. Symbols must comply with ITE publication, Equipment and Material Standards, chapter 3, "Pedestrian Traffic Control Signal Indications," and the *California MUTCD*.

LED PSF module must maintain an average luminance value over 48 months of continuous use in signal operation for a temperature range of -40 to +74 degrees C. In addition, LED PSF modules must meet or exceed the following luminance values upon initial testing at 25 degrees C.

The color output of LED PSF module must comply with chromaticity requirements in section 5.3 of ITE publication, Equipment and Material Standards, chapter 3, "Pedestrian Traffic Control Signal Indications."

When operating over a temperature range of -40 to +74 degrees C, the measured chromaticity coordinates of LED PSF module must comply with the following chromaticity requirements for 48 months:

Chromaticity Standards (CIE Chart)

Upraised hand	Not greater than 0.390 nor less than 0.331 nor less than 0.997 - X
Walking person	X: not less than 0.280 nor greater than 0.320 Y: not less than 1.055(X) - 0.0128 nor greater than 1.055(X) + 0.0072

LED PSF module maximum power consumption must not exceed the values shown in the following table:

Power Consumption Requirements

PSF module	Power consumption @ 24 °C	Power consumption @ 74 °C
Upraised hand	10.0 W	12.0 W
Walking person	9.0 W	12.0 W

Wiring and terminal block must comply with section 13.02 of ITE publication, Equipment and Material Standards, chapter 2, "Vehicle Traffic Control Signal Heads." The LED PSF module must be supplied with

spade lugs and 3 secured, color-coded, 3-foot-long, 600 V(ac), 20 AWG minimum stranded jacketed copper wires. Wires must comply with NEC, rated for service at +105 degrees C.

LED PSF module must operate:

1. At a frequency of 60 ± 3 Hz over a voltage range from 95 to 135 V(ac) without perceptible flicker to the unaided eye. Fluctuations of line voltage must have no visible effect on the luminous intensity of the indications. Rated voltage for measurements must be 120 V(ac).
2. Compatible with currently-used State controller assemblies including solid-state load switches, flashers, and conflict monitors. Comply with TEES chapters 3 and 6. If a 20 mA alternating current or less is applied to the unit, the voltage read across the 2 leads must be 15 V(ac) or less.

LED PSF module on-board circuitry must:

1. Include voltage surge protection to withstand high-repetition noise transients. The voltage surge protection must comply with NEMA Standard TS2, section 2.1.6.
2. Comply with FCC, title 47, subpart B, section 15 regulations for Class A emission limits for electronic noise.

LED PSF module must provide a power factor of 0.90 or greater.

Total harmonic distortion from a current and a voltage induced into an alternating current power line by an LED PSF module must not exceed 20 percent at an operating temperature of 25 degrees C.

The LED PSF module circuitry must prevent perceptible light emission to the unaided eye when a voltage 50 V(ac) or less is applied to the unit.

When power is applied to an LED PSF module, light emission must occur within 90 ms.

The "Upraised Hand" and "Walking Person" symbol indications must be electrically isolated from each other. Sharing a power supply or an interconnect circuitry between the 2 indications is not allowed.

86-4.03J Ramp Metering Sign

The "Meter On" sign must be a white message sign complying with section 86-4.03.

Lenses must be 3/16-inch-minimum-thick clear acrylic or polycarbonate plastic or 1/8-inch nominal thickness glass fiber reinforced plastic with molded 1 piece neoprene gasket. Message lettering for "Meter" must be series C, 4-1/2 inches high, with uniform 1/2-inch stroke. Lettering for "On" must be series C, 6 inches high, with uniform 1-inch stroke. Letters must be clear, transparent or translucent, with black opaque background silk screened onto the 2nd surface of the lens.

86-4.04 SIGNAL MOUNTING ASSEMBLIES

Signal mounting assembly must include:

1. 1-1/2-inch standard steel pipe or galvanized conduit
2. Pipe fitting made of ductile iron, galvanized steel, aluminum alloy Type AC-84B no. 380, or bronze
3. Mast arm and post top slip fitters and terminal compartments made of cast bronze or hot-dip galvanized ductile iron

After installation, clean and paint exposed threads of the galvanized conduit brackets and bracket areas damaged by a wrench or vise jaws. Use a wire brush to clean and apply 2 coats of authorized unthinned zinc-rich primer, organic vehicle type. Do not use aerosol can.

Fit each terminal compartment 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. Include a cover on the compartment for ready access to the terminal block. The terminal compartment used to bracket-mount signals must be bolted securely to a pole or standard.

The horizontal dimension of mounting assembly members between vertical centerline of the terminal compartment or slip fitter and the vertical centerline 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 faces.

Mounting assembly members must be plumb or level, symmetrically arranged, and securely assembled.

Mounting assembly must be watertight and free of sharp edges or protrusions that might damage conductor insulation. Include positive-locking serrated fittings that, if mated with similar fittings on signal faces, will prevent faces from rotating.

Orient each mounting assembly to allow maximum horizontal clearance to the adjacent roadway.

Use a slip fitter for post-top mounting of signals. Fit slip fitter over a 4-1/2-inch-outside-diameter pipe or tapered standard end. Include cadmium-plated steel set screws. Include an integral terminal compartment for each slip-fitter used to post-top mount signals with brackets.

For Type SV-1-T mountings with 5 sections and SV-2-TD mountings, bolt the mountings to the standard through the upper pipe fitting as shown for bolting the terminal compartment.

Do not install signal faces at an intersection until all other signal equipment, including complete controller assembly is in place and ready for operation. You may mount signal faces if covered or not directed toward traffic.

86-4.05 FLASHING BEACONS

Flashing beacon must include:

1. Single section traffic signal face with yellow or red LED module indications
2. Backplate
3. Tunnel visor
4. Flashing beacon control assembly or flashing LED signal module circuitry

Beacon flasher unit must be independent of the intersection flasher unit.

86-4.05A Flashing Beacon Control Assembly

86-4.05A(1) Enclosure

Enclosure must be:

1. NEMA 3R with a dead front panel and a hasp with a 7/16-inch hole for a padlock
2. Powder coated, hot-dip galvanized, or factory-applied rust resistant prime coat and finish coat

86-4.05A(2) Circuit Breakers and Switches

Circuit breakers must comply with section 86-2.11.

A switch for manually operating the sign lighting circuit must be a single-hole mounting toggle type with a single pole and throw and rated at 12 A, 120 V(ac). Furnish a switch with an indicating nameplate reading "Auto-Test."

86-4.05A(3) Flasher

If you use solid-state flashers, comply with the following requirements:

1. Comply with section 8 of NEMA Standards publication No. TS 1.
2. The flasher must be with no contact points or moving parts.
3. Include 2 output circuits to allow alternate flashing of the signal faces.
4. The flasher must be able to carry a minimum of 10 A per circuit at 120 V(ac).

86-4.05A(4) Wiring

Conductors and wiring in the enclosure must comply with section 86-2.09.

86-4.05A(5) Terminal Blocks

Terminal blocks must be:

1. Rated 25 A, 600 V(ac)
2. Molded phenolic or nylon material
3. Barrier type with plated-brass screw terminals and integral marking strips

86-4.05B Reserved

86-5 DETECTORS

86-5.01 VEHICLE DETECTORS

86-5.01A Inductive Loop Detectors

86-5.01A(1) General

Inductive loop detector includes a completely installed loop or group of loops, in the roadway and a lead-in cable installed and connected inside a controller cabinet.

86-5.01A(2) Sensor Unit Construction

Reserved

86-5.01A(3) Construction Materials

Conductor for each inductive loop detector must be continuous, unspliced, and one of the following:

Conductor Options for Inductive Loop Detector

Option	Specifications
Type 1 loop wire	Type RHW-USE neoprene-jacketed or Type USE cross-linked polyethylene insulated, No. 12, stranded copper wire with a 40 mils minimum thickness at any point.
Type 2 loop wire	Type THWN or Type XHHW, No. 14, stranded copper wire in a plastic tubing. Plastic tubing must be polyethylene or vinyl, rated for use at 105 °C, and resistant to oil and gasoline. Outside diameter of tubing must be 0.27 inch maximum with a wall thickness of 0.028 inch minimum.

Conductor for loop detector lead-in cable must be two no. 16, 19 by 29, stranded, tinned copper wires, comply with the calculated cross sectional area of ASTM B 286, Table 1, and be one of the following:

Conductor Options for Loop Detector Lead-In Cable

Option	Specifications
Type B lead-in cable	Insulated with 20 mils of HDPE. 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 no. 20, minimum, copper drain wire must be connected to equipment ground within cabinet. Cable must have a HDPE 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 lead-in cable	Comply with International Municipal Signal Association (IMSA) Specification No. 50-2. A No. 20, minimum, copper drain wire must be connected to equipment ground within cabinet.

Sealant for filling slots must be one of the following:

1. Elastomeric
2. Asphaltic emulsion
3. Hot-melt rubberized asphalt
4. Epoxy sealant for inductive loops

86-5.01A(3)(a) Elastomeric Sealant

Polyurethane material that will within stated shelf life cure only in the presence of moisture. Sealant must be suitable for use in both HMA and concrete pavement.

The cured sealant must have the performance characteristics shown in the following table:

Performance Characteristics of Cured Sealant

Characteristic	ASTM	Requirement
Hardness (indentation) at 25 °C and 50% relative humidity. (Type A, Model 1700 only)	D 2240 Rex.	65-85
Tensile strength: Pulled at 508 mm per minute	D 412 Die C	3.45 MPa, min
Elongation: Pulled at 508 mm per minute	D 412 Die C	400%, min
Flex at -40 °C: 0.6-mm free film bend (180°) over 13-mm mandrel	--	No cracks
Weathering resistance: Weatherometer 350 h, cured 7 days at 25 °C @ 50% relative humidity	D 822	Slight chalking
Salt spray resistance: 28 days at 38 °C with 5% NaCl, Die C & pulled at 508 mm per minute	B 117	3.45 MPa, minimum tensile 400%, minimum elongation
Dielectric constant over a temperature range of -30 °C to 50 °C	D 150	Less than 25% change

86-5.01A(3)(b) Asphaltic Emulsion Sealant

Comply with the Department's Specification 8040-41A-15. Use for filling slots in HMA pavement of a maximum of 5/8 inch in width. Do not use where the slope causes the material to run from the slot. Material must not be thinned beyond the manufacturer's instructions. Place material when the air temperature is at least 7 degrees C.

86-5.01A(3)(c) Hot-Melt Rubberized Asphalt Sealant

Hot-melt rubberized asphalt must be:

1. In solid form at room temperature and fluid at application temperature of 190 to 205 degrees C. Fumes must be nontoxic.
2. Suitable for use in both HMA and concrete pavement.
3. Melted in a jacketed, double-boiler type melting unit. Temperature of heat transfer medium must not exceed 245 degrees C.
4. Applied with a pressure feed applicator or a pour pot when the pavement surface temperature is greater than 4 degrees C.
5. Packaged in containers clearly marked "Detector Loop Sealant" and specifying manufacturer's batch and lot number.

The cured sealant must have the performance characteristics shown in the following table:

Performance Characteristics of Cured Sealant

Characteristic	ASTM	Requirement
Cone penetration, 25 °C, 150 g, 5 s	D 5329, Sec. 6	3.5 mm, max
Flow, 60 °C	D 5329, Sec. 8	5 mm, max
Resilience, 25 °C	D 5329, Sec. 12	25%, min
Softening point	D 36	82 °C, min
Ductility, 25 °C, 50 mm/min	D 113	300 mm, min
Flash point, COC, °C	D 92	288 °C, min
Viscosity, Brookfield thermosel, No. 27 Spindle, 20 rpm, 190 °C	D 150	Less than 25% change

86-5.01A(3)(d) Epoxy Sealant for Inductive Loops

Use for repair work on existing spalls, cracks, and other deformations in and around saw cuts housing inductor loops and leads. The maximum gel time of the combined components must be 30 minutes when

tested under California Test 434. The rapid cure allows minimum traffic delay when tested under California Test 434.

86-5.01A(4) Installation Details

Install loop conductors without splices and end in the nearest pull box. Seal the open end of the cable jacket or tubing similar to splicing requirements to prevent water from entering. Do not make final splices between loops and lead-in cable until loop operations under actual traffic conditions are authorized.

Splice all loop conductors for each direction of travel for the same phase of a traffic signal system, in the same pull box, to a detector lead-in cable that runs from the pull box adjacent to the loop detector to a sensor unit mounted in the controller cabinet.

End all loop conductors in a pull box or a terminal strip in the cabinet.

Identify and band conductors for inductive loop installations. Band conductors, in pairs, by lane, in the pull box adjacent to the loops and near the end of the conductors in the cabinet. Bands must comply with section 86-2.09.

If HMA surfacing is to be placed, install loop conductors before placing the uppermost layer of HMA. Install conductors in a compacted layer of HMA immediately below the uppermost layer. Install conductors as shown, except fill the slot with a sealant flush to the surface.

When cutting loops:

1. Saw cuts must be cleaned with compressed air to remove all excess moisture and debris. For repairing damaged saw cuts, all loose spalled material must be cleaned away from the saw cut, chipping back to sound asphalt concrete or concrete pavement, and cleaned away from the loop wires.
2. Residue from slot cutting activities must not be allowed to flow across shoulders or lanes occupied by traffic and must be removed from the pavement surface before residue flows off. Dispose of residue from slot cutting activities.
3. Before setting, surplus sealant must be removed from the adjacent road surface without using solvents.

86-5.01A(5) Preformed Inductive Loops

Preformed inductive loops must be the type shown.

The loop must be 6-foot square unless otherwise shown. The loop must consist of 4 turns of No. 16, or larger, wire with Type THWN or TFFN insulation.

Encase the loop wires in 3/8-inch, minimum, Schedule 40 or Schedule 80 PVC or polypropylene conduit and seal the conduit to prevent the entrance of water and the movement of wires within the conduit.

The loop wires from the preformed loop to the adjacent pull box must be twisted together into a pair, at least 2 turns per foot, and encased in Schedule 40 or Schedule 80 PVC or polypropylene conduit between the preformed loop and the adjacent pull box or detector handhole. The lead-in conduit must be sealed to prevent the entrance of water at the pull box or handhole end.

In new roadways, place the preformed loops and lead-in conduits in the base course with the top of the conduit flush with the top of the base. Cover with HMA or concrete pavement. Protect preformed loops and lead-in conduits from damage before and during pavement placement.

In new reinforced concrete structure decks, secure the preformed loops to the top of the uppermost layer of reinforcing steel using nylon wire ties. Hold the loop parallel to the structure deck by using PVC or polypropylene spacers where necessary. Place conduit for lead-in conductors between the uppermost 2 layers of reinforcing steel.

Do not install preformed inductive loops in existing structure decks.

Preformed loop installation in existing pavement must comply with the following:

1. Preformed loops and lead-in conduits must be placed in 1-1/4-inch-minimum-width slots cut into the existing pavement. The top of the conduit must be 2 inches, minimum, below the top of pavement.

2. Slots in asphalt concrete pavement must be filled with elastomeric or hot-melt rubberized asphalt sealant.
3. Slots in concrete pavement must be filled with epoxy sealant or hot melt rubberized asphalt sealant.

86-5.01B Magnetic Detectors

Cable from the pull box adjacent to the magnetic detector sensing element to the field terminals in the controller cabinet must be the type specified for inductive loop detectors.

86-5.01C Microwave Vehicle Detection System (Side Fire)

Reserved

86-5.01D Emergency Vehicle Detector System

Reserved

86-5.02 PEDESTRIAN PUSH BUTTON ASSEMBLIES

Housing must be either die-cast or permanent mold-cast aluminum. Assembly must be rainproof and shockproof in any weather condition.

The switch must be a single-pole, double-throw switching unit with screw-type terminals rated 15 A at 125 V(ac), and 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. 1/64-inch maximum pre-travel
4. 7/32-inch minimum overtravel
5. 0.0004- to 0.002-inch differential travel
6. 2-inch-minimum-diameter actuator

Wherever a pedestrian push button is attached to a pole, shape the housing to fit the pole curvature and secure. Include saddles to make a neat fit if needed.

Wherever a pedestrian push button is mounted on top of a 2-1/2-inch-diameter post, fit the housing with a slip-fitter and use screws for securing rigidly to post.

Pedestrian push button signs must be porcelain-enameled metal or structural plastic.

Install the push button and the sign on the crosswalk side of the pole.

Point arrows on the push button signs in the same direction as the corresponding crosswalk.

Attach the sign on a Type B push button assembly.

For Type C pedestrian push button assembly, mount the instruction sign on the same standard as the push button assembly, using 2 straps and saddle brackets. Straps and saddle brackets must be corrosion-resisting chromium nickel steel and comply with ASTM A 167, Type 302B. Theftproof bolts must be stainless steel with a chromium content of 17 percent and a nickel content of 8 percent.

86-6 LIGHTING

86-6.01 HIGH-PRESSURE SODIUM LUMINAIRES

High-pressure sodium luminaires must be the enclosed cutoff type. Each luminaire must consist of a housing, a reflector, a refractor or lens, a lamp socket, an integral ballast, a terminal strip, and a lamp.

Housing must be manufactured from aluminum. Painted or powder-coated housing must withstand a 1,000-hour salt spray test as specified in ASTM B 117.

Other metal parts must be corrosion resistant.

Each housing must include a slip fitter that can be mounted on a 2-inch pipe tenon and can be adjusted 5 degrees from the axis of the tenon. Clamping brackets of the slip-fitter must not bottom out on the housing bosses when adjusted within the ± 5 degree range.

Slip fitter mounting bracket must not permanently set in excess of 0.020 inch when the 3/8-inch-diameter cap screw used for mounting is tightened to 10 ft-lb.

When tested under California Test 611, the luminaire to be mounted horizontally on the mast arm must be capable of withstanding the following cyclic loading for a minimum of 2 million cycles without failure of any luminaire parts:

Cyclic Loading

Plane	Internal ballast	Minimum peak acceleration level (G = acceleration due to gravity)
Vertical	Removed	3.0 G peak-to-peak sinusoidal loading (same as 1.5 G peak)
Vertical	Installed	1.0 G peak-to-peak sinusoidal loading (same as 0.5 G peak)
Horizontal[a]	Installed	1.5 G peak-to-peak sinusoidal loading (same as 0.75 G peak)

[a]Perpendicular to direction of mast arm

If a photoelectric unit receptacle is included, a raintight shorting cap must be installed. If the luminaire housing has a hole for the receptacle, the hole must be permanently closed, covered, and sealed with weatherproof material.

The optical system must be in a sealed chamber and include:

1. Reflector shaped such that a minimum of light is reflected through the arc tube of the lamp. The reflector surface must be specular and protected by either an anodized finish or a silicate film on it's specular surface.
2. Refractor or lens mounted in a door frame hinged to the housing and secured with a spring-loaded latch. The refractor must be made of glass or polycarbonate plastic. The lens must be made of heat- and impact-resistant glass.
3. Lamp socket that is a porcelain enclosed mogul-multiple type. The shell must include integral lamp grips to assure electrical contact under conditions of normal vibration. Socket must be mounted in the luminaire to allow presetting a variety of specified light distribution patterns. Socket must be rated for 1,500 W, 600 V(ac), and a 4 kV pulse.
4. Lamp.

Provide a sealing gasket between the reflector and:

1. Refractor or lens
2. Lamp socket

The chamber must allow for filtered flow of air in and out of the chamber from lamp heat. Filtering must be accomplished by either a separate filter or a filtering gasket.

If components are mounted on a down-opening door, the door must be hinged and secured to the luminaire housing separately from the refractor or flat lens frame. The door must be easily removable and replaceable, and secured to the housing to prevent accidental opening when the refractor or flat lens frame is opened.

Field wires connected to the luminaire must terminate on a barrier-type terminal block secured to the housing. Terminal screws must be captive and equipped with wire grips for conductors up to no. 6. Each terminal position must be clearly identified.

Minimum light distribution for each luminaire must comply with the isolux diagrams.

Maximum brightness of each cutoff luminaire, with the lamp indicated, must be the value shown in the following table:

Cutoff Type

Lamp ANSI code no.	Lamp wattage	Maximum brightness (foot-lamberts)
S55	150	40
S66	200	40
S50	250	50
S67	310	60
S51	400	75

Brightness readings will be taken using a brightness meter with an acceptance angle of 1.5 degrees. When measured on the 90- and 270-degree lateral angle line, maximum brightness must not exceed the above specified brightness when the meter is located at a horizontal distance of 120 feet and a vertical distance of 7.5 feet between the luminaire and the meter, or at an angle of 3 degrees 35 minutes from the horizontal to the line between the luminaire and the meter. Measurements must be made from the 90- and 270-degree lines, and averaged. The lamp used for each test must operate at the wattage necessary to produce the light output shown in the following table:

Light Output

Lamp wattage	Lumens
150	16,000
200	22,000
250	27,000
310	37,000
400	50,000

86-6.01A High Pressure Sodium Lamp Ballasts

Each ballast must:

1. Operate the lamp for its rated characteristics and wattage
2. Continuously operate at ambient air temperatures from -20 to 25 degrees C without reduction in ballast life
3. Operate for at least 180 cycles of 12 hours on and 12 hours off, with the lamp circuit in an open or short-circuited condition and without measurable reduction in operating requirements
4. Have a design life of not less than 60,000 hours
5. Provide proper starting and operating waveforms, voltage, and current
6. Provide reliable lamp starting and operation at ambient temperature down to -20 degrees C for the rated life of lamp

Ballast must be tested under NEMA/ANSI C82.6.

Starting aids for a ballast of a given lamp wattage must be interchangeable between ballasts of the same wattage and manufacturer, without adjustment.

Each integral ballast must consist of separate components that can be easily replaced. An encapsulated starting aid will be counted as a single component. Each component must include screw terminals, NEMA tab connectors, or a single multi-circuit connector. Conductors and terminals must be identified.

Mount heat-generating component so as to use the portion of the luminaire it is mounted to as a heat sink. Place capacitor at maximum practicable distance from the heat-generating components or thermally shield to limit the case temperature to 75 degrees C.

Transformer and inductor must be resin impregnated for protection against moisture. Capacitors, except those in starting aids, must be metal cased and hermetically sealed.

The Department will test the high-pressure sodium lamp ballast. High-pressure sodium lamp ballast must have a characteristic curve that will intersect both of the lamp-voltage limit lines between the wattage limit lines and remain between the wattage limit lines throughout the full range of the lamp voltage and throughout the lifetime of the lamp. This requirement must be met at the rated input voltage of the ballast and at the lowest and highest rated input voltage of the ballast.

Ballast for luminaires must be located in the luminaire housing.

86-6.01A(1) Regulator Type Ballasts

Regulator type ballast must comply with the following:

1. For nominal input voltage and lamp voltage, the ballast design center must not vary more than 7.5 percent from the rated lamp wattage.
2. Ballast must be designed for a capacitance variance of ± 6 percent that will not cause more than ± 8 percent variation in the lamp wattage regulation during the rated lamp life.
3. Lamp current crest factor must not exceed 1.8 for an input voltage variation of ± 10 percent at any lamp voltage during the lamp life.

Regulator-type ballast must comply with one of the lamp regulations shown in the following table:

Regulator-Type Ballast

Ballast type	Power factor	Lamp regulation
Lag type[a]	Not less than 90 percent throughout the life of the lamp when the ballast is operated at nominal line voltage with a nominally-rated reference lamp	Lamp wattage regulation spread does not vary by more than 18 percent for ±10 percent input voltage variation from nominal through life
Lead type[b]	Not less than 90 percent throughout the life of the lamp when the ballast is operated at nominal line voltage with a nominally-rated reference lamp	Lamp wattage regulation spread does not vary by more than 30 percent for ±10 percent input voltage variation from nominal through life

[a]Primary and secondary windings must be electrically isolated
[b]Constant wattage autoregulator (CWA)

86-6.01A(2) Nonregulator Type Ballasts

Each nonregulator type ballast must comply with the following:

1. For nominal input voltage and lamp voltage, the ballast design center must not vary more than 7.5 percent from the rated lamp wattage.
2. Lamp current crest factor must not exceed 1.8 for input voltage variation of ± 5 percent at any lamp voltage during lthe amp life.

Nonregulator-type ballast must comply with the lamp regulation shown in the following table:

Nonregulator-Type Ballast

Ballast type	Power factor	Lamp regulation
Autotransformer or high reactance	Not less than 90 percent throughout the life of the lamp when the ballast is operated at nominal line voltage with a nominally-rated reference lamp	Lamp wattage regulation spread does not vary by more than 25 percent for ± 5 percent input voltage variation from the nominal through life

86-6.01B High Pressure Sodium Lamps

High-pressure sodium lamps must comply with ANSI C78.42 when tested under ANSI C78.389. High-pressure sodium lamps must have a minimum average rated life of 24,000 hours.

86-6.02 RESERVED

86-6.03 LOW PRESSURE SODIUM LUMINAIRES

Each low-pressure sodium luminaire must be completely assembled with a lamp and a ballast, and must:

1. Be the enclosed type, either semi-cutoff or cutoff type.

2. Consist of a housing, reflector, refractor or lens, lamp socket, integral ballast, removable ballast tray, lamp support, terminal strip, capacitor, and slip fitter. The reflector may be an integral part of the housing.

Luminaire housing must be a 1/16-inch thick, minimum, corrosion resistant die cast aluminum sheet and plate with concealed continuous welds or a minimum nominal wall thickness of 3/32-inch thick acrylonitrile-butadiene-styrene sheet material, on a cast aluminum frame that provides mounting for all electrical components and slip fitter. Housing must be divided into optical and power compartments individually accessible for service and maintenance. Position and clamp luminaire to pipe tenon by tightening the mounting bolts.

Painted exterior surface of the luminaire must be finished with a fused coating of electrostatically-applied polyester powder paint or other ultraviolet-inhibiting film. The color must be aluminum gray.

High-temperature neoprene, or equal, sealing ring must be installed in the pipe tenon opening to prevent entry of water and insects into the power and optical compartments.

Access to the power unit assembly must be through a weathertight hinged cover, secured with spring-type latches or captive screws, to the luminaire housing.

Hardware must be stainless steel or cadmium plated. Use machine screws or bolts to secure removable components. Do not use sheet metal screws.

Semi-cutoff luminaires and molded refractor-style cutoff luminaires must include a refractor. Other cutoff luminaires must include a flat lens.

Refractor must be a 1-piece injection molded polycarbonate of 3/32-inch minimum thickness or a 1-piece injection molded acrylic of 1/8-inch minimum thickness. Flat lens must be a 1-piece polycarbonate of 3/32-inch minimum thickness mounted to a metal frame. Refractor assembly and flat lens assembly must be constructed to rigidly maintain its shape and hinged and secured with spring type latches to the luminaire housing. Alternate methods of manufacturing the refractor may be authorized provided minimum specified thicknesses are maintained.

Lamp socket must be high-temperature flame-retardant thermoset material with self-wiping contacts or equivalent. Socket must be rated for 660 W and 1,000 V(ac). The position of the socket and support must maintain the lamp in correct relationship with the reflector and refractor for the designed distribution pattern.

Isofootcandle distribution must be ANSI Type III, short or Type IV, medium distribution, for cutoff or semi-cutoff luminaires.

With a 40-foot mounting height, each type of luminaire must maintain a minimum of 0.2 footcandle at least 60 feet each side, along the longitudinal roadway line below the luminaire, and a minimum of 0.35 footcandle at a transverse roadway distance from the luminaire location equal to 1.5 times the luminaire mounting height.

Certified luminaire performance data must be provided. This data must include complete photometric test data in isofootcandle charts at a scale of 1 inch equals 20 feet for the luminaire and lamp sizes shown.

Alternate data may be in the form of horizontal footcandle values recorded on a 15 by 15 foot area extending 90 feet longitudinally on each side of the light source, and 15 feet behind and 90 feet in front of the light source for the luminaire and lamp sizes and mounting height shown. Horizontal footcandle levels in the data submitted must equal or exceed the levels specified. Failure to comply with the referenced values will be justification for rejection of the luminaires.

Photometric testing must be performed and certified by an independent and recognized testing laboratory.

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 initial lumens during the rated life and must comply with the minimum performance requirements shown in the following table:

Performance Requirements

Lamp designation	ANSI L74/E
Initial lumens	33,000 lumens
Rated average life @ 10 hrs/Start	18,000 hours
Operating position	Horizontal ±20 degrees

3. Reach 80 percent of the light output within 10 minutes and must restrike within 1 minute after an outage due to power interruption or voltage drop at the lamp socket.
4. Identify the month and year of the installation.
5. Have an autotransformer or high-reactance-type ballast. The ballast must comply with the following:
   5.1. Lamp current crest factor must not exceed 1.8 at nominal line voltage
   5.2. Ballast loss must not exceed 24 percent for 180 W ballast at nominal line voltage
   5.3. Ballast must comply with the lamp regulation shown in the following table:

Autotransformer or High-Reactance-Type Ballast

Ballast type	Power factor	Lamp regulation
Autotransformer or high-reactance	Not less than 90 percent when ballast is operated at nominal line voltage with a nominally-rated reference lamp	Lamp wattage regulation spread does not vary by more than ±6 percent for ±10 percent input voltage variation from nominal through life

A multi-circuit connector must be included for quick disconnection of the ballast tray.

86-6.04 HIGH MAST LIGHTING ASSEMBLY

Reserved

86-6.05 SOFFIT AND WALL LUMINAIRES

Soffit and wall luminaire must be weatherproof and corrosion resistant.

Each flush-mounted soffit luminaire must consist of:

1. Metal body with two 1-inch minimum conduit hubs and provisions for anchoring into concrete
2. Prismatic refractor made of heat-resistant polycarbonate mounted in a door frame and clearly identified as to street side
3. Specular anodized aluminum reflector
4. Ballast located either within the housing or in a ceiling pull box as shown
5. Lamp socket

Door frame assembly must be hinged, gasketed, and secured to the body by at least 3 machine screws.

Each pendant soffit luminaire must be enclosed and gasketed, have an aluminum finish, and include:

1. Reflector with a specular anodized aluminum finish
2. Refractor made of heat-resistant polycarbonate
3. Optical assembly 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

Each wall-mounted luminaire must consist of:

1. Cast metal body
2. Prismatic refractor, made of glass, 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 two 5/16-inch-minimum-diameter mounting bolts

Cast-aluminum bodies to be cast into or mounted against concrete must have a thick application of alkali-resistant bituminous paint on all surfaces to be in contact with concrete.

Each soffit luminaire and wall luminaire must include a 70 W high-pressure sodium lamp with a minimum average rated life of 24,000 hours. Each lamp socket must be positioned to locate the light center of the lamp within 1/2 inch of the light center location of the luminaire design.

Ballast must comply with section 86-6.01A. Wall luminaire ballast must be located in the luminaire housing or, if shown, in a pull box adjacent to the luminaire.

86-6.06 PEDESTRIAN CROSSING

Before starting fixture manufacturing, submit fixture design for authorization. If requested, submit 1 complete prototype fixture for authorization at least 30 days before manufacturing the fixtures. The prototype fixture will be returned to you, and if allowed, the fixture may be installed in the work.

The lens unit in the door section must be formed of 1-1/2-inch methyl methacrylate rod cut and fire glazed for a clear finish or a cast unit with equivalent tolerances and finish.

The lens must be secured to the door section with an extruded lens retainer of 6063-T5 aluminum alloy that fits the lens shape. The lens retainer must fit the full length of the lens on both sides. Continuous lens retainer for the full length of 3 lenses is allowed. Z bars of 5052-H32 or 5005-H14 aluminum alloy, 1/16 inch minimum thickness, may be substituted for the extruded lens retainer.

A captive positive-keyed screw-type latching device requiring a special socket wrench must be installed at the upper edge to secure the door in the closed position as shown. Furnish 2 special wrenches to the Engineer.

Each fixture must include a F48T12/CW rapid-start fluorescent lamp with recessed, double contact base installed on the back side of the door directly behind the lens.

Each lampholder must be UL listed for outdoor use without an enclosure and with 1,500 mA rapid-start fluorescent lamp. Lampholder must be a spring-loaded type.

For each lamp, the distance from the face of the lampholder to the lamp must be designed to provide a compression of at least 0.10 inch on the spring-type lampholder when the lamp is in place. Lamp must have a positive mechanical and electrical contact when it is in place. Socket on the spring-type lampholder must have enough travel to allow the lamp installation. The spring must not be a part of the current-carrying circuit.

Ballast must be a high-power-factor type with weatherproof leads for operation of one 48-inch rapid-start lamp. The ballast must be UL listed for outdoor operation on 110 to 125 V(ac) 60 Hz circuit and rated at 1,500 mA.

Conductors from ballast leads to the lampholder must be a minimum size of No. 16, stranded, and UL-listed copper AWM. Splicing of lampholder conductors to ballast leads must be performed by using mechanically-secure connectors.

Conductors in the fixture except ballast leads and entrance line conductors, must be UL-listed AWM.

Provide sufficient slack in the conductors to allow the fixture door to fully open.

Circuit conductors entering the fixture must be terminated on molded phenolic barrier-type terminal blocks rated at 15 A and 600 V(ac) and must have integral-type white waterproof-marking strips. Current-carrying parts of terminal blocks must be insulated from the fixture with integral plugs or strips to provide protection from line-to-ground flashover voltage. Terminal blocks must be attached to the wireway cover in the top section. If you use sectionalized terminal blocks, each section must include an integral barrier on each side and be capable of rigid mounting and alignment.

Exposed surfaces of the fixture must be uniform in appearance and free from significant defects, including improper fit, dents, deep scratches and abrasions, burrs, roughness, off-square ends, holes off-center or jagged, and surface irregularities. Screws for attaching components to the fixture door, including Z bars,

ballasts, and terminal block, must be tapped into the door from the inside only. Screwheads, nuts, or other fasteners must not be removable from the outside.

86-6.06A Pedestrian Undercrossing Fixtures

Fixture shell must be cast aluminum alloy, industrial type, or Federal Class 18 aluminum of 1/4 inch minimum thickness.

Door must be 1 piece of 6061-T6 aluminum alloy of 1/8 inch minimum thickness.

Continuous piano hinge must be Type 1100 aluminum alloy. Piano hinge must be welded or riveted to the door section with 1/8-inch aluminum rivets. Matching holes must be drilled in the hinge and the lower edge of the fixture. After the shell is in place, the door assembly must be attached by 3/8-inch, No. 8 stainless steel self-tapping screws at a minimum.

A neoprene gasket must be attached to the frame to provide a cushion between the shell and the door.

Chain or other device must be included to prevent the door, when fully opened, from coming in contact with the undercrossing wall.

Fixture must be held in place by three 3/8 by 8 inch anchor bolts with 2 nuts each.

Fixture surfaces in contact with concrete and with anchor bolts and nuts must be painted with a thick application of alkali-resistant bituminous paint. Paint must comply with MIL-P-6883.

Circuit conductor entering the fixture must be terminated on 2-position terminal blocks.

Both ends of the fixture must have holes for 1-inch conduit. Unused holes must be plugged with pressed metal closures.

86-6.06B Pedestrian Overcrossing Fixtures

Fixture shell must consist of:

1. Top section and a door section of extruded 6063-T5 aluminum alloy, each with a nominal 1/8 inch wall thickness
2. 2 cast-end sections of 319 aluminum alloy
3. Internal wireway cover of 505-H32 aluminum alloy

Top section and door section must be joined together on 1 side by a continuous hinge formed as part of the 2 extrusions and must overlay to allow locking on the other side. Hinge must be treated with a silicone grease that will prevent the entrance of water by capillary action.

Wireway cover with 3/16-inch hemmed ends up and terminal blocks and circuit conductors must be inserted before welding end sections and must provide clearance at both ends for conductors. The cover must be fastened by at least two 1/4-inch, No. 4 self-threading sheet metal screws with a binding head and a blunt point. You may substitute blind rivets of equivalent strength.

One or more bronze sash chains or other device must be included to prevent the door from opening to an extent that will damage the hinge.

Lampholder must include heat-resistant circular cross section neoprene sealing gasket, silver-coated contacts, and waterproofed lead entrance for use with a 1,500 mA rapid start fluorescent lamp.

Ballast must be at most 13-1/4 inches long.

Circuit conductors entering the fixture must be terminated on 3-position terminal blocks.

Electrical system of a pedestrian overcrossing must be grounded by a No. 8 copper wire equipment grounding conductor installed in a conduit connecting and bonding all non current carrying metal parts in the system. The equipment grounding conductor must be connected to the system equipment grounding conductor.

Ground wire must be secured to the inside of the telescoping sleeve end casting where conductors are carried and to the inside of Type LB conduit fitting on end post by a connecting lug and a No. 8 self-threading pan screw.

Lamp, lampholder, ballast, and fixture wire must be attached to the door section. Terminal blocks must be attached to the top section or the wireway cover.

Three No. 10, solid copper circuit conductors must be installed between terminal blocks as part of each completed fixture.

Before shipment to the job site, fixture must be completely manufactured and assembled in the shop.

86-6.06C In-Roadway Warning Lights

Reserved

86-6.07 INDUCTION SIGN LIGHTING FIXTURES

Each induction sign lighting fixture must include a housing with a door, reflector, refractor or lens, lamp, power coupler, high-frequency generator, socket assembly, fuse block, and fuses.

Each induction sign lighting fixture must:

1. Be designed for mounting near the bottom of the sign panel on an overhead sign structure.
2. Be an enclosed design, raintight and corrosion resistant. The door and housing must be gasketed. Thickness of the gasket must be 1/4 inch, minimum.
3. Have a minimum average rating of 60,000 hours.
4. Be for a wattage of 87 W, 120/240 V(ac).
5. Have a power factor greater than 90 percent and total harmonic distortion less than 10 percent.
6. Be UL approved for wet locations and be FCC Class A listed.
7. Not exceed 44 lb in weight.
8. Include the manufacturer's brand name, trademark, model number, serial number, and date of manufacture on the packaged assembly. The same information must be permanently marked on the outside and inside of the housing.
9. Comply with the minimum horizontal footcandle requirement shown.
10. Be a maximum height of 12 inches above the top of the mounting rails.

If the fixture is located so the light center of the lamp is 55 inches in front of, 1 foot below, and centered on a 10-by-20-foot-wide sign panel, the ratio of the maximum to minimum illuminance level on the panel must not exceed 12 to 1 in 95 percent of the points measured. The illuminance gradient must not exceed 2 to 1 and is defined as the ratio of minimum illuminance on a 1-foot square of panel to that on an adjacent 1-foot square of panel.

Each fixture must have a mounting assembly that will allow the fixture to be mounted on continuous slot channels. The mounting assembly must be either cast aluminum, hot-dip galvanized steel plate, or steel plate that has been galvanized and finished with a polymeric coating system or same finish used for the housing.

Housing must have a door designed to hold a refractor or lens and to open without the use of special tools. Housing and door must be manufactured of sheet or cast aluminum and have a powder coat or polyester paint finish of a gray color resembling the unfinished manufacturing. Sheet aluminum must comply with ASTM B 209 or B 209M for 5052-H32 aluminum sheet. External bolts, screws, hinges, hinge pins, and door closure devices must be corrosion resistant.

Housing must include weep holes.

Door must be hinged to the housing on the side of the fixture away from the sign panel and include 2 captive latch bolts or other latching device. Door must be designed to lock in the open position, 50 degrees minimum from the plane of the door opening, with an 85-mph 3-second wind-gust load striking the door from either side.

Reflector must be 1 piece made from specularly-finished aluminum protected with an electrochemically-applied anodized finish or a chemically-applied silicate film, and designed so deposited water due to condensation will drain away. The reflector must be secured to the housing with a minimum of 2 screws and removable without removing any fixture parts. Do not attach reflectors to the outside of housing.

Refractor or lens must have a smooth exterior and must be manufactured from the material shown in the following table:

Refractor and Lens Material Requirements

Component	Manufactured from
Flat lens	Heat-resistant glass
Convex lens	Heat resistant, high-impact resistant tempered glass
Refractor	Borosilicate heat resistant glass

Refractor and convex lens must be designed or shielded so no fixture luminance is visible if the fixture is approached directly from the rear and viewing level is the bottom of the fixture. If a shield is used, it must be an integral part of the door casting.

Each fixture must include an 85 W induction lamp with a fluorescent phosphor-coated interior wall. Light output must be at least 70 percent at 60,000 hours. Lamp must have a minimum color-rendering index of 80, be rated at a color temperature of 4,000K, and be removable without the use of tools.

Lamp socket must be a porcelain enclosed mogul type with a shell that contains integral lamp grips to assure electrical contact under normal vibration conditions. The center contact must be spring loaded. The shell and center contact must be nickel-plated brass. The socket must be rated for 1,500 W and 600 V(ac).

Power coupler must include a construction base with antenna, heat sink, and electrical connection cable, and be designed so it can be removed 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 reduction in 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 FCC title 47, part 18, regulations regarding harmful interference
6. Be replaceable with common hand tools
7. Mounted so the fixture can be used as a heat sink

Conductor terminal must be identified by the component terminal the conductor connects to.

Submit a copy of the high-frequency generator test methods and results from the manufacturer with each lot of fixtures.

Each fixture must include a barrier-type fuse block for terminating field connections. The fuse block must be:

1. Secured to the housing and be accessible without removal of any fixture parts
2. Mounted to leave a minimum of 1/2 inch air space from the sidewalls of the housing
3. Designed for easy removal of fuses with a fuse puller, be rated at 600 V(ac), and have box terminals.

Fuses must be 13/32-inch-diameter, 1-1/2-inch-long ferrule type, and UL or NRTL listed. For 120 V(ac) input fixture, only the ungrounded conductor must be fused and a solid link must be provided between the neutral and the high-frequency generator.

If shown, include a wire guard to prevent damage to the refractor or lens. The guard must be constructed of 1/4-inch-minimum-diameter galvanized steel wire and either hot-dip galvanized or electroplated zinc-coated as specified in ASTM B 633, Service Condition SC4 with a clear chromate dip treatment. Guard elements must be spaced to prevent rocks larger than 1-1/2-inch diameter from passing through.

86-6.08 SIGN LIGHTING FIXTURES

86-6.08A General

Reserved

86-6.08B Fixtures for Flashing Beacons

Sign lighting fixture for flashing beacon must:

1. Be UL or NRTL listed for outdoor installation
2. Include a hood with a side outlet tapped for the conduit, a symmetrical 10-inch steel reflector with a white porcelain-enamel finish, and a medium base socket
3. Be rated at 150 W minimum

86-6.08C Reserved

86-6.08D Fluorescent Fixtures

Reserved

86-6.09 INTERNALLY ILLUMINATED STREET NAME SIGNS

Sign fixture must be:

1. Designed and constructed to prevent deformation or failure when subjected to an 85 mph, 3-second wind-gust load as specified in AASHTO publication, "Standard Specifications for Structural Supports of Highway Signs, Luminaires and Traffic Signals," and its interim revisions
2. Fabricated from all new material and all ferrous parts must be galvanized or cadmium plated
3. Type A or B sign

The top and bottom must be formed or extruded aluminum and must be attached to formed or cast aluminum end fittings. Housing must be designed for continuous sealing between the top and bottom assemblies and end fittings, and be constructed to resist torsional twist and warp. Opening or removing 1 panel must allow access to the interior of the sign for lamp, ballast, and fuse replacement.

Photoelectric unit sockets are not allowed.

For Type A sign, both sides must be hinged at the top to allow installation or removal of the sign panel, and to allow access to the interior of the sign.

For Type B sign, the sign panel must be slide mounted into the housing.

Reflectors may be used to obtain required sign brightness. Reflectors must be formed aluminum with acrylic baked white-enamel surface having a minimum reflectance of 0.85.

Sign panel must be slide mounted or rigid mounted in a frame, with white legend, symbols, arrows, and border on each face. Background must be green.

Sign panel surface must be evenly illuminated. Average of brightness readings for letters must be 150 foot-lamberts minimum. The light transmission factor of the sign panel must provide a letter to background brightness ratio between 10 to 1 and 20 to 1. The background luminance must not vary by more than 40 percent from the average background brightness reading. The luminance of letters, symbols, and arrows must not vary by more than 20 percent from their average brightness readings.

Sign panels must be translucent, high impact, resistant plastic panels of one of the following:

1. Glass fiber reinforced acrylated resin
2. Polycarbonate resin
3. Cellulose acetate butyrate plastic

Paint on the outside of the plastic must be protected by a plastic film that seals the front surface of the panel and filters out ultraviolet radiation. Paint must be acrylic plastic type.

Surface must be free of blemishes in the plastic or coating that may impair the serviceability or detract from the general appearance and color matching of the sign.

The white or green color must not fade or darken when the sign is exposed to an accelerated test of ultraviolet light equivalent to 2 years of outdoor exposure. The green color of the sign, when not illuminated, must match color no. 14109 of FED-STD-595.

Sign panel must not crack or shatter when a 1-inch-diameter steel ball with a weight of 2.4 ounces is dropped from a height of 8.5 feet above the sign panel to any point of sign panel. For this test, the sign panel must be lying in a horizontal position and supported within its frame.

For Type A sign, gasket must be installed between sign panel frame and fixture housing to prevent water entry between frame and fixture housing. Gasket must be uniform and even textured, and be the closed-cell, sponge-neoprene type, designed for use at temperatures between -20 and +74 degrees C.

Gasket must be neatly applied to thoroughly degreased, clean surface with a suitable heat-resistant adhesive that will not allow the gasket to slip at temperatures between -20 and +74 degrees C.

Ballast must be high-power factor type and capable of starting the lamp at -20 degrees C and above.

Ballast for Type A sign must be rated at 200 mA. Ballast for Type B sign must be rated at 430 mA. Ballast must be UL or NRTL listed for operation on 110 to 125 V(ac), 60 Hz circuits, and comply with ANSI C82.1 and ANSI C82.2.

Lampholder must be UL or NRTL listed for outdoor use and of the spring-loaded type. Lampholder must have silver-coated contacts and waterproofed entrance leads for use with a rapid-start fluorescent lamp. Removal of the lamp from the socket must de-energize the primary of the ballast. Each lampholder must include a heat-resistant, circular cross section, partially-recessed neoprene ring to seal against lamp ends and protect electrical contacts from moisture, dirt, or other injurious elements.

Distance between the face of lampholders must be designed to provide compression of at least 0.10 inch on the spring-type lampholder when the lamp is in place. Lamp must have positive mechanical and electrical contact when it is in place. Socket on spring-type lampholder must have sufficient travel to allow lamp installation. Spring must not be a part of the current carrying circuit. Lampholder must match lamp requirements and must not increase cathode filament circuit resistance by more than 0.10 Ω.

Lamp must comply with ANSI C78.

Wiring connections in the fixture must be terminated on molded, phenolic, barrier-type, terminal blocks rated at 15 A, 1,000 V(ac), and must have integral-type white waterproof-marking strips. Current carrying parts of terminal blocks must be insulated from the fixture with integral plugs or strips to provide protection from line-to-ground flashover voltage. If you choose to use sectionalized terminal blocks, each section must include an integral barrier on each side and be capable of rigid mounting and alignment. Terminal screws must be No. 10, minimum.

Fuses must be Type 3AG, miniature, slow-blowing type with appropriate current and voltage ratings.

Fuseholder must be a panel-mounting type with threaded or bayonet-type knob that grips the fuse tightly for extraction. Use a separate fuse for each ballast.

Screened weep holes must be constructed at strategic locations in members subject to moisture collection.

Fasteners, screws, and hardware must be passive stainless steel, Type 302 or 304, or aluminum Type 6060-T6.

Top of fixture housing must have 2 free-swinging mounting brackets. Each bracket must be adjustable vertically for leveling the sign to either a straight or curved mast arm. Bracket assembly must allow fixture to swing perpendicular to the sign panel.

Hinge pins for the free-swinging brackets must have a minimum diameter of 1/4 inch.

The message must be displayed on both sign panels, as shown.

If not shown, the message and the size of the symbols or arrows will be provided. Letters must be 8-inch upper case and 6-inch lower case, Series E.

Fixture conductors must be UL- or NRTL-listed AWM stranded copper wire with 28 mils, minimum, thermoplastic insulation, rated at 1,000 V(ac) and rated for use at 90 degrees C. Conductors must be no. 16 minimum and must match color coding of ballast leads.

Conductors within the fixture must be secured with easily removable spring cross straps, not clamped, in the chassis or fixture. Straps must be installed 12 inches apart or less.

Stranded copper conductors connected to screw-type terminals must terminate in UL-listed crimp-type ring connectors.

Splices are not allowed within the fixture.

Submit shop drawings showing the message for each sign, including size of letters, symbols, or arrows, as shown. If requested, you must supply, without cost to the Department, sufficient samples of materials to be used in the fabrication of the sign or a complete sign assembly, to allow adequate testing and evaluation of compliance to the specified requirements.

86-6.10 ELECTRICAL INFORMATION SIGNS

86-6.10A General

Reserved

86-6.10B Reserved

86-6.10C Extinguishable Message Sign

Reserved

86-6.10D Changeable Message Sign System

Reserved

86-6.11 PHOTOELECTRIC CONTROLS

Photoelectric controls must be capable of directly switching multiple lighting systems.

86-6.11A Types

Photoelectric control must be of the types shown in the following table:

Photoelectric Control Types

Type I	Includes: 1. Remote photoelectric unit 2. Test switch housed in an enclosure
Type II	Includes: 1. Remote photoelectric unit 2. Separator contactor and test switch located in a service equipment enclosure
Type III	Includes: 1. Remote photoelectric unit 2. Separator contactor and a test switch housed in an enclosure
Type IV	Includes a photoelectric unit that plugs into an NEMA twist-lock receptacle integral with the luminaire.
Type V	Includes a photoelectric unit, a separator contactor, and a test switch located in a service equipment enclosure.

A switch to allow manual operation of the lighting circuit must be included for each Type I, II, III, and V photoelectric control. Switches must be single-hole mounting toggle type, single pole, single throw, rated at 12 A with a voltage rating that matches the circuit. Switches must have an indicating nameplate reading "Auto-Test" and be connected in parallel with the load contacts of the photoelectric unit. Test switches must not have an "Off" position.

Photoelectric unit for Types I, II, and III photoelectric controls must be pole-top mounted.

86-6.11B Equipment Details

86-6.11B(1) Photoelectric Unit

Photoelectric unit must:

1. Have an output in response to changing light levels. Response level must remain stable throughout the life of the control unit.
2. Have a "turn-on" between 1 and 5 footcandles and a "turn-off" between 1.5 and 5 times the "turn-on." Measurements must be made by procedures in NEMA standards for physical and electrical interchangeability of light-sensitive control devices used in the control of roadway lighting.
3. Have a NEMA type receptacle. Mounting brackets must be used where pole-top mounting is not possible. Photoelectric controls must be installed at locations shown and oriented.
4. Be screened to prevent artificial light from causing cycling.
5. Have a supply voltage rating of 60 Hz, 105-130 V(ac), 210-240 V(ac), or 105-240 V(ac), as specified.
6. Have a load rating of 800 W minimum, high intensity discharge or fluorescent.
7. Operate at a temperature range of -20 to 55 degrees C.
8. Have a power consumption less than 10 W.
9. Be housed in a weatherproof enclosure.
10. Have a base with a 3-prong, NEMA standard, twist-lock plug mounting.
11. Have a "fail-on" feature.

Unit components must not require periodic replacement.

Photoelectric controls, except Types IV and V, must include a 4-inch-minimum-inside-diameter pole-top mounting adaptor containing a terminal block, and cable supports or clamps to support pole wires.

For switching 480 V(ac), 60 Hz circuits, a 100 VA, minimum, 480/120 V(ac) transformer must be installed in the contactor enclosure to allow 120 V(ac) for the photoelectric control unit. If more than 1 photoelectric unit is to be installed at a location, a single transformer with a volt-ampere rating capable of handling the total controlled load may be used.

86-6.11B(2) Contactor

Contactor must:

1. Have contacts rated to switch the specified lighting load
2. Be normally open
3. Be the mechanical armature type with contacts of fine silver, silver alloy, or superior alternative material

86-6.11B(3) Enclosure

Enclosure for Types I and III photoelectric controls must be NEMA 3R. Enclosure must be supplied with a factory-applied rust-resistant prime coat and finish coat. Two applications of paint to match the color of the standard must be applied as specified in section 86-2.16. Enclosure may be hot-dip galvanized instead of painting. A minimum of 2-1/2 inches must be provided between contactor terminals and the end of the enclosure for wiring connections. Enclosure must be mounted on the same standard as the photoelectric unit at a height of about 6 feet above finished grade.

86-6.11B(4) Terminal Blocks

Terminal blocks must be rated at 25 A, 600 V(ac), molded from phenolic or nylon material, and of the barrier type with plated-brass screw terminals and integral-type marking strips.

86-6.12 TRANSFORMERS

86-6.12A Electrical Requirements

Transformers must be single-phase dry type designed for operation on a 60 Hz supply. Transformers must have a decal showing a connection diagram. 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. Transformers must comply with the electrical requirements shown in the following table:

Transformer Electrical Requirements

Rating	120/480 V(ac), 240/480 V(ac), or 480/120 V(ac)
Efficiency	Exceed 95 percent
Secondary voltage regulation and tolerance	±3 percent from half load to full load

Secondary 480 V(ac) windings must be center tapped.

86-6.12B Physical Requirements

External leads for secondary connections must be Type USE, No. 10, rated 600 V(ac).

Transformer leads must extend a minimum of 12 inches from the case.

Transformer insulation must be NEMA 185 C or better.

Transformers must withstand the application of 2,200 V(ac) from core to coils and from coil to coil for a 1-minute period.

The above tests must be made immediately after operation of the transformer at full load for 24 hours.

Nonsubmersible transformers must include metal half-shell coil protection, have moisture resistant synthetic varnish impregnated windings, and be suitable for outdoor operation in a raintight enclosure.

Each transformer to be installed in a pull box must be the submersible type and include a handle and a hanger.

86-6.12C Submersible Type Transformers

Submersible type transformers must be securely encased in a rugged corrosion-resistant, watertight case and must withstand a 5-day test submerged in 2 feet of salt water, 2 percent salt by weight, with 12-hour on and off periods. The operating periods must be at full load.

Leads of submersible transformers must be brought out through 1 or more sealed hubs and secured to withstand a 100 lb static pull without loosening or leaking.

86-6.13 FALSEWORK LIGHTING

86-6.13A General

Falsework lighting must include lighting to illuminate the pavement, portals, and pedestrian walkways at or under openings in the falsework required for traffic.

Lighting for pedestrian walkway illumination must be installed at all pedestrian openings through or under the falsework.

Before starting falsework opening construction, submit a plan of the proposed lighting installations.

Design falsework lighting so that required maintenance can be performed with a minimum of inconvenience to traffic. Closing of traffic lanes for routine maintenance will not be allowed on roadways with posted speed limits greater than 25 mph.

Pavement under falsework with portals less than 150 feet apart and falsework portals must be illuminated only during the hours of darkness as defined in division 1, section 280, of the California Vehicle Code. 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 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 must pay for energy, line extension, service, and service hookup costs.

At Contract acceptance or if ordered, falsework lighting equipment will become your property and you must remove it from the job site.

You may propose a lighting plan that fulfills light intensity requirements to the systems specified herein. You must supply sufficient data to allow evaluation of alternative methods.

86-6.13B Pavement Illumination

Illumination of pavement at vehicular openings through falsework must comply with the following:

1. Fixture must include R/FL commercial-type floodlamp 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 floodlamp.
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.

86-6.13C Portal Illumination

Illumination of falsework portals must comply with the following:

1. On each side of each entrance portal, plywood sheet clearance guides, 4 feet wide by 8 feet high must be fastened vertically, facing traffic, with the bottom of the panel 3 to 4 feet above the roadway. The center of the panel must be located approximately 3 feet horizontally behind the roadway face of the railing. Panels must be freshly painted 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 in order to improve the general appearance of the painted surfaces. Painting is change order work.
3. Falsework portals must be illuminated on the side facing traffic with 150 W, minimum, PAR reflector 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.

86-6.13D Pedestrian Walkway Illumination

Illumination of pedestrian openings through or under the falsework must comply with the following:

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.

86-7 REMOVING, REINSTALLING, OR SALVAGING ELECTRICAL EQUIPMENT

86-7.01 REMOVING ELECTRICAL EQUIPMENT

Existing electrical equipment, pull boxes, and conduits, to be removed and not reused or salvaged, become your property and you must dispose of it. Unused underground conduit may be abandoned in place after all conductors have been removed except that conduit terminations from the conduit to be abandoned must be removed from the pull boxes to remain.

Exercise care in salvaging equipment so it will not be damaged or destroyed. Mast arms must be removed from the standards. Luminaires, signal heads, and signal mounting assemblies must be removed from the standards and mast arms.

Holes resulting from removing pull boxes must be filled with material equivalent to the surrounding material.

86-7.02 REINSTALLING REMOVED ELECTRICAL EQUIPMENT

If removed electrical equipment is to be reinstalled, you must supply all necessary materials and equipment, including signal mounting assemblies, anchor bolts, nuts, washers, and concrete as required to complete the new installation.

Luminaires to be reinstalled must be cleaned and relamped.

Existing materials required to be reused and found to be unsatisfactory by the Engineer must be replaced with new material and the replacement cost is change order work

86-8 PAYMENT

86-8.01 PAYMENT

If the pull box type is not a bid item, payment for that type of pull box is included in the payment for the system work involved.

If concrete foundation is not a bid item, payment for concrete foundation is included in the payment for the system work involved.

Payment for pedestrian barricade and for installing sign panels on pedestrian barricades, flashing beacon standards, and traffic signal mast arms is included in the payment for the system work involved.

If interconnection conduit and cable is a bid item, payment for all interconnection conductors, and conduit and pull boxes containing interconnection cable and no other conductors is included in the payment for interconnection conduit and cable. If interconnection conduit and cable is paid by the foot, the payment quantity is measured by the length of the conduit. If the conduit contains interconnection cable and other conductors, the conduit is paid for by the work that requires the other conductors.

Payment for furnishing, installing, maintaining, and removing falsework lighting equipment is included in the payment for the items of work involved in the structure that requires the falsework lighting.

DIVISION X MATERIALS

87 MATERIALS–GENERAL

87-1 GENERAL

Reserved

87-2 AGGREGATE

Reserved

88 GEOSYNTHETICS

88-1.01 GENERAL

88-1.01A Summary

Section 88 includes specifications for furnishing geosynthetics.

88-1.01B Submittals

For each type of geosynthetic submit:

1. Certificate of compliance
2. Test sample representing each lot
3. MARV

Label submittals with the manufacturer's name and product information.

88-1.01C Quality Control and Assurance

Treat geosynthetics to resist degradation from exposure to sunlight. Furnish geosynthetics in covers to protect against damage from moisture, sunlight, and shipping and storage.

88-1.02 MATERIALS

88-1.02A General

Reserved

88-1.02B 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

When tested under the referenced ASTMs, properties of filter fabric must have the values shown in the following table:

Filter Fabric

Property	Test	Value		
		Class A	Class B	Class C
Grab breaking load, 1-inch grip, lb min in each direction	ASTM D 4632	157		
Apparent elongation, percent min in each direction	ASTM D 4632	50		
Hydraulic bursting strength, psi min	ASTM D 3786	210		
Ultraviolet resistance, percent min retained grab breaking load, 500 hours	ASTM D 4355	70		
Permittivity, sec^{-1} min	ASTM D 4491	0.5	0.2	0.1
Apparent opening size, average roll value, U.S. standard sieve size, max	ASTM D 4751	40	60	70

88-1.02C 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 88-1.02B.

Geocomposite wall drain must be no more than 2 inches thick.

When tested under ASTM D 4716, properties of geocomposite wall drain must have the value shown in the following table:

Geocomposite Wall Drain

Property	Test	Value
Transmissivity, gal/min/ft gradient = 1.0, Normal stress = 5,000 psf	ASTM D 4716	4

88-1.02D Geotechnical Subsurface Reinforcement

88-1.02D(1) General

Geosynthetic reinforcement used for geotechnical subsurface reinforcement must be either geotextile or geogrid.

When tested under ASTM D 4491, 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.

88-1.02D(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.

Submit the LTDS and its supporting calculations at least 15 days before placing geosynthetic reinforcement. The calculations must be signed by an engineer registered as a civil engineer in the State. Do not install unless authorized.

88-1.02E Silt Fence Fabric

When tested under the referenced ASTMs, the properties of silt fence fabric must have the values shown in the following table:

Silt Fence Fabric

Property	Test	Value	
		Woven	Nonwoven
Grab breaking load, 1-inch grip, lb min, in each direction	ASTM D 4632	120	120
Apparent elongation, percent min, in each direction	ASTM D 4632	15	50
Water flow rate, gal per minute/sq ft min and max average roll value	ASTM D 4491	10–100	100–150
Permittivity, sec^{-1} min	ASTM D 4491	0.1	1.1
Apparent opening size, inches max average roll value	ASTM D 4751	0.023	0.023
Ultraviolet resistance, percent min retained grab breaking load, 500 hours	ASTM D 4355	70	70

88-1.02F Gravel-Filled Bag

When tested under the referenced ASTMs, the properties of gravel-filled bag must have the values shown in the following table:

Gravel-Filled Bag

Property	Test	Value
Grab breaking load, lb, 1-inch grip min, in each direction	ASTM D 4632	205
Water flow rate, gal per minute/sq ft min and max average roll value	ASTM D 4491	80–150
Permittivity, sec^{-1} min	ASTM D 4491	0.2
Apparent opening size, inches max average roll value	ASTM D 4751	0.016
Ultraviolet resistance, percent min retained grab breaking load, 500 hours	ASTM D 4355	70

88-1.02G Sediment Filter Bag

When tested under the referenced ASTMs, the properties of sediment filter bag must have the values shown in the following table:

Sediment Filter Bag

Property	Test	Value
Grab breaking load, lb, 1-inch grip min, in each direction	ASTM D 4632	255
Water flow rate, gal per minute/sq ft min and max average roll value	ASTM D 4491	80–200
Permittivity, sec^{-1} min	ASTM D 4491	1.0
Apparent opening size, inches max average roll value	ASTM D 4751	0.023
Ultraviolet resistance, percent min retained grab breaking load, 500 hours	ASTM D 4355	70

88-1.02H Temporary Cover

When tested under the referenced ASTMs, the properties of temporary cover must have the values shown in the following table:

Temporary Cover

Property	Test	Value
Grab breaking load, lb, 1-inch grip min, in each direction	ASTM D 4632	200
Apparent elongation, percent min, in each direction	ASTM D 4632	50
Water flow rate, gal per minute/sq ft min and max average roll value	ASTM D 4491	75–120
Permittivity, sec^{-1} min	ASTM D 4491	1.0
Apparent opening size, inches max average roll value	ASTM D 4751	0.007
Ultraviolet resistance, percent min retained grab breaking load, 500 hours	ASTM D 4355	70

88-1.02I 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.

When tested under the referenced ASTMs, the properties of Class 8 and Class 10 RSP fabric must have the values shown in the following table:

RSP Fabric

Property	Test	Value	
		Class 8	Class 10
Mass, oz/sq yd min	ASTM D 5261	7.5	9.5
Grab breaking load, lb, 1-inch grip min, in each direction	ASTM D 4632	200	250
Apparent elongation, percent min, in each direction	ASTM D 4632	50	50
Permittivity, sec^{-1}, min	ASTM D 4491	1.0	0.70
Apparent opening size, U.S. Standard sieve size: min and max	ASTM D 4751	70–100	70–100
Ultraviolet resistance, percent min retained grab breaking load, 500 hours	ASTM D 4355	70	70

88-1.02J Paving Fabric

Geosynthetics used for paving fabric must be nonwoven. When tested under the referenced ASTMs, properties of paving fabric must have the values shown in the following table:

Paving Fabric

Property	Test	Value
Mass per unit area, oz/sq yd min	ASTM D 5261	4.1
Grab breaking load, lb, 1-inch grip min, in each direction	ASTM D 4632	100
Apparent elongation, percent min, in each direction	ASTM D 4632	50
Hydraulic bursting strength, psi min	ASTM D 3786	200
Melting point, °F min	ASTM D 276	325
Asphalt retention, gal/sq yd min	ASTM D 6140	0.2

88-1.02K Paving Mat

Geosynthetics used for paving mat must be a nonwoven fiberglass and polyester hybrid material. When tested under the referenced ASTMs, properties of paving mat must have the values shown in the following table:

Paving Mat

Property	Test	Value
Breaking force, lb/2 inches min	ASTM D 5035	45
Ultimate elongation, percent max	ASTM D 5035	5
Mass per unit area, oz/sq yd min	ASTM D 5261	3.7
Melting point, °F min	ASTM D 276	400
Asphalt retention, gal/sq yd min	ASTM D 6140	0.10

88-1.02L Paving Grid

Geosynthetics used for paving grid must be a geopolymer material formed into a grid of integrally connected elements with openings. When tested under the referenced ASTMs, properties of paving grid must have the values shown in the following table:

Paving Grid

Property	Test	Value		
		Class I	Class II	Class III
Tensile strength at ultimate, lb/in[a] min	ASTM D 6637	560 x 1,120	560	280
Aperture size, inch min	Calipered	0.5	0.5	0.5
Elongation, percent max	ASTM D 6637	12	12	12
Mass per area, oz/sq yd min	ASTM D 5261	16	10	5.5
Melting point, °F min	ASTM D 276	325	325	325

[a] For Class I, machine direction x cross direction. For Class II and Class III, both directions.

88-1.02M Paving Geocomposite Grid

Paving geocomposite grid must consist of a paving grid specified in section 88-1.02L bonded or integrated with a paving fabric as specified in section 88-1.02J.

Paving geocomposite grid must have a peel strength of at least 10 lb/ft determined under ASTM D 413.

88-1.02N Geocomposite Strip Membrane

Geocomposite strip membrane must be various widths of strips manufactured from asphaltic rubber and geosynthetics. When tested under the referenced ASTMs, properties of geocomposite strip membrane must comply with the requirements shown in the following table:

Geocomposite Strip Membrane

Property	Test	Requirements
Strip tensile strength, lb/inch min	ASTM D 882	50
Elongation at break, percent min	ASTM D 882	50
Resistance to puncture, lb min	ASTM E 154	200
Permeance, perms max	ASTM E 96 / E 96M	0.10
Pliability, 1/4 inch mandrel with sample conditioned at 25 °F	ASTM D 146	No cracks in fabric or bitumen
Melting point, °F	ASTM D 276	325

88-1.02O Subgrade Enhancement Geotextile

Subgrade enhancement geotextile must be either polyester or polypropylene. When tested under the referenced ASTMs, properties of subgrade enhancement geotextile must have the values shown in the following table:

Subgrade Enhancement Geotextile

Property	Test	Value[a]				
		Class A1	Class A2	Class B1	Class B2	Class B3
Elongation at break, percent	ASTM D 4632	<50	≥50	<50	<50	≥50
Grab breaking load, lb, 1-inch grip min, in each direction	ASTM D 4632	250	160	--	320	200
Wide width tensile strength at 5 percent strain, lb/ft min	ASTM D 4595	--	--	2,000	--	--
Wide width tensile strength at ultimate strength, lb/ft min	ASTM D 4595	--	--	4,800	--	--
Tear strength, lb min	ASTM D 4533	90	60	--	120	80
Puncture strength, lb min	ASTM D 6241	500	310	620	620	430
Permittivity, sec^{-1} min	ASTM D 4491	0.05	0.05	0.20	0.20	0.20
Apparent opening size, inches max	ASTM D 4751	0.012	0.012	0.024	0.012	0.012
Ultraviolet resistance, percent min retained grab breaking load, 500 hours	ASTM D 4355	70	70	70	70	70

[a]Values are based on MARV in the weaker principal direction except apparent opening size is based on maximum average roll value.

88-1.02P–88-1.02S Reserved

88-1.03 CONSTRUCTION

Not Used

88-1.04 PAYMENT

Not Used

89 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 new gradations 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 weighing device as specified in section 9-1.02B or by chemical analysis.

90-1.01C(4) Admixtures

If you propose to use an admixture from the Authorized Material List, 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, 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 12 months 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.

If authorized, you may submit the weighmaster certificates electronically instead of in printed form.

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 Control and Assurance

90-1.01D(1) General

The cementitious materials and the admixture type and brand must be on the Authorized Material List at the time of the mix design submittal.

Both the coarse and fine aggregate must be on the Authorized Material List for the aggregate used in concrete to be considered innocuous.

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. However, 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 percent
Coarse aggregate content	10 percent
Fine aggregate content	10 percent
SCM content	5 percent
Admixture as originally dosed[a]	25 percent

[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 C 143 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 1 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 1 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 C 42.

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 far enough in advance 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 for:

1. Water loss at 24 hours under California Test 534
2. Reflectance under ASTM E 1347
3. Viscosity under ASTM D 2196
4. Nonvolatile content under ASTM D 2369
5. Pigment content under ASTM D 3723

A batch must be no larger than 10,000 gal.

The Engineer samples the curing compound at the manufacturer's supply source, at the job site, or at both locations.

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 C 143, the difference in slump values must not exceed the values shown in the following table:

Average slump, S (inches)	Maximum permissible difference (inches)
$S < 4$	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

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 C 150, 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 C 311.
   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 property	Requirement (percent)
Sulfur trioxide (SO_3)	1.5 max
Loss on ignition	1.2 max
Available alkalies as $Na_2O + 0.658\ K_2O$	1.5 max

Physical property	Requirement (percent)
Particle size distribution Less than 3.5 microns Less than 9.0 microns	 50 90
Strength activity index with portland cement 7 days 28 days	 95 (min percent of control) 110 (min percent of control)
Expansion at 16 days when testing project materials under ASTM C 1567[a]	0.10 max

[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 C 311.
   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 shown in the following 2 tables:

Chemical property	Requirement (percent)
Silicon dioxide (SiO_2) + aluminum oxide (Al_2O_3)	92.0 min
Calcium oxide (CaO)	1.0 max
Sulfur trioxide (SO_3)	1.0 max
Loss on ignition	1.2 max
Available alkalies as $Na_2O + 0.658\ K_2O$	1.0 max

Physical property	Requirement (percent)
Particle size distribution less than 45 microns	95
Strength activity index with portland cement 7 days 28 days	 100 (min percent of control) 100 (min percent of control)

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.

You may commingle fly ash from different sources 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

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 grading 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 grading 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 grading tests do not comply with the requirements for contract compliance, you must remove the concrete represented by the tests. However, 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 grading tests do not comply with the requirements for contract compliance, you must remove the concrete represented by the tests. However, 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 comply with the requirements shown in the following table:

Property	California Test	Requirement
Loss in Los Angeles rattler after 500 revolutions	211	45 percent max
Cleanness value		
Operating range	227	75 min
Contract compliance	227	71 min

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 comply with the requirements shown in the following table:

Property	California Test	Requirement
Organic impurities	213	Satisfactory[a]
Sand equivalent:		
Operating range	217	75 min
Contract compliance	217	71 min

[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 C 87.

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 Gradings

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 proposed gradation
1-1/2 inch 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 Grading

Coarse aggregate must be graded within the limits shown in the following table for each size of coarse aggregate:

Sieve size	Percentage passing primary aggregate nominal sizes							
	1-1/2 inch x 3/4 inch		1 inch x No. 4		1/2 inch x No. 4		3/8 inch x No. 8	
	Operating range	Contract compliance	Operating range	Contract compliance	Operating range	Contract compliance	Operating range	Contract compliance
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 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 grading 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 grading specifications for the primary aggregate nominal size.

You may separate the coarse aggregate for the 1-inch maximum combined aggregate grading under section 90-1.02C(4)(d) into 2 sizes and store them separately, provided that the combined material complies with the grading specifications for the 1 inch x No. 4 primary aggregate nominal size.

90-1.02C(4)(c) Fine Aggregate Grading

Fine aggregate must be graded within the limits shown in the following table:

Sieve size	Percentage passing	
	Operating range	Contract compliance
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 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 grading specifications.

90-1.02C(4)(d) Combined Aggregate Grading

Use combined aggregate grading limits only for the design of concrete mixes. Design concrete mixes such that aggregates are combined in proportions that produce a mixture within the grading limits for combined aggregate.

Use either the 1-1/2-inch maximum grading or the 1-inch maximum grading, unless otherwise specified.

Combined aggregate must be graded within the limits shown in the following table:

Sieve size	Percentage passing			
	1-1/2 inch max	1 inch max	1/2 inch max	3/8 inch max
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 grading 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 C 191 or ASTM C 266
   2.2. Reduction by more than 5 percent in the mortar compressive strength at 14 days when tested under ASTM C 109
3. Chlorides as Cl or sulfates as SO_4 in excess of the values shown in the following table:

Type of concrete work	Maximum chloride as Cl^{a}	Maximum sulfate as SO_4 [b]
Nonreinforced	2,000 ppm	1,500 ppm
Reinforced	1,000 ppm	1,300 ppm
PS	650 ppm	1,300 ppm

[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

Admixtures must comply with the following:

1. Chemical admixtures must comply with ASTM C 494.
2. Air-entraining admixtures must comply with ASTM C 260.
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.

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:

1. Segregation, degradation, or the combining of materials of different gradings and result in an aggregate size failing to comply with the grading 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 withdrawl 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 allowed by the Engineer, 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 allowed by the Engineer, 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 allowed by the Engineer. 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 C 143, complies with the nominal range shown in the following table:

Type of work	Nominal		Maximum	
	Penetration (inches)	Slump (inches)	Penetration (inches)	Slump (inches)
Concrete pavement	0–1	--	1.5	--
Nonreinforced concrete facilities	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:

$$(10 \times UF)/TC \leq 1.0$$

Equation 4:

$$2 \times (UF + FA + FB + SL)/TC \leq 1.0$$

The concrete mix design must satisfy the following equation:

Equation 5:

$27 \times (TC - MC)/MC \leq 5.0$

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

Cure newly placed concrete by the method specified for the type of work involved.

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 C 309 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. 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 C 309 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 shown 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 gage 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 AASHTO M 171 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 means allowed by the Engineer.

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, precast 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 grading. After authorization of the grading, the aggregate furnished for minor concrete must comply with that grading.

If requested, submit periodic test reports of the aggregate grading 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 Control and 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.

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 91-1.02G(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.

90-3.01D Quality Control and 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 C 219 and the requirements shown in the following table:

Property	Test	Requirement[b]
Contraction in air	California Test 527, W/C ratio = 0.390 ± 0.010	0.053 percent max
Mortar expansion in water	ASTM C 1038	0.04 percent max
Soluble chloride[a]	California Test 422	0.05 percent max
Soluble sulfate[a]	California Test 417	0.30 percent max
Thermal stability	California Test 553	90 percent min
Compressive strength at 3 days	ASTM C 109	2,500 psi

[a]Perform the test on a cube specimen fabricated in compliance with ASTM C 109, 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 the cement proportioning system only. 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.

The specifications for shrinkage in section 90-1.02A do not apply.

90-4.01B Definitions

Reserved

90-4.01C Submittals

Submit a certificate of compliance for the cementitious material used in PC concrete products that you purchase. The certificate must be signed by the PC concrete product manufacturer.

Submit expansion test data under section 90-4.02, if required.

90-4.01D Quality Control and Assurance

For PC concrete that is steam cured:

1. Determine the concrete compressive strength from test cylinders that have been handled and stored under California Test 540, Method 3
2. Engineer evaluates the compressive strength based on individual tests representing specific portions of production
3. 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

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.

90-4.02 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 C 1567. 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.

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 from 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 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. The curing temperature throughout the enclosure must not exceed 150 degrees F and must be maintained 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. Use a minimum of 1 temperature recording device per 200 feet of continuous bed length for checking the temperature. Temperature recording devices must provide an accurate, continuous, permanent record of the curing temperature.
6. 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.
7. Curing is complete at the end of the steam curing cycle.

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(3)
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 gradings as an informational submittal.

90-5.01D Quality Control and Assurance

90-5.01D(1) General

Reserved

90-5.01D(2) 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(3) 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 shown in the following table:

SCC Mix Design Requirements

Property	Test	Requirement
Slump flow	ASTM C 1611	At least 20 inches
Flow rate, T_{50}	ASTM C 1611	2–7 seconds
Visual stability index	ASTM C 1611	1 or less
J-Ring flow	ASTM C 1621	The difference between J-Ring flow and slump flow must not exceed 2 inches
Column segregation	ASTM C 1610	Static segregation must not exceed 15 percent
Bleeding	ASTM C 232	Bleeding capacity must not exceed 2.5 percent
Compressive strength	California Test 521	The average of 5 test cylinders must be at least 600 psi greater than the strength described[a]
Minimum compressive strength	California Test 521	The minimum for an individual test cylinder must not be less than the strength described[a]

[a]At the maximum age specified or allowed

90-5.01D(4) 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 and the authorized shop drawings, 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(5) Field Quality Control

90-5.01D(5)(a) General

Reserved

90-5.01D(5)(b) Fine Aggregate Moisture Content

Determine the fine aggregate moisture content for each batch of SCC.

90-5.01D(5)(c) 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 C 1611.

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

90-6–90-9 RESERVED

91 PAINT

91-1 GENERAL

91-1.01 GENERAL

Section 91-1 includes general specifications for furnishing paints used for highway construction.

91-1.02 SAMPLING AND TESTING

The Department tests samples of paint taken from the source. Do not use paint until authorized.

91-1.03 MANUFACTURING AND PACKAGING

Paint must be manufactured ready for application. Do not add materials such as thinner after manufacture.

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

91-1.04 MATERIALS

Paint must be homogeneous and free of contaminants. Paint must be smooth and any settled pigment must be soft and easily dispersed before using.

Paint must retain the properties that affect its application, adhesion, and curing for at least 1 year after the date of manufacture.

If a paint is designated by a State Specification number, you may obtain the paint specification from METS.

Zinc-rich primer must be on the Authorized Material List.

91-2 PAINTS FOR METAL

91-2.01 GENERAL

Section 91-2 includes specifications for furnishing paint for metal.

91-2.02 EXTERIOR GRADE LATEX PAINT

Exterior grade latex paint must be approved by the manufacturer of the zinc rich primer.

Exterior grade latex paint must comply with SSPC-Paint 24 and the following:

1. When tested for 800 hours under ASTM D4587, test cycle 2, visible color change in the finish coat must not occur
2. Vehicle must be an acrylic or modified acrylic copolymer with a minimum of necessary additives

91-3 PAINTS FOR TIMBER

91-3.01 GENERAL

Section 91-3 includes specifications for furnishing paint for timber.

91-3.02 WOOD PRIMER, LATEX-BASE

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.

91-3.03 PAINT, LATEX-BASE FOR EXTERIOR WOOD, WHITE AND TINTS

Latex base paint for exterior wood must comply with the MPI detailed performance standards for paint, latex, exterior 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 paint, latex, exterior 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)

For unpainted wood, apply wood primer before paint.

91-4 MISCELLANEOUS PAINTS

91-4.01 GENERAL

Section 91-4 includes specifications for furnishing paint for materials other than metal or timber.

91-4.02–91-4.04 RESERVED

91-4.05 PAINT, ACRYLIC EMULSION, EXTERIOR WHITE AND LIGHT AND MEDIUM TINTS

Acrylic emulsion paint for exterior masonry must comply with the MPI detailed performance standards for saint, latex, exterior 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.

92 ASPHALTS

92-1.01 GENERAL

92-1.01A Summary

Section 92 includes specifications for producing, mixing, and applying asphalts.

92-1.01B Definitions

Reserved

92-1.01C Submittals

Reserved

92-1.01D Quality Control and Assurance

92-1.02D(1) General

Reserved

92-1.01D(2) Certification

Certification for asphalt must comply with the Department's *Certification Program for Suppliers of Asphalt*. For program requirements, procedures, and a list of authorized material sources, go to the METS Web site.

92-1.01D(3) Sampling

A sampling device must be located in the asphalt feed line connecting the plant storage tanks to the asphalt 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 must consist of refined petroleum or a mixture of refined liquid asphalt and refined solid asphalt prepared from crude petroleum. Asphalt must not include residues caused by artificial distillation of coal, coal tar, or paraffin. Asphalt must be homogenous and free of water.

92-1.02B Grades

PG asphalt binder must comply with the requirements shown in the following table:

PG Asphalt Binder

Property	AASHTO Test Method	Grade				
		PG 58–22[a]	PG 64–10	PG 64–16	PG 64–28	PG 70–10
Original Binder						
Flash point, min °C	T 48	230	230	230	230	230
Solubility, min %[b]	T 44	99	99	99	99	99
Viscosity at 135°C[c], max, Pa·s	T 316	3.0	3.0	3.0	3.0	3.0
Dynamic shear, Test temperature at 10 rad/s, °C min G*/sin(delta), kPa	T 315	58 1.00	64 1.00	64 1.00	64 1.00	70 1.00
RTFO test[e], mass loss, max, %	T 240	1.00	1.00	1.00	1.00	1.00
RTFO Test Aged Binder						
Dynamic shear, Test temperature at 10 rad/s, °C min G*/sin(delta), kPa	T 315	58 2.20	64 2.20	64 2.20	64 2.20	70 2.20
Ductility at 25°C min, cm	T 51	75	75	75	75	75
PAV[f], Test temperature, °C	R 28	100	100	100	100	110
RTFO Test and PAV Aged Binder						
Dynamic shear, Test temperature at 10 rad/s, °C max G*sin(delta), kPa	T 315	22[d] 5000	31[d] 5000	28[d] 5000	22[d] 5000	34[d] 5000
Creep stiffness, Test temperature, °C max S-value, MPa min M-value	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 this specification 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 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]"RTFO Test" means the asphaltic residue obtained using the Rolling Thin Film Oven Test, AASHTO Test Method T 240 or ASTM D 2872. The residue from mass change determination may be used for other tests.
[f]"PAV" means "Pressure Aging Vessel."

PG polymer modified asphalt binder must comply with the requirements shown in the following table:

PG Polymer Modified Asphalt Binder [a]

Property	AASHTO Test Method	Grade		
		PG 58–34 PM	PG 64–28 PM	PG 76–22 PM
Original Binder				
Flash point, min °C	T 48	230	230	230
Solubility, min % [b]	T 44[c]	98.5	98.5	98.5
Viscosity at 135°C[d], max, Pa·s	T 316	3.0	3.0	3.0
Dynamic shear, Test temperature at 10 rad/s, °C min G*/sin(delta), kPa	T 315	58 1.00	64 1.00	76 1.00
RTFO test[g], Mass loss, max, %	T 240	1.00	1.00	1.00
RTFO Test Aged Binder				
Dynamic shear, Test temperature at 10 rad/s, °C min G*/sin(delta), kPa	T 315	58 2.20	64 2.20	76 2.20
Dynamic shear, Test temperature at 10 rad/s, °C max (delta), %	T 315	80[e]	80[e]	80[e]
Elastic recovery[f], Test temperature °C min recovery, %	T 301	25 75	25 75	25 65
PAV[h], temperature, °C	R 28	100	100	110
RTFO Test and PAV Aged Binder				
Dynamic shear, Test temperature at 10 rad/s, °C max G*sin(delta), kPa	T 315	16 5000	22 5000	31 5000
Creep stiffness, Test temperature, °C max S-value, MPa min M-value	T 313	-24 300 0.300	-18 300 0.300	-12 300 0.300

[a]Do not modify PG Polymer Modified using polyphosphoric acid modification.
[b]The Engineer waives this specification if the supplier is an Approved Supplier as defined by the Department's *Certification Program for Suppliers of Asphalt.*
[c]The Department allows ASTM D 5546 instead of AASHTO T 44
[d]The Engineer waives this specification if the supplier provides written certification the asphalt can be adequately pumped and mixed at temperatures meeting applicable safety standards.
[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 two 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 Test" means the asphaltic residue obtained using the Rolling Thin Film Oven Test, AASHTO Test Method T 240 or ASTM D 2872. The residue from mass change determination may be used for other tests.
[h]"PAV" means "Pressure Aging Vessel."

92-1.03 CONSTRUCTION

Heat and apply asphalt as specified for liquid asphalts under section 93. Do not heat asphalt to the point where carbonized particles form.

92-1.04 PAYMENT

Asphalt will be paid for under other sections specifying construction requiring asphalt.

Whenever asphalt is a bid item paid for by weight, asphalt is measured as specified for determining the weight of liquid asphalts under section 93.

Weight is determined from volumetric measurements if:

1. Partial loads are used
2. A mixing plant is not used and scales are not available within 20 miles
3. Asphalt is delivered in:
   - 3.1. Calibrated trucks and each tank is 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

Whenever hot mix asphalt is produced from a mixing plant operating for only 1 project, volume is measured by taking tank measurements at the start and at the end of the project. The tank must be calibrated and equipped with a measuring stick and calibration card. Pay quantities must comply with the following:

1. Before converting the volume to weight, the volume measured must be reduced to what the asphalt would occupy at 60 degrees F.
2. Two hundred thirty-five gal/ton and 8.51 lb/gal must be used for the average weight and volume for both PG and PG polymer modified grades of asphalt at 60 degrees F.
3. Conversion tables in section 93 must be used.

93 LIQUID ASPHALTS

93-1.01 GENERAL

93-1.01A Summary

Section 93 includes specifications for mixing and applying liquid asphalt.

93-1.01B Submittals

Submit manufacturer's materials data for any materials shipment. Data must show results from tests.

If liquid asphalt is used before sampling and testing submit a certificate of compliance for each shipment to the job site. Certificates 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

If no certificate of compliance is submitted, do not use liquid asphalt until authorized.

93-1.01C Quality Control and Assurance

Reserved

93-1.02 MATERIALS

SC liquid asphalt must consist of natural crude oils or residual oils from crude petroleum. SC grades must comply with the requirements shown in the following table:

SC Liquid Asphalt

Property	Test method	Grade			
		SC-70	SC-250	SC-800	SC-3000
Flash point, Cl.O.C., °C min	AASHTO T48	65	80	90	105
Kinematic viscosity at 60 °C, square meter per second ($x10^{-6}$)	AASHTO T201	70-140	250-500	800-1600	3000-6000
Water, max %	AASHTO T55	0.5	0.5	0.5	0.5
Distillation: total distillate to 360 °C, percent volume	AASHTO T78	10-30	4-20	2-12	0-5
Tests on residue from distillation:					
Kinematic viscosity test at 60 °C, square meter per second ($x10^{-8}$)	AASHTO T201	4-70	8-85	20-140	40-350
Heptane Xylene equivalent, Max %[a]	AASHTO T102	35	35	35	35
Asphalt residue of 100 pen, min %	ASTM D243	50	60	70	80
Ductility of asphalt residue at 25 °C, min mm	AASHTO T51	1000	1000	1000	1000
Solubility in Trichloroethylene, min %	AASHTO T44	99.5	99.5	99.5	99.5

[a]Normal spot test and glass plate test repeated at end of 24-hour period will not be required.

MC liquid asphalt must comply with the specifications for paving asphalt in section 92 fluxed or blended with kerosene. MC asphalts must comply with the requirements shown in the following table:

MC Liquid Asphalt

Property	AASHTO Test Method	Grade			
		MC-70	MC-250	MC-800	MC-3000
Flash point (open tag), min °C	T79	40	65	65	65
Kinematic viscosity at 60 °C, square meter per second ($x10^{-6}$)	T201	70-140	250-500	800-1600	3000-6000
Water, max %	T55	0.2	0.2	0.2	0.2
Distillation percent by volume of total distillate to 360 °C:					
To 225 °C	T78	0-20	0-10	0-3	0-2
To 260 °C	T78	20-60	15-55	0-35	0-15
To 315 °C	T78	65-90	60-87	45-80	15-75
Residue from distillation to 360 °C. Volume percent of sample by difference, min %	T78	55	67	75	80
Tests on residue from distillation:					
Penetration 25 °C	T49	120-250	120-250	120-250	120-250
Ductility, 25 °C, min mm[a]	T51	1000	1000	1000	1000
Solubility in Trichloroethylene, min %	T44	99.5	99.5	99.5	99.5
Heptane Xylene equivalent, max %[b]	T102	35	35	35	35

[a]If penetration of residue is more than 200 and its ductility at 25 °C is less than 1000, the material will be acceptable if its ductility at 15 °C is equal to or more than 1000.

[b]Normal spot test and glass plate test repeated at end of 24 hour period will not be required.

93-1.03 CONSTRUCTION

93-1.03A General

Do not overspray liquid asphalts on existing facilities in the roadway including:

1. Adjacent pavements
2. The portion of the traveled way being used by traffic
3. Structures, railings and barriers, and markers
4. Trees and shrubbery that are not to be removed, adjacent property, and improvements

93-1.03B Mixing

Heat liquid asphalt by a retort or by steam coils in a manner that prevents steam from being introduced directly into the liquid asphalt during heating. Furnish a thermometer for determining the temperature of the liquid asphalt being applied. The thermometer must be available at all times.

Apply various grades of liquid asphalt at temperatures within the limits indicated in the following table and under the following conditions:

1. If liquid asphalt is mixed with aggregate, the aggregate temperature, at the time of adding the liquid asphalt, must not exceed the maximum shown in the column for pugmill mixing temperatures.
2. Liquid asphalt loaded into tank cars or trucks for transportation to the job site must not exceed the maximum temperatures shown in the table column for distributor application temperature unless authorized.

Application Temperatures of Liquid Asphalts

Grade of liquid asphalt	Pug mill mixing temperature of aggregate	Distributor application temperature	
	max °F	min °F	max °F
SC-70	--	105	175
SC-250	200	140	230
SC-800	225	175	255
SC-3000	260	215	290
MC-70	--	105	175
MC-250	200	140	230
MC-800	225	175	255
MC-3000	260	215	290

93-1.03C Application

Distributor trucks must comply with the following requirements:

1. Be equipped with a pressure type system with insulated tanks.
2. Spray bars must have a minimum length of 9 feet and be the full circulating type.
3. Spray bar extensions used to cover a greater width must be the full circulating type.
4. The spray bar must be adjustable to permit positioning at various heights above the surface to be treated.
5. The spray bar valves must be operated by levers so that one or all valves may be quickly opened or closed in one operation.
6. Cab controlled valves are permitted for application of seals. The valves controlling the flow from nozzles must act positively to provide a uniform unbroken application of liquid asphalt on the surface.
7. The distributor truck must be equipped with devices and charts to provide for accurate and rapid determination and control of liquid asphalt quantities being applied. Include an auxiliary wheel type bitumeter that registers (1) speed in feet per minute, (2) trip by count, and (3) total distance in feet.
8. The distributor equipment must be (1) capable of producing a uniform application of liquid asphalt in controlled amounts ranging from 0.02 to 1 gal/sq yd of surface and a pressure range from 25 to 75 psi. (2) equipped with a hose and nozzle for application to areas inaccessible to the distributor, and (3) equipped with pressure gages and a thermometer for determining temperatures of the liquid asphalt.

The use of gravity distributors is not permitted.

Maintain distributor and storage tanks at all times to prevent dripping of liquid asphalt from any part of the equipment.

Applying liquid asphalt is not permitted whenever (1) the surface to be treated is damp, (2) weather conditions are unsuitable, or (3) atmospheric temperature is below the minimum temperature specified for the particular type of work.

Provide a satisfactory method of accurately measuring the volume of liquid asphalt in the storage tanks and in each distributor unit at any time.

Dispose of excess liquid asphalt.

93-1.04 PAYMENT

The Department accepts railroad car weight as the basis for computing pay quantities for shipments of liquid bituminous products if the material is not to be loaded into trucks and the loaded car is weighed on track scales. Unless proven to be inaccurate, the tare stenciled on the car is used to determine the net content. If bituminous products are weighed on track scales, submit weight tags to the Engineer. Do not release the cars until inspected by the Engineer to determine that they are completely empty.

When hot mix asphalt is produced at a commercial plant, and when the product is not devoted to 1 project, and liquid asphalt is a separate bid item, the weight of liquid asphalt will be determined by multiplying the weight of the hot mix asphalt by the following factor:

x / (100 + x)

where:
x = the specified asphalt content expressed as percent of the weight of dry aggregate

When hot mix asphalt is produced at a commercial plant producing for only 1 project, the volume in the plant tank is measured before project start and at the end of the project. The tank must be calibrated and equipped with a measuring stick and calibration card.

Weight is determined from volumetric measurements if:

1. Partial loads are used
2. A mixing plant is not used and scales are not available within 20 miles
3. Liquid asphalt is delivered in:
   - 3.1. Trucks and each tank is calibrated and accompanied by its measuring stick and calibration card
   - 3.2. Trucks equipped with a calibrated thermometer that determines the liquid asphalt temperature at delivery and equipped with a vehicle tank meter

When quantities of liquid asphalt are determined from volumetric measurements, the measured volume is reduced to the volume the material would occupy at 60 degrees F before converting the volume to weight using the Conversion Table. SC and MC liquid asphalts of the same grade are considered to have equal weight per volume.

Use the factors shown in the following table to convert volume to weight:

Average Weight And Volumes Of Liquid Asphalt

Grade of liquid asphalt	Gallons/ton at 60 °F	Pounds/gallon at 60 °F
70	253	7.90
250	249	8.03
800	244	8.16
3000	240	8.30

Convert volumes of liquid asphalt products using the conversion table legend and conversion tables for the following materials:

1. Liquid asphalt Grades 70 to 3000
2. Paving asphalt Grades PG 58-22, PG 64-10, PG 64-16, PG 64-28, and PG 70-10.
3. Paving asphalt, polymer modified, Grades PG 58-34 PM, PG 64-28 PM, and PG 76-22 PM

The following Conversion Table Legend applies to the Conversion Table:

Conversion Table Legend

t=observed temperature in degrees Celsius. A=multiplier for reducing volumes to the basis of 60 °F, for asphalts with density at 60 °F of 60.3 pcf or higher. B=multiplier for reducing volumes to the basis of 60 °F, for asphalts with density at 60 °F of from 53.1 to 60.2 pcf.

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

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

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

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

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

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

94 ASPHALTIC EMULSIONS

94-1.01 GENERAL

94-1.01A Summary

Section 94 includes specifications for mixing and applying asphaltic emulsion.

94-1.01B Submittals

If the polymer content of polymer modified asphaltic emulsion is determined under California Test 401, submit a 1-quart sample each of the base asphalt and the polymer. Submit samples to METS at least 10 days before beginning work using the asphaltic emulsion.

Submit manufacturer's materials data for any materials shipment. Data must show results from tests.

If asphaltic emulsion is used before sampling and testing submit a certificate of compliance for each shipment to the job site. Certificates of compliance must include the following:

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

If no certificate of compliance is submitted, do not use asphaltic emulsion until authorized.

94-1.01C Quality Control and 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.

94-1.02 MATERIALS

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 also 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.

Polymer used to manufacture polymer modified asphaltic emulsion must be a type that results in the test values shown

When tested under AASHTO T 59, unless otherwise noted, properties of asphaltic emulsion must comply with the requirements for the types and grades in the following 4 tables:

TABLE I: Requirements for Anionic Asphaltic Emulsion

Properties	Type	Rapid-Setting				Medium-Setting						Slow-Setting			
	Grade	RS1		RS2		MS1		MS2		MS2h		SS1		SS1h	
		min	max	min	max	min	max	min	max	min	max	min	max	min	max
Tests on emulsions:															
Saybolt Furol Viscosity, @ 25 °C, SFS[a]		20	100	--	--	20	100	100	--	100	--	20	100	20	100
Saybolt Furol Viscosity, @ 50 °C, SFS[a]		--	--	75	400	--	--	--	--	--	--	--	--	--	--
Settlement, 5 days, %[b]		--	5	--	5	--	5	--	5	--	5	--	5	--	5
Storage stability test, 1 day, %[c]		--	1	--	1	--	1	--	1	--	1	--	1	--	1
Demulsibility, 35 ml, 0.02 *N* $CaCl_2$, %[d]		60	--	60	--	--	--	--	--	--	--	--	--	--	--
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		--		--	
Cement mixing test, %		--	--	--	--	--	--	--	--	--	--	--	2.0	--	2.0
Sieve test, %		--	0.10	--	0.10	--	0.10	--	0.10	--	0.10	--	0.10	--	0.10
Residue by distillation, %		55	--	63	--	55	--	65	--	65	--	57	--	57	--
Tests on residue from distillation test:															
Penetration, 25 °C		100[e]	200	100[e]	200	100	200	100	200	40	90	100	200	40	90
Ductility, 25 °C, 50 mm/minute, mm		400	--	400	--	400	--	400	--	400	--	400	--	400	--
Solubility in trichloroethylene, %		97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--

[a]SFS means Saybolt Furol seconds

[b]The Engineer may require settlement tests from the time the sample is received until the asphaltic emulsion is used if the elapsed time is less than 5 days. Settlement tests may be waived when the asphaltic emulsion is used in less than 5 days.

[c]The 24-hour storage stability test may be used instead of the 5-day settlement test

[d]The demulsibility test must be made within 30 days from date of shipment.

[e]A harder base asphalt meeting current paving asphalt specifications may be specified if the test requirements on the residue from distillation are waived.

TABLE 2: Requirements for Cationic Asphaltic Emulsion

Type	Rapid-Setting				Medium-Setting						Slow-Setting			
Grade	CRS1		CRS2		CMS2S		CMS2		CMS2h		CSS1		CSS1h	
Properties	min	max	min	max	min	max	min	max	min	max	min	max	min	max
Tests on emulsions:														
Saybolt Furol Viscosity, @ 25 °C, SFS [a]	--	--	--	--	--	--	--	--	--	--	20	100	20	100
Saybolt Furol Viscosity, @ 50 °C, SFS [a]	20	100	100	400	50	450	50	450	50	450	--	--	--	--
Settlement, 5 days, % [b]	--	5	--	5	--	5	--	5	--	5	--	5	--	5
Storage stability test, 1 day, % [c]	--	1	--	1	--	1	--	1	--	1	--	1	--	1
Demulsibility, 35 ml, 0.8% sodium dioctyl sulfosuccinate, % [d]	40	--	40	--	--	--	--	--	--	--	--	--	--	--
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		positive		positive		positive [f]		positive [f]	
Sieve test, %	--	0.10	--	0.10	--	0.10	--	0.10	--	0.10	--	0.10	--	0.10
Cement mixing test, %	--	--	--	--	--	--	--	--	--	--	--	2.0	--	2.0
Distillation:														
Oil distillate by vol. of emulsion, %	--	3	--	3	--	20	--	12	--	12	--	--	--	--
Residue, %	60	--	65	--	60	--	65	--	65	--	57	--	57	--
Tests on residue from distillation test:														
Penetration, 25 °C	100 [e]	250	100 [e]	250	100	250	100	250	40	90	100	250	40	90
Ductility, 25 °C, 50 mm/min, mm	400	--	400	--	400	--	400	--	400	--	400	--	400	--
Solubility in trichloroethylene, %	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--	97.5	--

[a] Means Saybolt Furol seconds

[b] The Engineer may require settlement tests from the time the sample is received until the asphaltic emulsion is used if the elapsed time is less than 5 days. Settlement tests may be waived when the asphaltic emulsion is used in less than 5 days.

[c] The 24-hour storage stability test may be used instead of the 5-day settlement test.

[d] The demulsibility test must be made within 30 days from date of shipment.

[e] A harder base asphalt in compliance with the paving asphalt specifications may be specified if the test requirements on the residue from distillation are waived.

[f] Must comply with a pH requirement of 6.7 maximum (ASTM E 70) if the particle charge test result is inconclusive.

TABLE 3: Requirements for Polymer Modified Asphaltic Emulsion

Properties		Type	Anionic				Cationic			
		Grade	PMRS2		PMRS2h		PMCRS2		PMCRS2h	
			min	max	min	max	min	max	min	max
Tests on emulsions:	Test Method		--				--			
Saybolt Furol Viscosity, @ 50 °C, SFS [a]	AASHTO T 59		75	300	75	300	75	300	75	300
Settlement, 5 days, %			--	5	--	5	--	5	--	5
Storage Stability, 1 day, %			--	1	--	1	--	1	--	1
Sieve Test, %			--	0.30	--	0.30	--	0.30	--	0.30
Demulsibility, %			60[b]	--	60[b]	--	40[c]	--	40[c]	--
Particle Charge			--		--		Positive		Positive	
Ash Content, %	ASTM D 3723		--	0.2	--	0.2	--	0.2	--	0.2
Residue by Evaporation, %	California Test 331		65	--	65	--	65	--	65	--
Test on residue from evaporation test:	California Test 331		--				--			
Penetration, 25°C	AASHTO T 49		100	200	40	90	100	200	40	90
Ductility, 25°C, mm	AASHTO T 51		400	--	400	--	400	--	400	--
and either:	--									
Torsional recovery, %	California Test 332		18	--	18	--	18	--	18	--
or	--									
Polymer content, 5% (by weight)[d]	California Test 401		2.5	--	2.5	--	2.5	--	2.5	--

[a]Means Saybolt Furol seconds
[b]Use 35 ml of 0.02 *N* $CaCL_2$ solution
[c]Use 35 ml of 0.8% sodium dioctyl sulfosuccinate solution
[d]See sampling requirements specified in 94-1.01C and 94-1.01D.

TABLE 4: Requirements for Quick-Setting Asphaltic Emulsion

Properties	Type	Anionic				Cationic			
	Grade	QS1		QS1h		CQS1		CQS1h	
		min	max	min	max	min	max	min	max
Tests on emulsions:	Test Method	--				--			
Saybolt Furol Viscosity, @ 50 °C, SFS [a]	AASHTO T 59	15	90	15	90	15	90	15	90
Sieve test, %		--	0.30	--	0.30	--	0.30	--	0.30
Storage stability, 1 day, %		--	1	--	1	--	1	--	1
Residue by distillation, %		57	--	57	--	57	--	57	--
Particle charge[b]		negative		negative		positive		positive	
Tests on Residue from Distillation Test:	--	--				--			
Penetration, 25°C	AASHTO T 49	100	200	40	90	100	200	40	90
Ductility, 25°C, mm	AASHTO T 51	400	--	400	--	400	--	400	--
Solubility in trichloroethylene, %	AASHTO T 44	97	--	97	--	97	--	97	--

[a]Means Saybolt Furol seconds

[b]If the result of the particle charge test is inconclusive, the asphaltic emulsion must be tested for pH under ASTM E 70. 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

Asphaltic emulsion may be reheated if necessary. After loading into a tank car or truck for transport to the job site, do not heat asphaltic emulsion above 160 degrees F. During reheating agitate the asphaltic emulsion to prevent localized overheating.

Apply asphaltic emulsion under section 93.

Except when used for fog seal coats, apply Setting Grade 1 asphaltic emulsions at a temperature from 75 to 130 degrees F and apply Setting Grade 2 asphaltic emulsions from 110 to 185 degrees F.

Asphaltic emulsion must not cool to a temperature below 40 degrees F.

94-1.04 PAYMENT

Asphaltic emulsion is measured by weight under the specifications requiring its use not including the deducted weight of water if used.

Asphaltic emulsion quantities are determined as specified for liquid asphalts under section 93 except for volumetric measurement to determine pay quantities.

Weight is determined from volumetric measurements if:

1. Partial loads are used
2. A mixing plant is not used and scales are not available within 20 miles
3. Asphaltic emulsion is delivered in:
   - 3.1. Trucks with each tank calibrated accompanied by its measuring stick and calibration card
   - 3.2. Trucks equipped with a calibrated thermometer that determines the asphaltic emulsion temperature at delivery and equipped with a vehicle tank meter

For asphaltic emulsion determined from volumetric measurements, the measured volume is reduced to the volume the material would occupy at 60 degrees F before converting the volume to weight using the values in the table titled "Conversion Table."

Convert volume to weight using the factors shown in the following table:

Average Weight and Volume of Asphaltic Emulsion

Type of asphaltic emulsion	Gallons/Ton at 60 °F	Pounds/Gallon 60 °F
All types	240	8.33

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 Fahrenheit
M = multiplier for reducing volumes to the basis of 60 °F

95 EPOXY

95-1 GENERAL

95-1.01 DESCRIPTION

Section 95-1 includes general specifications for mixing and applying epoxy for highway construction.

Furnish epoxy as 2 components and mix them together at the job site.

The 2 proportioned epoxy components define a kit when packaged together.

95-1.02 SAMPLING AND TESTING

Submit a certificate of compliance for epoxy.

95-1.03 PACKAGING, LABELING, AND STORING

Each component must be packaged in a container of a size that complies with the epoxy manufacturer's instructions for proportions.

Component containers must be sealed and not leak. Containers must not react with components.

The container for each component must be clearly labeled by the epoxy manufacturer with the following information:

1. ASTM C 881/C 881M 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 components at temperatures greater than 35 degrees F.

95-1.04 DIRECTION FOR USE

Mix and apply the epoxy under the manufacturer's instructions.

Do not use a component if any of the following occur:

1. Evidence of crystallization or thickening
2. Settled pigments that cannot be readily dispersed with a paddle
3. Component is older than the manufacturer's recommended expiration date

Thoroughly stir each component before mixing a kit. 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 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.

95-2 TYPES OF EPOXIES

95-2.01 EPOXY BINDER

Epoxy binder must be 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 C 881/C 881M, Type IV, Grade 1, Class B or C.

For nonload bearing applications, the epoxy must comply with ASTM C 881/C 881M, 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.

Thoroughly mix the components before adding aggregate if the epoxy is used as binder for HS epoxy concrete or epoxy mortar. 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. Prime surfaces with epoxy immediately before placing epoxy concrete or mortar.

95-2.02 RESERVED

95-2.03 EPOXY ADHESIVE FOR BONDING FRESHLY MIXED CONCRETE TO HARDENED CONCRETE

Epoxy adhesive for bonding freshly mixed concrete to hardened concrete must comply with ASTM C 881/C 881M, 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.

Coat the blast-cleaned concrete surface with epoxy using a brush or roller. Place freshly mixed concrete while the epoxy is tacky. Apply a new coat of epoxy if the epoxy sets.

95-2.04 RAPID SET EPOXY ADHESIVE FOR PAVEMENT MARKERS

Rapid set epoxy adhesive for bonding pavement markers to concrete and HMA must comply with ASTM C 881/C 881M, Type IV, Grade 3, Class B or C, except the gel time 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.

When tested under California Test 434, epoxy must comply with the requirements for the properties shown in the following table:

Rapid Set Epoxy Adhesive For Pavement Markers

Property	Requirement
Gel time, minutes, maximum, at 77 °F	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, minimum, psi	
2 days at 77 ± 2 °F	1,000
14 days at 77 ± 2 °F, plus water soak	1,500
Tensile adhesion and cohesion, minimum, 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 D 4065

95-2.05 STANDARD SET EPOXY ADHESIVE FOR PAVEMENT MARKERS

Standard set epoxy adhesive for bonding pavement markers to concrete and HMA must comply with ASTM C 881/C 881M, 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.

When tested under California Test 434, epoxy must comply with the requirements for the properties shown in the following table:

Standard Set Epoxy Adhesive For Pavement Markers

Property	Requirement
Bond strength to concrete, time, maximum to reach not less than 200 psi	
at 77 ± 2 °F	3.5 hours
at 55 ± 2 °F	24 hours
Slant shear strength, minimum, psi	
2 days at 77 ± 2 °F	1,000
14 days at 77 ± 2 °F, plus water soak	1,500
Tensile adhesion and cohesion, minimum, 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 D 4065

95-2.06–95-2.08 RESERVED

95-2.09 EPOXY SEALANT FOR INDUCTIVE LOOPS

The epoxy for sealing inductive loops and leads imbedded in HMA and concrete must comply with ASTM C 881/C 881M, Type I, Grade 2.

When tested under California Test 434, epoxy sealant must comply with the values for the properties shown in the following table:

Epoxy Sealant for Inductive Loops

Property	Value
Tensile strength[a], minimum, psi	400
Elongation[a], minimum, %	90
Shore D hardness[a], minimum	45

[a]Test on a 0.125-inch cast sheet, cured 18 hours at 77 °F plus 5 hours at 160 °F

95-2.10 RESERVED

95-2.11 EPOXY RESIN ADHESIVE FOR PRESSURE INJECTION GROUTING OF CONCRETE PAVEMENT

Epoxy resin adhesive for injection grouting of concrete pavement must comply with the values for the properties when tested as shown in the following table:

Epoxy Resin Adhesive for Injection Grouting of Concrete Pavement

Property	California Test 434	Value
Brookfield viscosity, no. 3 spindle at 20 rpm, poise, maximum, at 77 °F	Part 4, "Brookfield Viscosity"	0.9
Gel time, minutes	Part 1, "Gel Time"	2–15
Slant shear strength on dry concrete, minimum, psi, after 4 days of cure in air at 77 ± 2 °F	Part 5, "Slant Shear Strength"[a]	3,000
Slant shear strength on wet concrete, minimum, psi, after 4 days of cure in air at 77 ± 2 °F	Part 5, "Slant Shear Strength"[a]	1,700
Tensile strength, minimum, psi	Part 7, "Tensile Strength and Elongation" except test after 4 days of cure at 77 ± 2 °F	4,500
Elongation, %, maximum	Part 7, "Tensile Strength and Elongation" except test after 4 days of cure at 77 ± 2 °F	10

[a]For slant shear strength on concrete, procedures B-1 and B-5 do not apply. Testing on dry concrete must comply with item 2 listed in the following. Testing on wet concrete must comply with both of the following:

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.

96–98 RESERVED

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