

**STATE OF OHIO**

**DEPARTMENT OF  
TRANSPORTATION  
COLUMBUS, OHIO**

**CONSTRUCTION AND MATERIAL  
SPECIFICATIONS**



**JANUARY 1, 2010**

An Equal Opportunity Employer

Copies of the Construction and Material Specifications may be purchased by contacting:

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## 100 GENERAL PROVISIONS

### 101 DEFINITIONS AND TERMS

**101.01 General.** These Construction and Material Specifications are written to the Bidder before award of the Contract and to the Contractor after award of the Contract. The sentences that direct the Contractor to perform Work are written as commands. For example, a requirement to provide cold-weather protection would be expressed as, “Provide cold-weather protection for concrete,” rather than “The Contractor shall provide cold-weather protection for concrete.” In the imperative mood, the subject “the Bidder” or “the Contractor” is understood.

All requirements to be performed by others have been written in the active voice. Sentences written in the active voice identify the party responsible for performing the action. For example, “The Engineer will determine the density of the compacted material.” Certain requirements of the Contractor may also be written in the active voice, rather than the active voice and imperative mood, if the sentence includes requirements for others in addition to the Contractor. For example, “After the Contractor provides initial written notice, the Engineer will revise the Contract as specified in 104.02.”

Sentences that define terms, describe a product or desired result, or describe a condition that may exist are written in indicative mood. These types of sentences use verbs requiring no action. For example, “The characteristics of the soils actually encountered in the subgrade may affect the quality of the cement and depth of treatment necessary.”

**101.02 Abbreviations.** The following abbreviations, when used in the Contract Documents, represent the full text shown.

AAN	American Association of Nurserymen
AASHTO	American Association of State Highway and Transportation Officials
AC	Asphalt Cement (pavement), Alternating Current (traffic)
ACBF	Air Cooled Blast Furnace slag (aggregate)
ACI	American Concrete Institute
ACIA	Asynchronous Communications Interface Adapter (traffic controller)
ADT	Average Daily Traffic
ADTT	Average Daily Truck Traffic
AIC	Amps Interrupting Capacity
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANFO	Ammonium Nitrate Fuel Oil
ANSI	American National Standards Institute
AOS	Apparent Opening Size (fabric)
AREA	American Railway Engineering Association

**101.02**

ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
ATFDB	Asphalt treated Free Draining Base
AWG	American Wire Gauge
AWPA	American Wood Preservers' Association
AWS	American Welding Society
AWWA	American Water Works Association
BBR	Bending Beam Rheometer (asphalt test)
BMP	Best Management Practice (erosion)
BOF	Basic Oxygen Furnace (aggregate)
BSG	Bulk Specific Gravity
BTEX	Benzene, toluene, ethyl benzene, and xylene (a soil test)
BUSTR	Bureau of Underground Storage Tank Regulations (Division of Fire Marshal)
C&MS	Construction and Material Specifications
CAPWAP	Case Pile Wave Analysis Program
CBAE	Cut Back Asphalt Emulsion
CCRL	Cement and Concrete Reference Laboratory
CCS	Crushed Carbonate Stone
CECI	Contactors Erosion Control Inspector
CFR	Code of Federal Regulations
CIE	Commission Internationale d'Eclairage (illumination)
CPESC	Certified Professional in Erosion and Sediment Control
CRS	Cationic Rapid Set (asphalt emulsion)
CRSI	Concrete Reinforcing Steel Institute
CSS	Cationic Slow Set (asphalt emulsion)
CVN	Charpy V-notch (steel test)
CWT	Hundred Weight (100 lbs)
DC	Direct Current
DCE	District Construction Engineer
DDD	District Deputy Director
DET	District Engineer of Tests
DGE	District Geotechnical Engineer
DLS	Data Logging System (traffic markings)
DNR	Department of Natural Resources
DRC	Dry Rodded Condition (asphalt test)
DSR	Dynamic Shear Rheometer (asphalt test)
DZA	Deficient Zone Average (concrete test)
EAF	Electric Arc Furnace
EDA	Earth Disturbing Activity
EEL	Edison Electric Institute
EIA	Electronic Industries Alliance
EPA	Environmental Protection Agency
EQS	Exceptional Quality Solids (compost)
FAA	Fine Aggregate Angularity (asphalt aggregate)
FCM	Fracture Critical Member (steel test)
FEMA	Federal Emergency Management Agency

FHWA	Federal Highway Administration, Department of Transportation
FRP	Fiber Reinforced Polymer
FSS	Federal Specifications and Standards, General Services Administration
GGBFS	Ground Granulated Blast Furnace Slag
GS	Granulated Slag
HDPE	High Density Polyethylene
HFRS	High Float Rapid Setting (emulsion)
HMWM	High Molecular Weight Methacrylate
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
IMSA	International Municipal Signal Association
IPCEA	Insulated Power Cable Engineers Association
IPS	International Pipe Standard
ISSA	International Slurry Seal Association
ITE	Institute of Transportation Engineers
IZEU	Inorganic Zinc Epoxy Urethane
JMF	Job Mix Formula
LED	Light Emitting Diode
LWT	Loaded Wheel Test (asphalt test)
MBF	Thousand Board Feet (wood)
MC	Medium Cure (asphalt emulsion)
MCB	Microchannel Bus (traffic controller)
MMK	Blaw-Knox Materials Management Kit
MOV	Metal Oxide Varistor (traffic controller)
MPI	Magnetic Particle Inspection (steel test)
MSDS	Material Safety Data Sheets
MSG	Maximum Specific Gravity (asphalt)
MTD	Maximum Theoretical Density (asphalt)
NACE	National Association of Corrosion Engineers
NCHRP	National Cooperative Highway Research Program
NEMA	National Electrical Manufacturers Association
NHI	National Highway Institute
NIST	National Institute of Standards and Technology
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
OAC	Ohio Administrative Code
ODOT	Ohio Department of Transportation
OEPA	Ohio Environmental Protection Agency
OH	Open Hearth (aggregate)
OHWM	Ordinary High Water Mark
OMM	Office of Materials Management (the Lab)
OMUTCD	Ohio Manual of Uniform Traffic Control Devices
ORC	Ohio Revised Code
ORDC	Ohio Rail Development Commission
OSHA	Occupational Safety and Health Administration
OTE	Office of Traffic Engineering

**101.02**

OWPCA	Ohio Water Pollution Control Act
OZEU	Organic Zinc Epoxy Urethane
PAT	Project Average Thickness (concrete test)
PAV	Pressure Aging Vessel (asphalt test)
PB	Polybutylene (conduit)
PCC	Portland Cement Concrete
PCS	Petroleum Contaminated Soil
PDA	Pile Dynamic Analysis (steel piling)
PE	Polyethylene (conduit)
PG	Performance Grade (asphalt test)
pH	Potential of Hydrogen
PLS	Pure Live Seed
PVC	Polyvinyl chloride
QA	Quality Assurance
QC	Quality Control
QCFS	Quality Control Fabricator Specialist (structures)
QCP	Quality Control Program, or Quality Control Points (steel test)
QCQC	Quality Control Qualification Committee
QPL	Qualified Products List
RACP	Reclaimed Asphalt Concrete Pavement
RAP	Recycled Asphalt Pavement
RC	Rapid Cure (asphalt emulsion)
REA	Rural Electrification Administration
RFI	Radio Frequency Interference (traffic controller)
RH	Relative Humidity
RMS	Root Mean Square (traffic controller)
RPCC	Recycled Portland Cement Concrete
RPM	Raised Pavement Marker (traffic)
RS	Rapid Set (asphalt emulsion)
RTFO	Rolling Thin-Film Oven (asphalt test)
RUS	Rural Utilities Service
SAE	Society of Automotive Engineers
SBA	Styrene Butadiene Amene
SBR	Styrene Butadiene Rubber
SBS	Styrene Butadiene Styrene
SCD	Standard Construction Drawing
SF	Standard Fabricated members (structures)
SI	International System of Units (Metric)
SMA	Stone Matrix Asphalt
SPD	Surge Protection Device (traffic controller)
SPST	Single Pole / Single Throw (traffic controller)
SS	Slow Set (asphalt emulsion)
SSD	Saturated Surface Dry (aggregate)
SSPC	Society for Protective Coatings
SWPPP	Storm Water Pollution Prevention Plan
TCE	Trichloroethylene
TMPTA	Tri-methylpropane Tri-acrylate (paint)
TNP	Total Neutralizing Power

TODS	Tourist-Oriented Directional Signs
TSECC	Temporary Sediment and Erosion Control
TSR	Tensile Strength Ratio (asphalt test)
UF	Unique Fabricated members (structures)
UL	Underwriters' Laboratories, Inc
USACE	United States Army Corps of Engineers
USC	United States Code
VA	Verification Acceptance
VAC	Volts Alternating Current
VCA	Volume of Coarse Aggregate (asphalt test)
VECP	Value Engineering Change Proposal
VMA	Voids in the Mineral Aggregate
VME	VersaModule Eurocard (traffic controller)
WDT	Watchdog Timer
WEAP	Wave Equation Analysis (steel piling)
WPS	Welding Procedure Specification (steel test)
WZRPMP	Work Zone Raised Pavement Marker (traffic)
XCU	Explosion, Collapse and Underground

**101.03 Definitions.** The following terms or pronouns, when used in the Contract Documents, are defined as follows:

**Advertisement.** The public announcement, as required by law, inviting Bids for Work to be performed or materials to be furnished.

**Award.** The written acceptance by the Director of a Bid.

**Bid.** The offer of a Bidder, on the prescribed form properly signed and guaranteed, to perform the Work and to furnish the labor and materials at the prices quoted.

**Bid Documents.** The Bid Documents include the Invitation for Bids, Addenda, Proposal, Expedite file, contract form and required bonds, Specifications, Supplemental Specifications, Special Provisions, general and detailed plans, Plan notes, standard construction drawings identified in the Plans, notice to contractor, and any other document designated by the Department as a Bid Document, all of which constitute one instrument.

**Bidder.** An individual, firm, or corporation submitting a Bid for the advertised Work, acting directly or through the duly authorized representative, and qualified as provided in ORC 5525.02 to 5525.09.

**Bridge.** A structure, including supports, erected over a depression or an obstruction, such as water, a highway, or a railway, and having a track or passageway for carrying traffic or other moving loads and having a length measured along the center of roadway of 10 feet (3.048 m) or more between undercopings of abutments or extreme limits of openings for multiple boxes.

**A. Length.** The length of a bridge structure is the over-all length measured along the centerline of the roadway surface.

**B. Roadway Width.** The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs or guard timbers or, in the case of multiple heights of curbs, between the bottoms of the lower risers. For curb widths of 1 foot (0.3 m) or less, the roadway width is measured between parapets or railings.

**Calendar Day or Day.** Every day shown on the calendar.

**Certified Test Data.** A test report from a manufacturer's or an independent laboratory approved by the Director listing actual test results of samples tested for compliance with specified Department requirements. The Department will accept certified test data from manufacturers' laboratories if their products have been used satisfactorily on prior Department contracts and their test data has been confirmed. Include a statement that the test data furnished is representative of the material furnished to a Department project or to a supplier. The report is identified by number or date and identifies the Department project or supplier to which the material is shipped. Submit reports signed by a person having legal authority to act for the manufacturer or independent laboratory.

**Change Order.** A written order issued by the Director to the Contractor, covering changes to the terms and conditions, plans and/or quantities, within or beyond the scope of the Contract and establishing the basis of payment and time adjustments for the work affected by the changes.

**Claims.** Disputes that are not settled through Steps 1 and 2 of the Dispute Resolution and Administrative Claim Process and for which the Contractor has documented costs or time incurred as a result of such disputes. The Dispute becomes a Claim when the Contractor submits a Notice of Intent to File a Claim.

**Completion Date.** The date, as shown in the Contract Documents, on which the Work contemplated shall be completed.

**Contract.** The written agreement between the Department and the Contractor setting forth the obligations of the parties, including, but not limited to, the performance of the Work and the basis of payment.

**Contract Bond.** The approved forms of security, executed by the Contractor and its Sureties, guaranteeing complete execution of the Work as required by the Contract Documents and the payment of all legal debts pertaining to the construction of the Project which security shall comply with and be subject to ORC 5525.16 and 5525.13, and related provisions.

**Contract Documents.** The Contract Documents include the Invitation for Bids, Addenda, Proposal, contract form and required bonds, Specifications, Supplemental Specifications, Special Provisions, general and detailed plans, Plan notes, standard construction drawings identified in the Plans, notice to contractor, Change Orders, Supplemental Agreements, Extra Work Contracts, and any other document designated by the Department as a Contract Document, all of which constitute one instrument.

**Contract Item (Pay Item).** A specifically described unit of Work for which a price is provided in the Contract.

**Contract Price.** The amount of compensation bid by the Contractor for a Contract Item in the Proposal or the amount of compensation established for a Contract Item added or modified pursuant to the Contract Documents. **Contract Time.** The number of workdays or calendar days, including authorized adjustments, allowed for completion of the Project. When a specified Completion Date is shown in the Contract Documents instead of the number of workdays or calendar days, completion of the Project shall occur on or before that date. Specified Completion Date and Calendar Day Contracts shall be completed on or before the day indicated even when that date is a Saturday, Sunday, or holiday.

**Contractor.** The individual, firm, or corporation contracting with the Department for performance of prescribed Work, acting directly or through a duly authorized representative and qualified under the provisions of ORC 5525.02 to 5525.09 inclusive, and any amendments thereto.

**County.** The designated county in which the Work specified is to be done.

**Culvert.** Any structure not classified as a Bridge that provides an opening under the roadway.

**Department.** The Department of Transportation, State of Ohio.

**Director.** Administrative head of the Department appointed by the Governor.

**Disputes.** Disagreements, matters in question and differences of opinion between the Department's personnel and the Contractor that may include a request for additional money and/or time.

**Engineer.** Duly authorized agent of the Department acting within the scope of its authority for purposes of engineering and administration of the Contract.

**Equipment.** All machinery and equipment, together with the necessary supplies for upkeep and maintenance, and also tools and apparatus necessary for the proper construction and acceptable completion of the Work.

**Extra Work.** An item of Work not provided for in the Contract as awarded but found essential to the satisfactory completion of the Contract within its intended scope.

**Extra Work Contract.** A Contract concerning the performance of Work or furnishing of materials involving Extra Work. Such Extra Work may be performed at agreed prices or on a force account basis as provided in ORC 5525.14.

**Fabricator.** The individual, firm, or corporation that fabricates structural metals or prestressed concrete members as an agent of the Contractor.

**Final Inspector.** An Engineer appointed by the DDD who inspects the completed Work and accepts it if it complies with the Contract Documents.

**Inspector.** The Engineer's authorized representative assigned to make detailed inspections of Contract performance.

**Invitation for Bids.** The invitation for Proposals for all Work on which Bids are required. Such Proposal will indicate with reasonable accuracy the quantity

### 101.03

and location of the Work to be done or the character and quality of the material to be furnished and the time and place of the opening of Proposals.

**Laboratory.** The testing laboratories of the Department, including the Office of Materials Management located at 1600 West Broad Street, Columbus, Ohio, and various District testing facilities.

**Materials.** Any materials or products specified for use in the construction of the Project and its appurtenances.

**Plans.** The drawings, standard construction drawings and supplemental drawings provided by the Department that show the location, character, dimensions, and details of the Work.

**Prebid Question.** A written inquiry submitted by a prospective bidder.

**Profile Grade.** The trace of a vertical plane intersecting the top surface of the proposed wearing surface, usually along the longitudinal centerline of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.

**Project Right-of-Way.** That portion of the Right-of-Way between the beginning and end of the Project.

**Project.** The specific section of the highway together with all appurtenances and Work to be performed thereon under the Contract.

**Proposal.** The approved form on which the Department requires Bids to be prepared and submitted for the Work.

**Proposal Guaranty.** The security furnished with a Bid to guarantee that the Bidder will enter into the Contract if its Bid is accepted.

**Questionnaire.** The specified forms on which the Contractor shall furnish required information as to its ability to perform and finance the Work required under ORC 5525.01.

**Reasonably Close Conformity.** Reasonably close conformity means compliance with reasonable and customary manufacturing and construction tolerances where working tolerances are not specified. Where working tolerances are specified, reasonably close conformity means compliance with such working tolerances. Without detracting from the complete and absolute discretion of the Engineer to insist upon such tolerances as establishing reasonably close conformity, the Engineer may accept variations beyond such tolerances as reasonably close conformity where they will not materially affect the value or utility of the Work and the interests of the Department.

**Registered Engineer.** An engineer registered with the Ohio State Board of Registration for Professional Engineers and Surveyors to practice professional engineering in the State of Ohio

**Registered Surveyor.** A surveyor registered with the Ohio State Board of Registration for Professional Engineers and Surveyors to practice professional surveying in the State of Ohio.

**Right-of-Way.** A general term denoting land, property, or interest therein, usually in a strip, acquired for or devoted to a highway.

**Road.** A general term denoting a public way for purposes of vehicular travel, including the entire area within the Right-of-Way, as defined in ORC 5501.01.

**Roadbed.** The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulder.

**Roadside.** The areas between the outside edges of the shoulders and the Right-of-Way boundaries. Unpaved median areas between inside shoulders of divided highways and infield areas of interchanges are included.

**Roadside Development.** Those items necessary to the highway that provide for the preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seeding, sodding, mulching, and the placing of other ground covers; such suitable planting; and other improvements as may increase the effectiveness and enhance the appearance of the highway.

**Roadway.** The portion of a highway within limits of construction.

**Shop Drawings.** The drawings provided by the Contractor or Supplier that describe any portion of the Work that will remain in place permanently.

**Shoulder.** The portion of the roadway contiguous to the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

**Sidewalk.** That portion of the roadway primarily constructed for the use of pedestrians.

**Signatures on Contract Documents.** All signatures on Contract Documents must meet the requirements of 102.06.

**Special Provisions.** Additions and revisions to the standard and Supplemental Specifications covering conditions peculiar to an individual Project.

**Specifications.** The directions, provisions, and requirements contained herein as supplemented by the Supplemental Specifications and Special Provisions.

**State.** The State of Ohio acting through its authorized representative.

**Street.** A general term denoting a public way for purpose of vehicular travel, including the entire area within the Right-of-Way.

**Structures.** Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, buildings, sewers, service pipes, underdrains, foundation drains, and other features that may be encountered in the Work and not otherwise classed herein.

**Subcontractor.** An individual, firm, or corporation to whom the Contractor sublets part of the Contract to be performed on the job site, who prior to such undertaking receives the written consent of the Director, and who is qualified under ORC 5525.02 through 5525.09 inclusive.

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**Subgrade.** The portion of a Roadbed upon which the pavement structure and shoulders are constructed.

**Substructure.** All of that part of the structure below the bearings of simple and continuous spans, skewbacks of arches, and tops of footings of rigid frames, together with backwalls and wings.

**Superintendent.** The Contractor's authorized representative in responsible charge of the Work.

**Superstructure.** The entire structure except the Substructure.

**Supplement.** A list of requirements for fabrication plants, methods of test, or other miscellaneous requirements that are maintained on file in the Office of the Director.

**Supplemental Agreement.** A written agreement executed by the Contractor and by the Director covering necessary alterations.

**Supplemental Specifications.** Detailed specifications supplemental to or superseding these Specifications.

**Surety.** The corporation, partnership, or individual, other than the Contractor, executing a bond furnished by the Contractor.

**Titles (or Headings).** The titles or headings of the sections and subsections herein are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.

**Waters of the United States.** Waters that are under the jurisdiction of the Corps of Engineers under the Clean Water Act as defined by 33 CFR Ch. II Part 328, which as applied to Ohio means: the Ohio River and Lake Erie and any other river, stream, creek, lake, pond, or wetland that drains directly or indirectly into the Ohio River or Lake Erie.

**Work.** All labor, materials, equipment, tools, transportation, supplies, and other incidentals and all tasks that comprise the project or any portion thereof, as described by the Contract Documents.

**Workday.** A calendar day that the Contractor normally works.

**Working Drawings.** Stress sheets, shop drawings, erection plans, falsework plans, installation plans, certified drawings, frame work plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data that the Contractor is required to submit.

**101.04 Interpretations.** In order to avoid cumbersome and confusing repetition of expressions in these Specifications, it is provided that whenever anything is, or is to be, done, if, as, or, when, or where "contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected, or condemned," it shall be understood as if the expression were followed by the words "by the Engineer" or "to the Engineer."

## 102 BIDDING REQUIREMENTS AND CONDITIONS

**102.01 Prequalification of Bidders.** A Bidder must be prequalified by the Department according to ORC Chapter 5525 and the rules and regulations governing prequalification in order to submit a Bid. Upon request, the Department will provide a prequalification application, applicable rules and regulations, and other relevant information. For prospective Bidders that are not yet prequalified, furnish the Department with a properly completed prequalification application at least 30 days before the date specified for the receipt of Bids. The prequalification certificate is the Bidder's license to Bid and perform construction for the Department.

For foreign Contractors, refer to ORC 5525.18 and Ohio Administrative Rule 5501:2-3-07.

**102.02 Contents of Bid Documents.** Use the Proposal to prepare and submit Bids for the Work. Upon request, the Department will provide Bid Documents that include or reference the following:

- A. Location and description of the Project.
- B. Estimate of quantities and description of the Work.
- C. Time to complete the Work.
- D. Amount of the Proposal Guaranty.
- E. Department's deadline for receiving a completed Bid.
- F. Schedule of contract items.
- G. Standard Specifications, Special Provisions, Supplemental Specifications, and the Plans.
- H. Proposal.

### 102.03 Issuance of Proposals.

**A. General.** Upon request, the Department will provide applicable rates and other relevant information for obtaining bidding information and submitting a Bid.

**B. Department Will Not Issue.** The Department may refuse to sell or issue Bid Documents to a prospective Bidder for any of the following reasons:

1. The prospective Bidder owes the Department for previously issued plans.
2. The prospective Bidder has defaulted on previous contracts.
3. The prospective Bidder is debarred from bidding on and receiving Department contracts.
4. The prospective Bidder is currently in the debarment process.

**102.04 Interpretation of Quantities in Proposal.** The quantities in the Bid Documents are approximate and the Department uses them for the comparison of Bids only.

The Department will only pay the Contractor for the actual quantities of Work performed and accepted according to the Contract Documents. The Department

## 102.05

may increase, decrease, or omit the scheduled quantities of Work as provided in 109.04 without invalidating the Bid prices.

**102.05 Examination of Bid Documents and Project Site and Submission of Prebid Questions.** Carefully examine the Bid Documents and perform a reasonable site investigation before submitting a Bid. Submitting a Bid is an affirmative statement that the Bidder has investigated the Project site and is satisfied as to the character, quality, quantities, and the conditions to be encountered in performing the Work. A reasonable site investigation includes investigating the Project site, borrow sites, hauling routes, and all other locations related to the performance of the Work.

When available, the Department will include in the Contract Documents or provide for the Bidder's review at the Department's offices or website, one or more of the following:

- A. Record drawings.
- B. Available information relative to subsurface exploration, borings, soundings, water levels, elevations, or profiles.
- C. The results of other preliminary investigations.

A reasonable site investigation includes a review of these documents.

Should a question arise at any time during the examination of Bid Documents or investigation of the site the Bidder may seek clarification by submitting a Prebid Question. Submit all Prebid Questions in writing via the Department's website. The Department will post a response on its website to all questions submitted before a deadline of 10:00 am four working days prior to the public opening of Bids. Responses to Prebid Questions posted on the Department's website are not revisions to the Bidding Documents and are not binding. The Department is not obligated to respond to, or otherwise act upon, a Prebid Question submitted after this deadline, but reserves the right to act upon any information received.

**102.06 Preparation of Bids.** Prepare a Bid according to this subsection and the requirements found in the Bid Documents. Properly complete the Expedite file and submit it using the software specified in the Bid Documents rather than completing it by handwriting, typing, or using unauthorized computer-generated forms.

Provide a unit price for each item listed in the Proposal. Calculate and place the products for the respective unit prices and quantities in the "Bid Amount" column. For a lump sum item, place the same price in the "Unit Price" column and in the "Bid Amount" column pertaining to that item. Indicate the total Bid amount by adding the values entered in the "Bid Amount" column for the listed items. Submit the Expedite file using the software specified in the Bid Documents.

Properly execute the Proposal by completing the miscellaneous section and attaching the required signatures in the space provided in the Expedite file.

**ENTITY SUBMITTING PROPOSAL  
REQUIRED SIGNATURE**

Individual	The individual or a duly authorized agent.
Partnership	A partner or a duly authorized agent.
Joint Venture	A member or a duly authorized agent of at least one of the joint venture firms.
Corporation	An authorized officer or duly authorized agent of the corporation. Also, show the name of the state chartering the corporation and affix the corporate seal.
Limited Liability Company	A manager, a member, or a duly authorized agent.

**102.07 Duty to Notify of Errors in Bid Documents.** Notify the Department of errors and omissions in the Bid Documents. Make notification by submitting a question in the manner described in 102.05. The Contractor's duty to disclose errors and omissions is not only a bidding requirement but is also a legal requirement that cannot be ignored.

Failure to provide the required notification prior to the opening of bids shall constitute a waiver by the Contractor and does not obligate the Department for any costs based upon any apparent or patent ambiguity arising from insufficient data or obvious errors in the Bid documents. Knowingly withholding information regarding an error or omission in the Bid Documents, or intentionally misrepresenting an item of Work for financial or competitive gain may result in civil or criminal penalties in excess of the value of the item bid.

**102.08 Unbalanced Bidding.** Bid all items correctly and price each quantity as indicated in the Bid Documents. The Department will reject a Mathematically Unbalanced Bid if the Bid is also Materially Unbalanced. A Mathematically Unbalanced Bid is a Bid containing lump sum or unit price items that do not include reasonable labor, equipment, and material costs plus a reasonable proportionate share of the Bidder's overhead costs, other indirect costs, and anticipated profit. A Materially Unbalanced Bid is when the Department determines that an award to the Bidder submitting a Mathematically Unbalanced Bid will not result in the lowest ultimate cost to the Department.

**102.09 Proposal Guaranty.** The Department will reject a Bid submitted without a Proposal Guaranty in the amount designated and payable to the Director. Submit the required Proposal Guaranty in one of the following forms:

- A. Properly executed project Bid bond submitted on the Department's form.
- B. Properly executed electronic bid transfer to the Department's account.
- C. Certified check drawn on the account of the Bidder submitting the Bid.
- D. Cashier's check.
- E. Properly executed electronic project Bid bond submitted using the software specified in the Bid Documents.

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When submitting a Bid bond, ensure that the Surety is licensed to do business in the State.

If the Department invites alternate Bids and the Bidder elects to Bid more than one alternate, the Bidder may submit one Proposal Guaranty in the amount required for a single alternate. The Proposal Guaranty covers each individual Bid.

If the Department invites combined Bids and the Bidder elects to Bid only on one package, then the Bidder must submit only one Proposal Guaranty. If the Bidder bids on the combined Bid package, the Bidder must submit a Proposal Guaranty in the amount required for the combined Bid. The combined Proposal Guaranty covers each individual Bid.

**102.10 Delivery of Bid.** Unless otherwise indicated in the Proposal, all Bids must be submitted using the electronic Bid submission software specified in the Proposal. The Department will accept Bids until the time and date designated in the Notice to Bidders. The Department will return Bids received after the designated time to the Bidders unopened. The Department will return all Bids not prepared and submitted in accordance with the Proposal.

**102.11 Withdrawal of Bids.** After Bids are opened, ORC 5525.01 requires that a Bidder identify a mistake in its Bid within 48 hours of the Bid opening. After Bids are opened the Bidder must provide a written request to withdraw a Bid already filed with the Department. Any Bidder for whom a request to withdraw its Bid is approved by the Department will not be permitted to participate in any manner in a contract awarded for that project for which the Bid was withdrawn.

**102.12 Combination Proposals.** The Department may elect to issue Bid Documents for projects in combination or separately, so that Bids may be submitted either on the combination or on separate units of the combination. The Department reserves the right to make awards on combination Bids or separate Bids to the best advantage of the Department. The Department will not consider combination Bids, other than those it specifically identifies in the Bid Documents. The Department will write separate Contracts for each individual Project included in the combination.

**102.13 Public Opening of Bids.** The Department will publicly open Bids at the time and place indicated in the notice to Contractors. The Department will announce the total Bid amount for each Bid.

Bidders or their authorized agent and other interested persons are invited to the opening.

The Department may postpone the receipt of Bid time or the opening of Bids time. If the Department changes the hour or the date of the receipt of Bids or the opening of Bids, it will issue an addendum or public notice to notify prospective Bidders.

**102.14 Disqualification of Bidders.** The Department will declare a Bid non-responsive and ineligible for award when any of the following occur:

A. The Bidder lacks sufficient prequalification work types or dollars to be eligible for award.

- B. The Bidder fails to furnish the required Proposal Guaranty in the proper form and amount.
- C. The Bid contains unauthorized alterations or omissions.
- D. The Bid contains conditions or qualifications not provided for in the Bid Documents.
- E. The Proposal is not prepared as specified.
- F. A single entity, under the same name or different names, or affiliated entities submits more than one Bid for the same Project.
- G. The Bidder fails to submit a unit price for each contract item listed, except for lump sum items where the Bidder may show a price in the "Bid Amount" column for that item.
- H. The Bidder fails to submit a lump sum price where required.
- I. The Bidder fails to submit a complete Expedite file using the software specified in the Proposal.
- J. The Bidder is debarred from submitting Bids.
- K. The Bidder has defaulted, has had a Contract terminated for cause by the Department, has either agreed not to Bid or has had debarment proceedings initiated against the Bidder's company and/or its key personnel.
- L. The Bidder submits its Bid or Proposal Guaranty on forms other than those provided by the Department.
- M. The Bidder fails to properly complete the supplemental questionnaire section of the Expedite file.
- N. The Bidder submits a Materially Unbalanced Bid as defined by 102.08.
- O. The Bidder fails to acknowledge addenda.
- P. The Department finds evidence of collusion.
- Q. Any other omission, error, or act that, in the judgment of the Department, renders the Bidder's bid non-responsive.

**102.15 Material Guaranty.** Before any Contract is awarded, the Department may require the Bidder to furnish a complete statement of the origin, composition, and manufacture of any or all Materials to be used in the construction of the Work together with samples. The Department may test the samples as specified in these Specifications to determine their quality and fitness for the Work.

### 103 AWARD AND EXECUTION OF CONTRACT

**103.01 Consideration of Proposals.** After opening and announcing the Bids, the Department will compare the Bidders' proposed prices. The proposed price is the summation of the products of the estimated quantities shown in the Proposal and the unit Bid prices. If the amount shown for the proposed product differs from the actual product of the unit Bid price and the estimated quantity, then the actual product will govern.

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The Department may reject any or all Bids, waive technicalities, or advertise for new Bids without liability to the Department.

**103.02 Award of Contract.** The Department will award a Contract or reject Bids within 10 days after Bid opening. The Department will mail a letter to the address on the Bid notifying the successful Bidder of Bid acceptance and Contract award. The Department will award to the lowest competent and responsible bidder. The Department will not award a Contract until it completes an investigation of the apparent low Bidder.

If the Department's estimate for the cost of the improvement is not confidential, the Department will not award a Contract for an amount greater than 5 percent more than the Department's estimate. If the Department's estimate is confidential, the Department may award the Contract according to ORC 5525.15.

**103.03 Cancellation of Award.** The Department may cancel a Contract award at any time before all parties sign the Contract without liability to the Department.

**103.04 Return of Proposal Guaranty.** Immediately after the opening and checking of Bids, the Department will return all Proposal Guaranties provided in the form of a certified check or cashier's check, except to the three lowest Bidders. Within 10 days after opening bids, the Department will return the Proposal Guaranties of the two remaining unsuccessful Bidders. After the successful Bidder submits the signed Contract, Contract Bonds, and other Contract Documents, and after the Department signs the Contract, the Department will return the Proposal Guaranty to the successful Bidder. The Department will not return Bid bonds.

**103.05 Requirement of Contract Bond.** Furnish Contract Bonds within 10 days after receiving notice of award. Furnish Contract Bonds to the Director on the prescribed form, in the amount of the Department's estimate, and according to ORC 5525.16.

**103.06 Execution of Contract.** Sign and return the Contract, along with the certificate of compliance, Contract Bonds, and other required Contract Documents, within 10 days after notice of award. The State does not consider a proposal binding until the Director signs the Contract. If the Director does not sign the Contract within 20 days after receiving the successful Bidder's signed Contract, certificates, Contract Bonds, and other Contract Documents, the successful Bidder may withdraw the Bid without prejudice.

**103.07 Failure to Execute Contract.** If the successful Bidder fails to sign the Contract and furnish the Contract Bonds, the Department will have just cause to cancel the award. The successful Bidder shall forfeit the Proposal Guaranty to the Department, not as a penalty, but as liquidated damages. The Department may award the Contract to the next lowest responsive Bidder, re-advertise the Work, or take any other action decided by the Director.

## 104 SCOPE OF WORK

**104.01 Intent of the Contract Documents.** The intent of the Contract Documents is to provide for the construction and completion of the Work. Perform the Work according to the Contract Documents.

### **104.02 Revisions to the Contract Documents.**

**A. General.** The Department reserves the right to revise the Contract Documents at any time. Such revisions do not invalidate the Contract or release the Surety, and the Contractor agrees to perform the Work as revised.

The provisions of this section are subject to the limitation of ORC 5525.14.

**B. Differing Site Conditions.** During the progress of the Work, if subsurface or latent physical conditions are encountered at the site differing materially from those indicated in the Contract Documents or if unknown 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 Documents, are encountered at the site, notify the Engineer as specified in 104.05 of the specific differing conditions before they are disturbed or the affected Work is performed.

Upon notification, the Engineer will investigate the conditions and if it is determined that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any Work under the Contract, the Department will make an adjustment and modify the Contract as specified in 108.06 and 109.05. The Engineer will notify the Contractor of the determination whether or not an adjustment of the Contract is warranted.

**C. Suspension of Work.** If the performance of all or any portion of the Work is suspended or delayed by the Engineer in writing for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) and the Contractor believes that additional compensation or time is due as a result of such suspension or delay, notify the Engineer as specified in 104.05.

Upon receipt of notice, the Engineer will evaluate the Contractor's request. If the Engineer agrees that the cost or time required for the performance of the Work has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or subcontractors at any approved tier, and not caused by weather, the Engineer will make an equitable adjustment (excluding profit) and modify the contract as specified in 108.06 and 109.05. The Engineer will notify the Contractor of its determination whether or not an adjustment to the Contract Documents is warranted. Failure of the Engineer to suspend or delay the Work in writing does not bar the Contractor from receiving a time extension or added compensation according to 108.06 or 109.05.

The Department will not make an adjustment under this subsection in the event that performance is suspended or delayed by any other cause, or for which an adjustment is provided or excluded under any other term or condition of this Contract.

**D. Significant Changes in Character of the Work.** The Engineer may alter the Work as necessary to complete the Project. The Engineer will make appropriate adjustments according to 108.06 and 109.05, if such alterations significantly change the character of the Work.

If the Contractor disagrees as to whether an alteration constitutes a significant change, use the notification procedures specified in 104.0205.

**104.02**

The term “significant change” is defined as follows:

1. when the character of the Work as altered differs materially in kind or nature from that involved or included in the original proposed construction; or
2. when the product of the quantity in excess of the estimated quantity of a contract item and the unit price exceeds the limits set forth in Table 104.02-1.

**TABLE 104.02-1**

Contract Price	Contract Limits
Up to \$500,000	\$25,000
\$500,001 to \$2,000,000	5% of Total Contract Price
Over \$2,000,000	\$100,000

If the decrease in quantity of any unit price Contract Item exceeds 25 percent of the estimated quantity, and the total of all such adjustments for all Contract Items is more than \$400, then after the determination of final quantities according to 109.12.C, the Engineer will adjust the unit prices for the affected Contract item by multiplying the bid unit price by the factor obtained from Table 104.02-2.

**TABLE 104.02-2**

% Decrease	Factor	% Decrease	Factor
25 to 28	1.02	61	1.14
29 to 32	1.03	62	1.15
33 to 35	1.04	63	1.16
36 to 38	1.05	64	1.17
39 to 41	1.06	65	1.18
42 to 44	1.07	66	1.19
45 to 47	1.08	67	1.20
48 to 50	1.09	68	1.21
51 to 53	1.10	69	1.22
54 to 56	1.11	70	1.23
57 to 59	1.12	71	1.24
60	1.13	72 and over	1.25

When the increase in quantity or decrease in quantity of any unit price contract item does not exceed the limits set forth in Tables 104.02-1 and 104.02-2, there is no significant change in the character of the work and the change is considered a minor change. Department will pay for minor changes in the Work at the unit bid price.

**E. Eliminated Items.** The Department may partially or completely eliminate contract items.

The Department will only make an adjustment to compensate the Contractor for the reasonable cost incurred in preparation to perform significantly changed work as set forth in 104.02.D or work completely eliminated prior to the date of the Engineer’s written order to significantly change or completely eliminate the

Work. The adjustment will be determined according to 109.04 and 109.05. Such payment will not exceed the price of the Contract Item.

The Department will not seek a savings for maintaining traffic, mobilization, and construction layout stakes items for Eliminated Items of Work, unless there is a significant change.

**F. Extra Work.** Perform Extra Work as directed by the Engineer. The Department will pay for Extra Work as specified in 109.05. Time extensions, if warranted, will be determined according to 108.06.

**G. Unilateral Authority to Pay.** The Department has unilateral authority to pay the contractor sums it determines to be due to the contractor for work performed on the project. This unilateral authority to pay by the Department does not preclude or limit the rights of the Department and the contractor to negotiate and agree to the amounts to be paid to the contractor.

**104.03 Rights in and Use of Materials Found on the Work.** Upon obtaining the Engineer's approval, the Contractor may use material, such as stone, gravel, or sand, found in the plan excavation for another Contract Item. The Department will pay for both the excavation of the material under the corresponding Contract Item and for the placement of the excavated material under the Contract Item(s) for which the excavated material is used. Excavate or remove material only from within the grading limits, as indicated by the slope and grade lines.

Obtain written permission from the Engineer according to 107.11.A.

**104.04 Cleaning Up.** Maintain the Project in a presentable condition. Remove all rubbish, layout stakes, sediment control devices as directed by the Engineer, excess material, temporary structures, and equipment, including stream channels and banks within the Right-of-Way at drainage structures, and all borrow and waste areas, storage sites, temporary plant sites, haul roads, and other ground occupied by the Contractor in connection with the Work. Establish suitable vegetative cover in these areas by seeding and mulching according to Item 659, except for cultivated fields. Leave the Project site in an acceptable condition as determined by the Engineer. The cost of cleanup is incidental to all contract items. The Department may withhold 10 percent of the Bid amount for the mobilization contract item, if included, until performance under this section is complete. See 624.04.

**104.05 Contractor Notification, Continuation of Work, Disputes and Claims.** Exhaust the Department's Dispute Resolution and Administrative Claim process as set forth below prior to seeking additional compensation or contract time by filing an action in the Ohio Court of Claims. The following procedures do not compromise the Contractor's right to seek relief in the Ohio Court of Claims.

All parties to the dispute must adhere to the Dispute Resolution and Administrative Claim process. Do not contact Department personnel who are to be involved in a Step 2 or Step 3 review until a decision has been issued by the previous tier. Department personnel involved in Step 2 or Step 3 reviews will not consider a dispute until the previous tier has properly reviewed the dispute and issued a decision.

Failure to meet any of the timeframes outlined below or to request an extension may terminate further review of the dispute and may serve as a waiver of the Contractor's right to file a claim.

Disputes and claims by subcontractors and suppliers may be pursued by the Contractor on behalf of subcontractors or suppliers. Disputes and claims by subcontractors and suppliers against the Department but not supported by the Contractor will not be reviewed by the Department. Disputes and claims of subcontractors and suppliers against the Contractor will not be reviewed by the Department.

**A. Contractor Initial Oral Notification.** Provide immediate oral notification to the Engineer upon discovering a circumstance that may require a revision to the Contract Documents or may result in a dispute. Upon notification, the Engineer will attempt to resolve the identified issue as quickly as possible.

**B. Contractor Written Early Notice.** If the Engineer has not resolved the identified issue within 2 working days after receipt of oral notification, provide written notice to the Engineer of any circumstance that may require a revision to the Contract Documents or may result in a dispute. This early notice must be given by the end of the second working day following the occurrence of the circumstance.

The Engineer and Contractor shall maintain records of labor, equipment, and materials used on the disputed work or made necessary by the circumstance. Such records will begin when early notice is received by the Engineer. Tracking such information is not an acknowledgement that the Department accepts responsibility for payment for this disputed work.

**C. Continuation of Work.** Continue with all Work, including that which is in dispute. The Department will continue to pay for Work.

**D. No Contract Adjustment Without Notification.** The Department will not make the adjustments allowed by 104.02.B, 104.02.C, and 104.02.D if the Contractor did not give notice as specified in 104.05.A and 104.05.B. This provision does not apply to adjustments provided in Table 104.02-2.

**E. Step 1 (On-Site Determination).** The Engineer will meet with the Contractor's superintendent within two (2) working days of receipt of the Contractor Written Early Notice set forth in 104.05.B. They will review all pertinent information and contract provisions and negotiate in an effort to reach a resolution according to the Contract Documents. The Engineer will issue a written decision of Step 1 within fourteen (14) calendar days of the meeting. If the dispute is not resolved either abandon or escalate the dispute to Step 2.

**F. Step 2 (District Dispute Resolution Committee).** Each District will establish a District Dispute Resolution Committee (DDRC) which will be responsible for hearing and deciding disputes at the Step 2 level. The DDRC will consist of the District Deputy Director, District Highway Management Administrator and District Construction Engineer or designees (other than the project personnel involved).

Within seven (7) calendar days of receipt of the Step 1 decision, submit a written request for a Step 2 meeting to the District Construction Engineer (DCE). The DCE will assign the dispute a dispute number. Within fourteen (14) calendar days of receipt of the request for a Step 2 meeting, submit the Dispute Documentation as follows:

1. Submit three (3) complete copies of the documentation of the dispute to the DCE.
2. Identify the Dispute on a cover page by county, project number, Contractor name, subcontractor or supplier if involved in the dispute, and dispute number.
3. Clearly identify each item for which additional compensation and/or time is requested.
4. Provide a detailed narrative of the disputed work or project circumstance at issue. Include the dates of the disputed work and the date of early notice.
5. Reference the applicable provisions of the plans, specifications, proposal, or other contract documents in dispute. Include copies of the cited provisions in the Dispute Documentation.
6. Include the dollar amount of additional compensation and length of contract time extension requested.
7. Include supporting documents for the requested compensation stated in number six (6) above.
8. Provide a detailed schedule analysis for any dispute involving additional contract time, actual or constructive acceleration, or delay damages. At a minimum, this schedule analysis must include the Schedule Update immediately preceding the occurrence of the circumstance alleged to have caused delay and must comply with accepted industry practices. Failure to submit the required schedule analysis will result in the denial of that portion of the Contractor's request.
9. Include copies of relevant correspondence and other pertinent documents.

The DDRC will conduct the Step 2 meeting with Contractor personnel who are authorized to resolve the dispute within fourteen (14) calendar days of receipt of the Contractor's Dispute Documentation. The DDRC will issue a written decision of Step 2 within fourteen (14) calendar days of the meeting. If the dispute is not resolved, either abandon or escalate the dispute to Step 3.

**G. Step 3 (Director's Claims Board Hearing or Alternative Dispute Resolution).** Submit a written Notice of Intent to File a Claim to the Claims Coordinator in the Division of Construction Management within fourteen (14) calendar days of receipt of the Step 2 decision. Include the Contractor's request for either: 1.) a Director's Claim Board hearing on the claim or 2.) an acceptable Alternative Dispute Resolution (ADR) practice.

The dispute becomes a claim when the Claims Coordinator receives the Notice of Intent to File a Claim.

**1. Director’s Claims Board Hearing.** The Director’s Claims Board (the Board) will consist of the Deputy Director of the Division of Construction Management, Deputy Director of Highway Operations, and the Deputy Director of Production Management, or designees. The Office of Chief Legal Counsel will provide legal advice to the Board. The Director or designee will be responsible for deciding claims.

Submit six (6) complete copies of the Claim Documentation to the Claims Coordinator within thirty (30) calendar days of receipt of the Notice of Intent to File a Claim. This timeframe may be extended upon mutual agreement of the parties and with approval of the Claims Coordinator.

In addition to the documentation submitted at Step 2:

a. Enhance the narrative to include sufficient description and information to enable understanding by a third party who has no knowledge of the dispute or familiarity with the project.

b. Certify the claim in writing and under oath using the following certification:

*I, (Name and Title of an Officer of the Contractor) certify that this claim is made in good faith, that all supporting data is accurate and complete to the best of my knowledge and belief, and that the claim amount accurately reflects the contract amendment for which ( Contractor Company name) believes the Department is liable.*

Sign and date this claim certification and have the signature notarized pursuant to the laws of the State of Ohio. The date the Claims Coordinator receives the certified claim documentation is the date of the Department’s Receipt of the Certified Claim for the purpose of the calculation of interest as defined in 104.05.H. The Claims Coordinator will forward one (1) complete copy of this documentation to the District.

Within thirty (30) calendar days of the District’s receipt of the Contractor’s Claim Documentation, the District will submit six (6) complete copies of its Claim Documentation to the Claims Coordinator. In the event that the Contractor is granted a time extension for the submission of its Claim Documentation, the District will be granted an equal time extension for submission of its Claim Documentation. At a minimum, the District’s Claim Documentation should include:

a. An overview of the project.

b. A narrative of the disputed work or project circumstance at issue with sufficient description and information to enable understanding by a third party who has no knowledge of the dispute or familiarity with the project.

c. The dates of the disputed work and the date of early notice.

d. References to the applicable provisions of the plans, specifications, proposal, or other contract documents. Copies of the cited provisions shall be included in the claim document.

e. Response to each argument set forth by the Contractor.

f. Any counterclaims, accompanied by supporting documentation, the District wishes to assert.

g. Copies of relevant correspondence and other pertinent documents.

Within fourteen (14) calendar days of receipt of the District's Claim Documentation, the Claims Coordinator will forward one (1) complete copy to the Contractor and will schedule a hearing on the dispute.

Once a hearing date has been established, both the Contractor and District shall provide the Claims Coordinator with a list of names of persons who may be presenting information at the hearing. Unless otherwise permitted by the Board, the exchange of documentation and all disclosures specified in this step of the process shall be completed at least fourteen (14) calendar days prior to the hearing.

Upon request or at the Board's discretion, the Board may delay the hearing one (1) time to allow more time for review and requests for more documentation.

The Board will hear the entire claim on behalf of the Director. The Board may have technical advisors at the hearing for assistance in reviewing the claim. The Contractor and District will each be allowed adequate time to present their respective positions before the Board. The Contractor and District will also each be allowed adequate time for one (1) rebuttal limited to the scope of the opposing party's presentation. The Contractor's position will be presented by a Contractor's representative who is thoroughly knowledgeable of the claim. Similarly, the District's position will be presented by a District representative who is thoroughly knowledgeable of the claim. Each party may have others assist in the presentation.

The Board may, on its own initiative, request information of the Contractor in addition to that submitted for the hearing. If the Contractor fails to reasonably comply with such request, the Board may render its decision without such information.

Upon completion of the hearing and consideration of any additional information submitted upon request, the Board will submit a written recommendation on the disposition of the claim to the Director. The Director or designee will ratify, modify, or reject the recommendation of the Board and render a decision within sixty (60) calendar days of the hearing. Within thirty (30) calendar days of receipt of the Board's decision, either accept or reject the decision in writing. In the event the Contractor fails to do so, the Board may revoke any offers of settlement contained in the decision.

The decision of the Director is the final step of the Department's Dispute Resolution Process and may not be appealed within the Department. The Director is not bound by any offers of settlement or findings of entitlement made during Steps 1 and 2 of the Dispute Resolution Process.

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**2. Alternative Dispute Resolution (ADR).** In lieu of the Board hearing, the Contractor may opt to proceed through an Alternative Dispute Resolution (ADR) Process. The Department will choose either binding arbitration as defined by ORC 5525.23 or mediation in the manner in which those methods are practiced by the Department and allowed by law.

The Claims Coordinator will coordinate the agreement of the parties to the ADR method, and the selection of a neutral third party or technical expert. The fees of the neutral third party or technical expert will be shared equally between the Department and the Contractor. The Claims Coordinator will obtain a written agreement, signed by both parties, that establishes the ADR process. The neutral third party or technical expert will have complete control of the claim upon execution of the ADR agreement.

**H. Interest on Claims.** The Department will pay interest in accordance with ORC Section 5703.47 on any amount found due on a claim which is not paid within 30 days of the Claims Coordinator's Receipt of the Certified Claim.

## 105 CONTROL OF WORK

**105.01 Authority of the Engineer.** The Engineer will decide questions concerning all of the following:

- A. The quality and acceptability of Materials furnished.
- B. The quantity of Work performed.
- C. The Contractor's rate of progress.
- D. The interpretation of the Contract Documents.
- E. Acceptable fulfillment of the Contract.
- F. Contractor compensation.

The Engineer may suspend all or part of the Work when the Contractor fails to correct conditions that are unsafe for the workers or the general public, fails to comply with the Contract Documents, or fails to comply with the Engineer's orders. The Engineer may suspend the Work due to adverse weather conditions, conditions considered adverse to the prosecution of the Work, or other conditions or reasons in the public interest.

The Engineer's acceptance does not constitute a waiver of the Department's right to pursue any and all legal remedies for defective work or work performed by the Contractor in an unworkmanlike manner.

**105.02 Plans and Working Drawings.** The Plans show details of structures, the lines and grades, typical cross-sections of the Roadway, and the location and design of structures. Keep at least one set of Plans at the Project at all times.

Prepare working drawings when required by the Contract Documents and after verifying applicable field and plan elevations, dimensions, and geometries. Where

Work consists of repairs, extension, or alteration of existing structures, take measurements of existing structures to accurately join old and new Work.

Unless otherwise indicated, the Department will review working drawing submittals to ensure conformance with the Contract and to provide the Contractor a written response to document the results of its review as follows:

- A. **“ACCEPTED.”** The Department accepts the submittal for construction, fabrication, or manufacture.
- B. **“ACCEPTED AS NOTED.”** The Department accepts the submittal for construction, fabrication, or manufacture, subject to the Contractor’s compliance with all Department comments or corrections to the submittal. If also marked “RESUBMIT,” the Department still accepts the submittal, but requires the Contractor to provide a corrected submittal to the Department.
- C. **“NOT ACCEPTED.”** The Department does not accept the submittal. The submittal does not conform to Contract requirements. Do not begin construction, fabrication, or manufacture of Work included in the submittal. Revise the submittal to comply with Department comments or corrections and Contract requirements and provide the revised submittal to the Department for another review.

The Department’s acceptance will not relieve the Contractor of responsibility to complete the Work according to the Contract. Include the cost of furnishing working drawings in the cost of the Work they cover.

**105.03 Conformity with Contract Documents.** Perform all Work and furnish all Materials in reasonably close conformity with the lines, grades, cross-sections, dimensions, and material requirements as shown on the Plans and as specified.

If the DCE determines the Work is not in reasonably close conformity with the Contract Documents and determines the Contractor produced reasonably acceptable Work, the DCE may accept the Work based on engineering judgment. The DCE will document the basis of acceptance in a Change Order that provides for an appropriate adjustment to the Contract Price of the accepted Work or Materials.

If the DCE determines the Work is not in reasonably close conformity with the Contract Documents and determines the Work is inferior or unsatisfactory, remove, replace, or otherwise correct the Work at no expense to the Department.

**105.04 Coordination of the Contract Documents.** The Contract Documents are those defined in 101.03. A requirement appearing in one of these documents is as binding as though it occurs in all. The Engineer will resolve discrepancies using the following descending order of precedence:

- A. Addenda.
- B. Proposal and Special Provisions.
- C. Plans.
- D. Supplemental Specifications.
- E. Standard Construction Drawings.

## 105.05

### F. Standard Specifications.

Immediately notify the Engineer upon discovering any latent error or omission in the Contract Documents.

**105.05 Cooperation by Contractor.** The Department will supply the Contractor with two sets of the Contract Documents, except for the standard construction drawings, which will only be supplied if requested. The Department will provide only one copy of these Specifications.

Provide the constant attention necessary to progress the Work according to the Contract Documents. Cooperate with the Engineer, inspectors, and all other contractors on or adjacent to the Project.

**105.06 Superintendent.** Provide a Superintendent for the Project that is available and responsive at all times and is responsible for all aspects of the Work, irrespective of the amount of subcontract Work. The Superintendent must be capable of reading and understanding the Contract Documents and experienced in the type of Work being performed. The Superintendent shall receive instructions from the Engineer or the Engineer's authorized representatives. The Superintendent shall promptly execute the Engineer's orders or directions and promptly supply the required materials, equipment, tools, labor, and incidentals.

**105.07 Cooperation with Utilities.** Unless otherwise provided for by the Contract Documents, the Department will direct the utility owners to relocate or adjust water lines, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cableways, signals, and all other utility appurtenances within the limits of the proposed construction at no cost to the Contractor.

The Contract Documents will indicate various utility items and indicate a time frame or date when the Department expects the owners to complete utility relocation or adjustment. Provide utility owners adjusting facilities during construction with adequate notification of the scheduled Work to prevent conflict with the Contractor's schedule of operations.

When bidding, consider all permanent and temporary utility appurtenances in present and relocated positions as shown in the Contract Documents.

According to ORC 153.64 and at least 2 Workdays prior to commencing construction operations in an area that may affect underground utilities shown on the Plans, notify the Engineer, the registered utility protection service, and the owners that are not members of the registered utility protection service.

The owner of the underground utility shall, within 48 hours, excluding Saturdays, Sundays, and legal holidays, after notice is received, start staking, marking, or otherwise designating the location, course,  $\pm 2$  feet ( $\pm 0.6$  m), together with the approximate depth of the underground utilities in the construction area.

If the utility owners fail to relocate or adjust utilities as provided for in the Contract Documents and the Contractor sustains losses that could not have been avoided by the judicious handling of forces, equipment, and plant, or by reasonable revisions to the schedule of operations, then the Engineer will adjust the Contract according to 108.06 and 109.05.

**105.08 Cooperation Between Contractors.** At any time, the Department may contract for other work on or near the Project.

Separate contractors working within the limits of the Project shall conduct their work without interfering with or hindering the progress or completion of Work being performed by other contractors and shall cooperate with each other as directed by the Engineer.

**105.09 Authority and Duties of the Inspector.** Inspectors are authorized to inspect the Work and the preparation, fabrication, or manufacture of materials. Inspectors are not authorized to alter or waive requirements of the Contract Documents. Inspectors are authorized to notify the Contractor of Work that does not conform to the Contract; reject materials that do not conform to Specification requirements; and until the issue is decided by the Engineer, suspend portions of the Work if there is a question regarding the Contract Documents, use of unapproved material, or safety. Inspectors are not obligated or authorized to provide direction, superintendence, or guidance to the Contractor, its crew, its subcontractors, or suppliers to accomplish the Work.

Any action or inaction of the Inspector does not constitute a waiver of the Department's right to pursue any and all legal remedies for defective work or work performed by the Contractor in an unworkmanlike manner.

**105.10 Inspection of Work.** The Engineer may inspect materials and the Work. Provide the Engineer or the Engineer's representative access to the Work, information, and assistance necessary to conduct a complete inspection. Notify the Engineer at least 24 hours prior to all required inspections.

When directed by the Engineer, remove or uncover completed Work to allow inspection. After the Engineer's inspection, restore the Work according to the requirements of the Contract Documents. If the inspected Work conformed to the requirements of the Contract Documents, the Department will pay for uncovering or removing and restoring the Work as Extra Work according to 109.05. If the inspected Work did not conform to the Contract Documents, the Department will not pay for uncovering or removing and restoring the Work.

The Department shall have the discretion to dictate the level of inspection for any item of work. The Contractor bears sole responsibility for the quality of work and compliance with the contract regardless of the Department's level of inspection.

The Department's failure to identify defective Work or material shall not, in any way, prevent later rejection when defective Work or material is discovered, or obligate the Department to grant acceptance under 109.11 or 109.12.

Inspection of Work may include inspection by representatives of other government agencies or railroad corporations that pay a portion of the cost of the Work. This inspection will not make other government agencies or railroad corporations a party to the Contract and will not interfere with the rights of the Contractor or Department.

**105.11 Removal of Defective and Unauthorized Work.** Work that does not conform to the requirements of the Contract is defective.

## 105.12

Unless the Department formally accepts defective Work according to 105.03, immediately remove and replace defective Work.

Unauthorized Work is Work done contrary to the instructions of the Engineer, beyond the plan lines, or any extra work done without the Department's permission. The Department will not pay for unauthorized Work. The Engineer may order the Contractor to remove or replace unauthorized Work at no expense to the Department.

If the Contractor fails to comply with the Engineer's orders under the provisions of this subsection, the DCE may correct or remove and replace defective or unauthorized Work and deduct the costs from the Contract Price.

**105.12 Load Restrictions.** Comply with all legal load restrictions when hauling materials on public roads.

Operate equipment of a weight or so loaded as to not cause damage to structures, to the roadway, or to other types of construction. Comply with subsection 501.05.B.6 for allowed loads on bridges.

Do not use off road vehicles on bases or pavements unless permitted by the DCE in writing.

Do not haul on concrete pavement, base, or structures before the expiration of the curing period.

Do not exceed the legal load limits in this section unless permitted by the Director in writing.

**105.13 Haul Roads.** Prior to hauling equipment or materials, provide written notification to the Engineer of the specific roads or streets on the haul route. If the haul route includes roads and streets that are not under the jurisdiction and control of the State and the DCE determines that State controlled roads are not available or practical for a haul route, the Contractor may use local roads and streets that are not restricted by local authorities. If the DCE determines that state controlled roads are available and practical for a haul route, revise the proposed haul route provided in the original written notification and resubmit to the DCE.

If the Engineer determines that haul route roads were properly used during construction to haul equipment and materials and that the haul route roads were damaged, then the Engineer may order the Contractor to perform immediate and practical repairs to ensure reasonably normal traveling conditions. The Engineer will pay for repairs according to applicable provisions of 109.04 and 109.05.

The Contractor shall not file a claim for delays or other impacts to the Work caused by disputes with the local authorities regarding the use of local roads or streets as haul routes. The Contractor shall save the State harmless for any closures or hauling restrictions outside the Project limits beyond the control of the Department.

**105.14 Maintenance During Construction.** Maintain the Work during construction and until Final Inspector accepts the work under 109.12, except for portions of the Work accepted under 109.11. The Contractor is responsible for damage done by its equipment.

Maintain the previous courses or subgrade during all construction operations, when placing a course upon other courses of embankment, base, subgrade, concrete or asphalt pavement, or other similar items previously constructed. This maintenance includes, but is not limited to draining, re-compacting, re-grading, or if destroyed, the removal of Work previously accepted by the Department.

Maintain the Post Construction Storm Water Best Management Practice (BMP) features. Prevent sediment laden surface water from coming in contact with the BMP features during construction.

Maintain the Work during construction and before acceptance of the Work under 109.12, except for portions of the Work accepted under 109.11. The Department will not provide additional compensation for maintenance work.

**105.15 Failure to Maintain Roadway or Structure.** If the Contractor, at any time, fails to comply with the provisions of 105.14, the Engineer will immediately notify the Contractor of such noncompliance. If the Contractor fails to remedy unsatisfactory maintenance within 24 hours after receipt of such notice, the Engineer may immediately proceed to maintain the Project, and deduct the entire cost of this maintenance from monies due or to become due the Contractor on the Contract.

**105.16 Borrow and Waste Areas.** Prior to beginning borrow or wasting operations, obtain the Engineer's written approval of a detailed operation plan that addresses the following concerns:

- A. Control of drainage water.
- B. Cleanup, shaping, and restoration of disturbed areas.
- C. Disposal of regulated materials.
- D. Avoidance of regulated areas.
- E. Excavation and filling of waste and borrow areas.
- F. Saving of topsoil.
- G. Temporary Sediment and Erosion Control BMPs required for compliance under the Clean Water Act, Ohio Water Pollution Control Act, (OWPCA) (ORC Chapter 6111) and the NPDES permit.

Perform all engineering necessary to ensure long term stability of all side slopes and foundations of all borrow and waste areas. Furnish a certification by a Registered Engineer attesting to the stability of all borrow and waste areas. All damage resulting from the instability of borrow and waste areas, the removal of borrow materials, the placement of waste materials, or the hauling of material to and from these areas is the sole responsibility of the Contractor. Repairs to approved haul roads will be made in accordance with 105.13.

Ensure that all side slopes of all borrow and waste areas are beyond the clear zone for the highway as defined by the current version of the Department's *Location and Design Manual*.

## 105.17

Ensure that all side slopes of all waste areas do not reduce horizontal sight distance as defined by the current version of the Department's *Location and Design Manual*.

Have the proposed borrow and waste areas reviewed by an environmental consultant that is pre-qualified by the Department for ecological work. Have the environmental consultant certify that the proposed borrow and waste operations will not impact the "Waters of the United States" or an isolated wetland. If consultant certification is not provided, obtain the 404/401 permits necessary to perform the operations as proposed. Have the environmental consultant certify that the work conforms to the requirements of the permit(s). Provide all documentation submitted to obtain the appropriate permit(s) and a copy of the permit(s) to the Department's Office of Environmental Services.

If burning is permitted under the OAC-3745-19 and ORC 1503.18, submit a copy of the Ohio EPA permit and the Ohio DNR permit to the Engineer and copies of all information used to obtain the permit.

Prior to the disposal of waste materials, submit to the Department an executed copy of the Contract or permission statement from the property owner. The Contract or permission statement must indicate that the waste materials are not the property of the Department. Further, it must expressly state that the Department is not a party to the Contract or permission statement and that the Contractor and property owner will hold the Department harmless from claims that may arise from their contract or permission statement.

Restoration of all borrow or waste areas includes cleanup, shaping, replacement of topsoil, and establishment of vegetative cover by seeding and mulching according to 104.04 and Item 659. Ensure the restored area is well drained unless approval is given by the Engineer to convert a pit area into a pond or lake, in which case confine restoration measures to the disturbed areas above the anticipated normal water level. The cost of work described herein is incidental to the Contract.

For waste sites shown on the plan, the plan will indicate if the clearances have or have not been obtained for the project right-of-way locations. No extension of time or additional compensation will be paid for any delays due to not having the written permit(s) to waste in a floodplain.

The allowed use of Project Right-of-Way and other Department property for borrow and waste is detailed in 104.03 and 107.11.

Borrow and Waste Area shall adhere to 107.10.

**105.17 Construction and Demolition Debris.** OAC-3745-37, OAC-3745-400, and ORC Chapter 3714 regulates the use and disposal of construction and demolition debris. Notify the local Board of Health or the local Ohio EPA office 7 days before placing clean hard fill off the Right-of-Way. Submit copies of this notification to the Engineer.

Legally dispose of debris containing wood, road metal, or plaster at a licensed construction and demolition debris site.

Under the regulations cited above the disposal of brush, trees, stumps, tree trimmings, branches, weeds, leaves, grass, shrubbery, yard trimmings, crop residue, and other plant matter is restricted. If allowed by the Contract Documents, the Contractor may waste brush, trees, stumps, tree trimming, branches, weeds, leaves, grass, shrubbery, yard trimmings, crop residue, and other plant matter within the Right-of-Way. Otherwise, submit a plan and any required permits to legally dispose of these materials off the Right-of-Way to the Engineer. Provide all documents submitted to obtain this permit to the Engineer.

If the Project contains garbage or solid and hazardous waste, the Contract Documents will detail the removal of these items.

When wasting PCC, mix the PCC with at least 30 percent natural soil to construct an inner core in the waste area. Cover this inner core with 3 feet (1.0 m) of natural soil on the top and 8 feet (2.4 m) on the side slopes. Place and compact the material according to 203.06.D to prevent future settlement and sliding.

When the wasting of clean hard fill is allowed, comply with all the requirements of this subsection and 105.16.

**105.18 Acceptance.** The Department will accept Work according to 109.12 or completed sections of the Project according to 109.11.

**105.19 Value Engineering Change Proposals.** The Department will consider the Contractor's submission of a Value Engineering Change Proposal (VECP) which will reduce construction costs on projects that do not contain Design Build provisions or incentive provisions based on time. The purpose of this provision is to encourage the use of the ingenuity and expertise of the Contractor in arriving at alternate plans, specifications or other requirements of the contract. Savings in construction costs will be shared equally between the Contractor and the Department. The Contractor's costs for development, design and implementation of the VECP are not eligible for reimbursement. The VECP must not impair any of the essential functions and characteristics of the project such as service life, reliability, economy of operation, ease of maintenance, safety and necessary standardized features. The submission of the value engineering change proposal shall conform with the current Guidelines on Value Engineering Change Proposals adopted by the Director. Acceptance of a VECP is at the sole discretion of the Director.

The Department will not approve VECPs with any of the following characteristics:

- A. Consist only of non-performing items of work contained in the plans.
- B. Include plan errors identified by the Contractor as part of the cost reduction.
- C. The VECP designer/consultant for the Contractor is also the designer of record for ODOT.
- D. Changes the special architectural aesthetic treatments of structures.
- E. Changes the design or thickness of cast-in-place concrete decks.
- F. Changes the cross section of geometric design features such as, but not limited to, bridge width, vertical clearance, horizontal clearance, shoulder width.

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- G. Requires concrete beams to be installed with less than 17' vertical clearance over a state highway.
- H. Changes the design of overhead sign supports and breakaway sign supports.
- I. Changes the type of noise barriers.
- J. Changes the type or buildup of permanent pavement.
- K. Changes prescribed sequence of operations for the work as originally contemplated and/or the method for maintaining traffic.
- L. Compromises controlling design criteria or would require a design exception as discussed in Volume I, Section 100, of the Location and Design Manual.
- M. Includes cost savings based on revisions of utility relocations or other similar items to be done by other non-contract parties.
- N. Causes additional work, increases the cost, or causes modifications to adjacent projects.

Engineering and drawing development and implementation costs for the VECP are not recoverable.

The Contractor shall have no claim against the Department for any costs or delays due to the Department's review or rejection of the initial VECP.

If the Department already is considering revisions to the contract which are subsequently proposed as a VECP, the Department may reject the Contractor's initial VECP or portions thereof and may proceed with such revisions without any obligations to the Contractor.

## 106 CONTROL OF MATERIAL

**106.01 Source of Supply and Quality Requirements.** Notify the Engineer of the proposed sources of supply before the delivery of materials. The Engineer may approve materials at the source of supply before delivery. If the proposed sources of supply cannot produce the specified material, then furnish materials from alternate sources without adjustment to the Contract Price or Completion Date.

**106.02 Samples, Tests, and Cited Specifications.** The Engineer will inspect and determine whether the materials comply with the specified requirements before they are incorporated into the Work. The Department may sample and test materials or require certifications. Unless specified, the Department will pay for and test materials according to AASHTO, ASTM, or the methods on file in the office of the Engineer. A qualified representative of the Department will take test samples according to Departmental procedures. Read any reference to other specifications or testing methods to mean the version in effect at the pertinent Project Advertisement date. All materials being used are subject to inspection, test, or rejection at any time before their incorporation into the Work. The Department will furnish copies of the tests to the Contractor's representative upon

request. Furnish the required samples and specified material certifications at no expense to the Department other than provided in 109.03.

Equip all transports and distributors hauling asphalt material with an approved submerged asphalt material sampling device.

**106.03 Small Quantities and Materials for Temporary Application.** The Engineer may accept small quantities and materials for temporary application that are not intended for permanent incorporation in the Work. The Engineer may accept these small quantities and materials for temporary application in either of the following cases:

- A. Where similar materials from the same source have recently been approved.
- B. Where the materials, in the judgment of the Engineer, will serve the intended purpose.

**106.04 Plant Sampling and Testing Plan.** The Engineer may undertake the inspection of materials at the source.

In the event plant sampling and testing is undertaken, the Contractor and its material provider shall meet the following conditions:

- A. Cooperate and assist the Engineer with the inspection of materials. Provide full entry to the Engineer at all times to such parts of the plant as may concern the manufacture or production of the materials being furnished. Agree to all documentation and inspection requirements of the TE-24 plant sampling and testing plan.
- B. If required by the Engineer, arrange for the inspector to use an approved building on site. The building should be located near the plant and independent of any building used by the material producer.
- C. Maintain and provide adequate safety measures at the plant at all times.

The Department reserves the right to retest all materials that have been tested and accepted at the source of supply before their incorporation into the Work. After the approved materials have been delivered to the site, the Department may reject all materials that when retested do not meet the requirements of the Contract Documents.

**106.05 Storage of Materials.** Properly store all materials to ensure the preservation of their quality and fitness for the Work. The Engineer may re-inspect stored materials before their incorporation into the Work, even though they were approved before storage. Locate stored materials to facilitate their prompt inspection. The Contractor may use approved portions of the Project Right-of-Way for storage; however, if any additional space is required, the Contractor must provide it at the Contractor's expense. Do not use private property for storage purposes without written permission from the owner or lessee. If requested by the Engineer, furnish copies of the written permission. Restore all storage sites to their original condition at no expense to the Department. The Contractor and property owner will hold the Department harmless from claims that may arise from their contract or permission statement. This subsection does not apply to the stripping and storing of topsoil, or to other materials salvaged from the Work.

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Areas used to Store Materials shall adhere to 107.10.

**106.06 Handling Materials.** Handle all materials in such manner as to preserve their quality and fitness for the Work. Transport aggregates from the storage site to the project site in vehicles constructed to prevent loss or segregation of materials after loading and measuring. Ensure that there are no inconsistencies in the quantities of materials loaded for delivery and the quantities actually received at the place of operations.

**106.07 Unacceptable Materials.** Unacceptable materials are all materials not conforming to the requirements of these Specifications at the time they are used. Immediately remove all unacceptable materials from the project site unless otherwise instructed by the DCE. The DCE must approve the use of previously identified unacceptable materials that have been corrected or repaired. If the Contractor fails to comply immediately with any order of the DCE made under the provisions of this subsection, the DCE will have authority to remove and replace defective materials and to deduct the cost of removal and replacement from any monies due or to become due to the Contractor.

**106.08 Department-Furnished Material.** Furnish all materials required to complete the Work, except when otherwise provided in the Proposal.

The Department will deliver the Department-furnished materials to the Contractor at the points specified in the Contract Documents.

Include the cost of handling and placing of all Department-furnished materials in the contract price for the contract item for which they are used.

The Department will hold the Contractor responsible for all material upon delivery of the materials to the Project site. The Department will make deductions from any monies due the Contractor to make good any shortages and deficiencies, for any cause whatsoever, and for any damage that may occur after such delivery, and for any demurrage charges.

**106.09 Steel and Iron Products Made in the United States.** Furnish steel and iron products that are made in the United States according to the applicable provisions of Federal regulations stated in 23 CFR 635.410 and State of Ohio laws, and ORC 153.011 and 5525.21. "United States" means the United States of America and includes all territory, continental or insular, subject to the jurisdiction of the United States.

**A. Federal Requirements.** All steel or iron products incorporated permanently into the Work must be made of steel or iron produced in the United States and all subsequent manufacturing must be performed in the United States. Manufacturing is any process that modifies the chemical content; physical shape or size; or final finish of a product. Manufacturing begins with the initial melting and mixing, and continues through the bending and coating stages. If a domestic product is taken out of the United States for any process, it becomes a foreign source material.

**B. State Requirements.** All steel products used in the Work for load-bearing structural purposes must be made from steel produced in the United States. State requirements do not apply to iron.

### C. Applications.

1. When the Work is Federally funded both the Federal and State requirements apply. This includes all portions of the Work, including portions that are not Federally funded.

2. When the Work has no Federal funds, only the State requirements apply.

**D. Exceptions.** The Director may grant specific written permission to use foreign steel or iron products in bridge construction and foreign iron products in any type of construction. The Director may grant such exceptions under either of the following conditions:

1. The cost of products to be used does not exceed 0.1 percent of the total Contract cost, or \$2,500, whichever is greater. The cost is the value of the product as delivered to the project.

2. The specified products are not produced in the United States in sufficient quantity or otherwise are not reasonably available to meet the requirements of the Contract Documents. The Director may require the Contractor to obtain letters from three different suppliers documenting the unavailability of a product from a domestic source, if the shortage is not previously established.

**E. Proof of Domestic Origin.** Furnish documentation to the Engineer showing the domestic origin of all steel and iron products covered by this section, before they are incorporated into the Work. Products without a traceable domestic origin will be treated as a non-domestic product.

**106.10 Qualified Products List.** The Department may use Qualified Product Lists (QPL) for approval of manufactured materials. The Office of Materials Management (OMM) will maintain the QPL and the standard procedure for the QPL process. Inclusion of a material onto the QPL will be determined by OMM with support from other Department offices. To be kept on the QPL, manufacturers must recertify their material according to the Department's standard procedure by January 1 of each year. When a material requires QPL acceptance, only provide materials listed on the QPL at the time of delivery of the material to the project. Provide the Engineer documentation according to the Department's standard procedure that, at the time of delivery, the material provided is on the QPL.

## 107 LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

**107.01 Laws to be Observed.** Stay fully informed of all Federal and State laws, all local laws, ordinances, and regulations, and all orders and decrees of authorities having any jurisdiction or authority that affect those engaged or employed on the Work, or that affect the conduct of the Work. Observe and comply with all such laws, ordinances, regulations, orders, and decrees. The Contractor shall protect and indemnify the State and its representatives against any claim or liability arising from or based on the violation of any such law, ordinance,

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regulation, order, or decree, whether by the Contractor or the Contractor's employees, subcontractors, or agents.

The Contractor agrees that in the hiring of employees for the performance of Work under this Contract or any subcontract hereunder, neither the Contractor, the subcontractor, nor any person acting on behalf of such Contractor or subcontractor shall, by reasons of race, religion, color, sex, or national origin, discriminate against any citizen of the United States in the employment of labor or workers, who is qualified and available to perform the Work to which the employment relates.

Neither the Contractor, the subcontractor, nor any person on their behalf shall, in any manner, discriminate against or intimidate any employee hired for the performance of Work under this Contract on account of race, religion, color, sex, or national origin.

Comply with OAC-4123:1-3, entitled "Specific Safety Requirements of the Industrial Commission of Ohio Relating to Construction," as amended, and with the Federal Occupational Safety and Health Act of 1970 and Code of Federal Regulations, Title 29, Chapter XVII, Part 1926 and as amended.

**107.02 Permits, Licenses, and Taxes.** Procure all permits and licenses; pay all charges, fees, and taxes; and provide all notices necessary and incidental to the due and lawful prosecution of the Work.

**107.03 Patented Devices, Materials, and Processes.** Before employing any design, device, material, or process covered by letters of patent or copyright, provide for its use by suitable legal agreement with the patentee or owner. The Contractor and the Surety shall indemnify and save harmless the State, any affected third party, or political subdivision from any and all claims for infringement of patented design, device, material, process, or any trademark or copyright, and shall indemnify the State for any costs, expenses, and damages that it may be obliged to pay by reason of any infringement, at any time during the prosecution or after the completion of the Work.

**107.04 Restoration of Surfaces Opened by Permit.** The Director may grant to the municipality in which the Work is performed a reservation of rights to construct or reconstruct any utility service in the highway or street or to grant permits for same, at any time.

Any individual, firm, or corporation wishing to make an opening in the highway must secure a permit. Allow parties bearing such permits, and only those parties, to make openings in the highway. When ordered by the Engineer, make in an acceptable manner all necessary repairs due to such openings. The necessary repairs will be paid for as Extra Work, or as provided in the Contract Documents, and will be subject to the same conditions as the original Work performed.

**107.05 Federal-Aid Provisions.** When the United States Government pays for all or any portion of the Project's cost, the Work is subject to the inspection of the appropriate Federal agency.

Such inspections will not make the Federal Government a party to this Contract. The inspections will in no way interfere with the rights of either party to the Contract.

**107.06 Sanitary Provisions.** Provide and maintain sanitary accommodations in a neat condition for the use of employees and Department representatives that comply with the requirements of the State and local Boards of Health, or of other authorities having jurisdiction over the Project.

**107.07 Public Convenience and Safety.** At all times, ensure that the Work interferes as little as possible with the traffic. Provide for the safety and convenience of the general public and the residents along the highway and the protection of persons and property. Do not close any highways or streets unless specifically allowed by the Contract.

**107.08 Bridges Over Navigable Waters.** Conduct all Work on navigable waters so that it does not interfere with free navigation of the waterways and that it does not alter the existing navigable depths, except as allowed by permit issued by the U.S. Coast Guard. Work within the flood plain of a navigable stream may require a permit from the U.S. Army Corps of Engineers. If an U.S. Army Corps of Engineers permit is required, provide all documentation submitted to obtain the permit(s) and a copy of the permit(s) to the Department.

**107.09 Use of Explosives.** When the use of explosives is necessary for the prosecution of the Work, exercise the utmost care not to endanger life or property, including new Work. The Contractor is responsible for all damage resulting from the use of explosives.

Obtain written permission to perform in-stream blasting from the Chief of the Division of Wildlife, Ohio DNR according to ORC 1533.58. Provide the Engineer with all documentation submitted to obtain this permit and with a copy of the permit.

The Contractor agrees, warrants, and certifies that it will observe State laws and local ordinances and regulations relative to the use and storing of explosives kept on the Project site.

Perform all blasting operations according to Item 208.

**107.10 Protection and Restoration of Property.** The Contractor is responsible for the preservation of all public and private property impacted by the Contractor's operations.

The Contractor is responsible for all damage or injury to property, during the prosecution of the Work, resulting from any act, omission, neglect, defective work or materials, or misconduct in the manner or method of executing the Work. The Contractor will remain responsible for all damage and injury to property until the Project is accepted under 109.12, except for portions of the Work accepted under 109.11.

If the Contractor causes any direct or indirect damage or injury to public or private property by any act, omission, neglect, or misconduct in the execution or the non-execution of the Work, then it must restore, at its own expense, the

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property to a condition similar or equal to that existing before the damage or injury.

If mail boxes, road, or street name signs and supports interfere with the Work, then remove and erect them in a temporary location during construction in a manner satisfactory to and as directed by the Engineer. After completion of the Work and before final acceptance of the Project, erect the mailboxes, road, or street name signs and supports in their permanent locations according to the plans unless otherwise directed by the Engineer. Consider the cost of this Work as incidental to the affected items.

Cooperate with the Engineer in protecting and preserving monuments, cornerstones and boundary survey markers that are affected by the Work as required by ORC 5519.05.

When specified in the plans, the Contractor will construct the Monument Assemblies with the iron pin and Reference Monuments with the iron pin and cap. Right-of-Way Monuments are property boundary monuments set to comply with Ohio Administrative Code Section 4733.37, "Minimum Standards for Boundary Surveys in the State of Ohio" and ORC 5519.05 and are recited in the Right-of-Way deeds to convey the property or easement rights. If shown in the Right-of-Way plans, Right-of-Way monuments will be set after acquisition and prior to construction activities by the Department. These monuments normally delineate the boundary secured for the highway construction. There are situations where temporary Right-of-Way easements are purchased to construct the work and it is expected that the permanent Right-of-Way monuments within the temporary easements may get destroyed to perform the work. Any permanent Right-of-Way Monuments or property monuments on or outside the Right-of-Way limits and not enclosed within a temporary easement for the project will be the Contractor's responsibility to protect. Upon completion of the final grading replace any Right-of-Way Monuments destroyed during or by construction activities. A quantity for replacement of Right-of-Way Monuments expected to be destroyed that are within a temporary easement will be paid under Item 604. When specified in the plans, the Contractor will construct the Monument Assemblies and Reference Monuments with the iron pin and cap. Right-of-Way Monuments, Monument Assemblies and Reference Monuments are to be set under the direct supervision of a Registered Surveyor.

Do not begin grading or resurfacing operations until the Contractor has referenced and verified the position of all known monuments, cornerstones, and boundary survey markers in the area to be improved, relative to the survey information provided to the Contractor by the Department. Make a reasonable search effort using common iron pin locating devices to locate monuments, cornerstones, and boundary survey markers at normal probable locations (i.e. offsets at occupation lines) if no monuments are shown on the plans. If monuments, cornerstones, and boundary survey markers are unexpectedly encountered, then protect, reference, and preserve them in the same manner. Referencing, as indicated above, shall mean locating their positions relative to a project control network, traverse line or centerline using standard acceptable surveying measurements and techniques suitable to meet the requirements of OAC

Section 4733-37-04, Measurement Specifications. The locating method, field data recording procedures and equipment to be used will be reviewed and approved by the Engineer prior to performing the work.

Provide the Engineer with a report indicating the monuments, cornerstones, and boundary survey markers located. List project coordinates and/or station and offset relative to the plan centerline and a description of the monuments, cornerstones, and boundary survey markers found, including size, material, condition, any cap stamping or markings and noting any differences from the plan locations of any of the monuments. The Engineer shall compare the Contractor's preconstruction monument report with the plans and any preconstruction checks provided by the Department.

If monuments, cornerstones, and boundary survey markers of the Public Land Survey System control corners are encountered in the performance of the Work, and adjustable monument assemblies are not listed in the Proposal, then the Department will furnish them and supervise their precise location and installation in conformity with ORC 5519.05. Furnish all labor, equipment, and materials required to perform such installations. The Department will pay for any labor, equipment, or materials furnished during the installation according to 109.05. Perform relocation Work under the supervision of a registered surveyor.

The Engineer will deduct from the estimates the cost incurred by the Department for repair, re-determination of location, and replacement of any monuments, cornerstones, or boundary survey markers within the highway that were damaged, destroyed, or made inaccessible during the progress of the Work by the Contractor or its employees, subcontractors, or their agents, in violation of these provisions.

Do not create staging areas, store materials and equipment, or borrow or waste materials in areas labeled as an environmental resources areas in the Contract Documents. All properties to be utilized by the Contractor outside the project Right-of-Way must be cleared for all environmental resource impacts prior to the beginning of work. Environmental resources include but may not be limited to:

1. Cultural Resources

a. Buildings, structures, objects, and sites eligible for or listed on the National Register of Historic Places

b. Historic or prehistoric human remains, cemeteries, and/or burial sites (pursuant with ORC 2909.05 and 2927.11)

2. Ecological Resources

a. Wetlands

b. Streams

c. Wooded areas with trees to be removed in excess of 8 inches diameter at breast height

3. Public Lands

a. Lands meeting the criteria of 49 U.S.C. 303, 23 CFR 771.135: 4(f).

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b. Lands meeting the criteria of 16 U.S.C. 4601-4, 36 CFR59.1: 6(f).

4. FEMA Mapped 100 year Floodplains

5. Hazardous Waste Areas

All areas proposed to be utilized by the Contractor outside the project construction limits shall be reviewed by environmental contractor(s) that are prequalified by the Department for each environmental resource. Have the consultant(s) certify that the proposed site to be utilized for the contractor will not impact:

Cultural Resources

Ecological Resources

Public Lands

FEMA Mapped 100 year Floodplains

Hazardous Waste Areas

Provide all documentation and the consultant certification to the Office of Environmental Services with a copy to the Engineer.

Should the areas proposed for use by the Contractor outside the project right of way limits contain environmental resources the Contractor is responsible to the Department for all environmental clearances and permits prior to the beginning of work.

### **107.11 Contractor's Use of the Project Right-of-Way or Other Department-Owned Property.**

**A. Disposal of Waste Material and Construction Debris and Excavation of Borrow on the Project Right-of-Way or on Other Department-Owned Property.** Dispose of waste material according to 105.16 and dispose of construction debris according to 105.17. In addition to the rights granted in 104.03, the Contractor's use of the Project Right-of-Way or other Department-owned property for the disposal of waste material and construction debris and excavation of borrow material is restricted as follows:

1. If the Contract Documents identify locations for the disposal of waste material and construction debris or excavation of borrow material within the Project Right-of-Way or on other Department-owned property, then only perform these operations in these designated locations.

2. If the Contract Documents do not identify locations for the disposal of waste material and construction debris or excavation of borrow material within the Project Right-of-Way or on other Department-owned property, then do not Bid assuming that the Department will make such locations available.

If the Contractor's request to use locations within the Project Right-of-Way or on other Department-owned property is approved by the Engineer, then the Department may allow the Contractor to dispose of waste material and construction debris or excavate borrow material for a fee of \$0.50 per cubic yard.

**B. Contractor's Use of Portable Plants Within the Project Right-of-Way or on Other Department-Owned Property.** The Contractor's use of portable plants within the Project Right-of-Way or on other Department-owned property is limited as follows:

1. If the Contract Documents identify locations within the Project Right-of-Way or on other Department-owned property to place a portable plant, then only place a portable plant in these designated locations subject to the requirements of 107.11.C.

2. If the Contract Documents do not identify locations within the Project Right-of-Way or on other Department-owned property to place a portable plant, then do not bid assuming that the Department will make such locations available.

However, the Department will consider a Value Engineering Change Proposal (VECP) for the placement of a portable plant within the Project Right-of-Way or on other Department-owned property and, if accepted, may allow the use of a particular site on its property subject to the requirements of 107.11.C.

**C. Placement of a Portable Plant within the Project Right-of-Way or on Other Department-Owned Property.** To place a portable plant within the Project Right-of-Way or on other Department-owned property, comply with the following requirements:

1. Local noise ordinances.

2. Obtain any necessary EPA permits for the operation of the plant. Provide the Department with a copy of the information submitted to obtain the permit and a copy of the permit.

3. Provide the Engineer written certification that the plant will supply material only for the Project for which it was approved. Do not use the plant to supply any other project or to sell materials commercially.

4. Submit a traffic control plan to the Engineer for approval that details the anticipated truck movements and provides acceptable protection, warning, and guidance to motorists, pedestrians, and the workers.

**D. Equipment Storage and Staging.** The Contractor may use, fee-free, any portion of the Project within the Project Right-of-Way for staging, equipment storage, or an office site with the approval of the Engineer, provided such usages do not interfere with the Work and are not prohibited by the Contract Documents. Do not bid in anticipation of using any properties within the Project Right-of-Way or Department-owned property outside the Project Right-of-Way for equipment storage or staging.

**E. Equipment Removal and Site Restoration.** Remove all Contractor equipment and completely restore all utilized sites used as required by 104.04 before Final Acceptance as provided in 109.12.

**107.12 Responsibility for Damage Claims and Liability Insurance.** The Contractor shall indemnify and save harmless the State and all of its representatives, municipalities, counties, public utilities, any affected railroad or railway company, and any fee owner from whom a temporary Right-of-Way was

acquired for the Project from all suits, actions, claims, damages, or costs of any character brought on account of any injuries or damages sustained by any person or property on account of any negligent act or omission by the Contractor or its subcontractors or agents in the prosecution or safeguarding of the Work.

The Contractor shall procure and maintain insurance for liability for damages imposed by law and assumed under this Contract, of the kinds and in the amounts hereinafter provided from insurance companies authorized to do business in the State by the Ohio Department of Insurance. The cost of insurance is incidental to all contract items. Before the execution of the Contract by the Director, furnish to the Department a certificate or certificates of insurance in the form satisfactory to the Department demonstrating compliance with this subsection. Provide an insurance certificate or certificates that show that the Contractor's liability and auto policies coverage are not reduced, restricted, or canceled until 30 days written notice has been given to the Department by the insurer. Mail all certificates and notices to: Administrator, Office of Contracts, Ohio Department of Transportation, 1980 West Broad Street, Columbus, Ohio 43223. Upon request, the Contractor shall furnish the Department with a certified copy of each policy, including the provisions establishing premiums.

The types and minimum limits of insurance are as follows:

**A. Workers' Compensation Insurance.** Comply with all provisions of the laws and rules of the Ohio Bureau of Workers' Compensation covering all operations under Contract with the Department whether performed by it or its subcontractors. In addition, if a portion of the Work is performed from a barge or ship or requires unloading material from a barge or ship on a navigable waterway of the United States, it is the responsibility of the Contractor to arrange coverage for that portion of the Work under the Longshore and Harborworkers' Compensation Act [33 USC Section 901 *et seq.*] and the Jones Act [5 USC Section 751 *et seq.*] and provide proof of coverage to the Department.

**B. Commercial General Liability Insurance.** The minimum limits for liability insurance are as follows:

General Aggregate Limit	\$2,000,000
Products - Completed Operations Aggregate Limit	\$2,000,000
Personal and Advertising Injury Limit	\$1,000,000
Each Occurrence Limit	\$1,000,000

Obtain the above minimum coverages through primary insurance or any combination of primary and umbrella insurance. In addition, the Department will require the General Aggregate Limit on a per project basis.

Ensure that the Commercial General Liability Insurance policy names the State of Ohio, Department of Transportation, its officers, agents, and employees as additional insureds with all rights to due notices in the manner set out above. Obtain Explosion, Collapse, and Underground (XCU) coverage at the same limits as the commercial general liability insurance policy. In addition, if blasting is to be performed, obtain XCU coverage providing a minimum Aggregate Limit of

\$5,000,000 and Each Occurrence Limit of \$1,000,000. Submit proof of insurance, endorsements, and attachments to the Engineer prior to starting the Work.

**C. Comprehensive Automobile Liability Insurance.** The Comprehensive Automobile Liability policy shall cover owned, non-owned, and hired vehicles with minimum limits as follows:

Bodily Injury and Property Damage Liability Limit	
Each Occurrence	\$1,000,000

Insurance coverage in the minimum amounts set forth neither relieves the Contractor from liability in excess of such coverage, nor precludes the Department from taking such other actions as are available to it under any other provisions of this Contract or otherwise in law.

Clearly set forth all exclusions and deductible clauses in all proof of insurance submitted to the Department. The Contractor is responsible for the deductible limit of the policy and all exclusions consistent with the risks it assumes under this Contract and as imposed by law.

If the Contractor provides evidence of insurance in the form of certificates of insurance, valid for a period of time less than the period during which the Contractor is required by terms of this Contract, then the Department will accept the certificates, but the Contractor is obligated to renew its insurance policies as necessary. Provide new certificates of insurance from time to time, so that the Department is continuously in possession of evidence that the Contractor's insurance is according to the foregoing provisions.

If the Contractor fails or refuses to renew its insurance policies or the policies are canceled or terminated, or if aggregate limits have been impaired by claims so that the amount available is under the minimum aggregate required, or modified so that the insurance does not meet the requirements of 107.12.C, the Department may refuse to make payment of any further monies due under this Contract or refuse to make payment of monies due or coming due under other contracts between the Contractor and the Department. The Department in its sole discretion may use monies retained pursuant to this subsection to renew or increase the Contractor's insurance as necessary for the periods and amounts referred to above. Alternatively, should the Contractor fail to comply with these requirements, the Department may default the Contractor and call upon the Contractor's Surety to remedy any deficiencies. During any period when the required insurance is not in effect, the Engineer may suspend performance of the Contract. If the Contract is so suspended, the Contractor is not entitled to additional compensation or an extension of time on account thereof.

Nothing in the Contract Documents and insurance requirements is intended to create in the public or any member thereof a third party beneficiary hereunder, nor is any term and condition or other provision of the Contract intended to establish a standard of care owed to the public or any member thereof.

**107.13 Reporting, Investigating, and Resolving Motorist Damage Claims.** The Contractor and the Department are required to report, investigate, and resolve motorist damage claims according to 107.10 and 107.12 and as follows.

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When a motorist reports damage to its vehicle either verbally or in writing to the Contractor, the Contractor shall within 3 days make and file a written report to the District's construction office. Forward the report to the Department's Court of Claims Coordinator who, as a co-insured party, may then contact the Contractor's insurance company and request that the insurance company investigate and resolve the claim. In the event that the Department directly receives the motorist's claim, the Department will send the claim report to the Contractor and may send a copy of the claim report to the Contractor's insurance company. If the Contractor or their insurance company does not resolve the claim in a timely manner, the Department may advise the motorist of the option of pursuing the claim in the Ohio Court of Claims.

In the event of a lawsuit filed against the Department in the Ohio Court of Claims by the motorist, the Department, as co-insured party, may request the Contractor's insurance company to defend this lawsuit and hold the Department harmless according to 107.12.

If the lawsuit claim amount is \$2,500 or less and the Court of Claims Coordinator determines that the Contractor is responsible for the claimed damages then the Department's Court of Claims Coordinator may, after notifying the Contractor, determine that it would be in the best interest of the Department to settle the claim. Any settlement amount including court costs may be assessed to the Contractor and deducted from the project. The Engineer will notify the Contractor prior to executing the deduction. The Contractor or the Contractor's insurance company may appeal the assessment decision of the Court of Claims Coordinator to the Engineer within 14 days of the Engineer's notice. The Engineer will consider the appeal within 14 days. The Engineer's determination of the assessment is final.

**107.14 Opening Sections of Project to Traffic.** The Engineer may order the Contractor to open a section of the Work to the safe use of traffic at any time. The Department will make an adjustment according 108.06 and 109.05 to compensate the Contractor for the added costs and delay, if any, resulting from such an opening.

**107.15 Contractor's Responsibility for Work.** Until the Final Inspector accepts the Work during the Final Inspection according to 109.12.A, the Contractor is responsible for the Project and will take every precaution against injury or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the non-execution of the Work. Rebuild, repair, restore, and make good all injuries or damages to any portion of the Work occasioned by any of the above causes before final acceptance. Bear the expense of the repairs except when damage to the Work was due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor, including but not restricted to weather, civil disturbances, or governmental acts.

In the event that the Engineer determines that damage to completed permanent items of Work results from traffic using a substantially completed section of Roadway, the Department may compensate the Contractor for repair of the damage

as authorized by Change Order. To receive compensation for the damage the Contractor must meet the following requirements.

A. Notify the Engineer of each occurrence of damage in writing within 10 Calendar Days.

B. Contact the local law enforcement agency to determine if the accident was investigated and a report filed. If an accident report was filed, obtain the report and notify the motorist, and copy their insurance company, via registered mail that the motorist is responsible for the cost of damage repairs. If the motorist does not respond within 30 days, make a second attempt to contact the motorist and copy the insurance company via registered mail.

C. If no response is received from the motorist or insurance company within 30 days, send a letter to the Engineer and include documentation of good faith effort to seek recovery from responsible parties.

D. The Department will make an adjustment according to 108.06 and 109.05 to compensate the Contractor for the added costs and delays, if any, resulting from repairing damaged Work.

If there is no accident report on file and no means of identifying the guilty motorist, the Contractor will likewise be compensated to repair the damaged Work.

In case of suspension of Work by the Contractor or under the provisions of 105.01, the Contractor is responsible for the Project and shall take necessary precautions to prevent damage to the Project; provide for normal drainage; and erect any necessary temporary structures, signs, or other facilities at its expense. During such period of suspension of Work, properly and continuously maintain in an acceptable growing condition all living material in newly established plantings, seedings, and soddings furnished under the Contract, and take adequate precautions to protect new tree growth and other important vegetative growth against injury.

The Engineer may direct the Contractor to remove graffiti any time during the Work. The Department will make an adjustment according to 108.06 and 109.05 to compensate the Contractor for the added costs and delays, if any, resulting from all ordered graffiti removal.

**107.16 Contractor's Responsibility for Utility Property and Services.** At points where the Contractor's operations are adjacent to properties of railway, cable, telephone, and power companies, or are adjacent to other property, and any damage to their property may result in considerable expense, loss, or inconvenience, do not commence with the operation until all arrangements necessary for the protection of the property have been made.

Cooperate with the owners of any underground or overhead utility lines in their removal and rearrangement operations to ensure these operations progress in a reasonable manner, that duplication of rearrangement Work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted.

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In the event interruption to underground or overhead utility services results from an accidental breakage or from being exposed or unsupported, immediately alert the occupants of nearby premises as to any emergency that the accidental breakage may create at or near such premises. Then notify the Engineer and the owner or operator of the utility facility of the disruption and cooperate with the said utility owner or operator in the restoration of service. If water service is interrupted, perform the repair work continuously until the service is restored unless the repair work is performed by the local governmental authority. Do not begin Work around fire hydrants until the local fire authority approves provisions for continued service.

**107.17 Furnishing Right-of-Way.** The Department is responsible for securing all necessary Right-of-Way in advance of construction. The Bid Documents will indicate any exceptions. The Department will notify all prospective Bidders in writing before the date scheduled for receipt of Bids regarding the specific dates certain parcels will be made available to the Contractor.

**107.18 No Waiver of Legal Rights.** The following Department actions do not waive the Department's rights or powers under the Contract, or any right to damages herein provided:

- A. Inspection by the Engineer or by any of Engineer's duly authorized representatives.
- B. Any order, measurements, or certificate by the Director, or Department representatives.
- C. Any order by the Director or Department representatives for the payments of money or the withholding of money.
- D. Acceptance of any Work.
- E. Any extension of time.
- F. Any possession taken by the State or its duly authorized representatives.

The Department will not consider any waiver of a breach of this Contract to be a waiver of any other subsequent breach.

**107.19 Environmental Protection.** Comply with all Federal, State, and local laws and regulations controlling pollution of the environment. Avoid polluting streams, lakes, ponds, and reservoirs with fuels, oils, bitumens, chemicals, sediments, or other harmful materials, and avoid polluting the atmosphere with particulate and gaseous matter.

Fording of streams is prohibited. Causeways for stream and river crossings or for Work below a bridge are permitted provided:

- A. The causeway is constructed according to 207.03.B.8.b.
- B. The causeway complies with the requirements of the 404 Permit the Department obtained for the Project.
- C. The Contractor obtains a 404 Permit from the U.S. Army Corps of Engineers if the Department has not obtained such a permit. Obtain the 404 Permit prior to

beginning construction of the causeway. The Department does not guarantee that the Contractor will be able to obtain a 404 Permit.

Comply with all current provisions of the Ohio Water Pollution Control Act, (OWPCA), (ORC Chapter 6111). The Department will obtain a storm water permit under the OWPCA provisions when the plan work acreage requires a permit. The storm water permit will not cover the Contractor's work outside the Project limits shown on the Plans. Apply for a permit to cover operations outside the Project limits shown on the plans as required by the OWPCA provisions. When the Department has not applied for a permit on the Project and a permit is required under the provisions of the OWPCA because of the total area of the Contractor's work, apply for, obtain, and comply with the required permit for both the Work within Project limits and the Contractor's work.

The Department has obtained the required permits from the U.S. Army Corps of Engineers and Ohio EPA for Work in the "Waters of the United States" and isolated wetlands under ORC Chapter 6111. Comply with the requirements of these permits.

When equipment is working next to a stream, lake, pond, or reservoir, spill response equipment is required in the event of a hydraulic leak. Do not stockpile fine material next to a stream, lake, pond, or reservoir.

Take precautions to avoid demolition debris and discharges associated with the excavation and hauling of material from entering the stream. Remove any material that does fall into the stream as soon as possible.

When excavating in or adjacent to streams, separate such areas from the main stream by a dike or barrier to keep sediment from entering the stream. Take care during the construction and removal of such barriers to minimize sediment entering the stream.

Accomplish control of ground water and water in excavations in a manner that prevents the degradation of the water quality of any surface water. Install wells and well points with suitable screens and filters where necessary to prevent the continuous pumping of fines. Pump sediment-laden water in a manner to prevent degradation of streams, lakes, ponds, or other areas of water impoundment. Such prevention may involve but is not limited to the means and methods described in Item 207. Use the current version of the *Sediment and Erosion Control Handbook* to plan this work. Use the methods necessary to prevent adverse effects to surface waters as provided in OAC-3745-1-04. The cost of constructing and maintaining these measures is incidental to the Contract.

Contain, collect, characterize and legally dispose of all waste water and sludge generated during the work. Do not mix waste water with storm water. Do not discharge any waste water without the appropriate regulatory permits. Manage waste water and sludge in accordance with ORC Chapter 6111 and all other laws, regulations, permits and local ordinances relating to this waste. Waste water management is incidental to the Work unless otherwise specified in the contract.

Control the fugitive dust generated by the Work according to OAC-3745-17-07(B), OAC-3745-17-08, OAC-3745-15-07, and OAC-3745-17-03 and local ordinances and regulations. In addition, use dust control measures when fugitive

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dust creates unsafe conditions as determined by the Engineer. Perform this work without additional compensation except for Item 616.

Perform open burning according to 105.16.

**107.20 Civil Rights.** Comply with Federal, State, and local laws, rules, and regulations that prohibit unlawful employment practices including that of discrimination because of race, religion, color, sex, or national origin and that define actions required for Affirmative Action and Disadvantaged Business Enterprise (DBE) programs.

**107.21 Prompt Payment.** Make payment to each subcontractor and supplier within 10 Calendar Days after receipt of payment from the Department for Work performed or materials delivered or incorporated into the Project, according to ORC 4113.61, provided that the pay estimate prepared by the Engineer includes Work performed or materials delivered or incorporated into the public improvement by the subcontractor or supplier.

Also require that this contractual obligation be placed in all subcontractor and supplier contracts that it enters into and further require that all subcontractor and suppliers place the same payment obligation in each of their lower tier contracts. If the Contractor, subcontractors, or supplier subject to this provision fail to comply with the 10 Calendar Day requirement, the offending party shall pay, in addition to the payment due, interest in the amount of 18 percent per annum of the payment due, beginning on the eleventh Calendar Day following the receipt of payment from the Department and ending on the date of full payment of the payment due plus interest.

Repeated failures to pay subcontractors and suppliers timely pursuant to this subsection will result in a finding by the Department that the Contractor is in breach of Contract and subject to all legal consequences that such a finding entails. Further, repeated failures to pay timely pursuant to this subsection will result in a lower evaluation score for the Contractor and those subcontractors who are subject to evaluation by the Department.

## 108 PROSECUTION AND PROGRESS

**108.01 Subletting of the Contract.** Perform Work amounting to not less than 50 percent of the Contract Price with its own organization, unless otherwise approved by the Director. The phrase “its own organization” includes only workers employed and paid directly, inclusive of employees who are employed by a lease agreement acceptable to the Department, and equipment owned or rented with or without operators by the Contractor. The phrase does not include employees or equipment of a subcontractor, assignee, or agent of the Contractor. Obtain the Director’s written consent to subcontract, sublet, sell, transfer, assign, or otherwise relinquish rights, title, or interest in the Work. Provide the Director with a copy of all Disadvantaged Business Enterprise subcontracts.

The Contractor’s percentage of the total Contract Price includes the cost of materials and manufactured products purchased by the Contractor, but not the cost of materials and manufactured products purchased by subcontractors.

The Director will calculate the Contractor's percentage based on the quantities shown in the Proposal and the unit prices of the contract items to be performed by the Contractor's organization. If the Contractor performs only a portion of a contract item, then the Director will determine the proportional value administratively on the same basis. The Director will follow this procedure even when the part not subcontracted consists only of the procurement of materials. However, if a firm both sells the materials to the Contractor and performs the Work of incorporating the materials into the Project, then the Department will consider these two phases in combination and as a single subcontract. If an affiliate of the firm either sells the materials or performs the Work, the Department may refuse approval. An affiliate is one who has some common ownership or other close relation to said firm.

Use actual subcontract prices for calculating compliance with any Disadvantaged Business Enterprise (DBE) percentage subcontracting obligations. If only a part of a contract item is sublet, then determine its proportional value administratively on the same basis. The Director will follow this procedure even when the part not sublet consists only of procuring materials. However, if a firm both sells the materials to the Contractor and performs the work of incorporating the materials into the Project, then the Department will consider these two phases in combination and as a single subcontract. If an affiliate of the firm either sells the materials or performs the Work, the Department may refuse approval.

**108.02 Preconstruction Conference, Partnering, and Progress Schedule.** Meet with the Engineer for a preconstruction conference before beginning the Work. At or before the conference, submit the initial progress schedule to the DCE. Prepare the schedule according to 108.02.

Furnish a list of proposed subcontractors and material suppliers at or before the preconstruction conference. If the Contractor fails to provide the required submissions at or before the preconstruction conference, the Engineer may order the conference suspended until they are furnished. Do not begin the Work until the conference is reconvened and concluded or the Engineer gives specific written permission to proceed.

**A. Partnering.** It is the intent of the Department to partner every project. Therefore, enter into a cooperative partnership agreement with the Department on each Project. The objective of this agreement is the timely completion of the Work and a quality product that will be a source of pride to both the Department and the Contractor. This Partnering Agreement will not affect the terms and conditions of the Contract. It is a document that is solely intended to establish an environment of cooperation between the parties. The cost of the partnering workshop(s) will be agreed to and shared equally between the Department and the Contractor. The Contractor will pay all costs directly and the Department will authorize its share to the Contractor by Change Order. The Contractor is not entitled to any mark ups on these costs.

**B. Progress Schedule.**

1. General. Furnish a bar chart progress schedule to the District Construction Engineer for review at or before the pre-construction conference. The Engineer will review the schedule and within 14 calendar days of receipt, will

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either accept the schedule or provide the Contractor with comments. Acceptance of the schedule does not revise the Contract Documents. Provide clarification or any needed additional information within 10 days of a written request by the Engineer. The Department will withhold Estimates until the Engineer accepts the schedule. The Engineer will not measure or pay for the preparation of the schedule and schedule updates directly, but the cost of preparing and updating the schedule is incidental to all Contract Items.

a. Include the following Administrative Identifier Information:

- (1) Project Number
- (2) County
- (3) Route Number
- (4) FHWA Number
- (5) PID Number
- (6) Contract Number
- (7) Date of Contract
- (8) Completion Date
- (9) Contractor's Name
- (10) Contractor's Dated Signature
- (11) ODOT's Dated Acceptance Signature

Provide a working day schedule that shows the various activities of Work in sufficient detail to demonstrate a reasonable and workable plan to complete the Project by the Completion Date. Show the order and the sequence for accomplishing the Work. Describe all activities in sufficient detail so that the Engineer can readily identify the Work and measure the progress of each activity. The bar chart schedule must reflect the scope of work, required phasing, maintenance of traffic requirements, interim completion dates, the Completion Date, and other project milestones established in the Contract Documents. Include activities for submittals, working and shop drawing preparation, submittal review time for the Department, material procurement and fabrication, and the delivery of materials, plant, and equipment, and other similar activities. The schedule must be detailed on letter or legal sized paper.

b. Activity requirements are discussed in further detail as follows:

- (1) Activity Description

Assign each activity an unambiguous descriptive word or phrase. For example, use "Excavate Area A," not "Start Excavation."

- (2) Activity Original Duration

Indicate a planned duration in calendar days for each activity. Do not exceed a duration of 20 working days for any activity unless approved by the Engineer. Do not represent the maintenance of traffic, erosion control, and other similar items as single activities extending to the Completion Date. Break these Contract

Items into component activities in order to meet the duration requirements of this paragraph.

2. **Early Completion Schedule.** An Early Completion Schedule is defined as a baseline schedule or update schedule which anticipates completion of all work prior to the Completion Date established by the contract documents and the Contractor submits as an Early Completion Schedule. In the event that an Early Completion Schedule is accepted, the Engineer will initiate a change order amending the Completion Date to the finish date shown on the accepted Early Completion Schedule. The amended Completion Date will be effective upon execution of that change order and all contract provisions concerning the Completion Date such as incentives, disincentives, excusable delays, compensable delays, and liquidated damages will be measured against the amended Completion Date. The Contractor may elect not to execute the change order amending the Completion Date; however, in so doing, the Contractor waives its rights to delay damages in meeting the projected early Completion Date.

3. **Updated Progress Schedule.** Submit an updated progress schedule when ordered by the Engineer. The Engineer may request an updated progress schedule when progress on the work has fallen more than 14 calendar days behind the latest accepted progress schedule. Information in the updated schedule must include a "% work completed" value for each activity.

4. **Recovery Schedule.** If the progress schedule projects a finish date for the Project more than 14 calendar days later than the Completion Date, submit a revised schedule showing a plan to finish by the Completion Date. The Department will withhold Estimates until the Engineer accepts the revised schedule. The Engineer will use the schedule to evaluate time extensions and associated costs requested by the Contractor.

**108.03 Prosecution and Progress.** Start the Work according to 108.02. Notify the Engineer at least 24 hours before starting the Work. If the prosecution of the Work is suspended, notify the Engineer a minimum of 24 hours in advance of resuming operations.

Pursue the Work diligently and continuously as to complete the Project by the Completion Date.

**108.04 Limitation of Operations.** Limit operations to prevent unnecessary inconvenience to the traveling public. If the Engineer concludes that the extent of the Contractor's Work unnecessarily inconveniences the public or concludes limiting operations are necessary to protect the existing or new construction from damage, the Engineer will require the Contractor to finish portions of Work in progress before starting new Work.

**108.05 Character of Workers, Methods, and Equipment.** Provide personnel with sufficient skills and experience to perform assigned tasks.

If the Engineer gives written notification that specific Contractor or subcontractor personnel are improperly performing the Work, intemperate, disorderly, or creating a hostile work environment, remove the identified personnel from the Project. Do not allow removed personnel to return to the Project without the Engineer's approval.

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The Engineer may suspend the Work by written notice under this subsection for the following reasons:

- A. The Contractor does not furnish sufficient skilled and experienced personnel to complete the Project by the Completion Date.
- B. The Contractor does not remove personnel from the Project as directed in writing by the Engineer.

Use equipment of sufficient size and mechanical condition to complete the Project by the Completion Date. Ensure that the equipment does not harm the roadway, adjacent property, other highways, workers, or the public.

If the Contract Documents do not prescribe the methods and equipment required to accomplish the Work, determine the methods or equipment necessary to complete the Work according to the Contract.

If the Contract Documents specify methods and equipment to perform the Work, use such methods and equipment, unless others are authorized by the Engineer. Obtain the Engineer's written approval before substituting alternate methods or equipment. To obtain the Engineer's approval, submit a written description of the alternate methods and equipment proposed and an explanation of the reasons for making the change. The Engineer's approval of the substitute methods and equipment does not relieve the Contractor of the obligation to produce Work according to 105.03. If after trial use of the substituted methods or equipment, the Engineer determines that the Work does not conform to the Contract Documents, then complete the remaining Work using the specified methods and equipment. Remove all deficient Work and replace it according to the Contract Documents, or take such other corrective action as directed by the Engineer. The Engineer's authorization to substitute alternate methods and equipment will not change the basis of payment for the construction items involved or the Contract Time.

### **108.06 Determining a Time Extension to the Completion Date and Payment for Excusable Delays.**

**A. General.** The Department will only extend the Completion Date if an excusable delay, as specified in 108.06.B or 108.06.D, delays Work on the critical path shown on the accepted progress schedule and impacts the Completion Date. The critical path is defined as; the longest path of activities in the project that determines the project schedule completion date. The activities that make-up the critical path of activities are the "Critical Activities." Any extension of the Completion Date will be executed by a change order.

Mitigation of any delay, whether caused by the Department, Contractor, third-party or an intervening event, is a shared contract and legal requirement. Mitigation efforts include, but are not limited to, re-sequencing work activities, acceleration, and continuation of work through an otherwise planned shutdown period. The Contractor and Engineer must explore and discuss potential mitigation efforts in a timely manner.

The Department will not evaluate a request for extension of the Completion Date unless the Contractor notifies the Engineer as specified in 104.05, submits the

request in writing to the Engineer within 30 days following the termination of the delay, and provides the required analysis as specified in 108.02.B.4. The Engineer will evaluate the Contractor's analysis and determine the time extension due, if any. The Engineer will measure all time extensions in Calendar Days. For delays measured in Workdays, the Engineer will convert Workdays to Calendar Days by multiplying by 1.4 for a 5-day work week or less; 1.2 for a 6-day work week; and 1 for a 7-day work week; and extend the Completion Date by the resulting number of Calendar Days plus any holidays the Contractor does not normally work that occur in the extension period. When the conversion of Workdays to Calendar Days results in a decimal of 0.5 or greater, the Engineer will round the number of Calendar Days to the next highest whole number. When the conversion results in a decimal less than 0.5, the Engineer will delete the decimal portion of the Calendar Days.

The Engineer will not grant an extension of time for delays incurred from December 1 to April 30 unless the Contractor's accepted progress schedule depicts work on the critical path occurring during this period.

The Engineer may order the Contractor to continue Work after November 30 and compensate the Contractor for costs incurred due to cold weather Work.

The Contractor's plea that insufficient time was specified is not a valid reason for an extension of time.

The Department will relieve the Contractor from associated liquidated damages, as specified in 108.07, if the Engineer extends the Completion Date under 108.06.A.

The extended Completion Date shall then have the same standing and effect as though it was the original Completion Date.

If the Contractor contends that an excusable delay is also compensable, as specified in 108.06.D, submit a detailed cost analysis of the requested additional compensation along with the request for extension of Completion Date.

**B. Excusable, Non-Compensable Delays.** Excusable, non-compensable delays are delays that are not the Contractor's or the Department's fault or responsibility. The Engineer will not grant additional payment for excusable, non-compensable delays.

The following are excusable, non-compensable delays:

1. Delays due to floods, tornadoes, lightning strikes, earthquakes, or other cataclysmic phenomena of nature.
2. Delays due to weather as specified in 108.06.C.
3. Extraordinary delays in material deliveries the Contractor or its suppliers cannot foresee or avoid resulting from freight embargoes, government acts, or area-wide material shortages. Delays due to the Contractor's, subcontractor's, or supplier's insolvency or mismanagement are not excusable.
4. Delays due to civil disturbances.
5. Delays from fires or epidemics.

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6. Delays from labor strikes that are beyond the Contractor’s, subcontractor’s, or supplier’s power to settle and are not caused by improper acts or omissions of the Contractor, subcontractor, or supplier.

7. Added quantities that delay an activity on the critical path.

8. All other delays not the Contractor’s and Department’s fault or responsibility.

**C. Extension to the Completion Date for Weather or Seasonal Conditions.**

A weather day is defined as a workday that weather or seasonal conditions reduced production by more than 50 percent on items of work on the critical path. Submit the dates and number of weather days in writing to the Engineer at the end of each month. In the event the Contractor fails to submit weather days at the end of each month the Engineer will determine the dates and number of weather days from project records. The Engineer will extend the Completion Date one workday for each lost workday caused by weather or seasonal conditions, except for workdays lost from December 1 to April 30.

When the Contractor’s accepted progress schedule depicts Work on the critical path occurring during the period from December 1 to April 30, then the Engineer will provide a time extension for weather days lost in excess of those tabulated in Table 108.06-1.

**TABLE 108.06-1**

<b>Month</b>	<b>Number of Workdays Lost Due to Weather</b>
December	6
January	8
February	8
March	7
April	6

The Engineer will not consider weekends and holidays as lost workdays unless the Contractor normally works those days or unless the Engineer directs the Contractor to work those days.

**D. Excusable, Compensable Delays.** Excusable, compensable delays are delays that are not the Contractor’s fault or responsibility, and are the Department’s fault or responsibility or are determined by judicial proceeding to be the Department’s sole responsibility or are the fault and responsibility of a local government. For the following excusable, compensable delays, the Engineer will extend the Completion Date if the conditions specified in 108.06.A are met:

1. Delays due to revised Work as specified in 104.02.B, 104.02.D, or 104.02.F.
2. Delays due to utility or railroad interference within the Project limits.
3. Delays due to an Engineer-ordered suspension as specified in 104.02.C.
4. Delays due to acts of the government or a political subdivision other than the Department; however, these compensable delay costs are limited to

escalated labor and material costs only, as allowed in 109.05.D.2.b and 109.05.D.2.d.

5. Delays due to the neglect of the Department or its failure to act in a timely manner.

Compensation for excusable, compensable delays will be determined by the Engineer according to 109.05.D.

**E. Non-Excusable Delays.** Non-excusable delays are delays that are the Contractor's fault or responsibility. All non-excusable delays are non-compensable.

**F. Concurrent Delays.** Concurrent delays are separate critical delays that occur at the same time. When a non-compensable delay is concurrent with a compensable delay, the Contractor is entitled to additional time but not entitled to additional compensation.

**108.07 Failure to Complete on Time.** If the Contractor fails to complete the Work by the Completion Date, then the Director, if satisfied that the Contractor is making reasonable progress, and deems it in the best interest of the public, may allow the Contractor to continue in control of the Work. The Department will pay the Contractor for Work performed on the Project less any liquidated damages incurred.

If the Work is not completed by the Completion Date and the Director permits the Contractor to remain in control, prosecute the Work at as many different places, at such times, and with such forces as the Director requests. Provide a written plan for the completion of the Work.

For each calendar day that Work remains uncompleted after the Completion Date, the Department will deduct the sum specified herein from any money due the Contractor, not as a penalty, but as liquidated damages. The Director will adjust the Completion Date or other contractually mandated dates for delays specified in 108.06.B.7 and 108.06.D.

Permitting the Contractor to continue and complete the Work or any part of the Work after the Completion Date, or after extensions to the Completion Date, will in no way operate as a waiver on the part of the Department of any of its rights under the Contract.

The Director may stop deducting liquidated damages when:

- A. The Work is substantially complete and the project is available for use as intended by the contract.
- B. The Contractor is diligently pursuing the remaining Work.
- C. The Work remaining will not interfere with the intended use of the project and will not impact traffic. For the limited purposes of assessing liquidate damages, the closing of a shoulder is not considered an impact upon traffic.
- D. All contract safety items are complete and operational. These safety items include but are not limited to signs, pavement markings, guardrail, attenuators, and

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signals. Raised pavement markers (RPM) are required safety items if the roadway section involved had RPMs before the project started.

E. Deemed reasonable and appropriate by the District Deputy Director.

**TABLE 108.07-1 SCHEDULE OF LIQUIDATED DAMAGES**

Original Contract Amount (Total Amount of the Bid)		Amount of Liquidated Damages to be Deducted for Each Calendar Day of Overrun in Time
From More Than	To and Including	
\$0.00	\$500,000	\$1,000
\$500,000	\$2,000,000	\$1,000
\$2,000,000	\$10,000,000	\$1,300
\$10,000,000	\$50,000,000	\$2,000
Over 50,000,000		\$2,500

**108.08 Unsatisfactory Progress and Default of Contractor.** The Director will notify the Contractor in writing of unsatisfactory progress for any of the following reasons:

- A. The Contractor has not commenced the Work by the dates established in the schedule.
- B. The Contractor does not proceed with the Work in a manner necessary for completion of the Project by the Completion Date.
- C. The Contractor is performing the Work improperly.
- D. The Contractor abandons, fails, or refuses to complete the Work.
- E. Any other reason the Director believes jeopardizes completion of the Work by the Completion Date.

If the Contractor does not respond to the satisfaction of the Director, the Director may declare the Contractor in default and may notify the Contractor and Surety that the responsibility to complete the Work is transferred to the Surety. Upon receipt of this notification, the Contractor’s right to control and supervise the Work will immediately cease. In such a case, the Director will proceed as specified in ORC 5525.17. The defaulted Contractor will not be compensated for costs resulting from the default and is not eligible to be retained by the Surety to complete the Work. If it is determined that the Department’s default of the Contractor according to 108.08 is wrongful, then the default will revert to a termination of the Contract according to 108.09.

**108.09 Termination of the Contract for Convenience of the Department.** The Director may terminate the Contract at any time for the convenience of the Department. The Department will compensate the Contractor according to 109.04 and 109.05 for termination of the Contract for the convenience of the Department. This subsection is subject to the provisions of ORC 5525.14.

**108.10 Payroll Records.** Keep payroll records as specified in ORC 4115.07 or as required by Federal law.

Authorized representatives of the Director may inspect the certified payroll and other payroll records. Upon completion of the Work and before receiving the final estimate and when required by ORC 4115.07, submit an affidavit stating that wages have been paid according to the minimum rates specified in the Contract Documents.

**108.11 Post Construction Meeting.** It is the intent of the Department to conduct a post construction meeting with the Contractor approximately 10 days after final inspection. The District will determine the time and place for the meeting. The District may contact the design agency or consultant and the local government agency to request a representative attend this meeting.

Both parties will discuss their performance including sublet portions of the Project. This shall include the Contractor's C95 evaluation form and the Contractor feedback form. Conduct a partnering evaluation survey to help get participants' feedback and improve the partnering process. (Sample evaluations are shown in the ODOT *Partnering Handbook*.)

The cost of attending this meeting is incidental to the Contract.

## 109 ACCEPTANCE, MEASUREMENT, AND PAYMENT

**109.01 Measurement of Quantities.** The Department will measure the quantities of Work and calculate payments based on the method of measurement and basis of payment provisions provided in these Specifications. When the following units of measure are specified, the Department will measure quantities as described below unless otherwise specified in the Contract Documents. The accuracy of individual pay item estimate payments will be one decimal more accurate than the unit of measure denoted for the pay item.

**Lump Sum.** Not measured. Describes payment as reimbursement for all resources necessary to complete the Work. When a complete structure or structural unit is specified as the unit of measurement, the unit will include all necessary fittings and accessories.

**Each.** Measured by the number of individual items of Work completed.

**Foot (Meter).** Measured parallel to the longitudinal base or foundation upon which items are placed, or along the longitudinal surface of the item. Measured vertically to the nearest 0.1 foot (0.01 m), with a minimum vertical measurement of 1 foot (0.10 m), at each unit.

**Square Yard or Square Foot (Square Meter).** Measured by a two-dimensional area method on the surface of the item.

**Cubic Yard (Cubic Meter).** Measured by a three-dimensional volume method. Measure all "loose material" or material "measured in the vehicle" by the cubic yard (cubic meter). Haul material "measured in the vehicle" in approved

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vehicles and measure in the vehicle at the point of delivery. For this purpose, use approved vehicles of any type or size satisfactory to the Engineer, provided the vehicle’s bed is of such type that the actual contents are readily and accurately determined. Unless all approved vehicles on a job are of uniform capacity, each approved vehicle must bear a legible identification mark indicating the specific approved capacity. The Inspector may reject all loads not hauled in such approved vehicles.

Cubic Yard (Cubic Meter) for Asphalt Concrete. Measure as specified in 401.21.

**Acre (Hectare).** Measured by a two-dimensional area method on the surface to the nearest 0.1 acre (0.05 ha).

**Pound (Kilogram).** Measured by actual item net weight avoirdupois (mass).

**Ton (Metric Ton).** The term “ton” means the short ton consisting of 2000 pounds avoirdupois. The term “metric ton” means 1000 kilograms. Weigh all materials that are proportioned by weight on accurate and approved scales that are operated by competent, qualified personnel at locations approved by the Engineer. However, car weights will not be acceptable for materials to be passed through mixing plants. If trucks are used to haul material being paid for by weight, weigh the empty truck at least once daily and as the Engineer directs and only if the weight of the truck is used in determining the ticket weight. Place a plainly legible identification mark on each truck bearing the weight of the truck.

For Work on a tonnage basis, file with the Engineer receipted freight bills for railroad shipments and certified weight-bills when materials are received by any other method, showing the actual tonnage used. For Work on a volume basis, itemize evidence of the volume used.

**Gallon (Liter).** Measured by actual item liquid volume. The Department will measure the following materials by the gallon (liter) at the following temperatures:

Temperatures	Items
60 °F (16 °C)	Creosote for Priming Coat, Creosote Oil, Creosote Solutions for Timber Preservatives, Asphalt Primer for Water-proofing, and Liquefier
100 °F (38 °C)	RC, MC Asphalt Emulsions, CBAE, Primer 20, and Primer 100
300 °F (149 °C)	Asphalt Binder

Measure tank car outage of asphalt material at its destination before any material has been removed from the tank car according to Supplement 1060.

Convert the net weight of asphalt material shipments to gallons (liters) at the specified pay temperature according to Supplement 1060.

Convert the gallons (liters) at the measured temperature to gallons (liters) of asphalt material at the specified pay temperature according to Supplement 1060.

**Thousand Board Feet, MBF (Cubic Meter).** Measure timber by MBF (cubic meter) actually incorporated in the structure. Base the measurement on nominal widths, thicknesses, and the extreme length of each piece.

**Standard Manufactured Items.** When standard manufactured items are specified such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by size, unit weight, section dimensions, etc., such identification will be to nominal weights or dimensions set by the industry.

**109.02 Measurement Units.** The Department will measure using either English or metric units as indicated in the Contract Documents. Use the Tables 109.02-1 and 109.02-2 to convert units when required. If Tables 109.02-1 and 109.02-2 do not provide a required factor, then use the appropriate factor provided in the IEEE/ASTM SI 10.

**TABLE 109.02-1 ENGLISH TO SI (METRIC) CONVERSION FACTORS**

Symbol	When You Know	Multiply By	To Find	Symbol
<b>Length</b>				
mil	mils	25.4	micrometers	$\mu\text{m}$
in	inches	25.4	millimeters	mm
ft	feet	0.3048	meters	m
yd	yards	0.9144	meters	m
mi	miles	1.609347	kilometers	km
<b>Area</b>				
$\text{in}^2$	square inches	645.16	square millimeters	$\text{mm}^2$
$\text{ft}^2$	square feet	0.09290304	square meters	$\text{m}^2$
$\text{yd}^2$	square yards	0.8361274	square meters	$\text{m}^2$
ac	acres	0.4046873	hectares	ha
ac	acres	4046.873	square meters	$\text{m}^2$
$\text{mi}^2$	square miles	2.589998	square kilometers	$\text{km}^2$
<b>Volume</b>				
fl oz	fluid ounces	29.57353	milliliters	mL
gal	gallons	3.785412	liters	L
$\text{ft}^3$	cubic feet	0.02831685	cubic meters	$\text{m}^3$
$\text{yd}^3$	cubic yards	0.7645549	cubic meters	$\text{m}^3$
<b>Mass</b>				
oz	ounces	28.34952	grams	g
lb	pounds	0.4535924	kilograms	kg
T	2000 pounds	0.9071847	metric tons	t
<b>Temperature</b>				
$^{\circ}\text{F}$	Fahrenheit	$C = (F - 32)/1.8$	Celsius	$^{\circ}\text{C}$
<b>Illumination</b>				
fc	foot-candles	10.76391	lux	lx
fl	foot-lamberts	3.426259	candelas per square meter	$\text{cd}/\text{m}^2$
<b>Force and Pressure or Stress</b>				
lbf·ft	pounds-force foot	1.355818	newton meter	N·m
lbf	pounds force	4.448222	newtons	N
$\text{lbf}/\text{ft}^2$ (psf)	pounds force per square foot	47.88026	pascals	Pa
$\text{lbf}/\text{in}^2$ (psi)	pounds force per square inch	0.006894757	megapascals	MPa

**TABLE 109.02-2 SI (METRIC) TO ENGLISH CONVERSION FACTORS**

Symbol	When You Know	Multiply By	To Find	Symbol
<b>Length</b>				
μm	micrometers	0.03937	mils	mil
mm	millimeters	0.03937	inches	in
m	meters	3.28084	feet	ft
m	meters	1.093613	yards	yd
km	kilometers	0.62137	miles	mi
<b>Area</b>				
mm <sup>2</sup>	square millimeters	0.00155	square inches	in <sup>2</sup>
m <sup>2</sup>	square meters	10.76391	square feet	ft <sup>2</sup>
m <sup>2</sup>	square meters	1.19599	square yards	yd <sup>2</sup>
ha	hectares	2.4710437	acres	ac
m <sup>2</sup>	square meters	0.000247	acres	ac
km <sup>2</sup>	square kilometers	0.3861	square miles	mi <sup>2</sup>
<b>Volume</b>				
mL	milliliters	0.033814	fluid ounces	fl oz
L	liters	0.264172	gallons	gal
m <sup>3</sup>	cubic meters	35.31466	cubic feet	ft <sup>3</sup>
m <sup>3</sup>	cubic meters	1.30795	cubic yard	yd <sup>3</sup>
<b>Mass</b>				
g	grams	0.035274	ounces	oz
kg	kilograms	2.204622	pounds	lb
t	metric tons	1.1023114	2000 pounds	T
<b>Temperature</b>				
°C	Celsius	F = 1.8C + 32	Fahrenheit	°F
<b>Illumination</b>				
lx	lux	0.09290304	foot-candles	fc
cd/m <sup>2</sup>	candelas per square meter	0.29186352	foot-lamberts	fl
<b>Force and Pressure or Stress</b>				
N·m	newton meters	0.7375621	pounds-foot force	lbf ft
N	newtons	0.22480892	pound force	lbf
Pa	pascals	0.02088543	pounds force per square foot	lbf/ft <sup>2</sup> (psf)
MPa	megapascals	145.03774	pounds force per square inch	lbf/in <sup>2</sup> (psi)

**109.03 Scope of Payment.** Payment of the Contract Price is full compensation for all resources necessary to complete the Contract Item and maintain the Work. Assume liability for risk, loss, damage, or expense resulting from the Work. The

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Contract Price and Contract Time shall only be changed by written Change Order or as determined by the Department in writing in accordance with the contract documents.

**109.04 Compensation for Altered Quantities, Eliminated Items or Termination of the Contract for Convenience of the Department.** If the agreed quantities of contract items vary from the quantities in the Contract, the Department will make payment at the original Contract unit prices for the agreed quantities of Work.

A. If an item is eliminated in accordance with 104.02.E or the contract is terminated in accordance with 108.09 the Department will pay the following in addition to that provided by 104.02.D:

1. Restocking charges supported by paid invoices and an additional 5 percent mark up on the compensation for overhead and profit.

2. The cost of material transferred to the Department or a local government agency in lieu of restocking or disposal. The allowed compensation is the paid invoice cost plus 15 percent markup, but no more than the unit bid price for the reference number involved.

3. Hauling costs, if not included in restocking charges, for returned material and for material delivered to the Department.

B. If the project is terminated for convenience of the Department, the Department will negotiate compensation with the Contractor for actual costs incurred as a result of the termination. The Department will pay for Extra Work as stipulated in approved Extra Work Change Orders or written authorizations subject to the limitations set forth in ORC 5525.14. Such authorizations for emergencies and to avoid Project delays are in advance of an approved Extra Work Change Order and commit the Department only to the terms of the authorizations. The Department will pay for Extra Work after the approval of the subsequent Change Order.

## 109.05 Changes and Extra Work.

**A. General.** If the Department revises the Contract under: 104.02, 105.07, 105.10, 105.13, 107.10, 107.14, 107.15, 108.09, 109.06, or 109.07, the Department will pay for changes and Extra Work with a Change Order using the sequence specified in 109.05.B through 109.05.E.

In establishing the method of payment for contract changes or extra work orders, force account procedures shall only be used when strictly necessary, such as when agreement cannot be reached with the contractor on the price of a new work item, or when the extent of work is unknown or is of such character that a price cannot be determined to a reasonable degree of accuracy. The reason or reasons for using force account procedures shall be documented.

Unless otherwise stated in 109.05, the compensation provided in 109.05.B through 109.05.E constitutes payment in full for all changes and Extra Work completed by original Contract Price, agreed unit price, agreed lump sum price, and for work performed on a force account basis, including:

1. Administration.
2. Superintendence.
3. Project and field office overhead.
4. Home office overhead.
5. Use of tools and equipment for which no rental is allowed.
6. Profit.
7. Taxes other than sales tax.

8. Premiums on insurance including additional premiums for Commercial General Liability Insurance required by 107.12.B and any additional coverage carried by the Contractor or subcontractor, excluding pollution and railroad General Liability Insurance. The Department will pay the Contractor's pollution and railroad liability insurance premiums, if required by the contract, by a separate Change Order for the cost of the premium without any mark up. When the Contractor's or subcontractors' basic rate for General Commercial Liability Insurance required by 107.12.B is greater than 5 percent of payroll, the Department will pay directly without mark up the portion of the premium in excess of 5 percent and provide copies of paid premiums.

Sales tax will not be allowed on any item for which tax exemption was obtained.

**B. Negotiated Prices.** Negotiated prices for changes and Extra Work shall be comparable to prices that would have resulted from a competitive bid contract. The Engineer and Contractor will negotiate agreed unit or lump sum prices using one or more of the following methods:

1. Original Contract prices for similar work but adjusted for:
  - a. increased or decreased material costs specified in 109.05.C.3.
  - b. increased or decreased labor costs specified in 109.05.C.2
  - c. increased or decreased equipment costs specified in 109.05.C.4

Adjustments of these prices for inflation or mark up for subcontractor work is not allowed.

2. State-wide average unit price awarded for the item or items as listed in the Department's annual "Summary of Contracts Awarded." These prices may be adjusted for inflation using factors issued by the Office of Construction Administration. No mark up for subcontractor work is allowed.

3. Average price awarded on three different projects of similar work and quantity. These prices may be adjusted for inflation using factors issued by the Office of Construction Administration. No mark up for subcontractor work is allowed.

4. Prices computed by the Office of Estimating.

5. Cost analysis of labor, material, equipment, and mark ups as allowed in 109.05.C.

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6. For the cost of compensable delays as defined in 108.06, prepare a cost analysis as allowed by 109.05.D.

Provide proposed pricing and cost justification for changes or Extra Work within 5 business days after the Department's request. The Department will respond within 5 business days after receipt of the Contractor's proposal. The Department and the Contractor can mutually agree to extend these 5-day time limits.

If the Department negotiates with the Contractor but does not agree on a price adjustment, the Engineer may direct the Contractor to perform all or part of the revised Work under force account.

### C. Force Account.

**1. General.** The Engineer may direct the Contractor to perform the revised Work under force account. Submit a written proposal and estimated costs for the Work, including the planned equipment, materials, labor, a work schedule.

The Department will pay the Contractor as specified in 109.05.C as full compensation for performing the force account Work. The Project and Contractor personnel will document the labor and equipment used on the force account work on a Daily Force Account Record. At the end of each Workday, the Project and Contractor personnel will compare and sign the Daily Force Account Record. The Department will make no force account payment before the Contractor submits an itemized statement of the costs for that work.

The Engineer will examine and, if found to be acceptable, approve all rates and costs submitted by the Contractor.

Provide the following content in itemized statements for all force account work:

a. Name, classification, date, daily hours, total hours, rate, and amount for all labor.

b. Designation, dates, daily hours, total hours of actual operation and idle time, Blue Book rate with reference or category, and amount for each unit of equipment and the applicable Blue Book hourly operating cost for each unit of equipment and invoices for all rental equipment. The designation includes the manufacturer's name or trademark, model number, and year of manufacture.

c. Quantities of materials and prices.

d. Transportation charges on materials, free on board (F.O.B.) at the job site.

e. Cost of workers' compensation insurance premiums, all applicable insurance premiums, unemployment insurance contributions, and social security tax and fees or dues required by a collective bargaining agreement. Express each of these items of cost as a percentage of payroll, except fees or dues, which should be expressed as a cost per hour.

f. Documentation showing payment for all surveying, professional, or similar specialized Work not normally a part of a Department contract.

g. If materials are taken from Contractor's stock and original receipted invoices for the materials and transportation charges do not exist, provide an affidavit and certify all of the following:

- (1) The materials were taken from the Contractor's stock.
- (2) The quantity shown was actually used for the force account work.
- (3) The price and transportation costs represent the actual cost to the Contractor.

h. Documentation showing payment to trucking firms and owner-operators. Submit documentation showing owner-operations status. When the trucking is subject to prevailing wage, submit payroll and equipment usage records according to 109.05.C.1.a, 109.05.C.1.b, and 109.05.C.1.e.

i. Provide "receipted invoices" for all costs substantiated by an invoice.

If only part of the expenditure represented by an invoice is applicable to force account work, or if the invoice represents expenditure for more than one item of work, clearly indicate the actual amount of expenditure applicable to each item of work.

**2. Labor.** The Department will pay the wages and fringe benefits currently in effect for each hour the Work is performed by all labor employed in the Work and all foremen in direct charge of the specific operation. The Department will pay an additional 38 percent mark up on these wages and benefits. "Fringe benefits" are the actual costs paid to, or on behalf of, workmen by reason of health and welfare benefits, pension fund benefits, or other benefits, when such amounts are required by prevailing wage laws or by a collective bargaining agreement or other employment contracts generally applicable to the classes of labor employed on the Project.

The Department will pay the actual itemized cost, without mark up, of the following payroll taxes and legally required insurances:

- a. Social Security Tax.
- b. Medicare Tax.
- c. Ohio Workers' Compensation Premiums.
- d. State and Federal Unemployment Insurance.
- e. Longshore and Harborworkers' Compensation Insurance for work from a barge or ship, or unloading material from a barge or ship.

Provide itemized statements in addition to the documentation requirements for all labor including the name, classification, date, daily hours, total hours, rate, and amount. If any person is paid more than the one rate, a separate listing shall be made for that person for each rate paid. Provide itemized statements for Ohio Workers' Compensation insurance premiums, all applicable insurance premiums, State and Federal Unemployment Insurance contributions, and Social Security Tax and fees or dues required by a collective bargaining

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agreement. Express each of these items of cost as a percentage of payroll, except fees or dues, which shall be expressed as a cost per hour.

Instead of itemizing the cost of Social Security Tax, Ohio Workers' Compensation, and State and Federal Unemployment Insurance, the Contractor may elect to receive as compensation for these payroll taxes and premiums, an amount equal to 22 percent of the paid wages. If the Contractor pays fringes directly to the worker in lieu of paying into a fringe benefit program, then the Department will treat these fringe payments as paid wages when calculating the allowed 22 percent compensation.

The Department will pay, without mark up, the actual itemized cost of fees and dues paid to labor unions or to business associations when they are based on payroll hours and required by a collective bargaining agreement.

The Department will not pay for wages or benefits for personnel connected with the Contractor's forces above the classification of foreman that have only general supervisory responsibility for the force account work.

If the foreman or timekeeper is employed partly on force account work and partly on other work, the Contractor shall prorate the number of hours between the force and non-force account work according to the number of people on each task as shown on payrolls.

The Department will pay the prevailing wage and fringe rates that apply to the Project for the classifications required for Extra Work. The Contractor must provide payroll records for pay rates higher than the prevailing wages and establish that the higher than prevailing rates are paid for original Contract Work. The Department will pay for foremen and time keepers not covered by prevailing wages not more than the salaried rate they receive when engaged in original Contract Work.

The Department will pay actual costs for subsistence and travel allowances when such payments are required by the collective bargaining agreement or other employment contracts applicable to the classes of labor employed on the Project. The Department will not pay a percent mark up on these costs.

**3. Materials.** The Department will pay the Contractor's actual invoice costs, including applicable taxes and actual freight charges, for Engineer approved materials the Contractor uses in force account Work. The Department will pay an additional 15 percent mark up on these costs.

Freight or hauling costs charged to the Contractor and not included in unit prices shall be itemized and supported by invoices. The cost of owned or rented equipment used to haul materials to the project is not part of the materials cost. Such equipment, when used for hauling materials, shall be listed under cost of equipment.

Provide itemized statements in addition to the documentation requirements for all equipment including the quantity and price of each material and transportation charges free on board (F.O.B.) at the job site. Attach invoices to support the quantities of materials used, unit prices paid and transportation

charges. If the Contractor uses materials from the Contractor's stock and original receipted invoices for the materials and transportation charges do not exist, the Department and the Contractor will agree on a price that represents the actual cost to the Contractor. Provide an affidavit and certify all of the following:

- a. The materials were taken from the Contractor's stock.
- b. The quantity shown was actually used for the force account work.
- c. The price and transportation costs represent the actual cost to the Contractor.

Do not incorporate materials into the Work without a price agreement.

#### **4. Equipment.**

**a. General.** The Department will pay the Contractor's costs for equipment the Engineer deems necessary to perform the force account work for the time directed by the Engineer or until the Contractor completes the force account Work, whichever happens first. The Department will pay the Contractor the established rates for equipment only during the hours that it is operated, except as otherwise allowed elsewhere in these Specifications. The Department will pay for non-operating hours at the idle equipment rate as specified in 109.05.C.4.c. Report equipment hours to the nearest 1/2 hour. The established equipment rates in these Specifications include compensation for overhead and profit except as otherwise specified.

The Department will pay for use of Contractor-owned equipment the Engineer approves for force account Work at established rates. The Department will pay the rates, as modified in 109.05.C.4.b, given in the Rental Rate Blue Book for Construction Equipment (Blue Book) published by Equipment Watch, a unit of Interec Publishing, a PRIMEDIA Company.

Provide, and the Engineer will confirm, the manufacturer's ratings and manufacturer-approved modifications required to classify equipment for rental rate determination. For equipment with no direct power unit, use a unit of at least the minimum recommended manufacturer's rating.

The Department will not pay rental for small tools or equipment that show a daily rate less than \$5.00 or for unlisted equipment that has a value of less than \$400.

Tool trucks will be allowed for compensation if they are used at the force account site. Only the tools used from the tool truck will be allowed for compensation. Tools in the tool truck that are not used in the force account work will not be compensated. A tool trailer that remains at the Contractor's office or yard will not be allowed on the force account work. Tool trailers that are taken to the force account site will be allowed for compensation along with the tools used on the force account work that were taken from the trailer.

Treat traffic control devices used in Maintaining Traffic and owned by the Contractor as owned equipment. Allowed rates for common traffic control devices and concrete barrier that are not listed in the Blue Book will be as determined by the Department.

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Use Engineer approved equipment in good working condition and providing normal output or production. The Engineer may reject equipment not in good working condition or not properly sized for efficient performance of the Work.

For each piece of equipment used, whether owned or rented, provide the Engineer with the following information:

- (1) Manufacturer's name or trademark.
- (2) Equipment type.
- (3) Year of manufacture.
- (4) Model number.
- (5) Type of fuel used.
- (6) Horsepower rating.
- (7) Attachments required, together with their size or capacity.
- (8) All further information necessary to determine the proper rate.
- (9) Dates, daily hours, total hours of actual operation and idle time,
- (10) Blue Book rate with reference or category,
- (11) Amount
- (12) Applicable Blue Book hourly operating cost
- (13) Invoices for all rental equipment.

**b. Hourly Owned Equipment Rates.** The base rate for the machine and attachments represent the major cost of equipment ownership, such as depreciation, interest, taxes, insurance, storage, and major repairs. The hourly operating rate represents the major costs of equipment operation, such as fuel and oil lubrication, field repairs, tires, expendable parts, and supplies.

For all equipment used on force account work, determine, and have the Department confirm, the hourly owned equipment rates as follows:

$$HOER = [RAF \times ARA \times (R / 176)] + HOC$$

Where:

- HOER* = hourly owned equipment rate
- RAF* = regional adjustment factor shown in the Blue Book
- ARA* = age rate adjustment factor shown in the Blue Book
- R* = current Blue Book monthly rate
- HOC* = estimated hourly operating cost shown in the Blue Book

However, compensation for equipment normally used on a 24 hours per day basis will not exceed the monthly rate plus adjustments and operating costs.

The rate adjustment factor assigned to any attachment will be the yearly factor as determined for the base equipment.

When multiple attachments are included with the rental equipment, only the attachment having the highest rental rate will be eligible for payment, provided that the attachment has been approved by the Engineer as being necessary to the force account Work.

When a piece of owned equipment is not listed in the Blue Book, use the rate for similar equipment found in the Blue Book or use 6 percent of the purchase price as the monthly rate ( $R$ ) and add the hourly operating rate found in the Blue Book for similar equipment of the same horsepower.

For equipment brought to the Project exclusively for force account work and on the Project for less than a month, multiply the monthly rate ( $R$ ) by the factor listed below:

**TABLE 109.05-1**

Working Hours	Factor
Less than or equal to 8.0	2.00
8.1 to 175.9	2.048 - (hours/168)
176 or greater	1.00

The term “WORKING HOURS,” as used in Table 109.05-1, includes only those hours the equipment is actually in operation performing force account work; apply the factor, as determined above, to these actual working hours only. Calculate compensation for any idle time according to 109.05.C.4.c without application of the factor.

The Department will pay as working equipment for the entire Workday equipment used intermittently during the Workday. The following criteria qualify for intermittently used equipment:

(1) Equipment dedicated to the force account exclusively all day and not used on bid work.

(2) Equipment works before and after the intermittent idle period and its total working time during the Workday is at least 2 hours.

Equipment that is captive to the force account work (i.e. it must remain at the force account site), but does not qualify for intermittently used owned equipment, is paid as idle equipment according to C&MS Section 109.05.C.4.c. for the time it is not working.

**c. Hourly Idle Equipment Rate.** For equipment that is in operational condition, on site, and necessary for force account Work, but is idle, the Department will pay an hourly idle equipment rate. The procedure to determine the hourly idle equipment rate for Contractor owned equipment is as follows:

$$HIER = RAF \times ARA \times (R / 176) \times (1/2)$$

Where:

*HIER* = Hourly idle equipment rate.

*RAF* = Regional adjustment factor shown in the Blue Book.

*ARA* = Age rate adjustment factor shown in the Blue Book.

*R* = Current Blue Book monthly rate.

If rented equipment necessary for force account work is idle, the Department will pay the Contractor for the actual invoiced rates prorated for the duration of the idle period. The actual invoiced rates must be reasonably in line with the Blue Book rates and approved by the Engineer. The Department will pay a 15 percent mark up for overhead and profit for the actual invoiced rates during the idle period.

The Department will not pay idle owned equipment costs for more than 8 hours in a 24-hour day or 40 hours in a week.

The Department will not pay for inoperable equipment.

The Engineer may order specific equipment to the site up to 5 days before its planned usage. If this equipment is not used for other work, the Department will pay for it as idle equipment until used.

The Department will pay for the cost of idle owned or rented equipment when the Work was suspended for the convenience of the State. The Department will not pay the cost of idle equipment when the Work was suspended by the Contractor for the Contractor's own reasons.

The Department will only pay for the number of Calendar Days during the existence of the suspension. The Department will not compensate the Contractor for days that the Engineer determined were lost to weather.

The Department will only pay for equipment physically located at the Project site that was received to prosecute the scheduled work during the delay.

Compensation for idle equipment will stop at the completion of the force account Work or at the end of the suspension of Work.

**d. Rented Equipment.** The Department will pay a 15 percent mark up for overhead and profit for all rented equipment, its corresponding Blue Book hourly operating costs, and State and Local sales taxes.

**(1) Equipment Rented Solely for Force Account Work.** If the Contractor rents or leases equipment from a third party exclusively for force account Work, the Department will pay the actual invoiced amount. The actual invoiced rates must be reasonably in line with the Blue Book and approved by the Engineer. The Department will pay a 15 percent mark up for overhead and profit for all rented equipment paid for by the actual invoices. Add the Blue Book hourly operating cost to the marked up actual invoiced rates.

**(2) Equipment Rented for Original Contract Work, but Used for Force Account Work.** If the Contractor uses rented equipment

currently on the Project for original Contract Work to perform force account Work, then determine the hourly outside-rented equipment rate as follows:

$$HRER = (HRI \times 115\%) + HOC$$

Where:

*HRER* = hourly rented equipment rate

*HRI* = hourly rental invoice costs prorated for the actual number of hours that rented equipment is operated solely on force account work. Use a monthly invoice rate divided by 176, a weekly invoice rate divided by 40, or a daily invoice rate divided by 8.

*HOC* = hourly operating cost shown in the Blue Book

The Department will not compensate for rental rates that exceed the Blue Book rates unless approved in advance of the Work by the Engineer.

**e. Moving of Equipment.** The Department will also pay for the time required to move needed equipment to the location of the force account work and to return it to its original location. The Department will pay for loading and transportation costs instead of moving time if equipment is moved by means other than its own power. Moving time back to the original location or loading and transportation costs will not be allowed if the equipment is used at the site of the force account work on contract items or related work.

The Department will consider the actual cost of transferring the equipment to the Project and returning it to the original location as an additional expense and pay for it as specified, for equipment moved on the Project exclusively for force account work.

The Engineer will confirm the original location of the equipment before the Contractor moves and uses it for force account work.

If the equipment is transported by a common carrier, the allowance is the invoiced amount paid for the freight plus 15 percent. However, if the Contractor's forces transport the equipment, the allowable compensation will be Blue Book rate of the hauling unit and hourly Blue Book operating cost plus the driver's wages and the cost of loading and unloading the equipment calculated according to 109.05.C.2.

**5. Foreman's Transportation.** The Department will pay the Blue Book rate for every hour the foreman's truck is on the force account site or moving to or from the site. This rate includes equipment cost, fuel and lubricants, overhead, profit, and mobile phone or two-way radios.

**6. Subcontract Work.** For Work performed by an approved subcontractor, the Department will pay an amount to cover administrative costs pursuant to Table 109.05-2. No additional mark-up is allowed for work of a sub-subcontractor or trucking services employed by a subcontractor.

**TABLE 109.05-2**

Subcontractor Force Account Costs (109.05.C.2 through 109.05.C.5)	Mark-up Amount
Up to \$10,000	\$500
\$10,001 to \$500,000	5% of Subcontractor Force Account Costs
Over \$500,000	\$25,000 + 2.5% of Subcontractor Force Account amount over \$500,000 to a maximum of \$37,500

**7. Final Adjustment to Premium for Contract Bonds.** The final bond premium amount for the payment and performance bonds will be computed based on the actual final contract value. For the purpose of computing a bond premium adjustment the actual final contract value is defined as the whole sum of money, excluding any bond premium adjustment, which is passed from the department to the contractor as a result of the completion of the Work. If the actual final contract value is different from the original contract value, the premium shall be adjusted accordingly; either by refund of part of the original bond premium by the contractor if the original contract value is larger than the actual final contract value; or by payment of additional bond premium by the department if the original contract value is smaller than the actual final contract value. Additional payment by the department or refund by the contractor will be based on the difference between the invoiced bond premium for the original contract value and the invoiced bond premium for the actual final contract value without any markup. A final bond premium adjustment will not be made when the actual final contract value differs from the original contract value by less than \$ 40,000.00.

**8. Trucking.**

a. Trucking that is not subject to prevailing wage will be paid at the invoiced cost plus administrative costs pursuant to Table 109.05-3.

**TABLE 109.05-3**

Trucking Invoice Costs	Mark-up Amount
Up to \$10,000	\$500
\$10,001 to \$500,000	5% of Invoice Costs
Over \$500,000	\$25,000 + 2.5% of invoice amount over \$500,000 to a maximum of \$37,500

b. Trucking that is subject to the prevailing wage law will be compensated according to 109.05.C.1, 109.05.C.2, 109.05.C.4, 109.05.C.6, 109.05.C.10, and 109.05.C.11.

Provide documentation showing payment to trucking firms and owner-operators and owner-operations status. When the trucking is subject to prevailing

wage, submit payroll and equipment usage records according to 109.05.C.2 and 109.05.C.4.

**9. Professional and Specialized Work.** The following work, when performed by a firm hired by the Contractor, is paid at the reasonable and fair market invoiced cost plus a 5 percent mark up. The mark up is limited to \$10,000 for all the work performed by the firm.

- a. Surveying.
- b. Engineering design.
- c. Specialized work that is not normally part of a Department Contract and is not normally subject to prevailing wage.
- d. Installation, periodic maintenance, and removal of traffic control devices under Item 614 performed by a traffic control service or rental company, provided the workers are not on the Project full-time. Maintenance of Traffic services performed by LEO.
- e. Other professional or specialized work not contemplated at the time of Bid.

Provide documentation showing payment for professional and specialized Work.

**10. Payment for Force Account Work.** Submit an analysis of estimated cost prepared in accordance with 109.05C for work that will be performed on a force account basis. Attach an original affidavit to the analysis stating:

"Labor rates shown are the actual rates paid for labor, unit prices for materials and rates for owned and rented equipment have been estimated on the basis they are not in excess of those charged in the area in which the work will be performed."

The Engineer will process an Estimated Cost of Force Account (ECFA) if the amount of the force account work is likely to be greater than \$100,000 and is expected to take more than two weeks to complete. The Engineer will process an Actual Cost of Force Account (ACFA) to make any necessary adjustment between the ECFA and the final itemized costs for the force account work.

For force account work estimated to be less than \$100,000 and anticipated to require less than two weeks to perform, the Engineer will process an Actual Cost of Force Account (ACFA) at the conclusion of the work.

Submit biweekly itemized statement of costs prepared from the Daily Force Account Records to the Engineer as the work is being performed. The Engineer will process estimates as the force account work is performed. Payment will only be made upon receipt of the Contractor's itemized statement of costs.

Upon conclusion of the work performed by an ECFA or work performed by an ACFA submit an itemized statement of the actual costs prepared from the Daily Force Account Record and utilizing the Department's electronic template titled "Electronic Force Account." Submit a compact disk (CD), labeled with the contractor's name and the project number, and a hard copy of the "Electronic

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Force Account.” The “Electronic Force Account” template can be downloaded from the following website:

[www.dot.state.oh.us/divisions/constructionmgt/admin/pages/default.aspx](http://www.dot.state.oh.us/divisions/constructionmgt/admin/pages/default.aspx)

The Engineer may approve an alternative electronic template provided all calculations and printouts are equivalent to those generated by the “Electronic Force Account” template.

Attach an original affidavit to the hard copy stating:

“The name, classification, total hours worked and rates paid each person listed on the Summary of Actual Cost are substantiated by actual records of persons employed on the force account work. All unit prices for materials and rates for owned and rented equipment listed on the Summary of Actual Costs are substantiated by actual records of materials and equipment actually used in performance of the force account work and the price of any owned equipment not previously agreed upon does not exceed prices charged for similar equipment in the area in which the work was performed.”

Daily Force Account Records signed by both the Department and Contractor will govern over other Department and Contractor records subject to the following:

(1) When the Contractor is subject to a Union Contract that requires a minimum number of paid hours, the compensation will be for the verified contract minimum hours.

(2) Material quantity disagreements will be resolved by field measurements of the installed quantities or the Engineer’s estimate of the amount of temporary or un-measurable material used. The Engineer may also review and consider the Contractor’s material invoices and material certifications to make the final determination.

In the event the Contractor declines to sign the Daily Force Account Record, the Department’s records shall govern. Any resulting dispute must be pursued in accordance with 104.05.

### **D. Delay Costs.**

**1. General.** If the Department agrees that it has caused a delay, the Department will pay for the costs specified in 109.05.D as allowed by 108.06.D, unless these costs have been previously paid as listed in 109.05.B or 109.05.C. Such payment constitutes full compensation for any and all delay costs

The Department will make no payment for delays occurring during the period from December 1 to April 30 unless the Contractor’s approved progress schedule depicts critical Work occurring throughout this period.

The Department will not pay for delay costs until the Contractor submits an itemized statement of those costs. Provide the content specified in 109.05.C.1, for the applicable items in this statement and as follows:

- a. Proof of cost of Superintendent, or other project staff salaries, wages, and payroll taxes and insurance.
- b. Proof of cost of office rent, utilities, land rent, and office supplies.

- c. Proof of escalated cost for labor and material.
- d. Proof of material storage costs.

## 2. Allowable Delay Costs.

**a. Extended Labor.** Compute labor costs during delays as specified in 109.05.C.2 for all non-salaried personnel remaining on the Project as required under collective bargaining agreements or for other Engineer-approved reasons.

**b. Escalated Labor.** To receive payment for escalated labor costs, demonstrate that the Department-caused delay forced the Work to be performed during a period when labor costs were higher than planned at the time of Bid. Provide adequate support documentation for the costs, allowances, and benefits specified in 109.05.C.2. The Department will pay wages and fringes with a 5% mark-up to cover administrative costs.

**c. Idle Equipment or Equipment Demobilization.** The Department will pay the Contractor according to 109.05.C.4.c for idle equipment, other than small tools, that must remain on the Project during the delays. The Department will pay the Contractor's transportation costs to remove and return equipment not required on the Project during the delays. No other equipment costs are recoverable as a result of delay.

**d. Material Escalation or Material Storage.** The Department will pay the Contractor for increased material costs or material storage costs due to the delay. Obtain the Engineer's approval before storing materials due to a delay. The Department will pay increased material costs with a 5% mark-up to cover administrative costs.

**e. Field Overhead.** The Department will pay any Contractor or subcontractor for field overhead costs which include the cost of supervision, field office and office supplies, and utilities for which payment is not provided for in 109.05.D.2.f, during a delay period provided all of the following criteria are met:

(1) The Contractor or subcontractor has incurred an excusable, compensable delay that delays the Work at least 10 Calendar Days beyond the original Completion Date. These days are cumulative throughout the project.

(2) The delay for which payment of field overhead is sought is only due to delays defined in 108.06.D.2, 108.06.D.3, and 108.06.D.5.

The Department will pay the salary and fringes plus a 5 percent mark up for field personnel identified in Table 109.05-4.

TABLE 109.05-4

Original Contract Amount	Field Personnel
Up to \$5,000,000	One Superintendent
\$5,000,001 to \$50,000,000	One Superintendent, One Assistant Superintendent or One Engineer, One Clerk
Over \$50,000,000	One Superintendent, One Assistant Superintendent, One Engineer, One Clerk

Superintendent's transportation is compensable at the same rate allowed for foreman's transportation in Section 109.05.C.5, which includes the cost of mobile communication devices. The allowed hours are when the superintendent is at the project site.

Superintendent's subsistence, provided this is the company's terms of compensation to such employees, as documented by the Contractor's written company policy or contracts with their employees.

The Contractor's or subcontractor's field office costs include field office trailers, tool trailers, office equipment rental, temporary toilets, and other incidental facilities and supplies. Compute these costs on a Calendar Day basis. Owned trailers are paid at the Blue Book rate. Rented trailers are paid at the invoiced cost plus a 15 percent mark up. Rented office space, toilets, and office equipment are allowed a 5 percent mark up. Purchased office supplies are allowed a 5 percent mark up.

Office utilities include, but are not limited to, telephone, electric, water, and natural gas. Compute these costs on a Calendar Day basis and allow a 5 percent mark up.

**f. Home Office Overhead.** The Department will pay the Contractor for home office overhead, unabsorbed home office overhead, extended home office overhead, and all other overhead costs for which payment is not provided for in 109.05.D.2.e, including overhead costs that would otherwise be calculated using the Eichleay formula or some other apportionment formula, provided all of the following criteria are met:

(1) The Contractor has incurred an excusable, compensable delay that delays the Work at least 10 Calendar Days beyond the original Completion Date. These days are cumulative throughout the project.

(2) The delay for which payment of home office overhead is sought is only due to delays defined in 108.06.D.2, 108.06.D.3 and 108.06.D.5.

Any subcontractor that has approved C-92's for subcontracted work totaling \$4,000,000 or more is eligible for reimbursement of home office

overhead provided the criteria set forth in 109.05.D.2.f.(1) and 109.05.D.2.f.(2) are met.

Payment will be made for every eligible day beyond the original contract completion date at the rate determined by 109.05.D.2.f.i. Payment for eligible days occurring during an unanticipated construction period will be calculated in accordance with 109.05.D.2.f.ii. Payment for eligible days occurring during an unanticipated winter period will be calculated in accordance with 109.05.D.2.f.iii.

**(i) Home Office Overhead Daily Rate**

Calculate the home office overhead daily rate using the following formula:

$$\text{Daily HOOP} = (A \times C)/B$$

Where:

*A* = original contract amount

*B* = contract duration in Calendar Days

*C* = value from Table 109.05-5

TABLE 109.05-5	
Original Contract Amount	<i>C</i>
Up to \$5,000,000	0.08
\$5,000,001 to \$25,000,000	0.06
Over \$25,000,000	0.05

*Daily HOOP* = home office overhead daily rate

Contract duration term, *B*, includes every Calendar Day from the execution of the Contract, unless otherwise specified by the Director, to the original Contract Completion Date.

When the Contractor requests home office overhead compensation for a subcontractor, use the above formula to calculate the subcontractor's Daily HOOP; however, in the subcontractor calculation, *A* is equal to the subcontractor's portion of the original contract amount as determined by the sum of all approved C-92's issued for the subcontracted work.

**(ii) Home Office Overhead Payment for an Unanticipated Construction Period**

Calculate the home office overhead payment for an unanticipated construction period occurring between May 1 and November 30 using the following formula:

$$\text{CP HOOP} = \text{Daily HOOP} \times D$$

Where:

*D* = sum of all excusable, compensable delays in Calendar Days minus the sum of all delays due to 108.06.D.1 and 108.06.D.4 in Calendar Days

*Daily HOOP* = daily home office overhead rate

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*CP HOOP* = home office overhead payment for an unanticipated construction period occurring between May 1 and November 30

The excusable, compensable delay term, *D*, is the additional, unanticipated extended period for work performed between May 1 and November 30 in Calendar Days.

**(iii) Home Office Overhead Payment for an Unanticipated Winter Period**

Calculate the payment for home office overhead for an unanticipated winter period occurring between December 1 and April 30 using the following formula:

$$WP\ HOOP = Daily\ HOOP \times F \times D/E$$

Where:

*D* = sum of all excusable, compensable delays in Calendar Days minus the sum of all delays due to 108.06.D.1 and 108.06.D.4 in Calendar Days

*E* = sum of all excusable, compensable delays in Calendar Days plus the sum of all excusable, non-compensable delays in Calendar Days

*F* = 151 for a non leap year or 152 for a leap year

*Daily HOOP* = daily home office overhead rate

*WP HOOP* = home office overhead payment for an unanticipated winter period occurring between December 1 and April 30

Payment for Home Office Overhead for an unanticipated winter period will not be made when the value of the remaining work is below the lesser of \$500,000.00 or 10% of the estimated final contract value.

**(iv) Total Home Office Overhead Payment**

Calculate the total home office overhead payment using the following formula:

$$Total\ HOOP = CP\ HOOP + WP\ HOOP$$

Where:

*CP HOOP* = home office overhead payment for an unanticipated construction period occurring between May 1 and November 30

*WP HOOP* = home office overhead payment for an unanticipated winter period occurring between December 1 and April 30

*Total HOOP* = total home office overhead payment

**E. Changes in Materials**

Changes in material specifications that result in increased cost to the Contractor are compensated by lump sum adjustment to the reference number. The allowed compensation is equal to the invoice supported material cost increase plus 15 percent markup for profit and overhead.

Material cost savings resulting from a specification change shall be credited to the project by a lump sum adjustment to the reference number plus a 15 percent markup if the originally specified material has not been ordered.

If the original material was ordered before the Contractor was informed of the change, the savings markup allowed is 2.5 percent in order to exclude profit on the original bid price and pay only for incurred overhead.

**109.06 Directed Acceleration.** The Engineer may order the Contractor to accelerate the Work to avoid delay costs or to complete the Project early. The Director and the Contractor will negotiate acceleration costs.

**109.07 Inefficiency.** The Department will compensate the Contractor for inefficiency or loss of productivity resulting from 104.02 Revisions to the Contract Documents. Use the Measured Mile analysis comparing the productivity of work impacted by a change to the productivity of similar work performed under unimpacted conditions to prove and quantify the inefficiency.

**109.08 Unrecoverable Costs.** The Contractor is not entitled to additional compensation for costs not specifically allowed or provided for in 109.05 including, but not limited to, the following:

- A. Loss of anticipated profit.
- B. Consequential damages, including loss of bonding capacity, loss of bidding opportunities, insolvency, and the effects of force account work on other projects, or business interruption.
- C. Indirect costs.
- D. Attorneys fees, claim preparation expenses, and the costs of litigation.

**109.09 Estimates.** If satisfactory progress is being made, the Contractor will receive monthly payments equaling the Work and materials in place. The monthly payment is approximate, and all partial estimates and payments are subject to correction in the Final Estimate and payment. Payment for Work and materials shall not, in any way, prevent later rejection when defective Work or material is discovered, or constitute acceptance under 109.11 or 109.12.

The Department will not pay an estimate until the Contractor certifies to the Engineer that the work for which payment is being made was performed in accordance with the contract. Certification will be made on forms provided by the Department.

The Department may pay estimates twice each month if the Engineer concludes the amount of work performed is sufficient.

No estimate or payment shall be construed as acceptance of defective Work or improper materials.

The Department will not pay the adjusted final estimate until the Contractor remedies all defective Work and accepted Work damaged by the Contractor's operations.

Interest will be paid in accordance with ORC 126.30 when warranted.

**109.10 Payment for Delivered Materials.** The Department will pay, up to 75 percent of the applicable contract item, for the invoiced cost of the delivered and approved materials before they are incorporated in the Work, if the approved

## 109.11

materials are delivered, accepted, and properly stored on the project or stored in acceptable storage places in the vicinity of the Project.

The Department will pay for the cost of approved materials before they are incorporated in the Work when asked by the Contractor, if the Engineer determines that it is not practical to deliver the material to the Project site. This provision applies only to bulky materials that are durable in nature and represent a significant portion of the project cost, such as aggregates, steel, and pre-cast concrete. The Department will not pay delivered materials on small warehouse items or for plant materials.

**109.11 Partial Acceptance.** Upon completion of a portion of the Work, the Contractor may request acceptance of a completed portion of the Work.

An inspection may be performed on a completed portion of the project roadway section provided:

- A. All safety items are in place including permanent pavement markings.
- B. Traffic is in its final pattern.
- C. A completed portion of the project constitutes a completed geographic section of the project or a direction of traffic on a divided highway.
- D. Is in accordance with other contract provisions.

An inspection may be performed on a completed bridge provided:

- A. All work on the bridge and approaches are complete, including all safety items and permanent pavement markings.
- B. The Contractor will not return to the bridge for any work except as allowed in D.
- C. Traffic is in its final pattern.
- D. Painting of structural steel is either completed or scheduled to be performed.
- E. Is in accordance with other contract provisions.

The Final Inspector will grant written partial acceptance for that portion of the Work or reject the Contractor's request. Such written partial acceptance will designate what portion of the Work is accepted, the date of acceptance, and the warranty provisions started by the partial acceptance.

Partial acceptance will relieve the Contractor of maintenance responsibility for the designated portion of the Work. This does not relieve the Contractor of responsibility to correct defective Work or repair damage caused by the Contractor or waive any other remedy to which the Department is entitled at law or in equity.

## **109.12 Final Acceptance..**

**A. Final Inspection.** The Department will perform a Final Inspection for the sole purpose of relieving the Contractor of maintenance responsibility for the Work.

The Final Inspection shall be a limited visual review of the Work and shall only serve as the Department's verification that the Work appears substantially

complete. Final Inspection does not waive any available rights or remedies of the Department, nor divest the Contractor of any responsibility for compliance with the contract or liability for damages.

Notify the Engineer when the Project is complete and all of the Engineer's punch list items are complete. If the Engineer agrees the Project is complete, then within 10 business days the District Final Inspector will inspect the Work and categorize it as one of the following:

1. Unacceptable or not complete.
2. Substantially complete with punch list items found by the Final Inspector.
3. Substantially complete.

If the Final Inspector finds the Work substantially complete or substantially complete with punch list items, then the Contractor's maintenance responsibilities end on the day of the Final Inspection, except for any maintenance related to unfinished punch list items. This does not relieve the Contractor of responsibility to correct defective Work or repair damage caused by the Contractor or waive any other remedy to which the Department is entitled at law or in equity. The Final Inspector will issue a Final Inspection Report that will document the findings of the inspection and start any warranty period.

**B. Punch List.** The Final Inspector will issue to the Contractor a written punch list of work required as a condition of acceptance. The Final Inspector's punch list will stipulate a reasonable time to complete the required Work. Failure of the Contractor to complete the punch list items by the stipulated time will result in the assessment of fifty percent of the Liquidated Damages according to 108.07 for each Calendar Day for every day beyond the stipulated time the punch list work remains incomplete and beyond the revised Completion Date.

**C. Finalization.** The Contractor shall accept the final quantities as determined by the Engineer or provide a written notice indicating the reason for disagreement within 30 Calendar Days of receiving the Engineer's list of final quantities. The prescribed 30 Calendar Day period can be modified by mutual agreement of the Contractor and the District Construction Engineer. If no notice of disagreement is received, then the final payment will be based on the Engineer's list of final quantities.

Supply all documents necessary for Project finalization within 60 Calendar Days from the date that the Work is physically complete. These documents include:

1. Delinquent material certifications.
2. Delinquent certified payrolls or required revised payrolls.
3. Wage affidavit required by ORC Chapter 4115 on projects without any Federal funding.
4. Delinquent force account records.
5. If applicable, DBE affidavits.

## 109.12

Failure to submit these acceptably completed documents will result in an administrative fee of \$100 per Calendar Day for every day that any of the required documents remain delinquent, starting 30 Calendar Days after receipt of written notification from the Engineer of a document deficiency.

**D. Final Payment.** Final payment is based on:

1. The agreed final quantities or as determined by the Engineer if agreement is not possible, no compensation for unauthorized work is allowed.
2. Finding of substantial completion by the Final Inspector.
3. Receipt of acceptable finalization documents.
4. Contractor certification that the Work was performed in accordance with the contract.

**E. Completion of Contract and Continuation of Contractor's Responsibility.** The Contract is complete, except for items covered by the required bonds, when the Contractor receives final payment. The DCE will issue a letter confirming completion of the contract, noting any exception as provided in Items 659 and 661 and any warranty. The date the final payment is approved by the District constitutes acceptance for the purpose of ORC 5525.16. Neither Completion of the Contract nor substantial completion relieves the Contractor of any responsibilities to properly perform or correct the Work or to repair damage or waives any remedies to which the Department is entitled at law or in equity.

## 200 EARTHWORK

### ITEM 201 CLEARING AND GRUBBING

#### 201.01 Description

#### 201.02 General

#### 201.03 Clearing and Grubbing

#### 201.04 Scalping

#### 201.05 Method of Measurement

#### 201.06 Basis of Payment

**201.01 Description.** This work consists of clearing, grubbing, scalping, removing trees and stumps, and removing all vegetation and construction debris from the limits shown on the plans, except such objects that are to remain or are to be removed according to other items of work.

Use removed or excavated materials in the work when the material conforms to the specifications; if not then recycle, burn, or dispose of the material according to 105.16 and 105.17.

#### 201.02 General

A. Remove or save all trees, shrubs, and plants as designated on the plans. Preserve all vegetation and objects not designated for removal. Paint cut or scarred surfaces of trees or shrubs selected for retention according to 666.04.

B. In order to retard and prevent the spread of the Emerald Ash Borer, limit the movement of regulated articles according to Ohio Administrative Code 901:5-56. Observe requirements for handling and transporting of regulated articles in quarantined areas as defined by the Ohio Department of Agriculture (<http://www.agri.ohio.gov/eab/>).

The following are considered regulated articles and are subject to the quarantine established by the Ohio Department of Agriculture:

1. Deciduous trees of any size.
2. Deciduous limbs and branches
3. Any cut non-coniferous (non-evergreen) firewood.
4. Deciduous tree bark and deciduous tree wood chips larger than 1 inch (25 mm).
5. Deciduous logs and lumber with the bark, outer inch of sapwood, or both attached.
6. Any item made from or containing deciduous tree wood capable of spreading Emerald Ash Borer.
7. Any means of conveyance capable of spreading Emerald Ash Borer.

Should the Contractor elect to hire a certified arborist to distinguish between ash wood (*Fraxinus* spp.) and other deciduous wood, then only ash wood will be considered regulated articles.

Follow all other federal and state Emerald Ash Borer quarantines.

### 201.03

C. Restrictions on when the Contractor may perform the clearing and grubbing work are located in other parts of the Contract Documents.

**201.03 Clearing and Grubbing.** Clear and grub all trees and stumps marked for removal and all surface objects, brush, roots, and other protruding obstructions not designated to remain, except for special treatments listed below:

- A. In locations to be seeded, remove stumps at least 6 inches (150 mm) below ground surface.
- B. In unseeded areas to be rounded at the top of backslopes, cut the stumps flush with or below the surface of the final slope line.
- C. The Contractor may leave undisturbed stumps and roots, and nonperishable solid objects 6 inches (150 mm) above the existing ground surface in the plan embankment construction locations when both of the following conditions are true:
  - 1. The embankment height is greater than 9 feet (3 m) as measured vertically from the existing ground surface to the proposed ground surface, and
  - 2. The slope of the existing ground is 8:1 or flatter.
- D. In locations outside of the construction limits of the cut and embankment areas not to be seeded, the Contractor may leave sound stumps 24 inches (0.6 m) above the existing ground surface.

Except in areas to be excavated, backfill stump holes and other holes created by removing obstructions with Item 203 embankment material. Place and compact according to Item 203.

Remove low hanging, unsound, or unsightly branches on trees or shrubs designated to remain. Trim branches of trees extending over the roadbed to provide a clear height of 20 feet (6 m) above the roadbed surface.

Dispose of debris contaminated with garbage, solid waste, or hazardous waste or material according to other contract items.

**201.04 Scalping.** Scalping includes removing surface material such as roots, sod, grass, residue of agricultural crops, sawdust, and decayed vegetable matter. The depth of scalping does not include topsoil or other material below the scalping operation. The Engineer will not require areas to be scalped in the plan embankment construction locations when both of the following conditions are true:

- 1. The embankment height is greater than 9 feet (3 m) as measured vertically from the existing ground surface to the proposed ground surface, and
- 2. The slope of the existing ground is 8:1 or flatter.

Scalp all other areas where excavation or embankment is required.

**201.05 Method of Measurement.** The Department will measure by one of the following methods:

If Clearing and Grubbing is specified in the Contract, the Department will not measure the area cleared and grubbed.

If Item 201 Tree Removed or Item 201 Stump Removed is specified in the Contract, the Department will measure trees and stumps designated for removal according to the following table.

**TABLE 201.05-1**

<b>Tree or Stump Diameter</b>	<b>Pay Item Designation</b>
Over 12 inches to 24 inches	18-inch size
Over 24 inches to 36 inches	30-inch size
Over 36 inches to 60 inches	48-inch size
Over 60 inches	60-inch size
Over 0.3 m to 0.6 m	0.5 m size
Over 0.6 m to 0.9 m	0.8 m size
Over 0.9 m to 1.5 m	1.2 m size
Over 1.5 m	1.5 m size

The Department will measure the diameter of trees at a height of 54 inches (1.4 m) above the ground. Trees 12 inches (0.3 m) and less in diameter are classified as brush. The Department will measure stumps by taking the average diameter at the cutoff.

**201.06 Basis of Payment.** If Item 201 Clearing and Grubbing is specified in the Contract, the Department will pay for all work described, including backfilling holes, scalping, and removing all trees and stumps, at the lump sum price bid. If Item 201 Tree Removed or Item 201 Stump Removed is specified in the Contract, the Department will consider the remaining work described incidental and will not pay for performing this work directly.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
201	Lump Sum	Clearing and Grubbing
201	Each	Tree Removed, ___ Size
201	Each	Stump Removed, ___ Size

## **ITEM 202 REMOVAL OF STRUCTURES AND OBSTRUCTIONS**

### **202.01 Description**

### **202.02 General Construction Requirements**

### **202.03 Structures Removed**

### **202.04 Pipe Removal**

### **202.05 Pavement, Walks, Curbs, Steps, Gutters, or Traffic Dividers Removed**

### **202.06 Buildings Demolished**

### **202.07 Septic Tanks and Privy Vaults Removed**

### **202.08 Underground Storage Tanks Removed**

### **202.09 Guardrail and Fence Removed**

### **202.11 Manhole, Catch Basin, and Inlet Removed**

## 202.01

### **202.12 Manhole, Catch Basin, and Inlet Abandoned**

### **202.13 Method of Measurement**

### **202.14 Basis of Payment**

**202.01 Description.** This work consists of removing, entirely or in part, and disposing of all buildings, fences, guardrails, structures, old pavements, abandoned pipe lines, storage tanks, septic tanks, privy vaults, and other obstructions not designated or permitted to remain, except for utilities and obstructions to be removed and disposed of under other items in the Contract. This work also consists of backfilling the resulting trenches, holes, and pits, and salvaging designated materials.

When specific pay items for removal of structures and obstructions are not listed in the Contract Documents, perform this work under Item 203.

**202.02 General Construction Requirements.** Raze, remove, and dispose of all buildings and foundations, structures, fences, guardrails, old pavements, abandoned pipe lines, storage tanks, septic tanks, privy vaults, and other obstructions within the Right-of-Way, except for utilities and those items where other provisions have been made for removal. Remove and store, at the specified locations within the Project limits, or reuse all designated salvageable materials.

The Department will take ownership of all salvageable items specified for storage. Reuse all salvageable items specified for reuse on the project. When the Contract Documents do not indicate for storage or for reuse, take ownership of the material.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

Do not remove any item in use by traffic until after making arrangements to accommodate traffic.

When backfilling is required, backfill the resulting cavities, voids, or trenches with either Item 203 embankment material or Item 603 Structural Backfill Type 1 or 2. Use Item 603 Structural Backfill when the removed item is under the proposed pavement or paved shoulder and when the site limits the use of compaction equipment larger than an 8-ton (7 metric tons) roller; otherwise the Contractor may use Item 203 embankment material. Place and compact the embankment or Item 603 Structural Backfill according to 203.

For backfilled areas outside the plan construction limits, provide a final grade that presents a neat, well-drained appearance that conforms to the final topography and prevents water from draining onto adjacent properties.

**202.03 Structures Removed.** Remove bridges, culverts, and other structures indicated for removal in the Contract Documents. If within a stream, remove the substructures of existing structures, including piling, down to the proposed stream bottom. For those parts outside the stream, remove substructures to a minimum of 1 foot (0.3 m) below proposed ground surface. Remove, as necessary, those portions of existing structures that lie entirely or partially within the limits for a new structure to accommodate the construction of the proposed structure.

Where alteration of an existing structure requires removal of portions of the structure, remove those portions with sufficient care as to avoid damage to the remaining portion of the structure. In case of damage to the existing structure, repair or replace the structure at no expense to the Department.

If removing a bridge or portion of a bridge with an asphalt wearing course, remove the wearing course separately before removing the bridge or portion of the bridge.

Backfill the cavity created by the removal item according to 202.02, except when the cavity lies within the limits of subsequent excavation or other work.

**202.04 Pipe Removal.** Remove and reuse, store, or dispose of pipe, or culvert as specified in the Contract Documents.

If removing an existing concrete waterline pipe that was constructed before 1980, it may be an asbestos pipe. Test the pipe by using a Department prequalified environmental consultant to determine if it is an asbestos pipe. If it is determined that the pipe is asbestos, then a certified asbestos Contractor must perform the removal. Dispose of all asbestos pipe at a solid waste facility that is licensed by the Local Health Department and permitted by the OEPA.

Seal openings left in walls of manholes or catch basins that are to remain in place, and remove and dispose of pipe headwalls.

If an adjacent existing pipe is encountered during removal operations and the pipe is inactive or is to be abandoned, plug or seal the remaining ends of the pipe before proceeding with backfilling operations. Perform plugging by using approved precast stoppers. Perform sealing by using masonry bulkheads.

Remove a sufficient section of the pipe to allow the Engineer to determine the quality of the pipe and the possibility of its removal without damage to pipe specified for reuse or storage. If the Engineer determines the pipe is salvageable, carefully remove the remainder of the pipe to avoid breaking or damaging the pipe. Transport and store the removed pipe, as necessary before relaying. Replace sections of pipe lost or damaged by negligence or by use of improper methods at no additional cost to the Department. Clean all pipe before reusing. Remove salvageable pipe under Item 202 Pipe Removed for Reuse or Storage.

If the Engineer determines the pipe is unusable, take ownership of the pipe, and dispose of or recycle it according to 202.02. Remove unusable pipe under Item 202 Pipe Removed.

Before backfilling the trench, excavate the caved material, as necessary.

Backfill trenches resulting from the removal of pipe according to 202.02, except when the trench lies within the limits of subsequent excavation or other work.

**202.05 Pavement, Walks, Curbs, Steps, Gutters, or Traffic Dividers Removed.** As designated, remove and dispose of the existing wearing course, concrete base course, concrete pavement, asphalt wearing course on brick or concrete base, concrete walks, concrete steps, concrete gutters, stone or concrete curbs, and concrete traffic dividers. If removing only a portion of an existing

## 202.06

pavement, walk, step, gutter, curb, or traffic divider, saw or otherwise cut a neat joint at the removal limit if it does not occur at an existing joint.

If Item 202 Pavement Removed is specified in the Contract, remove all asphalt, concrete, or brick from the surface to the bottom of the pavement courses as shown on the plans. If 202 Base Removed is specified in the Contract, remove the specific layer as shown on the plans. If Item 202 Wearing Course Removed is specified in the Contract, remove all asphalt from the surface to the top of the concrete or brick or remove the specific layer or layers shown on the plans.

Backfill the cavity created by the removal item according to 202.02, except when the cavity lies within the limits of subsequent excavation or other work.

**202.06 Buildings Demolished.** Do not disturb buildings and appurtenances designated for demolition until the Engineer provides a Notice of Possession and Approval to Proceed. Immediately after receiving approval, schedule and perform the demolition under the Engineer's direction in order to accommodate utility rearrangements and clearance of structures. Whether the building is located partially or totally on temporary or permanent Right-of-Way perform the demolition the same.

The Contractor may use buildings located partially on and off the permanent Right-of-Way for storage, office, living quarters, or other purposes. The agreement shall allow such use during the period of the Contract and save the Department harmless from any claims whatsoever by reason of such use.

Remove foundations; floors; floor slabs; and basement, pit, well, and cistern walls to a minimum of 1 foot (0.3 m) below the grade of the surrounding area.

Completely remove all tanks and clear basements of all materials, debris, appliances, wood or metal partitions, and wood floors so only masonry walls and concrete basement floors remain. Break up and remove all floor slabs under which a pit, well, cistern, or tank exists. Break up basement floors to be left in place, and seal remaining drains with masonry or with precast clay or concrete stoppers.

Take ownership of all materials, except those belonging to a public or private utility. Notify the owners of water, electric, or gas meters when the meters are ready for removal. Disconnect all utilities according to local requirements.

After completing demolition work and obtaining the Engineer's approval, immediately backfill the cavity created by the removal item according to 202.02, except when the cavity lies within the limits of subsequent excavation or other work.

**202.07 Septic Tanks and Privy Vaults Removed.** Empty all septic tanks and privy vaults. Dispose of the removed contents in a manner that conforms to the requirements of the State and Local Boards of Health or other authorities having jurisdiction.

Completely remove and dispose of septic tanks and privy vaults located above the subgrade or finished ground surface. For septic tanks and privy vaults located below the subgrade or finished ground surface, remove tops and walls to a minimum depth of 3 feet (1 m) below subgrade or 1 foot (0.3 m) below finished

ground surface. Break up floors and seal remaining drains with masonry or with precast clay or concrete stoppers.

Backfill the cavity created by the removal, partial removal, or emptying operation according to 202.02, except when the cavity lies within the limits of subsequent excavation or other work.

**202.08 Underground Storage Tank Removed.** Remove and dispose of underground storage tanks or regulated underground storage tanks, as designated in the Contract Documents, and according to the requirements of the authorities having jurisdiction.

If Item 202 Regulated Underground Storage Tank Removed is specified in the Contract, remove the tank according to the Bureau of Underground Storage Tank Regulations of the Division of Fire Marshal (BUSTR), Ohio EPA, and all applicable Federal, State, and local regulations. Removal includes obtaining the required permit, disposing of the tank and its contents, testing the excavated material, and preparing the closure report. Provide a Certified Tank Installer to supervise the removal. Provide an independent non-Contractor employee BUSTR inspector or a State Certified BUSTR inspector to perform the BUSTR required inspections. For tanks containing hazardous substances other than petroleum, use the Ohio EPA regulations in addition to State Fire Marshal regulations.

Completely remove regulated underground storage tank and contents. Take ownership and dispose of tanks according to 202.02 and the above requirements. If because of leakage from the tank, any contaminated water or soil disposal or remediation is required, perform the necessary work under other items in the Contract or according to 109.05.

If Item 202 Underground Storage Tank Removed is specified in the Contract, completely remove and dispose of the tank. Dispose of the removed contents in a manner that conforms to the requirements of the State and local Boards of Health, or other authorities having jurisdiction.

Backfill the cavity created by the removal items according to 202.02, except when the cavity lies within the limits of subsequent excavation or other work.

**202.09 Guardrail and Fence Removed.** Carefully dismantle and store existing guardrail (including anchor assemblies and terminal assemblies, and any attached posts, signs, and delineators) and fence when designated for reuse or storage by the Department. Dispose of wood posts and other materials not considered salvageable according to 202.02.

When fence is designated for replacement, do not remove the existing fence until the replacement material is on site. Begin the new installation within 7 workdays of beginning the removal process.

When guardrail is designated to be replaced and traffic is being maintained in the adjacent lane, do not leave hazards unprotected except for the actual time required to remove the existing guardrail and install the proposed guardrail in a continuous operation. Do not remove the guardrail until the replacement material is on the site and ready for installation. The Engineer will suspend work for failure to comply with this requirement.

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Backfill the cavity created by the removal item according to 202.02, except when the cavity lies within the limits of subsequent excavation or other work.

**202.11 Manhole, Catch Basin, and Inlet Removed.** Remove existing drainage structures of the types designated for removal. Take ownership of castings unless otherwise noted on the plans.

Backfill the cavity created by the removal item according to 202.02, except when the cavity lies within the limits of subsequent excavation or other work.

**202.12 Manhole, Catch Basin, and Inlet Abandoned.** Remove existing drainage structures of the types designated to be abandoned to a minimum of 1 foot (0.3 m) below the finished subgrade or ground surface. Do not damage pipes that are to remain. Take ownership of castings unless otherwise noted on the plans.

Connect existing pipes with new pipe through the structures. Seal the existing inlet and outlet pipes with precast vitrified or concrete stoppers or with masonry of a type and thickness to fill the inlet or outlet pipe.

After connecting or sealing the existing pipes and removing the walls to the required depth, backfill the remaining cavities according to 202.02. If using connecting pipes, carefully hand tamp backfill under and around the pipe according to 202.02.

**202.13 Method of Measurement.** If the Contract specifies that removal of structures and obstructions is on a lump sum basis, the work will include all structures or obstructions encountered at locations or within areas designated in the Contract Documents. However, the Department will measure asphalt wearing course removal on a bridge separate from the lump sum item for structure removal.

If the Contract specifies that removal of specific items is on a unit basis, the Department will measure the quantity of each item by the unit stipulated in the Contract.

**202.14 Basis of Payment.** Payment is full compensation for all work involved in the removal and storage, reuse, or disposal of structures and obstructions, including excavation and backfill incidental to their removal, removing the contents of the underground storage and septic tanks and the custody, preservation, storage on the Right-of-Way, and disposal as provided in this specification.

For pipe removed and reused or stored, the Department will pay for the accepted work under Item 202 Pipe Removed for Reuse or Storage. For unusable pipe removed, the Department will pay for the accepted work under Item 202 Pipe Removed.

If the Contract Documents do not include a pay item for Item 202 Asbestos Pipe Removed, then the Department will pay for removal and disposal of asbestos pipe according to 109.05.

When removed pavement is replaced with embankment material, the Department will pay for the embankment material under the applicable 203 or 204 pay item. When pipe is removed from beneath existing pavement, the Department will pay for pavement removal under the applicable pay item for pavement

removal or excavation, and the Department will pay for new pavement under the applicable pavement pay item.

Include all of the costs and work associated with compliance of the rules or regulations under Item 202 Regulated Underground Storage Tank Removed. If the underground storage tank is not regulated, the work does not include obtaining inspection services, permits, testing excavated material, or closure reporting and the payment will be under Item 202 Underground Storage Tank Removed.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
202	Lump Sum	Structure Removed
202	Lump Sum, or Cubic Yard or Pound (Cubic Meter or Kilogram)	Portions of Structure Removed
202	Foot (Meter)	Pipe Removed for Reuse or Storage
202	Foot (Meter)	Pipe Removed
202	Foot (Meter)	Asbestos Pipe Removed
202	Square Yard (Square Meter)	Pavement Removed
202	Square Yard (Square Meter)	Wearing Course Removed
202	Square Yard (Square Meter)	Base Removed
202	Square Foot (Square Meter)	Walk Removed
202	Lump Sum	Steps Removed
202	Foot (Meter)	Curb Removed
202	Foot (Meter)	Curb and Gutter Removed
202	Foot or Square Yard (Meter or Square Meter)	Gutter Removed
202	Foot (Meter)	Curb Removed for Storage
202	Each	Precast Traffic Divider Removed for Reuse or Storage
202	Lump Sum	Building Demolished
202	Each	Underground Storage Tank Removed
202	Each	Regulated Underground Storage Tank Removed
202	Each	Septic Tank Removed
202	Each	Privy Vault Removed
202	Foot (Meter)	Guardrail Removed
202	Foot (Meter)	Guardrail Removed for Reuse or Storage
202	Foot (Meter)	Fence Removed for Reuse or Storage
202	Each	Manhole Removed
202	Each	Manhole Abandoned
202	Each	Catch Basin or Inlet Removed

## ITEM 203 ROADWAY EXCAVATION AND EMBANKMENT

### 203.01 Description

### 203.02 Material Definitions

### 203.03 Restrictions on the Use of Embankment Materials

### 203.04 General

### 203.05 Embankment Construction Methods

### 203.06 Spreading and Compacting

### 203.07 Compaction and Moisture Requirements

### 203.08 Earthwork Construction Tolerances

### 203.09 Method of Measurement

### 203.10 Basis of Payment

**203.01 Description.** This work consists of preparing areas upon which embankments are to be placed; excavating for the roadways and channels, including the removal of all material encountered not being removed under another item; constructing embankments with the excavated material and material from other approved sources as necessary to complete the planned embankments; furnishing and incorporating all water required for compacting embankment; disposing of unsuitable and surplus material and finishing shoulders, slopes, and ditches.

All excavation is considered unclassified excavation. If the excavation contains regulated materials such as garbage, solid waste, and hazardous waste or material, the Contract Documents will detail the removal for these items.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

### 203.02 Material Definitions.

**A. Asphalt Concrete.** Reclaimed asphalt concrete pavement (RACP) that is blended to meet the requirements in 703.16.

**B. Base.** Selected material of planned thickness placed on the subgrade as a foundation for other bases, or asphalt or concrete pavements. The base is a part of the pavement structure.

**C. Borrow.** Material obtained from approved sources, located outside the construction limits that are required for the construction of the embankment. When borrow is specified or used, use suitable materials that conform to 203.02.R.

**D. Compaction Testing.** The Department will perform the compaction testing of embankment and subgrade according to Supplement 1015.

**E. Embankment.** A structure consisting of suitable materials conforming to 203.02.R and constructed in lifts to a predetermined elevation and cross-section.

**F. Excavation.** The excavation and disposal of all materials required by the Contract Documents.

**G. Maximum Dry Density.** The maximum dry density is determined according to AASHTO T 99, AASHTO T 272, or Supplement 1015. The Department will use this maximum dry density for compaction acceptance.

**H. Natural Granular Materials.** Natural granular materials include broken or crushed rock, gravel, sand, durable siltstone, and durable sandstone that can be placed in an 8-inch (200 mm) loose lift.

**I. Natural Soil.** All natural earth materials, organic or inorganic, resulting from natural processes such as weathering, decay, and chemical action.

**J. Optimum Moisture.** The water content at which the maximum dry density is produced in an embankment material. The optimum moisture is determined according to AASHTO T 99, AASHTO T 272, or Supplement 1015.

**K. Petroleum Contaminated Soil (PCS).** Petroleum contaminated soil (PCS) that is regulated under OAC-1301:7-9-16.

**L. Random Material.** Mixtures of suitable materials that can be placed in 8-inch (200 mm) loose lifts.

**M. Recycled Portland Cement Concrete.** Recycled portland cement concrete (RPCC) that is blended to meet the requirements in 703.16.

**N. Recycled Materials.** Fly ash, bottom ash, foundry sand, recycled glass, tire shreds, or other materials or manufacturing bi-products not specifically named as suitable materials in 203.02.R.

**O. Rock.** Sandstone, limestone, dolomite, glacial boulders, brick, and RPCC too large to be placed in an 8-inch (200 mm) loose lift.

**P. Shale.** Laminated material with a finely stratified structure formed by the natural consolidation of soil. For the purpose of this specification, the following bedrock types are also considered as shale: mudstone, claystone, siltstone, and clay bedrock.

**Q. Slag Materials.** Slag materials include air cooled blast furnace slag (ACBF), granulated slag (GS), open hearth (OH) slag, basic oxygen furnace (BOF) slag, and electric arc furnace (EAF) slag meeting the requirements in 703.16.

**R. Suitable Materials.** All suitable materials are restricted in 203.03. Furnish soil or embankment material conforming to 703.16, when Item 203 Embankment is specified. Furnish material that conforms to 703.16.B or 703.16.C when Item 203 Granular Embankment is specified. Furnish material that conforms to 703.16.C when Item 203 Granular Material Types A, B, C, D, E or F are specified. Do not use recycled materials unless specifically allowed by the Supplemental Specifications.

**203.03 Restrictions on the Use of Embankment Materials.** Suitable materials are further restricted as follows:

A. Use silt identified as ODOT Group Classification A-4b and RACP only if placed at least 3 feet (1 m) below the surface of the subgrade.

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B. Do not place RPCC and RACP in any location where it would inhibit the growth of vegetation.

C. Do not use any suitable material that cannot be incorporated in an 8-inch (200 mm) lift in the top 2 feet (0.6 m) of the embankment.

D. Do not use shale in the top 2 feet (0.6 m) of the embankment that is not completely compacted and pulverized into a soil with 100 percent of the material passing the No. 4 (4.75 mm) sieve, except for hard shale or durable siltstone.

E. If using RPCC, OH slag, EAF slag, BOF slags, or blends of these materials, place these materials at least 1 foot (0.3 m) below the flow line of the underdrains.

F. Do not use RPCC, OH slag, EAF slag, BOF slags, granulated slag, or blends of these materials for underwater applications.

G. Do not use materials that cannot be satisfactorily placed and compacted to a stable and durable condition.

H. Material excavated in the work that contains excessive moisture is unsuitable for embankment construction unless dried. Dry or aerate such material before incorporating in the work. The Contractor may elect to waste this material, instead of drying it.

I. If Granular Material Type E in 703.16.C is allowed or specified, use a geotextile fabric conforming to 712.09, Type D on the top, bottom, and around the Type E material to prevent piping of the material into the Type E material.

J. If electing to use PCS, submit the information stated below in a suitable format at least 10 workdays before the intended usage.

1. Have an independent ODOT consultant pre-qualified in remedial design environmental site assessment review the proposed usage. The consultant shall provide all documentation used to ensure that the proposed usage obeys all Ohio EPA regulations. The consultant shall coordinate all EPA required meetings, documentation, and testing requirements. The consultant shall randomly monitor the construction to ensure that the environmental requirements are carried out on the project. The consultant shall report any discrepancies to the Department and the Contractor. The consultant shall certify the report or reports to the Department.

2. Use PCS that conforms to all current environmental policies, rules, and regulations and the following:

a. Use PCS material that does not exceed the petroleum constituent concentrations stated below:

Benzene (B)	35 parts per million
Toluene (T)	109 parts per million
Ethyl benzene (E)	32 parts per million
Total Xylenes (X)	165 parts per million

b. Include test results from BTEX testing by using U.S. EPA test method SW 846, method 8020, or equivalent method.

- c. Perform the tests on every 100 tons (90 metric tons) of PCS used.

**203.04 General.** Perform the required clearing and grubbing before starting the excavation, grading, and embankment operations.

Coordinate the amount of and limit the areas of the project that are cleared and grubbed with the quantity of erosion controls that are placed according to Item 207.

Remove all existing pavement and underdrains before the embankment construction.

Temporarily discontinue operations when the excavating operations encounter remains of prehistoric archaeological sites, historical archaeological sites, or human remains. The Engineer will contact the Department's Office of Environmental Services to determine the disposition thereof. Preserve the artifacts or other archeological items or human remains until a determination as to what the disposition and/or removal of such items is made by the Office of Environmental Services. Such excavation is considered Extra Work.

If the Contractor encounters any abnormal material such as, but not limited to, drums, tanks, or stained earth or any unusual odors during construction operations, the Contractor shall temporarily discontinue the work in this area, leave equipment in place, cordon off the area, and notify the Engineer. The area is considered to contain hazardous waste or material and must be handled according to *The Construction Inspection Manual of Procedures*. Upon notification by the Engineer to resume work, the Contractor may file for an extension of time according to 108.06.

**A. Drainage and Maintenance of the Work.** Maintain a well drained embankment and excavation operation. If trenching for narrow widening and in other areas of the embankment construction, construct ditches of an adequate depth and at frequent intervals across the berm or embankment to maintain drainage. Deepen side ditches when necessary to ensure thorough embankment or subgrade drainage.

Construct the embankment with sufficient cross-slope to drain in case of rain.

If precipitation saturates the embankment construction, stay off the embankment construction until the embankment dries or stabilizes. Expedite the construction by removing the saturated embankment or dry the embankment by scarifying, plowing, disking, and recompacting the embankment.

Throughout the embankment construction operation and at the end of each day's operation, shape to drain, compact, and re-compact the work area to a uniform cross-section. Eliminate all ruts and low spots that could hold water.

If using embankment construction or cut areas to haul on, continuously move the hauling equipment around on the area to take advantage of the compactive effort. Continually re-grade and compact the haul roads and maintain the construction according to 105.13 and 105.14.

Plug and cover the upstream ends of all pipe lines encountered during earthwork operations.

**B. Rock or Shale Blasting Operations.** Conform to Item 208 when blasting.

**C. Slides and Breakages.** Remove all slides and breakages beyond the limits of the planned finished work when caused by improper excavation methods.

**D. Shoulders, Slopes, and Ditches.** When specified, place the topsoil in areas to be seeded or sodded according to Item 659. Build shoulders to the lines shown on the plans and to the tolerances specified in 203.08. Reshape shoulders, slopes, and ditches that have been damaged by erosion during construction.

Keep new and existing pavement, and the paved area of the berm clear of earth stockpiles or other berm materials.

**E. Pavement Widening Construction.** Locate sound pavement edges, and cut and trim pavement to a neat line. Repair and restore damage caused by the equipment or methods. Include the cost of cutting, trimming, and disposal under Item 203 Excavation.

**F. Borrow.** Unless otherwise designated in the Contract, make arrangements for obtaining borrow and pay all costs involved. If borrow is specified, use all suitable excavated material in the work prior to using the borrow material.

Place borrow used as embankment according to all the requirements for constructing embankment.

Blade and leave all borrow areas in such shape as to allow accurate measurements after the excavation has been completed.

Notify the Engineer sufficiently in advance of opening any borrow areas so that cross-section elevations and measurements of the ground surface after stripping may be taken.

Construct borrow areas that conform to 105.16; clean up the borrow areas according to 104.04.

**G. Staged Construction and Waiting Periods.** If specified in the Contract Documents, control the rate of fill accordingly. Adhere to the rate of fill and to the waiting periods during the work.

**203.05 Embankment Construction Methods.** Embankment construction includes preparing areas upon which embankments are to be placed; placing and compacting approved material within roadway areas where unsuitable material has been removed; and placing and compacting approved material in holes, pits, and other depressions within the roadway.

If scalping is required, scarify, plow, disk, and compact the existing embankment foundation. Compact the top 8 inches (200 mm) of the foundation to 95 percent of the maximum dry density or to a maximum test section dry density according to Supplement 1015. If the foundation cannot be compacted, the Department will design replacement material or the Engineer may increase the lift thickness of the next layer of embankment.

The Engineer may increase the lift thickness of the next embankment layer to bridge the soft or wet foundation areas that will not support the weight of the trucks or hauling equipment. Dump successive loads of rock, hard shale, or

granular material in a uniform lift. Do not exceed the thickness required to support the equipment placing the material. Manipulate, blade, distribute, level, and doze the material in place until the area is stabilized and material is above the normal water elevation. Once the bridging has been accomplished, construct the remaining lifts according to 203.06.

If the existing slope is steeper than 8:1, bench into the existing slope as follows:

- A. Scalp the existing slope according to Item 201.
- B. Cut horizontal benches in the existing slope to a sufficient width to blend the new embankment with the existing embankment and to accommodate the placement, and compaction operations and equipment.
- C. Bench the slope as the embankment is placed, and compact into layers.
- D. Begin each bench at the intersection of the existing slope and the vertical cut of the previous bench. Recompact the cut materials along with the new embankment.

If constructing embankment on only one side of abutments, wing walls, piers, or culvert headwalls, construct the embankment so that the area immediately adjacent to the structure is not compacted in a manner that causes overturning of or excessive pressure against the structure. If constructing embankment on both sides of a concrete wall, pipe, or box type structure, construct the embankment so that the elevation on both sides of the structure is always approximately the same.

**203.06 Spreading and Compacting.** Do not construct frozen embankment material or place embankment material on frozen ground.

Spread all embankment material, except for rock in 203.06.C. and RPCC in 203.06.D, in successive horizontal loose lifts, not to exceed 8 inches (200 mm) in thickness. Compact all embankment material lifts, except for Type D granular material, Type E granular material, rock and hard shale, to the specified density and moisture controls in 203.07.

When a minimum weight requirement is specified in 203.06 or 203.07, the Contractor may use a roller with an equivalent centrifugal force. In all cases, submit documentation proving the minimum weight requirements are met.

The Engineer may reduce the minimum passes if the passes are detrimental to compaction.

**A. Soil and Granular Embankment.** For soil or granular material, when a test section is used, use a minimum compactive effort of eight passes with a steel wheel roller having a minimum weight of 10 tons (9 metric tons).

Compact Type D and Type E granular material using at least ten passes of a steel wheeled vibratory roller having a minimum weight of 10 tons (9 metric tons). Add water to Type D granular material as needed or directed by the Engineer.

**B. Shale.** The Engineer will test for soft shale according to 703.16, to determine if compaction testing is required. For soft shale, when a test section is used, use a minimum compactive effort of ten passes with a tamping foot roller

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having a minimum weight of 15 tons (14 metric tons) or with rollers meeting the requirements of 703.16.D.

Use water to aid in breaking down large particles and to bring the shale to at least 2 percent above optimum moisture content.

Compact hard shale, as defined in 703.16, with a minimum compactive effort of ten passes of a tamping foot roller having a minimum weight of 15 tons (14 metric tons) or with rollers meeting the requirements of 703.16.D. When the hard shale is mixed with fine material, use fine material that is at least 2 percent above optimum moisture content. No density testing will be required. If shale mixture contains large particles of shale, break down the particles during placement until the voids are filled.

Place and compact shale and rock mixtures using the same procedure as for shale. Reduce rock size in a shale-rock mixture to less than or equal to 8 inches (200 mm), or separate rock greater than 8 inches (200 mm) from the mixture and use as rock fill. Use the construction methods for rock when the shale-rock mixture contains less than 15 percent shale.

**C. Rock.** Reduce the rock until it is small enough to be incorporated into the following horizontal lift thickness: Place rock in a maximum loose lift thickness 6 inches larger than the largest diameter of the rock pieces or 3 feet (1 m), which ever results in the smaller lift thickness. When placing rock fill within a length of six times the height of the fill at an abutment, place rock fill in loose lifts not to exceed 18 inches (0.5 m). [For example, if the fill height is 20 feet (6 m), then the rock fill within 120 feet (36 m) of the abutment is placed in less than 18-inch (0.5 m) loose lifts.]

Do not dump the rock, but distribute and place the full width of the lift by blading or dozing to ensure proper placement. Evenly distribute the larger rocks, and reduce the voids, pockets, and bridging to ensure minimum deformation. Incorporate smaller rock pieces in the upper portions of each rock lift to fill the voids during this manipulation.

When placing embankment material other than rock on top of the rock lift, level and smooth the rock surface using suitable leveling equipment and evenly distribute the smaller rock, rock spalls, or finer rock fragments.

Water and roll all rock lift surfaces and lifts made up principally of rock smaller than 8 inches (200 mm) with eight passes with a vibratory steel wheel roller having a minimum weight of 10 tons (9 metric tons).

When constructing rock and other embankment materials at approximately the same time, perform the following:

1. Use the rock at the base of the embankment.
2. Use rock in the outer portions of the embankment.
3. Use the larger rocks on the outside side slopes.
4. Use the other embankment material in the inner portion of the fill.
5. Keep the top of the other embankment materials higher than the rock.

6. Construct the other embankment materials to a sufficient width to allow the specified compaction.

7. When rock is placed on top of other embankment material, construct the other embankment material at a center-to-side slope grade of approximately 4 percent.

**D. Random Materials.** Reduce the random material until it is small enough to incorporate into an 8-inch (200 mm) lift, except for RPCC in 203.06.D.1 through 203.06.D.4.

When using a uniformly graded mixture, use material with a moisture content less than 2 percent below optimum to obtain compaction. When large pieces are incorporated in the lifts, use fine material with a moisture content less than 2 percent below optimum to obtain compaction.

Compact natural soil and natural granular material blends with RACP or RPCC to the same requirements as a granular embankment in 203.06.

When using RPCC slabs or large RPCC pieces in the embankment construction, conform to the following:

1. Use natural soil or natural granular material that is less than 2 percent below optimum moisture in the blend. Reduce the slabs or pieces to less than 3 × 3 feet (1 × 1 m) in size and place the blend in a maximum loose lift thickness of 12 inches (300 mm).

2. Manipulate, level, and distribute the mixture by blading or dozing to fill the voids and pockets, and reduce bridging.

3. Compact the natural soil or natural granular embankment to the compaction and moisture requirements in 203.07.

4. When the RPCC slabs or large RPCC pieces consists of more than 50 percent of the embankment lift, place the blended material in maximum loose lifts of 18 inches (0.5 m). Do not place one slab directly on the other. Compact, manipulate, level, and distribute as stated in 203.06.D.1 through 203.06.D.3.

**E. Areas Inaccessible to Rollers.** For areas inaccessible to rollers, such as adjacent to culverts, retaining walls, or other structures, construct the embankment in 6-inch (150 mm) horizontal loose lifts.

**203.07 Compaction and Moisture Requirements.** Construct all embankments, except rock and hard shale, using moisture and density controls. Unless otherwise specified in the Contract Documents, the Engineer will perform all compaction tests according to Supplement 1015.

**A. Moisture Controls.** Sprinkle enough water on embankment material that contains too little moisture to wet it to a moisture content needed to meet the density requirements. Apply the water using tank trucks equipped with suitable sprinkling devices. Thoroughly incorporate the water into the material by using discs, plows, or other approved equipment. Continue to water and to manipulate until the required moisture is uniformly distributed throughout the lift.

Before or during compaction, allow the embankment material that contains excess moisture to dry to a moisture content needed to meet the density requirements. Continue drying until the required moisture is uniform throughout the lift. However, for material that displays pronounced elasticity or deformation under the action of loaded rubber tire construction equipment or other equipment, reduce the moisture content to secure stability. Expedite and manipulate the embankment material by drying the wet embankment material by using plows or discs; by adding dry material, lime, or cement; or by other methods.

Do not mix shale in the lifts to reduce the moisture content of the embankment material.

**B. Compaction Requirements.** Compact all embankment materials, except for rock and hard shale, in horizontal lifts to a dry density greater than the percentage of maximum dry density in Table 203.07-1, or to 98 percent of the maximum dry density determined by the test section methods specified in Supplement 1015.

**TABLE 203.07-1 EMBANKMENT COMPACTION REQUIREMENTS**

Maximum Dry Density [lb/ft <sup>3</sup> (kg/m <sup>3</sup> )]	Minimum Compaction Requirements in Percent of Maximum Dry Density
90 to 104.9 (1440 to 1680)	102
105 to 119.9 (1681 to 1920)	100
120 and more (1921 and more)	98

If needed for compaction acceptance, construct a test section using the following:

1. Use at least the same number of passes and compactive effort used to construct the test section to construct the production embankment areas.
2. Construct a new test section when the material, supporting foundation, or embankment changes.
3. Reduce the moisture content if the material becomes unstable.

**203.08 Earthwork Construction Tolerances.** Finish the completed excavation and embankment to the cross-sections shown on the plans. Check the excavation and embankment work with templates, slope boards, electronic methods, or other methods specified in Item 623. The Engineer will allow occasional deviations in the work within the following tolerances:

- A. When topsoil is specified, use the following:
  1. In fill areas, construct the embankment to the bottom of the topsoil depth.
  2. In cut areas, construct the cut an additional depth for the topsoil.
  3. For cuts or fills, the cross-sections show the finished grade, which is the top of the topsoil.
- B. For the backslopes (cut slopes), from the back of the ditch to the existing ground, and for the foreslopes (fill slopes), from the edge of the graded shoulder to

the bottom of the ditch, do not allow deviations greater than 1 foot (0.3 m) as measured in the horizontal plane.

C. Do not construct shoulders and ditches less than the horizontal measurement from the centerline or to a higher elevation than shown on the plans. However, the cross-section may vary below the plan grades by less than 1/2 inch (15 mm) at the pavement edge and by less than 2 inches (50 mm) elsewhere.

D. Construct or fine grade the subgrade to within 1/2 inch (15 mm) of the plan elevation at any location. Construct or fine grade the subgrade to within 1/2 inch (15 mm) of the plan grade as measured with a 10-foot (3 m) straightedge applied to the surface parallel to the centerline of the pavement.

E. For all rock or shale cut slopes that do not require control blasting techniques, rake excavate, hoe, ram, or mechanically shape these slopes to obtain a neat and smooth appearance.

**203.09 Method of Measurement.** The Department will measure Excavation by the number of cubic yards (cubic meters) of material in the original position, acceptably excavated, using the average end area method.

The Department will measure Embankment; Rock; Granular Embankment; and Granular Material, Type \_\_\_ by the number of cubic yards (cubic meters) of material in the final position, acceptably placed, using the average end area method.

Measurement will include overbreakage or slides not attributable to carelessness of the Contractor, embankment settlement caused by soft embankment foundation, unsuitable materials excavated and removed to obtain proper stability in cut sections and in foundation areas for fill sections.

The Department may use three-dimensional measurements where it is impractical to measure material by the cross-section method due to the erratic location of isolated deposits.

The Department will not measure excavation or embankment outside plan limits.

The Department will measure Borrow by the cubic yard (cubic meter) or ton (metric ton) as specified in the Contract Documents.

When in-place density tests are needed, the Department will perform the tests according to Supplement 1015.

The Contract Documents will specify borrow only when the measurement of the material in its final location by volume is impractical. For example, this would apply when the borrow material is to be placed in locations that are under water or in locations with extremely soft foundations. In addition, the Department may specify borrow when additional material is needed and when Item 209 is specified. In this case, the Department will pay for borrow for under 209 Borrow.

The Department will measure the volume of borrow material in a natural formation either by the average end area method or by weight.

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Where measurement is by the average end area, the Department will take cross-sections after the surface has been cleared and scalped and again after the borrow area excavation has been completed. The cross-sections determine the volume for payment.

Where the total weight is measured and converted to volume, the Department will determine material density in pounds per cubic yard (kilograms per cubic meters) in its original position by a series of representative field measurements made after clearing and scalping have been performed, and as the excavation exposes the borrow material. Weigh the acceptable material, minus excess moisture, excavated from the borrow area for incorporation into the embankment, and furnish the Department with load slips. The Department will determine the cubic yards (cubic meters) for payment by dividing the total weight of the borrow material by the average weight per cubic yard (cubic meter) of the undisturbed material. If the moistures of the in-place borrow site density test material is not within 2 percent of the accepted delivered material, the Department will calculate volume based on the dry densities and weights.

The Department will calculate the volume of borrow from sources other than natural in-place formations, such as processed slag, sand, stone or gravel, and quarry material as follows: Determine the material in-place compacted density in pounds per cubic yard (kilograms per cubic meter). The volume paid will be the total weight of the material furnished, minus excess moisture, divided by 95 percent of the average embankment density. If the moistures of the accepted in-place density test material is not within 2 percent of the delivered material, the Department will calculate volume based on the dry densities and weights. Where measurements show that completed embankment exists outside the plan cross-sections or outside the allowable tolerances, the Department will multiply the quantity outside plan lines by a shrinkage factor to determine the quantity deducted from the measured borrow quantity. The shrinkage factor is determined by dividing the volume or weight of the material excavated or used as borrow by the volume or weight of the material compacted in place.

When the measurement is by weight, the Department will accept the material based on the freight bills and weight and volume evidence according to 109.

**203.10 Basis of Payment.** If the Contract does not include 201 Clearing and Grubbing or an estimated quantity for 201 Tree Removed or 201 Stump Removed, or an estimated quantity for the pay items under Item 202, the Department will not pay for this work directly but will considered it incidental to pay items under Item 203.

The Department will not pay for additional wasting cost of material excavated in the work that was wasted instead of being dried as detailed in 203.03.H.

If the Contractor elects to use PCS, the Department will not pay for additional work necessary to comply with the requirements specified in 203.03.J.

If during excavation the Contractor encounters remains of prehistoric archaeological sites, historical archaeological sites, or human remains, the Department will pay for such excavation according to 109.05.

If during excavation the Contractor encounters hazardous material or waste, the Department will pay according to 109.05.

If necessary during the construction in 203.03.H, 203.04.A, or 203.07.A, the Department will not pay for removing the saturated embankment or drying the embankment.

If caused by improper excavation methods, the Department will not pay for removing slides and breakages beyond the limits of the planned finished work. The Department will pay for the removal of slides and breakages beyond the limits of the planned finished work according to 109.05, when there is no Contractor fault or neglect.

If caused by the lack of implementing erosion controls, the Department will not pay for reshaping shoulders, slopes, and ditches damaged by erosion during construction.

If caused by the Contractor's equipment or methods, the Department will not pay for repairing or restoring damaged areas designated for salvage.

When topsoil is specified, the Department will not make deductions or additions from the earthwork quantities for the topsoil.

The Department will adjust earthwork quantities for changes resulting from the following: undercutting, foundation settlement, changes to grades or slopes, and removing slides. The Department will not adjust earthwork quantities when the volume between two consecutive cross-sections differs by less than 5 percent from the plan quantity. For quantity differences greater than 5 percent, submit supporting documentation to the Engineer.

For quantities measured for payment, the Department will use the plan cross-sections, corrected for errors, as the original field cross-sections. Additional cross-sections may be interpolated from the plans at points necessary to more accurately determine quantities.

The Department will pay according to 109.05 for changes or extra work that increases the haul distance more than 1/2 mile (1 km) to the work detailed in the Contract Documents. The Department will pay for additional quantities that increase the haul distance 1/2 mile (1 km) or less at the unit bid price.

When specified, the payment for borrow includes all work to complete the embankment construction to the cross-sections shown on the plans. The Department will not make additional payment for the embankment construction of the borrow material. When borrow is not specified, all work is included in the excavation or embankment pay items.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
203	Cubic Yard (Cubic Meter)	Excavation
203	Cubic Yard (Cubic Meter)	Embankment

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203	Cubic Yard or Ton (Cubic Meter or Metric Ton)	Granular Embankment
203	Cubic Yard or Ton (Cubic Meter or Metric Ton)	Granular Material, Type ____
203	Cubic Yard or Ton (Cubic Meter or Metric Ton)	Borrow
203	Cubic Yard or Ton (Cubic Meter or Metric Ton)	Rock

**ITEM 204 SUBGRADE COMPACTION AND PROOF ROLLING**

**204.01 Description**

**204.02 Materials**

**204.03 Compaction of the Subgrade**

**204.04 Soft Subgrade**

**204.05 Rock, Shale, or Coal Subgrade**

**204.06 Proof Rolling**

**204.07 Spreading and Placing of Materials**

**204.08 Method of Measurement**

**204.09 Basis of Payment**

**204.01 Description.** This work consists of preparing suitable subgrade material by drying, compacting, proof rolling, and grading. This work also consists of removing unsuitable subgrade material and constructing new embankment to the limits shown on the plans.

The contract documents provide the anticipated amount of excavation of unsuitable subgrade material which includes wet or soft subgrade and rock, shale, and coal in the subgrade.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

**204.02 Materials.** Furnish suitable material conforming to 203.02.R, 203.03, and 703.16, except use soils in the top 12 inches (300 mm) of the subgrade that have a maximum dry density of at least 100 pounds per cubic foot (1600 kg/m<sup>3</sup>).

Furnish material that conforms to 703.16.B or 703.16.C when Granular Embankment is specified. Furnish material that conforms to 703.16.C when Granular Material, Type \_\_\_\_ is specified.

Do not use Granular Material Type D, E, or F in the location where underdrains are to be constructed.

Furnish geotextile fabric that conforms to 712.09, Type D. Do not use geotextile fabric in the location where underdrains are to be constructed.

**204.03 Compaction of the Subgrade.** The Engineer will perform the compaction testing according to Supplement 1015. The Department may check for compaction before or after the fine grading operation.

Compact the subgrade materials that have a maximum dry density of 100 to 105 pounds per cubic foot (1600 to 1680 kg/m<sup>3</sup>) to not less than 102 percent of maximum dry density. Compact all other subgrade materials to not less than 100 percent of maximum dry density. The Engineer will determine the maximum dry density using AASHTO T 99, AASHTO T 272, or test section method in Supplement 1015.

If needed for compaction acceptance, use the test section method as follows:

- A. Use a minimum of eight passes with a steel wheel roller having a minimum weight or centrifugal force of 10 tons (9 metric tons).
- B. The Engineer will use at least 98 percent of the test section maximum dry density for acceptance of the production subgrade compaction.
- C. Use at least the same number of passes and compactive effort used to construct the test section for the production subgrade compaction.
- D. Construct a new test section when the subgrade material, supporting foundation or embankment material changes.
- E. Reduce the moisture content if the material becomes unstable. The Engineer may reduce the minimum number of passes if the passes are detrimental to compaction.

Use the moisture controls specified in 203.07.A.

Compact the subgrade under pavements to a depth of 12 inches (300 mm) below the subgrade surface and 18 inches (450 mm) beyond the edge of the surface of the pavement, paved shoulders, or paved medians. Compact all subgrades under paved driveways, paved mailbox turnouts, curbs and gutters to a depth of 12 inches (300 mm) below the subgrade surface.

Maintain and drain the subgrade according to 203.04.A.

**204.04 Soft Subgrade.** If satisfactory subgrade stability cannot be obtained by moisture control and compaction according to 204.03, the Engineer will direct the Contractor to remove the soft material and to construct the replacement material to the finished grade within the tolerances specified in 203.08.

Conduct the removal and replacement operations to allow the Engineer to measure the cross-sections before placing the replacement material.

Remove the soft subgrade material to the depth determined by the Engineer or specified in the Contract Documents. Replace with suitable material according to 204.07.

**204.05 Rock, Shale, or Coal Subgrade.** If an aggregate base is not a part of the pavement design, undercut the subgrade 2 feet (0.6 m) below the final subgrade elevation where rock, shale, or coal is encountered. If an aggregate base

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is part of the pavement design, reduce the above 2-foot (0.6 m) undercut by the thickness of the aggregate base or bases. Maintain a total undercut depth of 2 feet (0.6 m) below the bottom of the asphalt or concrete pavement.

Excavate for a width of 1 foot (0.3 m) beyond the shoulders. Replace with suitable material according to 204.07.

**204.06 Proof Rolling.** Perform the testing of the stability and uniformity of the subgrade compaction in locations shown on the plans by proof rolling.

Use a proof roller conforming to the following:

- A. Four heavy pneumatic tire wheels mounted on a rigid steel frame.
- B. Wheels evenly spaced in one line across the width of the roller.
- C. Wheels arranged so that all wheels carry approximately equal loads when operated over an uneven surface.
- D. A maximum center-to-center spacing between adjacent wheels not exceeding 32 inches (0.8 m).
- E. A body for ballast loading capable of varying the gross load from 25 to 50 tons (23 to 45 metric tons).
- F. Tires capable of operating at inflation pressures ranging from 90 to 150 pounds per square inch (620 to 1040 kPa). Provide a tire pressure gage for measurement before use.
- G. Tires filled with liquid from 90 to 95 percent by volume.

Provide ballast that consist of ingots of known weight, sand bags with a weight of 100 pounds (45 kg), bags of other material of known weight, or other suitable material such that the total ballast weight is readily determinable at all times. Provide sufficient ballast to load equipment to a maximum gross weight of 50 tons (45 metric tons).

Furnish the Engineer information verifying that the weights and tire pressures can be met.

After compacting the subgrade according to 204.03 and before placing overlying course, proof roll designated subgrade areas. If proof rolling is performed after the underdrains are installed, do not use the proof roller within 1 1/2 feet (450 mm) of the underdrains.

Ensure that the subgrade moisture content at the time of proof rolling is within 2 percent of the moisture used for acceptance in 204.03.

Adjust the load and tire inflation pressure according to the following:

- A. For soils classified as A-3, A-4, A-6, or A-7-6, use a 35-ton (32 metric tons) roller with a tire pressure of 120 pounds per square inch (820 kPa).
- B. For granular soils, and soil, rock, and granular mixtures, use a 50-ton (46 metric tons) roller with a tire pressure of 150 pounds per square inch (1030 kPa).
- C. Measure the tire pressure in the presence of the Engineer.

Operate equipment at a speed between 2 1/2 and 5 miles per hour (4 and 8 km/hr). Adjust the speed to allow the Engineer to measure the deflections, ruts, or elasticity.

Make only one trip of the proof roller over any area. Offset trips to completely cover the subgrade area.

Where proof rolling indicates areas of soft subgrade or areas of non-uniform subgrade stability, the Engineer will investigate for the source of the problem. The Engineer will check the subgrade materials, density, and moisture content according to 204.02 and 204.03. The Contractor is responsible for all problems found in the materials constructed under the Contract Documents. Correct all deficiencies found.

Correct the subgrade to a uniform and satisfactory stability as directed by the Engineer.

After proof rolling, check the subgrade for conformance to the plans, and correct all surface irregularities. Shape the subgrade within the tolerances specified in 203.08.

**204.07 Spreading and Placing of Materials.** Place materials, conforming to 204.02, in 8-inch (200 mm) loose lifts. The Engineer may increase the lift thickness depending on the stability of the bottom of the cut. The Engineer may increase the lift thickness up to 24 inches (600 mm) to obtain stability at the top of the lift. Doze, track, or manipulate the material to maximize the density and stability. Once stability is achieved, compact according to 204.03.

When specified, place the geotextile fabric at the bottom of the cut or at locations designated in the Contract Documents. Place the geotextile fabric smooth and free of tension or wrinkles. Fold or cut the geotextile fabric to conform to curves. Overlap a minimum of 18 inches (450 mm) at the ends and sides. Hold the fabric in place with pins or staples.

End dump the suitable material on the fabric. Do not operate the equipment directly on the fabric. Unless stated otherwise, spread the end dumped material and maintain a minimum lift thickness of 12 inches (300 mm).

When granular material Type E is specified or allowed, use a geotextile fabric on the top, bottom and around the Type E granular material to prevent piping of material into the Type E granular material. The Engineer will use granular material Type E when excess water is at the bottom of the cut.

**204.08 Method of Measurement.** The Department will measure Subgrade Compaction by the number of square yards (square meters) computed from the profile grade and typical sections and actually compacted. The Department will measure 18 inches (450 mm) beyond the edge of the pavement surface, paved shoulders, and paved medians. The Department will measure the surface area of the paved driveways, paved mailbox turnouts, curb, and gutter.

The Department will measure Proof Rolling by the number of hours accepted. The Department will not measure idle time for repairs, servicing, loading and unloading ballast, adjusting tire pressure, bad weather, wet subgrade, usage at

**204.09**

times and at locations other than Department directed, and stand-by time to be available when next needed or other cause for stand-by time.

The Department will measure Excavation of Subgrade; Embankment; Granular Embankment; and Granular Material, Type \_\_\_ according to 203.09. All excavation is unclassified.

The Department will measure Geotextile Fabric by the number square yards (square meters) of surface area of geotextile fabric placed. The Department will not measure the specified lap length.

**204.09 Basis of Payment.** The Department will pay according to 109.05 for changes or extra work that increases the haul distance more than a 1/2 mile (1 km) to the work detailed in the Contract Documents. The Department will pay for additional quantities that increase the haul distance 1/2 mile (1 km) or less at the unit bid price.

If soft subgrade results from inadequate surface drainage or lack of maintenance, as required by 203.04.A, the Department will not pay for replacing the soft subgrade and disposing of the removed material.

For problems identified in 204.06 that are the result of soils or conditions at lower elevations than the Contract work, the Department will pay for the corrections.

The Department will pay for the subgrade compaction in areas requiring undercut and replacement in 204.04, 204.05, and 204.07. The Department will not pay for subgrade compaction in areas stabilized with lime or cement.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
204	Square Yard (Square Meter)	Subgrade Compaction
204	Square Yard (Square Meter)	Subgrade Compaction ___ inches (___ mm) Deep
204	Hour	Proof Rolling
204	Cubic Yard (Cubic Meter)	Excavation of Subgrade
204	Cubic Yard (Cubic Meter)	Embankment
204	Cubic Yard (Cubic Meter)	Granular Embankment
204	Cubic Yard (Cubic Meter)	Granular Material Type ___
204	Square Yard (Square Meter)	Geotextile Fabric

## ITEM 205 CHEMICALLY STABILIZED EMBANKMENT

### 205.01 Description

### 205.02 Materials

### 205.03 Submittals

### 205.04 Construction

### 205.05 Mixture Design for Chemically Stabilized Soils

### 205.06 Method of Measurement

### 205.07 Basis of Payment

**205.01 Description.** This work consists of constructing a chemically stabilized embankment by mixing cement, lime, or lime kiln dust into the embankment soil using the method for the specified chemical.

The Contract Documents include an estimated quantity for the specified chemical.

**205.02 Materials.** Furnish materials conforming to:

Portland cement .....	701.04
Lime (quick lime) .....	712.04.B
Lime kiln dust .....	712.04.C

Furnish water conforming to 499.02. Furnish suitable natural soil, from on or off the project site, conforming to 703.16 and 203.03.

**205.03 Submittals.** Submit, for the Engineer's acceptance, a report that lists the type of equipment to be used, speed of the intended equipment usage, rate of application of the chemical, and calculations that demonstrate how the required percentage of chemical will be applied. Submit the report to the Engineer for acceptance at least 2 workdays before the stabilization work begins.

If the pay item for Mixture Design for Chemically Stabilized Soils is included in the Contract Documents, prepare and submit reports according to Supplement 1120.

**205.04 Construction.** Perform chemically stabilized embankment work when the air temperature is 40 °F (5 °C) or above and when the soil is not frozen.

Do not perform this work during wet or unsuitable weather.

Drain and maintain the work according to 203.04.A.

**A. Spreading.** If the pay item for Mixture Design for Chemically Stabilized Soils is not included in the Contract Documents, use the following spreading percentage rate for the specified chemical. The percentage is based on a dry density for soil of 110 pounds per cubic foot (1760 kg/m<sup>3</sup>):

**TABLE 206.05-1**

<b>Chemical</b>	<b>Spreading Rate</b>
Cement	6 %
Lime	4 %
Lime Kiln Dust	8 %

Spread the chemical uniformly on the surface using a mechanical spreader at the approved rate and at a constant slow rate of speed.

Use a distribution bar with a maximum height of 3 feet (1 meter) above the ground surface. Use a canvas shroud that surrounds the distribution bar and extends to the ground surface.

Minimize dusting when spreading the chemical. Control dust according to 107.17. Do not spread chemical when wind conditions create blowing dust that exceeds the limits in 107.19.

Do not spread the chemical on standing water.

**B. Mixing.** Immediately after spreading the chemical, mix the soil and chemical by using a power driven rotary type mixer. If necessary, add water to bring the mixed material to at least optimum moisture content for cement and lime kiln dust, and to at least 3 percent above optimum moisture content for lime. Continue mixing until the chemical is thoroughly incorporated into the soil, all soil clods are reduced to a maximum size of 2 inches (50 mm), and the mixture is a uniform color.

For areas not under pavements or paved shoulders, the Contractor may use a spring tooth or disk harrow in place of the power-driven rotary type mixer by modifying the above procedure as follows:

1. Open the soil with a spring tooth or disc harrow before spreading.
2. Spread the chemical.
3. Use a minimum disc harrow coverage of ten passes in one direction and ten passes in the perpendicular direction to thoroughly incorporate the chemical into the soil. Continue mixing until all soil clods are reduced to a maximum size of 1 inch (25 mm) and the mixture is a uniform color.

**C. Compacting.** Construct and compact chemically stabilized embankment according to 203.07, except the Engineer will use 98 percent of the maximum dry density for acceptance.

The Engineer will obtain the maximum dry density for acceptance by using the Ohio Typical Moisture Density Curves, the moisture density curves from the Contractor’s mixture design submittal, or the maximum dry density obtained by test section method.

**205.05 Mixture Design for Chemically Stabilized Soils.** When included in the plans, perform a mixture design for chemically stabilized soils according to Supplement 1120.

**205.06 Method of Measurement.** The Department will measure chemically stabilized embankment by the number of cubic yards (cubic meters) used in the complete and accepted work, as determined by Item 203.

The Department will measure cement, lime, and lime kiln dust by the number of tons (metric tons) incorporated in the complete and accepted work.

**205.07 Basis of Payment.** The Department will pay lump sum for all work, labor, and equipment described in 205.05. The Department will pay two-thirds of the lump sum amount bid when the sampling and testing is complete and the report is accepted by the Department. The Department will pay one-third of the lump sum amount bid when the chemically stabilized embankment is completed and accepted by the Department.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
205	Cubic Yard (Cubic Meter)	Cement Stabilized Embankment
205	Cubic Yard (Cubic Meter)	Lime Stabilized Embankment
205	Cubic Yard (Cubic Meter)	Lime Kiln Dust Stabilized Embankment
205	Ton (Metric Ton)	Cement
205	Ton (Metric Ton)	Lime
205	Ton (Metric Ton)	Lime Kiln Dust
205	Lump Sum	Mixture Design for Chemically Stabilized Soils

## **ITEM 206 CHEMICALLY STABILIZED SUBGRADE**

### **206.01 Description**

### **206.02 Materials**

### **206.03 Submittals**

### **206.04 Test Rolling**

### **206.05 Construction**

### **206.06 Mixture Design for Chemically Stabilized Soils**

### **206.07 Method of Measurement**

### **206.08 Basis of Payment**

**206.01 Description.** This work consists of constructing a chemically stabilized subgrade by mixing cement, lime, or lime kiln dust into the subgrade soil using the method for the specified chemical. The Contract Documents include an estimated quantity for the specified chemical.

**206.02 Materials.** Furnish materials conforming to:

Portland cement .....	701.04
Lime (quick lime) .....	712.04.B
Lime kiln dust .....	712.04.C

**206.03**

Furnish water conforming to 499.02.

For the curing coat, furnish rapid setting emulsified asphalt conforming to 702.04 or the curing materials specified in 451.02.

**206.03 Submittals.** Submit, for the Engineer’s acceptance, a report that lists the type of equipment to be used, speed of the intended equipment usage, rate of application of the chemical, and calculations that demonstrate how the required percentage of chemical will be applied. Submit the report to the Engineer for acceptance at least 2 workdays before the stabilization work begins.

If the pay item for Mixture Design for Chemically Stabilized Soils is included in the Contract Documents, prepare and submit reports according to Supplement 1120.

**206.04 Test Rolling.** When specified, test roll prior to chemical stabilization with a proof roller conforming to 204.06.

**206.05 Construction.** Perform chemical stabilization work when the air temperature is 40 °F (5 °C) or above and when the soil is not frozen. Do not perform this work during wet or unsuitable weather.

**A. Spreading.** Shape the subgrade to the approximate profile grade prior to spreading the chemical so as to permit the construction of a uniformly compacted course of chemically treated soil to the thickness shown on the plans. The addition of the chemical will raise the subgrade profile approximately 1 inch (25 mm). Remove this excess material during the fine grading.

If the pay item for Mixture Design for Chemically Stabilized Soils is not included in the Contract Documents, use the following spreading percentage rate for the specified chemical. The percentage is based on a dry density for soil of 110 pounds per cubic foot (1760 kg/m<sup>3</sup>):

**TABLE 206.05-1**

<b>Chemical</b>	<b>Spreading Rate</b>
Cement	6 %
Lime	4 %
Lime Kiln Dust	8 %

Spread the chemical uniformly on the subgrade using a mechanical spreader at the approved rate and at a constant slow rate of speed.

Use a distribution bar with a maximum height of 3 feet (1 meter) above the subgrade. Use a canvas shroud that surrounds the distribution bar and extends to the subgrade.

Minimize dusting when spreading the chemical. Control dust according to 107.19. Do not spread the chemical when wind conditions create blowing dust that exceeds the limits in 107.19.

Do not spread the chemical on standing water.

**B. Mixing.** Immediately after spreading the chemical, mix the soil and chemical as follows.

**1. Cement or Lime Kiln Dust.** Mix the chemical and soil using a power driven transverse type mixer equipped with a computer controlled volumetric water readout. Continue mixing until the cement or lime kiln dust is thoroughly incorporated into the soil and is a uniform color.

Do not water during the initial mixing.

Perform the initial mixing so that 60 percent of the soil mixture passes the No. 4 sieve (4.75 mm) and 100 percent passes the 1 inch sieve (25mm), exclusive of aggregate larger than the No. 4 sieve (4.75 mm) size.

After the initial mixing, remix the soil and introduce water through the mixer to bring the mixed material to at least optimum moisture. Uniformly distribute the water in sufficient quantity to hydrate the cement or lime kiln dust.

If the chemical and soil can be mixed to the required gradation and the water can be added to bring the soil mixture to the required moisture content in one mixing, then only one mixing of the soil, water and chemical is required.

Restrict the addition of water when the moisture content of the soil exceeds 3 percent above optimum moisture. Add water to the mixed soil within 2 hours after the initial mixing.

Once the water is added to the mixture, complete the mixing, compacting, and shaping within 2 hours from start to finish.

**2. Lime.** Mix the lime and soil using a power driven transverse type mixer equipped with a computer controlled volumetric water readout. If necessary, add water to bring the mixed material to at least 3 percent above optimum moisture content. Continue mixing until the lime is thoroughly incorporated into the soil, all soil clods are reduced to a maximum size of 2 inches (50 mm), and the mixture is a uniform color.

After the initial mixing, lightly compact the material to seal it against rain or excessive drying by using a steel wheel or pneumatic tire roller.

Allow the lime and soil mixture to cure (mellow) for a period of not less than 24 hours and not more than 7 days. If more than 7 days elapse between initial mixing and final mixing, add an additional 0.5 percent of lime during the final mixing. Furnish the additional lime at no cost to the Department unless the delay beyond the 7-day limit is caused by conditions beyond the Contractor's control.

Perform the final mixing until the soil mixture is completely pulverized with all clods reduced to a maximum size of 1 inch (25 mm) and at least 60 percent of the clods passing the No. 4 (4.75 mm) sieve, exclusive of aggregate larger than the No. 4 sieve (4.75 mm). Continue mixing until the lime is uniformly distributed throughout the pulverized soil.

During final mixing, return the mixture to the moisture contents stated above, then shape and compact the mixture.

**3. Mixture Depth Check.** Check the uniformity of the mix by digging trenches or a series of holes at regular intervals for the full depth of treatment and inspecting the color and depth of the exposed material. The Engineer will use

## 206.05

diluted hydrochloric acid or phenolphthalein to ensure that the chemical is mixed to the desired depth.

**C. Compacting.** Start compaction no more than 30 minutes after the final mixing.

Compact all chemically stabilized subgrade to the requirements in 204.03, except the Engineer will use 98 percent of the maximum dry density for acceptance. The Engineer will obtain the maximum dry density for acceptance by using the Ohio Typical Moisture Density Curves, the moisture density curves from the Contractor's mixture design submittal, or the maximum dry density obtained by test section method.

Use a vibratory footed roller weighing at least 10 tons (9 metric tons).

Use the moisture controls according to 203.07.A, except ensure that the moisture content at time of compaction is at or above optimum.

Perform the final rolling using a steel-wheeled roller. Do not use vibration during the final rolling.

The Contractor may either shape and fine grade the chemically stabilized subgrade before the curing period, or shape the subgrade before the curing period and fine grade after the curing period. If fine grading after the curing period, shape the subgrade approximately 1 inch above the profile grade and typical sections. In either case, fine grade the subgrade to the profile grade and typical sections within the tolerances in 203.08.

**D. Curing.** Immediately after the compaction and shaping of the chemically stabilized subgrade, cover the surface with curing coat for curing the chemically stabilized subgrade. Use a rate of 1 gallon per 30 square feet (1.36 liters per square meter) for emulsions or a rate of 1 gallon per 150 square feet (0.27 liters per square meter) when the curing materials in 451.02 are used.

Apply the curing coat prior to the surface drying out. If the curing coat is delayed or the surface starts to dry out, indicated by turning white, apply water for temporary curing until the curing coat can be applied. Do not apply the curing coat unless the curing coat can set up before it rains. When the application of curing coat must be delayed, keep the chemically stabilized subgrade wet by using water until the curing coat can be applied.

Cure the chemically stabilized subgrade for at least five days before the placement of the overlying course.

**E. Proof Rolling.** After the curing period, proof roll the chemically stabilized subgrade according to Item 204.

**F. Protection.** Drain and maintain the work according to 203.04.A.

Do not operate any equipment on the chemically stabilized subgrade during the curing period.

Do not allow the chemically stabilized subgrade to freeze during the cure period.

Cover the completed chemically stabilized subgrade with the aggregate base within 60 calendar days.

**206.06 Mixture Design for Chemically Stabilized Soils.** When included in the plans, perform a mixture design for chemically stabilized soils according to Supplement 1120.

**206.07 Method of Measurement.** The Department will measure chemically stabilized subgrade by the number of square yards (square meters) computed from the profile grade and typical sections accepted in place.

The Department will measure cement, lime, and lime kiln dust by the number of tons (metric tons) incorporated in the complete and accepted work.

The Department will measure Test Rolling according to 204.08 as specified for Proof Rolling.

The Department will measure Curing Coat by the number of square yards (square meters) computed from the profile grade and typical sections accepted in place.

**206.08 Basis of Payment.** The Department will pay lump sum for all work, labor, and equipment described in 206.06. The Department will pay two-thirds of the lump sum amount bid when the soil sampling and testing is complete and the report is accepted by the Department. The Department will pay one-third of the lump sum amount bid when the chemically stabilized subgrade is completed and accepted by the Department.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
206	Square Yard (Square Meter)	Cement Stabilized Subgrade, __ inches deep
206	Square Yard (Square Meter)	Lime Stabilized Subgrade, __ inches deep
206	Square Yard (Square Meter)	Lime Kiln Dust Stabilized Subgrade, __ inches deep
206	Ton (Metric Ton)	Cement
206	Ton (Metric Ton)	Lime
206	Ton (Metric Ton)	Lime Kiln Dust
206	Square Yard (Square Meter)	Curing Coat
206	Hour	Test Rolling
206	Lump Sum	Mixture Design for Chemically Stabilized Soils

## **ITEM 207 TEMPORARY SEDIMENT AND EROSION CONTROLS**

### **207.01 Description**

### **207.02 Materials**

### **207.03 Construction Requirements**

## 207.01

### 207.04 Maintenance

### 207.05 Performance

### 207.06 Method of Measurement

### 207.07 Basis of Payment

**207.01 Description.** This work consists of constructing temporary sediment and erosion control items.

To the extent practical, coordinate temporary sediment and erosion control items with permanent control provisions contained in the Contract to ensure continuous erosion control throughout the construction and post-construction periods.

Provide temporary sediment and erosion controls according to Item 207 for construction work outside of the construction limits, such as borrow pit operations, haul roads, equipment and material storage sites, waste areas, and temporary plant sites at no additional cost to the Department.

**207.02 Materials.** Furnish commercial fertilizer, seed, and mulch materials conforming to Item 659.

Furnish filter fabric ditch checks, rock checks, inlet protection, perimeter filter fabric fence, bale filter dikes, sediment basins and dams, dikes, slope drains, and rock channel protection materials as specified on the standard construction drawings.

Furnish construction ditch and slope protection conforming to the requirements of Item 670. The seeding and mulching of the mats is not required.

**207.03 Construction Requirements.** The Storm Water Pollution Prevention Plan (SWPPP) details the placement, location, and description of the temporary and permanent erosion control items. Use the SWPPP along with Item 207 to rearrange and modify the SWPPP and Contract Document quantities to meet the field conditions and to adhere to the National Pollutant Discharge Elimination System (NPDES) permit.

In the event of conflict between these requirements and pollution control laws, rules, or regulations of other Federal, State, or local agencies, adhere to the more restrictive laws, rules, or regulations.

**A. Clearing and Grubbing.** Limit the surface area of erodible earth material exposed by clearing and grubbing, excavation, and borrow and fill operations by the amount of erosion control items capable of being placed according to the requirements of this specification. Where attainable, preserve existing vegetation.

Within 7 days following clearing and grubbing operations, stabilize all inactive cleared and grubbed areas that are scheduled to remain idle for more than 45 days with construction seed and mulch. At a minimum, use construction seed and mulch on all cuts and fills greater than 20 feet (6 m) high within 7 days of inactivity. The 20-foot (6 m) requirement applies when the total inactive acreage exceeds 5 acres (2.0 ha).

If an area is within 50 feet (15 m) of any water body (i.e., stream, river, pond, etc.) and is scheduled to remain idle for more than 45 days, then stabilize the area

with construction seed and mulch within 2 days following the clearing and grubbing operations.

**B. Installation of Sediment and Erosion Control Items.** Install temporary sediment and erosion control items as detailed and according to the following requirements. Keep the sediment and erosion control items functional until the upper slope drainage areas are fully stabilized.

Construct items 1, 2, and 4 through 7 below according to the standard construction drawings.

**1. Perimeter Controls.** Use perimeter filter fabric fence to protect the project from sheet flow runoff from off Right-of-Way and off construction limit locations. Use perimeter filter fabric fence to protect the following project items from sheet flow runoff: water bodies, wetlands, or other significant items shown on the plans.

Use dikes to prevent sediment flow from coming on to the project and to non-vegetated barren areas on the project.

Install perimeter filter fabric fence and dikes concurrent with clearing and grubbing operations.

**2. Inlet Protection.** Construct the inlet protection for the existing inlets at the beginning of construction and for the new inlets immediately after completing the inlet.

**3. Construction Seeding and Mulching.** Apply seed and mulch materials according to Item 659 as modified below. When straw mulch is used, apply at a rate of 2 tons per acre (0.5 metric ton/1000 m<sup>2</sup>). Seed and mulch during and after construction, and before or during winter shut down to stabilize the areas according to 207.03.A. Fertilize construction seeding areas at one-half the application rate specified in Item 659. If project conditions prevent fertilizing the soil and preparing the seed bed, then the fertilizing and preparation requirements of Item 659 may be waived. Do not place construction seed on frozen ground.

**4. Slope Protection.** Place dikes, install slope drains, and construct ditches to divert water from bare non-vegetated areas and to protect cut and fill slopes. Place dikes at the top of fill slopes to protect the side slopes from erosion.

For fill slopes, if no filling activity occurs for 3 or more weeks and if slope height is steeper than 8 feet (2.5 m), install dikes and slope drains.

Before cutting the slope, construct a ditch at the top of cut slopes to reduce runoff coming on the slope.

Place the construction slope protection at the locations shown on the plans as the slopes are constructed. Construct according to Item 670.

**5. Ditch Checks and Ditch Protection.** Place filter fabric ditch checks or rock checks across a ditch and perpendicular to the flow to protect the ditch from erosion and to filter sediment from the flowing water.

Place ditch checks as soon as the ditch is cut. While working on a ditch, place the ditch checks by the end of the day's work.

Install filter fabric ditch checks in ditches for drainage areas less than or equal to 2 acres (0.8 ha). Install rock checks in ditches for drainage areas between 2 to 5 acres (0.8 to 2.0 ha).

Install ditch checks in conjunction with sediment basins and dams.

Place the construction ditch protection at the locations shown on the plans as the ditches are cut. Construct according to Item 670.

**6. Bale Filter Dike.** Install bale filter dike a few feet (meters) from the toe of a slope to filter and direct sediment to an appropriate control item before the runoff enters a water body on or off the Project limits.

Use the bale filter dike to collect sediment from:

- a. Areas less than 1/4 acre (0.1 ha) for each sediment pit.
- b. Slopes with a length of less than 100 feet (30 m) and having a maximum 2:1 slope.

Use a sediment pit every 100 feet (30 m) for a 2:1 slope for every 1/4 acre (0.1 ha). Use a greater spacing of the sediment pit for flatter slopes.

Begin constructing bale filter dikes within 7 days of commencing grubbing operations. Complete the construction of the bale filter dike before starting the grading operations.

**7. Sediment Basins and Dams.** Construct basins and dams at concentrated and critical flow locations to settle out sediment before the water leaves the project. Use basins at the bottom of a ravine, at a culvert inlet, or outlet, along or at the end of a ditch and at any concentrated water exit point of the project. Construct basins to retain 67 cubic yards (125 m<sup>3</sup>) of water for every acre (0.1 ha) of drainage area. Use a series of smaller basins or dams as a substitute for a larger basin or dam.

Begin constructing sediment basins and dams within 7 days of commencing grubbing operations. Complete the construction of the sediment basins and dams before starting the grading operations.

When specified, construct construction fence around the Sediment Basins or Dams

**8. River, Stream, and Water Body Protection.** Protect all streams or water bodies passing through or on the project using perimeter filter fabric fence or bale filter dikes to line the water edge. Divert project water flow using dikes and slope protection. The Contractor may use a combination of items listed in one through seven above and other sediment and erosion control items, as approved by the Engineer.

**a. Stream Relocation.** Fully stabilize the new stream channel with erosion control mats, or 70 percent grass growth before diverting flow into the new channel. This also applies to ditches that incorporate stream flow.

**b. Stream and River Crossings (Causeways).** Forging is not allowed. Provide a crossing for construction equipment that does not erode stream banks or allow sediment deposits in the channel. Plan and locate crossings well in

advance of needing them. Minimize disturbance to water bodies during construction, maintenance and removal of the stream crossing. Construct the crossings as narrow as practical. Make crossings in shallow areas rather than deep pools where possible. Minimize clearing, grubbing, and excavation of stream banks, bed, and approach sections.

Construct the stream crossings to a water elevation at least 1 foot (0.3 m) above the normal water elevation. If the stream crossing fills more than one-third the width of the stream, then use culvert pipes to allow the movement of aquatic life.

The following minimum requirements apply where culverts are used. Place culverts on the existing stream bed to avoid a drop in water elevation at the downstream end of the pipe. Furnish culverts with a diameter at least two times the depth of normal stream flow measured at the crossing centerline or with a minimum diameter of 18 inches (0.5 m) whichever is greater. Furnish a sufficient number of culverts to completely cross the channel from stream bank to stream bank with no more than 10 feet (3 m) between each culvert.

For all fill and surface material placed in the channel, around the culverts, or on the surface of the crossing, provide clean nontoxic dumped rock fill, Type B, C, or D, as specified in 703.19.B. Extend rock fill up slope from original stream bank for 50 feet (10 m) to catch and remove erodible material from equipment.

When the causeway is removed, the Contractor may elect to leave the dumped rock fill used around the pipe. Avoid impoundment or a restriction to fish passage when the rock remains. Remove all pipe when the causeway is removed.

**207.04 Maintenance.** Properly maintain temporary erosion control items with the Engineer's approval. Dispose of silt removed from erosion control items according to 105.16.

The Engineer will check temporary and permanent erosion control items every 7 days or within 24 hours after a rainfall of more than 1/2 inch (10 mm).

**A. Perimeter Filter Fabric Fence, Filter Fabric Ditch Checks, Rock Checks, Inlet Protection, Dikes, and Bale Filter Dikes.** Remove trapped sediment when it reaches half the height of the lowest section. Make appropriate corrections when the erosion control items become nonfunctional. Maintain the erosion control items until the up-slope permanent grass coverage is 70 percent or better. At this stage, remove the erosion control items.

**B. Sediment Basins and Dams.** Remove deposited sediment when sediments reduce the initial volume of the sediment basin or dam by one-half. Make appropriate corrections when these erosion control items fail. Remove dams and basins no sooner than 3 days before placing the permanent seed and mulch on the entire project.

**C. Temporary Erosion Control.** Remove all temporary erosion control items before the project is accepted. Dispose of the removed materials according to 105.16 and 105.17.

## 207.05

**207.05 Performance.** With the Engineer's concurrence, install additional erosion control items, make adjustments to meet the field conditions, and anticipated future work or corrections based on the Engineer's weekly storm water inspections.

The Department will withhold progress payments if proper sediment and erosion controls are not provided and will continue to withhold progress payments until proper erosion controls are placed.

Comply with all applicable Federal, State, and local laws in the conduct of the work. The Contractor represents and warrants that the erosion control items under this item will be performed so as to be in compliance with the requirements of the Clean Water Act, 33 USC Section 1251 *et seq.* and the OWPCA, ORC 6111.01 *et seq.* and related rules. The Contractor warrants and agrees that it is equipped to limit water pollution for its activity according to applicable Federal and State standards.

Provide personnel, equipment, and other services necessary to comply with this requirement and include costs for the same in the bid.

The Contractor further agrees to indemnify and hold harmless the Department, and shall reimburse the Department for the actual cost of any liability, damage judgment or finding, fine, penalty, or expense as a result of a violation of the above noted laws arising out of the activity of the Contractor in its performance of the Contract.

The Contractor shall reimburse the Department within 10 Calendar Days of the amount of the assessment, damage judgment or finding, fine, penalty, or expense or the Department may withhold this amount from the Contractor's next pay estimate and deliver that sum to the permitting agencies issuing the assessment, damage judgment or finding, fine, or penalty.

These assessments are not to be construed as a penalty but are actual damages to recover the costs assessed against the Department due to the Contractor's refusal or failure to comply with the above requirements.

These above provisions survive the completion and/or termination of the Contract.

**207.06 Method of Measurement.** The Department will measure fertilizer by the number of tons (metric tons) under 659 Commercial Fertilizer.

The Department will measure Construction Seeding and Mulching by the number of square yards (square meters).

The Department will measure Slope Drains by the number of feet (meters).

The Department will measure Sediment Basins and Dams by the number of cubic yards (cubic meters) of excavation and embankment.

The Department will measure Perimeter Filter Fabric Fence, Bale Filter Dike and Construction Fence by the number of feet (meters).

The Department will measure Filter Fabric Ditch Check by the number of feet (meters).

The Department will measure Inlet Protection by the number of feet (meters).

The Department will measure Dikes by the number of cubic yards (cubic meters) of excavation and embankment.

The Department will measure Construction Ditch Protection and Construction Slope Protection by the number of square yards (square meters).

The Department will measure Rock Channel Protection, Type C or D (with or without) filter by the number of cubic yards (cubic meters).

The Department will measure Sediment Removal by the cubic yards (cubic meters).

**207.07 Basis of Payment.** The Department will not pay if temporary erosion and sediment control items are required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of the work as scheduled; install such temporary work at no expense to the Department.

The Department will not pay for stream crossing work specified in 207.03.B.8.b.

If erosion control items in the Contract are properly placed according to the Contract Documents, the Department will pay to maintain or replace erosion control items at the unit bid prices or according to 109.05.

The Department will pay for sediment removed from dams, basins, inlet protection, ditch checks, rock checks, perimeter filter fabric fence, bale filter dikes, and all other types of filter fabrics, straw or hay bales, or any other temporary sediment control items under 207 Sediment Removal.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
207	Square Yard (Square Meter)	Construction Seeding and Mulching
207	Foot (Meter)	Slope Drains
207	Cubic Yard (Cubic Meter)	Sediment Basins and Dams
207	Foot (Meter)	Perimeter Filter Fabric Fence
207	Foot (Meter)	Bale Filter Dike
207	Foot (Meter)	Filter Fabric Ditch Check
207	Foot (Meter)	Inlet Protection
207	Cubic Yard (Cubic Meter)	Dikes
207	Square Yard (Square Meter)	Construction Ditch Protection
207	Square Yard (Square Meter)	Construction Slope Protection
207	Cubic Yard (Cubic Meter)	Rock Channel Protection Type C or D with Filter
207	Cubic Yard (Cubic Meter)	Rock Channel Protection Type C or D without Filter

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207	Cubic Yard (Cubic Meter)	Sediment Removal
207	Foot (Meter)	Construction Fence

**ITEM 208 ROCK BLASTING**

- 208.01 Description**
- 208.02 Regulations on the Use of Explosives**
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**208.01 Description.** This work consists of using production and controlled blasting techniques to fracture rock or shale and to construct stable final rock cut faces.

Controlled blasting refers to the controlled use of explosives and blasting accessories in carefully spaced and aligned drill holes to produce a free surface or shear plane in the rock along the specified excavation backslopes. Controlled blasting techniques include presplitting, cushion (trim) blasting, and sliver cut blasting.

If the designed cut slope is steeper than 1:1 and deeper than 5 feet (1.5 m), use controlled blasting techniques, even if the main excavation is ripped or excavated. In rare instances, the Department will specify presplitting for 1 to 1 slopes. For all slopes that do not require controlled blasting techniques, rake, excavate, hoe ram, or mechanically shape these slopes to obtain a neat and smooth appearance.

Production blasting refers to the rock fragmentation blasts resulting from more widely spaced production holes drilled throughout the main excavation area adjacent to the controlled blast line. Detonate production holes in a controlled delay sequence.

**208.02 Regulations on the Use of Explosives.** Perform all blasting operations according to all applicable Federal, State, and local laws and regulations, and the provisions of 107.09. These regulated blasting operations include but are not limited to the following:

- A. Storage and handling of explosives, blasting agents, and detonators.
- B. Use of explosives in character and amount as allowed.
- C. Storage plan, including the type of magazine or explosive storage facility to be used on the job site.
- D. Record keeping, placarding, safe distances, and all other requirements concerning storage.
- E. Obtaining and displaying magazine permits.

**208.03 Product Specifications.** Be aware that delay elements in blasting caps may deteriorate with age. Aged explosives are known to deliver much less than the rated energy.

If evaporation occurs or if improperly mixed, bulk explosives (such as ammonium nitrate and fuel oil) may not contain the proper amount of diesel oil. Low diesel oil drastically reduces the energy content of the explosive and commonly produces reddish brown or yellow fumes upon detonation even in dry blast holes.

Use products conforming to manufacturers' specifications. Ship the manufacturer recommended expiration dates with the products delivered to the project. Do not use any blasting product that is either excessively old or in a deteriorated condition. Cease all work until the product's age or quality is determined.

**208.04 Stabilization.** Remove or stabilize rock along the cut face that is loose, hanging, or creates a potentially dangerous situation during or upon the completion of the excavation in each lift. Do not drill the next lift until this work is performed.

**208.05 Blasting Plan Submittal.** Submit three copies of the Blasting Plan to the Engineer and one copy of the Blasting Plan to the Office of Construction Administration for review at least 2 weeks before beginning drilling and blasting operations, or at any time the drilling and blasting methods change. If the drilling and blasting methods change, submit four copies of the changed sections one week prior to the work.

The Blasting Plan shall include, at a minimum, the following:

- A. General details of the drilling and blasting patterns and controls proposed to use for both the controlled and production blasting.
- B. Station limits of proposed shots. Critical distances to structures. Place the pre-blast survey limits detailed in 208.14 on the Right-of-Way or plan view sheets.
- C. One plan and section view per main excavation cut of the proposed typical range of drill patterns including a range of free face, burden, blast hole spacing, blast hole diameters, blast hole angles, lift heights, and subdrill depths.

## 208.06

D. A typical loading diagram showing the type and amount of explosives, primers, and initiators and location and depth of stemming.

E. Typical range of initiator sequence of blast holes including delay times and delay system.

F. Manufacturers' data sheets for all explosives, primers, and initiators to be employed.

G. Use the blaster's plan form or the blasting plan forms in FHWA Publication FHWA-HI-92-001 *Rock Blasting and Overbreak Control*. Adapt these forms to meet the project requirements.

In a subsequent submittal, submit one Detailed Plan for all test sections. (Submit or fax at least 24 hours before the shot.) Detail the specific proposed amounts of materials and work described in 208.05.A through 208.05.G above on this Detailed Plan.

The Blasting Plan submittal is for quality control, informational, and record keeping purposes. The review of the Blasting Plan does not relieve the Contractor of the responsibility for using existing drilling and blasting technology and for obtaining the required results.

If specified in the Contract, use an approved blasting consultant, conforming to 208.13, to assist with the blast design and to ensure that the Blasting Plan is carried out on the project.

**208.06 Production Holes.** Perform all production blasting, including blasting carried out in conjunction with the blasting test section requirements of 208.07, according to the following requirements:

A. Drill the production blast holes on the patterns and to the depths submitted in the Blasting Plan and Detailed Plan, as specified in 208.05, but not exceeding a depth of 60 feet (18 m). Drill the production blast holes within two blast hole diameters of the staked collar location. If the blaster does not drill the production holes then the blaster shall inspect the holes and review the drilling logs prior to loading the holes.

B. Deepen or clean-out blast holes if they are plugged or unable to be fully loaded. Check and measure blast holes before any explosives are loaded into any of the holes to eliminate any safety hazard resulting from drilling near loaded holes.

C. Maintain a burden distance that is equal to or less than the bench height in order to control the blasting effects.

D. Drill the row of production blast holes immediately adjacent to the controlled blast line on a plane approximately parallel to the controlled blast line. Drill the production blast holes no closer than 6 feet (2 m) to the controlled blast line. Drill the bottom of the production holes no lower than the bottom of the controlled blast holes except by the amount of subdrilling used in the production holes. Do not exceed 6 3/4 inches (170 mm) in diameter for the production blast holes. Delay the detonation sequence of the production holes toward a free face.

E. Maintain a stemming depth of at least 0.7 times the burden distance. If water is present or when blasting within 200 feet (61 m) of a structure, use crushed No. 8 coarse aggregate for holes less than 4 inches (100 mm) in diameter and crushed No. 57 coarse aggregate for holes 4 inches (100 mm) in diameter and larger for the stemming material. Use the coarse aggregate gradations of Nos. 8 and 57 gradations on Table 703.01-1. If gravel is used, use crushed material with a minimum of two mechanically fractured faces on 60 percent of the material. In other locations, the Contractor may use drill cuttings for stemming, if it does not compromise the shot integrity.

F. Take all necessary precautions in the production blasting to minimize blast damage to the rock backslope.

G. Drill a line of buffer holes on a parallel plane adjacent to the presplit holes if presplit results are not satisfactory and production holes are damaging the presplit line. Drill the buffer hole  $3 \pm 1$  inch ( $75 \pm 25$  mm) in diameter. Drill the line of buffer holes approximately 3 feet (1 m) from the presplit line, and space 3 to 5 feet (1 to 1.5 m) center-to-center. Do not load the buffer holes with more than 50 percent of the full explosive load that could be placed in a 3-inch (75 mm) production hole. Delay the detonation sequence toward a free face.

**208.07 Blasting Test Sections.** Before commencing full-scale blasting operations, demonstrate the adequacy of the proposed Blasting Plan. Drill, blast, and excavate short test sections to determine which combination of methods, hole spacing, and charge works best. Use a test section with lengths up to 150 feet (45 m) for presplitting and 120 feet (36 m) for production blasting when field conditions warrant.

Do not exceed a production hole depth of 30 feet (9 m) for the first test section.

Begin the controlled blasting tests for presplitting with the controlled blast holes spaced 36 inches (900 mm) apart, then adjust, if needed, until the spacing for full-scale presplit blasting operations is approved. A new test section is required to increase the spacing for the presplitting to a maximum of 48 inches (1200 mm).

Perform two test sections per project. Use explosive depths greater than 20 feet (6.7 m) for these test sections. Use one test section for controlled blasting and one test section for production blasting.

Apply the requirements specified for controlled and production blasting operations to the test section blasting.

For controlled blasting and for production blasts within 10 feet (3 m) of the finished slope, do not drill ahead of the test shot area until the test section has been excavated and the results evaluated. If the test shots are unsatisfactory, revise methods as necessary to achieve the required results. Unsatisfactory test shot results include an excessive amount of fragmentation beyond the indicated lines and grade, excessive flyrock, or violation of other requirements within Item 208.

If the drilling and blasting methods do not produce the desired result of a uniform slope and shear face, within the tolerances specified, drill, blast, and excavate short sections, not exceeding 150 feet (45 m) in length for a presplit line

## 208.08

or 120 feet (36 m) for a production hole line, until a technique produces the desired results.

The blasting consultant shall witness the test sections drilling and loading operations and be present when all test sections are shot. The time spent witnessing these operations is considered part of the time required to observe the loading, drilling, and blasting operations, as specified in 208.13.

### **208.08 Safety Procedures.**

**A. Warnings and Signals.** Establish a method of warning all employees on the job site of an impending blast.

Define the limits of the blasting area where there is a flyrock danger. Control the access to the blasting area to prevent the presents of livestock or unauthorized persons at least ten minutes before each blast.

Notify all employees in the area that a blast shall be fired with a 1-minute signal. After the blast is over, sound an “all clear” signal so all employees in the area understand that all blasting operations are finished.

One minute before the blast, sound three long signals, lasting 5 seconds, on an air horn or siren. For the all “clear” signal, sound one long signal, lasting at least 5 seconds, to indicate that all blasting has ceased.

Fill out the Department’s Blast Site Security Plan Form (CA-EW-11).

**B. Lightning Protection.** Furnish, maintain, and operate lightning detection equipment during the entire period of blasting operations and during the periods that explosives are used at the site. Use equipment similar or equal to the Thomas Instruments SD250 Storm Alert as manufactured by DL Thomas Equipment, Keene, New Hampshire. Install the equipment when approved. If the lightning detection device indicates a blasting hazard potential, evacuate personnel from all areas where explosives are present. If a lightning detector indicates a blasting hazard, perform the following:

1. Clear the blasting area of all personnel.
2. Notify the Engineer of the potential hazards and precautions to be taken.
3. Terminate the loading of holes and return the unused explosives to the day storage area.
4. If blast holes are loaded and would pose a hazard to traffic if detonated, close the roads until the lightning hazard has passed.
5. When the hazard dissipates, inform the Engineer that production blasting can continue.

**C. Check for Misfires.** Observe the entire blast area for a minimum of 5 minutes following a blast to guard against rock fall before commencing work in the cut. The 5-minute delay between blasting and not allowing anyone but the blaster to enter the area is needed to make sure that no misfires have occurred.

During the 5-minute delay, the blaster is responsible for going into the shot area and checking all the holes to make sure that they have detonated. If any holes have not fired, the blaster shall handle these misfires before others enter the work area.

Halt the blasting operations if the methods being employed result in the required slopes not being in a stable condition or the safety and convenience of the traveling public is jeopardized.

**D. Misfire Handling Procedures.** If a visual inspection indicates that complete detonation of all charges did not take place, proceed as follows:

1. If the system was energized and no charges fired for electric systems, test the lead wire continuity before inspection of the remainder of the blast. For nonelectric systems, check the lead in or tube to make sure that detonation has entered the blast area.

2. If an inspection of the electrical trunkline or lead in tubing-line indicates that there is a break in the line or if the tubing did not fire, repair the system and refire the blast. If the inspection indicates that the trunkline has fired, and misfired charges remain, the blaster shall do the following:

a. Exclude all employees except those necessary to rectify the problem.

b. Close traffic, if a premature explosion could be a hazard to traffic on nearby roads.

c. Correct the misfire in a safe manner. If the misfire poses a problem that the blaster cannot safely correct, the Contractor shall call a consultant or an explosive company representative skilled in the art of correcting misfires to rectify the problem.

**208.09 Presplitting.** Perform all presplitting, including that carried out in conjunction with the blasting test section requirements of 208.07, according to the following requirements:

A. Completely remove all overburden soil and loose or decomposed rock along the top of the excavation for a distance of at least 30 feet (9 m) beyond the end of the production hole drilling limits, or to the end of the cut, before drilling the presplitting holes.

B. Remove potentially dangerous boulders or other material located beyond the excavation limits.

C. Drill the presplit holes  $3 \pm 1$  inch ( $75 \pm 25$  mm) in diameter.

D. Control the drilling operations by using proper equipment and technique to ensure that no hole deviates from the plane of the planned slope by more than 12 inches (300 mm) either parallel or normal to the slope.

E. Extend presplit holes a minimum of 30 feet (9 m) beyond the limits of the production holes to be detonated, or to the end of the cut as applicable.

F. Drill the presplit holes for any individual lift to a vertical depth of less than or equal to 30 feet (9 m). Demonstrate that the blast can stay within the above

## 208.09

tolerances and produce a uniform slope. If more than 5 percent of the presplit holes are misaligned in any one lift, reduce the depth of the lifts until the 12-inch (300 mm) alignment tolerance is met.

G. If a cut height requires more than one lift or if there is a slope change (for example, when changing from a 1:1 slope to a 0.75:1 slope), use a maximum 2-foot (0.6 m) offset between lifts for drill equipment clearances. Begin the presplit blast hole drilling at a point that allows for the necessary offsets and adjust to compensate for any drift that may occur in the upper lifts. Move the controlled blast line back if required to accommodate for these conditions.

H. The Contractor may drill 2 feet (0.6 m) below ditch bottom to remove the toe berm.

I. Before placing charges, determine if the hole is free of obstructions for its entire depth. Exercise all necessary precautions so that the placing of the charges will not cause caving of material from the walls of the holes.

J. Drill hole conditions may vary from dry to filled with water. Use whatever types of explosives and/or blasting accessories necessary to accomplish the specified results.

K. Use a maximum diameter of explosives that is not greater than one-half the diameter of the presplit hole.

L. Do not use bulk ammonium nitrate and fuel oil (ANFO) in the presplit holes.

M. Use only standard explosives manufactured especially for presplitting in the presplit holes.

N. If using a continuous column cartridge type of explosives with detonating cord, assemble and affix the detonating cord according to the explosive manufacturer's instructions. Furnish a copy of the instructions to the Engineer.

O. The Contractor may make the bottom charge of a presplit hole larger than the line charges but not large enough to cause overbreak. Place the top charge of the presplitting far enough below the collar, and reduce the charge sufficiently, to avoid overbreaking and heaving.

P. Stem the upper portion of all presplit holes, from the top most charge to the hole collar. Use stemming material conforming to the stemming specified for the production holes in 208.06.

Q. As long as equally satisfactory presplit slopes are obtained, either presplit the slope face before drilling for production blasting or presplit the slope face and production blast at the same time, provided the presplitting drill holes are fired first. If required to reduce ground vibrations or noise, delay the presplit holes, except that the hole-to-hole delay must be less than 25 milliseconds.

R. Do not deviate the presplit slope face more than 1 foot (0.3 m) from a plane passing through adjacent drill holes, except where the character of the rock is such that irregularities are unavoidable. Measure the 1-foot (0.3 m) tolerance perpendicular to the plane of the slope. Do not encroach on the roadbed with any portion of the slope.

S. Use the same diameter and drilled in the same plane and to the same tolerance as the presplit holes when using unloaded and unstemmed guide holes between presplit holes.

T. Detonate the presplit line before detonating any production holes, except when the closest horizontal distance between the production line and presplit line is greater than 50 feet (16 m).

**208.10 Cushion (Trim) Blasting.** If the horizontal distance from the cut face to the existing rock face is less than 15 feet (4.5 m), the Contractor may use cushion blasting instead of presplitting. Perform cushion blasting according to 208.09, except as follows:

A. Detonate along the cut face after the detonation of all production holes.

B. Between the trim line and the nearest production row, use a difference in delay time of 25 to 75 milliseconds.

**208.11 Sliver Cuts.** For sliver cuts, pioneering the top of cuts and preparing a working platform to begin the controlled blasting and drilling operations may require unusual working methods and use of equipment. Use angle drilled holes or fan drilled holes during the initial pioneering operations to obtain the desired rock face. Apply the hole diameter requirements for controlled blasting for pioneering work. Do not exceed a hole spacing of 36 inches (900 mm).

**208.12 Blaster.** Use an experienced blaster in charge of all blasting operations. Use a blaster with at least 5 years of proven experience in heavy construction or highway rock blasting and with a sufficient amount of proven experience of the type of highway rock blasting required by the Contract.

Before or at the preconstruction conference, submit a resume of the credentials of the proposed blaster. Include in the resume a list of at least five heavy construction or highway rock blasting projects on which the blaster was responsibly in charge of the rock blasting. List a description of the projects, with details of the blasting operations. List the names and telephone numbers of project owners with sufficient knowledge of the projects to verify the submitted information. Obtain approval of the blaster before beginning any drilling and blasting work. Allow 30 days for the review of this documentation. The blaster shall perform the following:

A. Control the ground vibrations by the use of properly designed delay sequences and by using allowable charge weights per delay.

B. Base the allowable charge weights per delay on vibration levels that will not cause damage.

C. Establish the allowable charge weights per delay by carrying out trial blasts and measuring the vibration levels.

D. Independently measure the vibrations and airblast at the closest structure using the criteria and limits set in 208.15 and 208.16. Ensure that only trained and certified personnel set up the seismographs.

## 208.13

E. Use appropriate blast hole patterns, detonation systems, and stemming to prevent venting of blasts and to minimize airblast and noise levels produced by the blasting operations.

F. Carry out the trial blasts according to the blasting test section requirements of 208.07.

G. Report the vibrations (velocity and frequency) and airblasts on both seismographs before the next blast. This report shall denote whether or not these numbers exceeded the allowable set by the vibration specialist.

H. Modify 208.12.A through 208.12.F above as required to limit ground vibrations and airblast to the levels established by the vibration specialist, and the airblast and noise control specialist.

I. Coordinate and review the blast hole layout and drilling operations.

The blaster, blasting contractor, or the contractor shall obtain insurance as specified in 107.12. Present a certificate of insurance 10 days before the blasting operations begin.

**208.13 Blasting Consultant.** If specified in the Contract, retain an experienced and recognized blasting consultant to assist in the blast design. The blasting consultant shall assist in the design of both the controlled and production blasting.

Retain a blasting consultant with at least 5 years of proven experience in heavy construction or highway rock blasting design and with a sufficient amount of proven experience of the type of highway rock blasting design required by the Contract. The Contractor shall not use a blasting consultant that is an employee of the Contractor, explosives manufacturer, or explosives distributor.

Before or at the preconstruction conference, submit a resume of the credentials of the proposed blasting consultant. Include in the resume a list of at least five heavy construction or highway rock blasting projects on which the blasting consultant was responsibly in charge of the rock blasting design. List a description of the projects, with details of the blast plans and modifications made during the project. List the names and telephone numbers of project owners with sufficient knowledge of the projects to verify the submitted information. Obtain approval of the blasting consultant before beginning any drilling and blasting work. Allow 30 days for the review of this documentation.

The blasting consultant shall observe the loading, drilling, or blasting operations for at least 8 hours per week if these operations are in progress for 40 or more hours per week. The blasting consultant shall witness the drilling, loading and blasting of the first shot in each major cut. At a minimum, the blasting consultant shall witness the drilling, loading and blasting of every 20<sup>th</sup> shot on the project. The blasting consultant shall write a written report to the Engineer at least once a month detailing the blasting operations. The time spent writing this report is not considered part of the time required to observe the loading, drilling, and blasting operations. The Contractor shall coordinate the blasting consultant's hours with the Engineer.

**208.14 Pre-Blast Condition Survey.** If specified in the Contract, conduct a pre-blast survey of any buildings, structures, or utilities within 1500 feet (460 m) or to the nearest structure up to 1/2-mile (0.8 km) radius of the blasting operations. Use a greater radius if the structures are potentially at risk from blasting damage. The Contractor shall use a survey method acceptable to its insurance company. The Contractor is responsible for any damage resulting from blasting.

If owners or occupants fail to allow access to the property for the pre-blast survey, send a certified letter to the owner or occupant. Make the notification effort and the certified letter part of the pre-blast survey records.

Submit a copy of the pre-blast survey records to the Engineer before beginning the blasting operations at the critical blasting locations.

Notify occupants of local buildings before the commencement of blasting.

**208.15 Vibration Control and Monitoring.** If specified in the Contract, use vibration control and monitoring if blasting near buildings, structures, or utilities that may be subject to damage from blast induced ground vibrations. The vibration specialist interprets the seismograph records to ensure that the seismograph data is effective in the control of the blasting operations with respect to the existing structures.

Retain an experienced vibration specialist to establish the safe vibration limits. Use a vibration specialist with at least 5 years of proven experience in monitoring vibrations on heavy construction or highway rock blasting projects and with a sufficient amount of proven experience of the type of highway rock blasting vibration monitoring required by the Contract.

Use a vibration specialist that is an expert in the interpretation of the vibration data. The Contractor shall not use a vibration specialist that is an employee of the Contractor, explosives manufacturer, or explosives distributor.

Before or at the preconstruction conference, submit a resume of the credentials of the proposed vibration specialist. Include in the resume a list of at least five heavy construction or highway rock blasting projects on which the vibration specialist was responsibly in charge of monitoring the rock blasting vibrations. List a description of the projects, with details of the vibration interpretations made on the project. List the names and telephone numbers of project owners with sufficient knowledge of the projects to verify the submitted information. Obtain approval of the vibration specialist before beginning any drilling and blasting work. Allow 30 days for the review of this documentation.

The vibration specialist shall perform the following:

- A. Monitor each blast with an approved seismograph located between the blast area and the closest structure subject to blast damage.
- B. Use a seismograph capable of recording particle velocity for three mutually perpendicular components of vibration in the range generally found with controlled blasting.
- C. Furnish the data recorded for each shot before the next blast and include the following:

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1. Identification of instrument used.
2. Name of approved observer and interpreter.
3. Distance and direction of recording station from blast area.
4. Type of ground at recording station and material on which the instrument is sitting.

D. Ensure that the peak particle velocity of each component of the safe limits of the nearest structure subject to vibration damage is not exceeded.

E. The vibration specialist may elect to summarize and report this information monthly, when the blaster measures the vibration and airblast with its own seismograph and reports the measurements on the vibration specialist's seismographs.

F. Establish what vibration limits are being used and explain why they are being used to the Engineer before blasting begins near structures denoted in the pre-blast survey in 208.14.

G. Stop all operations if the vibration limits are exceeded until the vibration specialist reports to the Engineer that no damage has occurred or will occur and that corrective action has been taken to lower the vibration.

**208.16 Airblast and Noise Control.** If specified in the Contract, install an airblast monitoring system between the main blasting area and the nearest structure subject to blast damage or annoyance.

Retain an experienced airblast and noise control specialist. Use an airblast and noise control specialist with at least 5 years of proven experience in airblast and noise control on heavy construction highway rock blasting projects and with a sufficient amount of proven experience of the type of rock blasting airblast and noise control monitoring required by the Contract. Use an airblast and noise control specialist that is an expert in airblast and noise control. The Contractor shall not use an airblast and noise control specialist that is an employee of the Contractor, explosives manufacturer, or explosives distributor.

Before or at the preconstruction conference, submit a resume of the credentials of the proposed airblast and noise control specialist. Include in the resume a list of at least five heavy construction or highway rock blasting projects on which the airblast and noise control specialist was responsibly in charge of the airblast and noise control of the rock blasting operations. List a description of the projects, with details of the airblast and noise control monitoring made on the project. List the names and telephone numbers of project owners with sufficient knowledge of the projects to verify the submitted information. Obtain approval of the airblast and noise control specialist before beginning any drilling and blasting work. Allow 30 days for the review of this documentation.

The airblast and noise control specialist shall perform the following:

A. Use equipment of the type specifically manufactured for the purpose to make the airblast measurements. Hold peak overpressure below 134 dB at the nearest structure or other designated location. Lower the overpressure limit if it proves too high based on damage or complaints.

- B. The airblast and noise control specialist may establish the peak overpressure limits higher than 134 dB. Submit information explaining why higher limits are needed and are safe to the Engineer before blasting begins near structures denoted in the pre-blast survey in 208.14.
- C. Furnish a permanent signed and dated record of the peak overpressure measurements to the Engineer immediately after each shot or use the same reporting procedures and time frames denoted for vibration in 208.15.
- D. Stop all operations if the overpressure limits are exceeded until the airblast and noise control specialist reports to the Engineer that no damage has occurred or will occur and that corrective action has been taken to lower the airblast.

**208.17 Hydrologist.** If specified in the Contract, use a qualified hydrologist to monitor the before, during, and after blasting or major excavation quantity and quality of the water supplies within 1500 feet (460 m) of the blasting or major excavation areas. The water supplies shall include, but not be limited to, all wells, springs, or other water supplies for human consumption.

Retain an experienced hydrologist. The Contractor shall not use a hydrologist that is an employee of the Contractor, explosives manufacturer, or explosives distributor.

Before or at the preconstruction conference, submit a resume of the credentials of the proposed hydrologist. Include in the resume a list of at least five heavy construction or highway projects on which the hydrologist was responsibly in charge of monitoring water quality and quantities. List a description of the projects, with details of the water monitoring or modeling made on the projects. List the names and telephone numbers of project owners with sufficient knowledge of the projects to verify the submitted information. Obtain approval of the hydrologist before beginning any major excavation, drilling, or blasting work. Allow 30 days for the review of this documentation.

The hydrologist shall perform, at minimum, all of the following:

- A. Review the available public records, including Ohio DNR well logs, to obtain background information and to identify the locations and geology of water supplies within 1500 feet (460 m) of the blasting areas or major excavations.
- B. Examine private wells, and public and industrial water supplies (as allowed by property owners or occupants), and measure water levels and well depths with a water level meter. Clean the water level meter before and between each use.
- C. Collect water quality data (pH, e-coli, specific conductivity, turbidity, sulfur, and iron) from private wells, and public and industrial water supplies to determine the major excavation work or blasting affects on the water supplies by using field instruments.
- D. Measure the water quality and water level for a minimum of two times per week for 2 weeks before, during, and 2 weeks after major excavation or blasting within 1500 feet (460 m) of the water supplies.
- E. Perform an associated field survey of the locations and elevations of wells and springs.

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F. Evaluate the need for piezometers to monitor the ground water conditions. Place and monitor the piezometers as necessary.

G. Provide a monitoring plan report detailing the proposed activities, frequencies, testing, and any recommendations for monitoring the water supplies as detailed in 208.17.A through 208.17.F above. Submit this report at least 10 days before beginning the scheduled blasting or major excavation.

H. Provide a monthly report of the conclusions and results of the monitoring plan.

I. Provide a final report on the final condition or affect of the blasting or major excavation on the water supplies. Submit this report within 30 days after the blasting or major excavation is completed on the project.

J. Meet with the Engineer in order to coordinate this work and provide input, update the project schedule, report progress (including completed work and updated schedule), and make recommendations. Allow for ten meetings.

The Contractor is not responsible for damages to the above denoted water supplies if the blasting or excavation is done according to this specification. The Contractor is responsible for damage caused by negligence, vibration or noise above the allowable limits, flyrock, or back break.

**208.18 Flyrock Control.** Before firing any blast in areas where flying rock may result in personal injury or unacceptable damage to property or the work, cover the rock with blasting mats, soil, or other equally serviceable material to prevent flyrock.

If flyrock leaves the construction site or lands on a traveled road, the Contractor shall cease all blasting operations until the blasting consultant specified in 208.13 reviews the site and determines the cause and solution to the flyrock problem. Before blasting proceeds, submit a written report addressing the following:

- A. Why the flyrock left the construction site or landed on a traveled road.
- B. What corrective measures were taken to prevent this from reoccurring?

**208.19 Public Meetings.** If a blasting consultant, vibration specialist, airblast and noise control specialist, or hydrologist are specified in the Contract, make the consultant, specialists, Contractor's superintendent and blaster available for one day to prepare for and participate in a public meeting organized by the Engineer and conducted by the Contractor to better inform the public about anticipated drilling and blasting operations. The consultant and specialists shall be prepared to answer any questions dealing with the magnitude of seismic motion, vibrations, airblast overpressure, flyrock, and water problems that may affect the public.

### **208.20 Record Keeping.**

**A. Daily Explosive Material Consumption.** Keep a daily record of the transactions at each storage magazine. Update inventory records at the close of every business day. Show on the records the class and quantities received and issued and total remaining on hand at the end of each day. Check the remaining explosive inventory each day and report any discrepancies that would indicate a theft or loss of explosive material.

**B. Report of Loss.** If a loss or theft of explosives occur, report all circumstances and details of the loss or theft immediately to the nearest Bureau of Alcohol, Tobacco and Firearms, as well as to the local law enforcement authorities and the Engineer.

**C. Daily Drilling and Blasting Logs.** On a weekly basis, provide a daily log of the drilling and blasting operations. Update the log at the close of each business day.

Fill out the Department or blaster's drilling form to document the following: burden, spacing, bench height, hole depth and diameter, and subdrill depth. Document additional information about the drilling such as voids, mud seams, air pressure loss and lack of cuttings. The driller shall give this form to the blaster and the Department.

Document on the blasting log the number of blasts, times and dates of blasts, the blasting locations and patterns, and all of the following information:

1. Station limits of the shot.
2. Plan and section views of drill pattern including free face, burden, blast hole spacing, blast hole diameters, blast hole angles, lift height, and subdrill depth.
3. Loading diagram showing type and amount of explosive, primers, and initiators and location and depth of stemming.
4. Initiators sequence of blast holes including delay times and delay system in each blast hole.
5. Trade names and sizes of all explosives, primers, and initiators to be employed.
6. Signature of the blaster in charge.
7. Use the blaster's blasting form or the Blasting Report form in FHWA Publication FHWA-HI-92-001 *Rock Blasting and Overbreak Control*. Adapt these forms to meet the project requirements.

The drilling and blasting logs are for quality control, informational, and record keeping purposes. Review of the blast log by the Engineer does not relieve the Contractor of responsibility for the accuracy and adequacy of the drilling and blasting log.

**D. Video Recording of Blasts.** Record video of each blast. Index the recordings in a manner that permits easy and correct identification of each blast. Submit copies of the blast recordings on a weekly basis. If submitting the video recordings as electronic data files, furnish them in a video format acceptable to the Engineer and capable of being viewed on the Department's computers.

**208.21 Method of Measurement.** The Department will measure Presplitting by the number of square yards (square meters) along the slope face of the cut. The horizontal measurement will begin at the first hole and end at the last hole of the cut, and the vertical slope measurement will be along the sloped drill hole.

**208.22 Basis of Payment.** The Department will not make separate payment for the production blasting operations. Payment for the production blasting is

**208.22**

incidental to the other work items in the Contract requiring blasting. The Department will pay for additional excavation volume resulting from the 2-foot (0.6 m) offsets at the Contract unit price for Item 203 Excavation. The Department will pay for the removal of this material beyond the excavation limits under 109.05.

The Department will pay lump sum for all work for the Pre-Blast Condition Survey, Blasting Consultant, Airblast and Noise Control, Vibration Control and Monitoring, and Hydrologist. The same person or consultant may perform the pre-blast survey, vibration control and monitoring, airblast and noise control, and the work required of the hydrologists. The Department may make intermediate payments based on the percentage of the work completed for Pre-Blast Condition Survey, Blasting Consultant, Airblast and Noise Control, Vibration Control and Monitoring, or Hydrologist.

Payment for guide holes is incidental to Presplitting. Payment for all of controlled blasting is included in the payment for Presplitting.

The Department will pay for stabilization under 109.05 if caused by geology. The Department will not pay for stabilization if caused by the Contractor's blasting operations.

The Department will pay for the placement and monitoring of piezometers according to 109.05.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
208	Square Yard (Square Meter)	Presplitting
208	Lump Sum	Pre-Blast Condition Survey
208	Lump Sum	Blasting Consultant
208	Lump Sum	Airblast and Noise Control
208	Lump Sum	Vibration Control and Monitoring
208	Lump Sum	Hydrologist

**ITEM 209 LINEAR GRADING**

- 209.01 Description**
- 209.02 Materials**
- 209.03 Construction Requirements**
- 209.04 Ditch Cleanout**
- 209.05 Reshaping Under Guardrail**
- 209.06 Preparing Subgrade for Shoulder Paving**
- 209.07 Grading Tolerances**
- 209.08 Method of Measurement**
- 209.09 Basis of Payment**

**209.01 Description.** This work consists of performing linear grading within the specified alignment detailed in the Contract Documents and within the grading tolerances.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

**209.02 Materials.** Furnish suitable materials as defined in 203.02.R.

**209.03 Construction Requirements.** Construct embankment and subgrade work according to Items 203 and 204.

When off-project-limit embankment material is needed for the work, an estimated quantity for Item 209 Borrow will be specified in the Contract Documents.

**209.04 Ditch Cleanout.** Reestablish the cross-section of the existing ditch. Use the required embankment material to fill the eroded conditions. The compaction requirements specified in Item 203 do not apply.

**209.05 Reshaping Under Guardrail.** Reshape graded shoulders at locations where the existing guardrail is removed or where the new guardrail is to be erected to ensure a smooth drainable surface free of all irregularities.

**209.06 Preparing Subgrade for Shoulder Paving.** Prepare the subgrade for shoulder paving by excavating the existing shoulder material to the depth shown in the plan. Trim unsound or broken edges of asphalt concrete or concrete pavement to a line established by the Engineer. Remove any unstable material and shape and compact the subgrade.

Compact the subgrade according to 204.03. Backfill areas graded in excess of the depth shown on the plans with Item 617 compacted aggregate at no expense to the Department.

**209.07 Grading Tolerances.** Do not encroach on stream channels, impact wetlands, or extend beyond construction limits, Right-of-Way or easement limits. Do not make alignment or profile grade adjustments that adversely affect drainage. Construct the work to the tolerances in 203.08.

**209.08 Method of Measurement.** The Department will measure Linear Grading, Linear Grading Method \_\_\_, Reshaping Under Guardrail, and Preparing Subgrade for Shoulder Paving by the number of either stations or miles (meters or kilometers) completed and accepted, along each side of the pavement. The Department will not make deductions for intersections and other gaps.

The Department will measure Ditch Cleanout by the number of feet (meters) measured along the centerline of the ditch.

The Department will measure Borrow according to 203.09.

**209.09 Basis of Payment.** The Department will pay according to 109.05 for changes or extra work that increases the haul distance by more than 1/2 mile (1 km) to the work detailed in the Contract Documents. The Department will pay for

**209.09**

additional quantities that increase the haul distance 1/2 mile (1 km) or less at the unit bid price.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
209	Station or Mile (Meter or Kilometer)	Linear Grading
209	Station or Mile (Meter or Kilometer)	Linear Grading Method ____
209	Feet (Meters)	Ditch Cleanout
209	Station or Mile (Meter or Kilometer)	Reshaping Under Guardrail
209	Station or Mile (Meter or Kilometer)	Preparing Subgrade for Shoulder Paving
209	Cubic Yard or Ton (Cubic Meter or Metric Ton)	Borrow

## 250 PAVEMENT REPAIRS

### ITEM 251 PARTIAL DEPTH PAVEMENT REPAIR

#### 251.01 Description

#### 251.02 Removal of Existing Pavement

#### 251.03 Placement of Asphalt Concrete

#### 251.04 Method of Measurement

#### 251.05 Basis of Payment

**251.01 Description.** This work consists of partial depth removal of existing pavement in areas exhibiting deterioration at the surface, applying tack coat, and placing and compacting asphalt concrete.

**251.02 Removal of Existing Pavement.** The Engineer will designate the location and limits of areas to be repaired. Provide the Engineer with aerosol spray paint to outline those areas for repair. Provide rectangular repair areas with dimensions as required to envelop surface deterioration. Unless otherwise specified, extend repair areas the full width of a traffic lane at transverse joints and along portions of longitudinal joints. Remove pavement to the depth shown on the plans.

Remove the pavement to the specified depth within the designated limits without loosening or otherwise damaging adjacent pavement. Dispose of removed pavement according to 202.

**251.03 Placement of Asphalt Concrete.** Apply 407.02 material to thoroughly coat the exposed surface and to fill cracks and joint openings.

Place and compact approved Item 448 asphalt concrete in one or more lifts as necessary to finish flush with the adjacent pavement surface.

Thoroughly compact the final lift using a Type I pneumatic tire roller that conforms to 401.13. As the rolling progresses, add additional patching material, as necessary, to produce a smooth surface flush with the existing pavement surface.

Continuously compact each lift while the material is in a workable condition throughout the depth of the lift.

Trim the limits of the repair to form a vertical face 1.5 inches (38 mm) deep from the surface before placing the final asphalt concrete layer adjacent to the existing pavement unless the repair is covered with an overlay within 60 days.

If the Contract does not include resurfacing, seal the perimeter surface of the repaired area by applying a nominal 4 inch (100 mm) wide strip of approved 702.04 asphalt material, RS-1, RS-2, CRS-1, or CRS-2, or 702.01 approved PG binder.

**251.04 Method of Measurement.** The Department will measure the quantity of Partial Depth Pavement Repair by the number of square yards (square meters) of pavement repaired in the complete and accepted work, calculated using the dimensions established by the Engineer.

**251.05**

**251.05 Basis of Payment.** Payment is full compensation for furnishing all materials, including aerosol spray paint, tack coat, asphalt concrete, seal coat, and cover aggregate and for all labor, equipment, and incidentals necessary to complete this work.

The Department will pay for accepted quantities at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
251	Square Yard (Square Meter)	Partial Depth Pavement Repair

**ITEM 252 FULL DEPTH RIGID PAVEMENT REMOVAL AND FLEXIBLE REPLACEMENT**

- 252.01 Description**
- 252.02 Removal of Existing Rigid Pavement**
- 252.03 Correction of Subgrade**
- 252.04 Placement of Asphalt Concrete**
- 252.05 Method of Measurement**
- 252.06 Basis of Payment**

**252.01 Description.** This work consists of the full depth removal of existing rigid pavement in areas exhibiting deterioration, correcting the subgrade, placing and compacting asphalt concrete, and restoring the shoulders.

**252.02 Removal of Existing Rigid Pavement.** Conform to 255.03, except the last paragraph does not apply.

**252.03 Correction of Subgrade.** Shape and recompact the subgrade as the Engineer directs. Clean all vertical faces of the existing pavement, and coat them with asphalt material according to 401.14.

**252.04 Placement of Asphalt Concrete.** Construct the pavement replacement by placing and compacting Item 301 or 448, Type 2 material in two or more lifts according to 401.16.

Thoroughly and uniformly compact the first lift and all intermediate lifts using suitable mechanical compaction equipment operated over the entire replacement area.

Thoroughly compact the final lift using a pneumatic tire roller that conforms to 401.13. As the rolling progresses, add additional patching material, as necessary, to produce a smooth surface flush with the existing pavement surface.

Continuously compact each lift while the material is in a workable condition throughout the depth of the lift.

Trim the limits of the repair to form a vertical face 1.5 inches (38 mm) deep from the surface before placing the final asphalt concrete layer adjacent to the existing pavement unless the repair is covered with an overlay within 60 days.

If the Contract does not include resurfacing, seal the perimeter surface of the repaired areas by applying a nominal 4 inch (100 mm) wide strip of approved 702.04 asphalt material, RS-1, RS-2, CRS-1, or CRS-2 or 702.01 approved PG binder.

After completing repairs, restore the existing shoulders to the condition that existed prior to the repair work.

**252.05 Method of Measurement.** The Department will measure the quantity of Full Depth Rigid Pavement Removal and Flexible Replacement by the number of square yards (square meters) of rigid pavement repaired in the complete and accepted work, calculated using the dimensions established by the Engineer.

The Department will measure the quantity of Full Depth Pavement Sawing by the number of feet (meters) of full depth saw cuts in the complete and accepted work. The Department will not measure offset saw cuts. The Department will not measure additional cuts made to facilitate the removal of the pavement

**252.06 Basis of Payment.** Payment is full compensation for furnishing all materials, including aerosol spray paint, removing pavement, correcting the subgrade, placing flexible pavement, sealing, and restoring the shoulders and for all labor, equipment, and incidentals necessary to complete this work.

The Department will not pay for removal, disposal, and replacement of pavement damaged adjacent to the repair area.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
252	Square Yard (Square Meter)	Full Depth Rigid Pavement Removal and Flexible Replacement
252	Foot (Meter)	Full Depth Pavement Sawing

## **ITEM 253 PAVEMENT REPAIR**

- 253.01 Description**
- 253.02 Removal of Existing Pavement**
- 253.03 Placement of Asphalt Concrete**
- 253.04 Method of Measurement**
- 253.05 Basis of Payment**

**253.01 Description.** This work consists of removing existing asphalt concrete, brick, portland cement concrete, or aggregate pavement courses; shaping and compacting the exposed material; and placing new asphalt concrete pavement or aggregate and asphalt concrete pavement courses.

The plans show details about the repairs and replacement material.

## 253.02

**253.02 Removal of Existing Pavement.** The Engineer will designate the location and limits of areas to be repaired. Provide the Engineer with aerosol spray paint to outline those areas for repairs. Repair the full depth of the pavement, unless otherwise shown on the plans.

Cut the existing pavement at the limits specified and as necessary to prevent disturbing or undermining the remaining pavement during removal. Completely remove pavement in the repair area to the specified depth without displacing, undermining, or otherwise damaging the remaining pavement. Dispose of removed pavement according to 202.

**253.03 Placement of Asphalt Concrete.** Shape and compact the exposed underlying material as the Engineer directs. Before placing asphalt concrete, clean all vertical faces of the existing pavement and coat them with asphalt material according to 401.14. Place the replacement material in lifts as the Engineer directs. Thoroughly and uniformly compact each lift using suitable compaction equipment as the Engineer directs. Finish the final lift flush with the existing pavement surface.

Thoroughly compact the final lift using a pneumatic tire roller that conforms to 401.13. As the rolling progresses, add additional patching material, as necessary, to produce a smooth surface flush with the existing pavement surface.

Continuously compact each lift while the material is in a workable condition throughout the depth of the lift.

Trim the limits of the repair to form a vertical face 1.5 inches (38 mm) deep from the surface before placing the final asphalt concrete layer adjacent to the existing pavement unless the repair is covered with an overlay within 60 days.

If the Contract does not include resurfacing, seal the perimeter surface of the repaired areas by applying a nominal 4 inch (100 mm) wide strip of approved 702.04 asphalt material, RS-1, RS-2, CRS-1, or CRS-2 or 702.01 approved PG binder.

After completing repairs, restore the existing shoulders to the condition that existed prior to the repair work.

**253.04 Method of Measurement.** The Engineer will measure the quantity of Pavement Repair by either the number of square yards (square meters) or cubic yards (cubic meters) of pavement repaired in the complete and accepted work, calculated using the dimensions established by the Engineer. The Engineer will not measure removal and replacement pavement beyond the designated limits.

**253.05 Basis of Payment.** Payment is full compensation for furnishing all materials, including aerosol spray paint and replacement and restoration materials; cutting, removing, and disposing of existing pavement; shaping and compacting the exposed underlying material; placing new pavement; and restoring the shoulders and for all labor, equipment, and incidentals necessary to complete this work.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
253	Square Yard (Square Meter)	Pavement Repair
253	Cubic Yard (Cubic Meter)	Pavement Repair

## ITEM 254 PAVEMENT PLANING

### 254.01 Description

### 254.02 Equipment

### 254.03 Planing

### 254.04 Surface Patching

### 254.05 Surface Tolerances

### 254.06 Method of Measurement

### 254.07 Basis of Payment

**254.01 Description.** This work consists of planing the existing asphalt concrete and disposing of the cuttings, and, if specified in the Contract, patching the planed surface.

**254.02 Equipment.** Use self-propelled planing equipment that has sufficient power and stability to consistently and efficiently meet the requirements of 254.05 and the plans. Use equipment with either grinding, sawing, or milling type cutters. Ensure that the cutters are mounted rigidly to the carrier and are adjustable to control the depth of cut and cross-slope. Accomplish longitudinal planing action by using equipment with a suitable carrier wheelbase or with an automatic control system having an external reference. Ensure that cross-slope adjustments or automatic controls are capable of producing either a variable or a constant cross-slope, as required.

For small or confined areas, the Contractor may use suitable supplemental equipment or methods approved by the Engineer.

**254.03 Planing.** Make one or more planing passes, as necessary, over the designated area to the depth specified in the plans. Remove irregularities such as bumps, corrugations, and wheel ruts, when required, to establish a new pavement surface elevation or cross-slope.

Remove cuttings from the surface following each pass. Before opening the completed area to traffic, thoroughly clean the surface of all loose material that would create a hazard or nuisance, or would redeposit into the surface texture. Dispose of cuttings according to 202.

Implement effective measures to control dust, pavement contamination, and the scattering of loose particles during planing and cleaning operations.

If planing damages the adjacent pavement, repair the damaged area to the Engineer's satisfaction. Ensure that the repaired area matches the adjacent pavement in terms of smoothness and mix type.

**254.04**

**254.04 Surface Patching.** Patch areas of the planed surface that the Engineer designates that have spalling or dislodged unsound pavement. Before patching, clean areas of loose material, coat with 407.02 asphalt material, and fill with Item 448, Type 1 material. Level and compact new material flush to the adjacent planed pavement.

**254.05 Surface Tolerances.** Plane the surface free from grooves, ridges, gouges, or other irregularities detrimental to the safe operation of vehicles on the planed surface.

If the Contract specifies planing without resurfacing, plane the surface to a smoothness of 1/8 inch in 10 feet (3 mm in 3 m). If the Contract specifies resurfacing after planing, plane the surface to a smoothness of 1/4 inch in 10 feet (6 mm in 3 m). Match the surfaces at the edges of adjacent passes within 1/8 inch (3 mm). Ensure that the cross-slope of the planed surface is within 3/8 inch in 10 feet (10 mm in 3 m) of the specified cross-slope.

**254.06 Method of Measurement.** The Engineer will measure the quantity of Pavement Planing, Asphalt Concrete by the number of square yards (square meters).

The Engineer will measure the quantity of Patching Planed Surface by the number of square yards (square meters).

**254.07 Basis of Payment.** The Department will not pay for repairs due to damage caused by planing operations. If the depth of the planed surfaces is increased by more than 3/8 inches (10 mm) the Department will compensate for the additional work.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
254	Square Yard (Square Meter)	Pavement Planing, Asphalt Concrete
254	Square Yard (Square Meter)	Patching Planed Surface

**ITEM 255 FULL DEPTH PAVEMENT REMOVAL AND RIGID REPLACEMENT**

**255.01 Description**

**255.02 Materials**

**255.03 Removal of Existing Pavement**

**255.04 Correction of Disturbed Subgrade**

**255.05 Placing Dowels and Tiebars**

**255.06 Placement of Portland Cement Concrete**

**255.07 Wearing Course Replacement**

**255.08 Opening to Traffic**

**255.09 Method of Measurement**

## 255.10 Basis of Payment

**255.01 Description.** This work consists of full depth removal of existing pavement; removing subbase where specified; compacting the subgrade; furnishing and placing dowels, tiebars, and mesh where specified; placing, consolidating, finishing, and curing new portland cement concrete to the level of the existing portland cement concrete pavement; and restoring affected shoulders.

**255.02 Materials.** Furnish materials conforming to:

Concrete, Class C, S, FS, or MS .....	499
Curing materials, Type 2 .....	705.07
Non-shrink non-metallic grout.....	705.20
Reinforcing steel .....	709.00
Preformed elastomeric joint sealer.....	705.11
Tiebar steel, epoxy coated.....	709.00
Dowel bars and basket assemblies.....	705.01 or 709.13
Expansion shield anchors Type A.....	712.01

Use epoxy coated Hook bolt, Wiggle bolt, and Coupling.

Select and furnish grout from the Qualified Product List issued by the Laboratory that firmly anchors the dowel or tiebar within 30 minutes.

**255.03 Removal of Existing Pavement.** The Engineer will locate and mark all areas for repair before the start of diamond sawing. Provide the Engineer with aerosol spray paint to outline those areas for repair.

Saw cut the existing rigid pavement to the full depth at the limits of the area designated by the Engineer using a diamond saw blade. Where there is an existing asphalt concrete overlay on top of the concrete pavement to be removed, the Contractor may make either a full depth saw cut through the asphalt concrete overlay and the concrete pavement, or make an offset saw cut through the asphalt concrete overlay. If making an offset saw cut through the asphalt concrete overlay, remove the overlay as necessary to provide clearance for the full depth saw cut through the concrete pavement. The Contractor may elect to make additional cuts to facilitate the removal of the pavement.

Remove pavement in the repair area by the lift-out method without damaging or undermining the remaining pavement. After the repair area is isolated by full depth saw cuts, drill holes through the deteriorated slab, and install lift pins. Vertically lift the pavement out of the repair area. Remove loose debris left behind after lift-out using hand methods. Dispose of removed pavement according to Item 202.

Do not break the pavement and clean out the material using a backhoe unless the Engineer determines that the lift-out method is not feasible due to deteriorated pavement or existing asphalt concrete repairs., or deteriorated concrete pavement.

If the bottom face of the adjacent concrete pavement is deteriorated for a height greater than one-fourth (1/4) the thickness of the rigid pavement, make additional full depth saw cuts as directed by the Engineer along the full width of the lane or

## 255.04

lanes to remove the deteriorated areas. Repair pavement damaged during the pavement sawing or pavement removal according to Item 255 or Item 256.

**255.04 Correction of Subgrade.** After removing the existing pavement full depth and before installing dowels or tiebars, shape and recompact the subgrade to the satisfaction of the Engineer. Replace any subgrade material removed with the existing concrete pavement removal with concrete as part of the rigid pavement replacement.

**255.05 Placing Dowels and Tiebars.** Drill dowel and tiebar holes using hydraulic or electric drills without spalling or damaging the existing concrete. To drill for dowels, use a device capable of drilling a minimum of three holes at a time. For patches 10 feet (3 m) or greater in length, provide tie bars or wiggle bolts of the size and spaced as shown on the standard construction drawings. Blow clean all drilled holes with oil-free compressed air. Maintain holes dry and frost free before grouting the dowels or tiebars. Pneumatically inject grout into the rear portion of the drilled holes. Use a grout retention disc with a radius slot as shown in the standard drawings to retain the grout within the drilled holes. Inject grout to fill all voids behind the grout retention disc and until grout extrudes through the radius slot. Insert dowels and tiebars through the grout retention disc while the disc is placed flush with the sawed edge of pavement and aligned with the drilled hole. Insertion of the dowels and tiebars shall force the grout out of the radius slot in the grout retention disc. Hold dowel bars in proper alignment until the grout has hardened.

**255.06 Placement of Portland Cement Concrete.** Do not place any portland cement concrete for rigid pavement replacement until the grout around the dowel or tiebar has hardened. Coat dowel bars with bond breaking material conforming to 451.08.B. Place portland cement concrete according to 451.06. Use forms at the shoulder. Cast each patch in one continuous operation. Consolidate the concrete around the perimeter of the patch and within the limits of the patch area using an internal type vibrator. Use approved internal type vibrators capable of visibly affecting the concrete for a distance of 12 inches (0.3 m) from the vibrator head.

Screed repairs less than 12 feet (3.7 m) in length parallel to the centerline. Screed repairs 12 feet (3.7 m) in length and longer perpendicular to the centerline.

While the concrete is still in a plastic state, test the surface for trueness and for being flush with the edges of the adjacent slabs using a 10-foot (3 m) straightedge. Place the straightedge parallel to the pavement centerline with half of the straightedge resting on the existing pavement, and draw the straightedge across the patch to test the patch edges. Check areas within the patch length in a similar manner. Where the straightedge does not remain in contact with the existing pavement while drawing it across the patch, correct all high or low areas exceeding 1/8 inch in 10 feet (3 mm in 3 m). Recheck the concrete surface after making corrections to ensure conformance to the above tolerance. Make additional checks and corrections until patch is within tolerance.

Texture the new concrete surface similar to that of the surrounding pavement.

Apply the liquid membrane-forming compound conforming to 705.07, Type 2 for curing at a minimum rate of 1 gallon (1 L) of material for each 150 square feet (3.7 m<sup>2</sup>).

**255.07 Wearing Course Replacement.** Replace the removed asphalt concrete overlay with Item 301 or 448 Type 2 material as shown on the plans. Compact these mixtures as approved by the Engineer using any of the roller types specified in 401.13. Apply Item 407 tack coat to the replacement surfaces.

Trim the limits of the repair to form a vertical face 1.5 inches (38 mm) deep from the surface before placing the final asphalt concrete layer adjacent to the existing pavement.

Before opening the rigid replacement to traffic, restore the shoulders to the original line and grade. Use either aggregate or asphalt concrete as shown on the plans or as the Engineer directs. Fill the low areas, and compact them flush with the surrounding shoulder.

Seal the perimeter surface of the repaired areas by applying a nominal 4 inch (100 mm) wide strip of approved 702.04 asphalt material, RS-1, RS-2, CRS-1, or CRS-2 or 702.01 approved PG binder.

**255.08 Opening to Traffic.** Do not open the rigid replacement to traffic until the concrete attains a modulus of rupture of 400 pounds per square inch (2.8 MPa). If maintaining traffic in adjacent lanes, schedule work in order to place the concrete in the prepared repair area within 48 hours after removing the existing pavement. If unable to complete placement of the concrete in the exposed repair area by the end of the daily work shift, cover unfilled repair areas 10 feet (3 m) or less in length with a steel plate. Do not leave repair areas unfilled with concrete when work is suspended on weekends or holidays. If unable to complete placement of the concrete in the exposed repair area before suspending work for a weekend or holiday or within the time specified above, fill the excavation with an asphalt concrete mixture or other suitable temporary patch material with a durable surface as the Engineer directs. Maintain the temporary patches while they are in service.

**255.09 Method of Measurement.** The Department will measure the quantity of Full Depth Pavement Removal and Rigid Replacement by the number of square yards (square meters) repaired in the complete and accepted work.

The Department will measure the quantity of Full Depth Pavement Sawing by the number of feet (meters) of perimeter full depth saw cuts in the complete and accepted work. The Department will not measure offset saw cuts. The Department will not measure additional cuts made to facilitate the removal of the pavement.

**255.10 Basis of Payment.** Payment is full compensation for furnishing all materials, including paint; removing pavement by any method; removing subbase for undercut replacement; compacting subbase and subgrade; placing rigid pavement, including concrete necessary to replace removed subbase or subgrade; furnishing and placing dowels, tiebars, and mesh; placing, maintaining, removing, and disposing of temporary patches, and restoring the shoulders.

**256.01**

The Department will not pay for additional concrete sawing and removal depths within 1 inch (25 mm) greater than those shown on the plans.

The Department will not pay for additional work to repair damage caused by pavement sawing or pavement removal.

The Department will include tack coat in the cost of the asphalt concrete. The Department will pay for asphalt concrete according to Item 301 or Item 448.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
255	Square Yard (Square Meter)	Full Depth Pavement Removal and Rigid Replacement, Class ____
255	Foot (Meter)	Full Depth Pavement Sawing

**ITEM 256 BONDED PATCHING OF PORTLAND CEMENT  
CONCRETE PAVEMENT**

**256.01 Description**

**256.02 Materials**

**256.03 Equipment**

**256.04 Removal of Unsound Concrete**

**256.05 Preparation of Patch Area**

**256.06 Bonding Grout Installation**

**256.07 Placing Patching Material**

**256.08 Curing and Loading**

**256.09 Method of Measurement**

**256.10 Basis of Payment**

**256.01 Description.** This work consists of bonded patching of portland cement concrete pavements at spall areas adjacent to cracks or joints or other areas of the pavement as designated by the Engineer. This work involves removing all loose and unsound concrete and asphalt material patches; removing sound concrete as directed; preparing the surface; applying a bonding grout if required; reconstructing the joint or crack; and mixing, placing, finishing, and curing of the patching material called out in the pay item description.

**256.02 Materials.** Furnish materials conforming to:

Portland cement.....	701.05
Fine aggregate .....	703.02
Coarse aggregate, No. 8 size .....	703.02
Curing material.....	705.07
Air-entraining admixture.....	705.10
Quick setting concrete mortar .....	705.21

**256.03 Equipment.** Use a milling machine, concrete saw, jackhammers, or other approved equipment to remove existing surface material. Provide oil and moisture free compressed air for cleaning and abrasive blasting the prepared area. Provide an on-site concrete mixer capable of mixing a minimum of 2-cubic foot (0.06 m<sup>3</sup>) batches of patching material. Provide chipping hammers not heavier than the nominal 35-pound (16 kg) class.

**256.04 Removal of Unsound Concrete.** The Engineer will locate and mark all areas to be repaired prior to concrete sawing. Provide the Engineer with aerosol spray paint to outline the areas for repair. Repair areas will be rectangular or square in shape with dimensions as required to envelope the surface deterioration.

Saw the perimeter of all areas designated for removal to a depth of 1 inch (25 mm) to produce a vertical or slightly undercut face. Make additional saw cuts as required to facilitate removal. Remove all unsound concrete, all asphalt material, and all obviously loose and disintegrated concrete within the patch area. Remove sound concrete where required to achieve the minimum depth within the patch area. Remove concrete by jack hammering or milling. The minimum depth of any partial depth repair is 1-1/2 inch (38 mm) except at the perimeter saw cuts. Operate chipping hammers at an angle of less than 45 degrees measured from the surface of the pavement. During removal of unsound concrete, remove all pavement reinforcing exposed in the patch areas using a cutting tool or a torch.

**256.05 Preparation of Patch Area.** Before applying bonding grout and/or the patching material, abrasive blast the exposed concrete surfaces to which the patching material is to bond until free of loose particles, oil, dust, traces of asphalt concrete and joint sealer, and other contaminates. Remove all sandblasting residue with compressed air just prior to placing the concrete bonding grout or the patching material. Do not begin abrasive blasting operations until implementing reasonably available engineering controls to limit fugitive dust that are acceptable to the Engineer. Conform to State, regional, and local government agency requirements regarding control of dust generated by the blasting operation. For Types B and C patching materials that do not use water as the activator, perform additional surface preparation according to the patching material manufacturer's recommendations.

Recreate joints in or along the patch using a joint board that extends below the prepared surface and has a width equal to the existing joint. One hour after placing the patching material, remove the joint board in a manner that does not damage the patch.

**256.06 Bonding Grout Installation.** For bonding Type A patches, use grout that consists of equal parts, by volume, of portland cement and sand, mixed with sufficient water to form a stiff slurry. Using a stiff brush or broom, apply a thin, uniform coating of grout to the prepared surface. Scrub the grout onto the dry surfaces of the prepared area to be patched immediately before placing the patching material. Do not allow excess grout to collect in low spots. Do not allow the grout to dry before placing the new concrete. Paint grout over all sawed joints between the new and existing concrete immediately after completing the finishing.

## 256.07

For bonding Types B and C patches, conform to the patching material manufacturer's recommendations.

**256.07 Placement of Patch Material.** Use Type A, B, or C patch material as follows:

**A. Type A.** Provide patch material consisting of one part high early strength portland cement, one and a half parts fine aggregate, and one and a half parts No. 8 coarse aggregate by volume. Add sufficient air-entraining admixture to maintain an air content of  $8 \pm 2$  percent. Add enough water to obtain the minimum slump practical for placing, and do not allow slump to exceed 4 inches (100 mm). Mix the materials on site. Do not use ready-mixed concrete. Place the concrete mixture in the patch area while the bonding grout is still wet. Slightly overfill, vibrate, and strike off the concrete.

**B. Type B.** Provide patch material consisting of quick setting concrete mortar 705.21, Type 1 or 2. Mix and place the mortar according to the manufacturer's recommendations. Add coarse aggregate, as needed, according to the manufacturer's instructions. Place the concrete mixture in the patch area. If the manufacturer's requirements specify using bonding grout, place the concrete mixture while the bonding grout is still wet. Slightly overfill, vibrate, and strike off the concrete.

**C. Type C.** Provide patch material consisting of a blend of quick setting concrete mortar 705.21, Type 2 and selected aggregates with an activator. Mix and place these materials according to the manufacturer's recommendations. Add coarse aggregate, as needed, according to the manufacturer's instructions. Place the concrete mixture in the patch area. If the manufacturer's requirements specify using bonding grout, place the concrete mixture while the bonding grout is still wet. Slightly overfill, vibrate, and strike off the concrete.

Screed patches 12 feet (3.7 m) and less in length parallel to the centerline. Screed patches over 12 feet (3.7 m) in length perpendicular to the centerline.

While the concrete is still in a plastic state, test the surface for trueness and for being flush with the edges of the adjacent slabs using a 10-foot (3 m) straightedge. Place the straightedge parallel to the pavement centerline with the ends resting on the existing pavement and draw the straightedge across the patch. Where the straightedge does not remain in contact with the existing pavement while drawing it across the patch, correct all high or low areas exceeding 1/8 inch in 10 feet (3 mm in 3 m). Recheck the concrete surface after making corrections to assure that the patch area meets the surface tolerance before the patching material hardens.

Texture the new concrete surface similar to that of the surrounding pavement.

**256.08 Curing and Opening to Traffic.** Cure Type A patches according to 451.10, except allow the patch to attain a modulus of rupture of 400 pounds per square inch (2.8 MPa) before opening to traffic. Cure Types B and C patches according to the manufacturer's recommendations.

**256.09 Method of Measurement.** The Department will measure the quantity of Bonded Patching of Portland Cement Concrete Pavement, Type \_\_\_ by the number of square feet (square meters) of the exposed surface of all patches,

irrespective of the depth of the patch, repaired in the complete and accepted work. If the actual measured area of a patch is less than 2 square feet (0.2 m<sup>2</sup>), the Engineer will increase each such measurement to 2 square feet (0.2 m<sup>2</sup>).

**256.10 Basis of Payment.** The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
256	Square Feet (Square Meter)	Bonded Patching of Portland Cement Concrete Pavement, Type ___

## ITEM 257 DIAMOND GRINDING PORTLAND CEMENT CONCRETE PAVEMENT

### 257.01 Description

### 257.02 Equipment

### 257.03 Construction

### 257.04 Final Surface Finish

### 257.05 Method of Measurement

### 257.06 Basis of Payment

**257.01 Description.** This work consists of diamond grinding and texturing Portland cement concrete pavement longitudinally to substantially eliminate joint and crack faulting and to restore proper riding characteristics to the pavement surface.

**257.02 Equipment.** Provide grinding equipment that is a power driven, self-propelled machine that is specifically designed to smooth and texture Portland cement concrete pavement with diamond blades or diamond impregnated cylinder rings. Mount the blades or cylinder rings on an arbor head. Provide a grinding head at least 3 feet (0.9 m) wide. Ensure the equipment is capable of grinding the surface in the longitudinal direction without causing spalls or other damage at cracks, joints and other locations. Ensure the equipment is capable of correcting the pavement profile and providing proper cross slope on the concrete pavement.

Provide equipment with an effective wheelbase of at least 12.0 feet (3.6 m); a set of pivoting tandem bogey wheels at the front of the machine and rear wheels that travel and track in the fresh cut pavement. Ensure the center of the grinding head is no further than 3.0 feet (0.9 m) forward from the center of the back wheels. Ensure it is also of a shape and dimension that does not encroach on traffic movement outside of the work area.

Furnish and maintain a profiler conforming to Supplement 1058 for daily use during the grinding operations. Provide all necessary supplies to fully operate and graph the results of testing the ground pavement for smoothness. The Engineer will verify the profiler according to Supplement 1058.

**257.03 Construction.** The plans will designate the areas of pavement surfaces to be ground. Grinding of bridge decks and roadway shoulders will not be required unless indicated on the plans or required to provide drainage. Perform

## 257.04

grinding in a manner that eliminates crack or joint faults while providing positive lateral drainage by maintaining a constant cross-slope between grinding extremities in each lane. Transition auxiliary or ramp lane grinding as required from the mainline edge to provide positive drainage and an acceptable riding surface.

Ensure the operation results in pavement that conforms to the typical cross-section and the requirements specified for the final surface finish, however, it is the intention of this specification that the faulting at joints and cracks be eliminated and the overall riding characteristics be restored within the limits specified. To accomplish the smoothness required, grinding may not be required on 100 percent of the pavement surface.

During initial grinding operations, use the profiler to test the pavement surface as soon as the concrete has been ground full lane width. This initial testing is to aid the Contractor in evaluating the grinding methods and equipment being used. Subsequent to the initial testing, run daily profiles of each day's grinding the next working day.

Remove all grinding residue. Remove solid residue before it is blown by traffic action or wind. Do not allow residue to flow across lanes used by the traveling public or into gutters or drainage facilities.

**257.04 Final Surface Finish.** Produce a pavement surface that is true to grade with the ground area consisting of a longitudinal corduroy-type texture. Ensure the peaks of the ridges are approximately 1/16 inch (1.5 mm) higher than the grooves with 53 to 57 evenly spaced grooves per foot (174 to 187 per meter).

Measure the finished pavement surface for riding quality.

Produce a mainline riding surface which does not exceed an IRI of 95 inches per mile (1.50 m/km), nor any localized surface deviations in excess of 0.4 inches in 25 feet (10 mm in 7.6 m), as measured with the approved profiler. Use equipment conforming to Supplement 1058 and obtain a profile and smoothness measurements using ProVAL and Supplement 1110. The Engineer will witness the testing of the pavement surface's wheel paths. The wheel paths are located parallel to the centerline of the pavement and approximately 3 feet (0.9 m) measured transversely, inside all lane edges. Maintain the alignment of the profiler with reference to the pavement edge at all times. Re-grind any 0.10 mile (0.16 km) sections with an IRI greater than 95 inches per mile (1.5 m/km) until the measured IRI is less than 95 inches per mile (1.5 m/km).

Provide the necessary traffic control and survey stationing for initial measurements or any subsequent measurements. Measure the entire length of pavement, starting and stopping the measuring equipment when any wheel is within 1.0 foot (0.3 m) of any existing pavement, pressure relief joint or approach slab.

Ensure transverse joints and cracks are flush with adjacent surfaces. The Engineer will visually inspect transverse joints and cracks to ensure that adjacent surfaces are in the same plane. Adjacent sides of joints or cracks within of 1/16 inch (1.5 mm) of each other will be considered flush. Ensure the transverse slope

of the pavement is uniform to a degree that no depressions or misalignments of slope greater 1/4 inch in 12 feet (6 mm in 3.6 m) are present. Use a straightedge placed perpendicular to the centerline to measure depressions and misalignments. Straightedge requirements do not apply outside of area ground.

**257.05 Method of Measurement.** The Department will measure diamond grinding by the number of square yards (square meters) of pavement ground and accepted. The quantity of diamond grinding will be determined by multiplying the width specified on the plan by the total length of the finished pavement surface, excluding bridge decks, approach slabs or the 1.0 foot (0.3 m) adjacent to the existing pavement, pressure relief joints, approach slabs and other areas designated by the Engineer.

**257.06 Basis of Payment.** Payment is full compensation for furnishing all labor, materials, tools, equipment and incidentals and for doing all work involved in grinding the existing surface, removing residue, cleaning the pavement, and testing with a profiler.

The Department will pay for accepted quantities at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
257	Square Yard (Square Meter)	Diamond Grinding Portland Cement Concrete Pavement

## **ITEM 258**

## **DOWEL BAR RETROFIT**

### **258.01 Description**

### **258.02 Materials**

### **258.03 Equipment**

### **258.04 Construction**

### **258.05 Method of Measurement**

### **258.06 Basis of Payment**

**258.01 Description.** This work consists of sawing slots across transverse cracks, cleaning the slot, injecting caulking filler, placing a dowel in the slot, and filling the slot with a patching material.

### **258.02 Materials.**

Furnish a one part silicone sealant which does not require a primer for bond to concrete and conforms to the following Table:

Properties	Requirements
Flow, ASTM D5893	0.3 inches(7.6 mm) maximum
Extrusion Rate, C1183 method A	75-350 grams/minute
Tack free time @ 77° F ± 3°F (25°C ±2°C) –ASTM C679	20-90 minutes
Specific Gravity - ASTM D 792, Method A	1.010-1.515
Durometer Hardness - Shore A, cured 7 days @ 77°F± 3° F (25°C ± 2°C) and 45-55% R.H.; ASTM D 2240	10-25 at 0°F (-18°C)
Tensile Stress -@ 150% elongation, 7 day cure @ 77°F ± 3°F (25°C ±2°C) and 45-55% R.H.; ASTM D 412, Die C	45 psi (310 kPa) maximum
Elongation - 7 day cure @ 77° F ± 3°F (25°C ± 2°C) and 45-55% R.H.; ASTM D 412, Die C.	800% minimum
Bond to Concrete Mortar Briquettes - Air cured 12 days @ 77° F ± 3°F (25°C ± 2°C);**	50 psi (345 kPa) minimum
Movement Capability and Adhesion ***	Extend 100% and compress 50%; No adhesive or cohesive failure after 10 cycles at 0°F (-18°C)
Shelf Life	9 months from date of shipment from manufacturer
** Bond to Concrete Mortar Briquettes molded in accordance with AASHTO T 132 sawed in half and bonded with a thin section of sealant and tested in accordance with AASHTO T 132. Briquettes will be dried to constant weight in oven at 212° F ± 9°F (100°C ± 5°C).	
*** Movement Capability and Adhesion: Prepare 1-inch x 2-inch x 3-inch(25 mm x 50 mm x 75 mm ) concrete blocks in accordance with ASTM C 719. A sawed face will be used for bond surface. Seal 2 inches (50 mm) of block leaving 1/2 inch (13 mm) on each end of specimen unsealed. The depth of sealant will be 3/8 inch (10 mm) and the width 1/2 inch (13 mm). Subject sealant to movement in accordance with ASTM C 719. The magnitude of the movement will be as specified, and the rate of extension or compression will be 1/8 inch (3.2 mm) per hour.	

Furnish materials conforming to:

- Aggregate .....703.02.A.3
- Curing material..... 705.07, Type 2.
- Dowel bars ..... 709.13 or 705.01
- Dowel bar chairs ..... 709.14 or non-metallic material
- Preformed filler ..... 705.03
- Patching material. Must meet the performance requirements of ASTM C928, Table 1, R3 concrete material with the following exceptions and additions:
  - Final Set Time (ASTM C403) .... 25 minutes minimum
  - Length Change (ASTM C157)
    - @ 4 days ..... ± 0.13% maximum
    - Freeze Thaw Durability Factor (ASTM C666) Procedure A @ 300 cycles or Procedure B @ 350 cycles,
    - Durability Factor: .....90% minimum

Furnish patching material according to the Departments Qualified Products List (QPL)

Mix prepackaged materials that contain all aggregates needed to produce the desired concrete as specified by the manufacturer. For bagged cementitious materials that need additional aggregates, grade the aggregate according to the patching material manufacturer’s recommendation except ensure that 100% passes

the 1/2 -inch (12.5 mm) sieve and a minimum of 85 percent, by weight, passes the 3/8-inch (9.5 mm) sieve.

**258.03 Equipment.** Furnish equipment to create slots that has a power driven gang type assembly, consisting of diamond blade saws, capable of sawing a minimum of three slots at one time to the required dimensions, without damage to the surrounding pavement.

Furnish jack hammers weighing less than 30 pounds (13.6 kg).

Furnish abrasive blast equipment capable of removing the saw slurry or other foreign material from the exposed surfaces leaving a clean, newly exposed concrete surface free of spalls, laitance, and all contaminants detrimental to achieving an adequate bond. Ensure water blasting pressure with abrasives in the water is 10,000 psi (690 bar) or less.

**258.04 Construction.** The Engineer will locate and mark cracks to be retrofitted. Provide the Engineer with aerosol spray paint to mark the cracks to be retrofit.

Cut 2-1/2 inch (65 mm) wide slots into the pavement to a depth which places the center of the dowel at mid-depth in the concrete slab. Make the slots parallel to the centerline of the pavement. Make multiple saw cuts parallel to the centerline if necessary to properly remove material from the slot and to provide a level surface for the feet of the dowel bar chairs. Cut three slots, on one foot (0.3 m) centers, in each wheel path, as shown in the standard drawings.

Do not allow traffic across the crack once the concrete has been removed from the slots until all six retrofit dowel bars are in place, cured and completed. Do not allow the tires of construction vehicles to travel on slots where concrete has been removed.

Clean the edge of the slots by approved blast methods to produce a rough surface. Insure any blasting operation does not damage the surrounding pavement. Do not begin abrasive blasting operations until implementing reasonably available engineering controls to limit fugitive dust that are acceptable to the Engineer. Conform to state, regional, and local government agency requirements regarding control of dust generated by the blasting operation.

Caulk cracks at the bottom and sides of the slot with an approved silicone sealant in order to prevent any grout from entering the crack. Apply the sealant with a pressure applicator that forces it into the crack.

Place a 1/2 inch (13 mm) thick preformed filler board to maintain the crack, as shown in the plan details. Ensure the filler board fits tight around the dowel and to the bottom and edges of the slot. Maintain the filler board in a vertical position and tight to all edges during placement of the patching material. Ensure the filler board extends from the bottom of the slot to the surface of the pavement. If for any reason the filler board shifts during placement of the patching material, redo the dowel bar retrofit at no expense to the Department.

Ensure the dowel bar chair firmly holds the bar centered in the slot. Obtain the Engineer's approval before using any dowel bar chairs. The Engineer will reject

**258.05**

any chair design that may allow movement of the bar during the placement of grout.

Use dowel bars 1-1/2 inches (38 mm) in diameter and 18 inches (460 mm) long. Center the filler board on the dowel. Coat the dowel bars with a thin uniform coat of new light form oil as a bond-breaking material just prior to installation in the slot. Place an expansion cap on each end of the dowels prior to installation. Ensure the expansion caps are tight fitting and made of non-metallic material which will allow 1/4 inch (6 mm) movement at each end of the dowel.

Use two chairs to firmly hold the dowel bar in the slot during placement of the patching material. Furnish chairs that are a nominal 2-1/2 inch (65 mm) wide and center the dowel bar across the crack. Ensure the bar varies no more than 1/4 inch (6 mm) from parallel to the pavement surface and the centerline of the pavement. Just prior to placement of the patching material, make one or more passes of an air blast to provide a dust-free, clean slot to insure an adequate bond of the patching material.

Mix, place, and cure the patching material in accordance with the manufacturer’s recommendations. Consolidate the patching material using a vibrator approved by the Engineer. Place the patching material in the slot and finish to produce a smooth, even surface.

Repair any damage to the pavement due to the Contractor’s operation at no expense to the Department.

Cure the patching material for a minimum of four hours before placing any vehicle loads on the repair, or as directed by the Engineer.

**258.05 Method of Measurement.** The Department will measure the quantity of Retrofit Dowel Bars by the actual number in the complete and accepted work.

**258.06 Basis of Payment.** Payment is full compensation for furnishing all materials including paint; sawing and cleaning the slots; installing dowel chairs, dowels, bond breaker material, dowel bar end caps, sealant/caulking material, filler material, and patching material.

The Department will not pay for additional work or materials required due to shifting of the filler board.

The Department will not pay for any additional work to repair damage to the pavement caused by the Contractor.

The Department will pay for accepted quantities at the contract unit price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
258	Each	Retrofit Dowel Bar

## 300 BASES

### ITEM 301 ASPHALT CONCRETE BASE

**301.01 Description**

**301.02 Composition**

**301.03 Mixing**

**301.04 Spreading and Finishing**

**301.05 Spreading and Surface Tolerances**

**301.06 Basis of Payment**

**301.01 Description.** This work consists of constructing a base course of aggregate and asphalt binder, mixed in a central plant and spread and compacted on a prepared surface.

The requirements of Item 401 apply, except as modified by this specification.

**301.02 Composition.** Furnish aggregate for the mix that conforms to the following gradation:

Sieve Size	Total Percent Passing
2 inch (50 mm)	100
1 inch (25.0 mm)	75 to 100
1/2 inch (12.5 mm)	50 to 85
No. 4 (4.75 mm)	25 to 60
No. 8 (2.36 mm)	15 to 45
No. 16 (1.18 mm)	10 to 35
No. 50 (300 μm)	3 to 18
No. 200 (75 μm)	1 to 7

Submit for the Laboratory's approval the desired percentage of the aggregate passing the No. 4 (4.75 mm) sieve and blend of individual components. The Contractor may use reclaimed asphalt concrete pavement according to 401.04. The Laboratory will establish the required binder content within a range of 4 to 8 percent. Do not make changes in these JMF values due to unsatisfactory results or other conditions except as authorized by the Laboratory. Obtain a new JMF approval for any desired change to an existing JMF.

**301.03 Mixing.** If using a batch plant, use screens with openings of sizes that result in a reasonably balanced separation of the dried and heated aggregate into a minimum of two bins.

**301.04 Spreading and Finishing.** Ensure that the maximum compacted depth of any one layer is 6 inches (150 mm). Ensure that the temperature of the mixture when delivered to the paver is a minimum of 250 °F (120 °C) if a hot mix asphalt and 230 °F (110 °C) if a warm mix asphalt according to 402.09. Ensure the temperature of the mixture is sufficient for the roller coverage to be effective in compacting the mixture.

**301.05 Spreading and Surface Tolerances.** Do not exceed 3/8 inch (10 mm) in surface variation from the testing edge of a 10-foot (3 m) straightedge. If using

**301.06**

Item 301 Asphalt Concrete Base as a subbase for a rigid pavement or base, do not exceed a variation of 1/4 inch (6 mm).

Correct variations in excess of slope or surface tolerances by adding or removing material in a manner satisfactory to the Engineer. The Contractor may use asphalt concrete approved by the Engineer.

**301.06 Basis of Payment.** The Department will pay for accepted quantities, complete in place, at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
301	Cubic Yard (Cubic Meter)	Asphalt Concrete Base

**ITEM 302 ASPHALT CONCRETE BASE**

**302.01 Description**

**302.02 Composition**

**302.03 Mixing**

**302.04 Spreading and Finishing**

**302.05 Spreading and Surface Tolerances**

**302.06 Basis of Payment**

**302.01 Description.** This work consists of constructing a base course of aggregate and asphalt binder, mixed in a central plant and spread and compacted on a prepared surface.

The requirements of Item 401 apply, except as modified by this specification.

**302.02 Composition.**

A. General. Furnish a mixture that conforms to the following gradation:

Sieve Size	Total Percent Passing
2 inch (50 mm)	100
1 1/2 inch (37.5 mm)	85 to 100
1 inch (25.0 mm)[1]	68 to 88
3/4 inch (19.0 mm)[1]	56 to 80
1/2 inch (12.5 mm)[1]	44 to 68
3/8 inch (9.5 mm)[1]	37 to 60
No. 4 (4.75 mm)	22 to 45
No. 8 (2.36 mm)	14 to 35
No. 16 (1.18 mm)	8 to 25
No. 30 (600 μm)	6 to 18
No. 50 (300 μm)	4 to 13
No. 200 (75 μm)	2 to 6

[1] Provide aggregate to retain a minimum of 7 percent of the material on each of these sieves. This requirement applies to the gradation of the JMF and the mix production according to Item 403.

In the design of the asphalt concrete base, the requirements of Item 441 apply, except as follows:

The Contractor may use reclaimed asphalt concrete pavement according to 401.04. Should problems with proper coating or other material issues related to the use of reclaimed asphalt concrete pavement be evident, the Laboratory may limit reclaimed asphalt concrete pavement to 30 percent. In this case virgin binder content will be adjusted by the Laboratory.

Add hydrated lime in the dry form at a rate of 0.75 percent by the dry weight of aggregate for asphalt concrete base, if antistripping additive is required and hydrated lime is used.

Design the asphalt concrete base to yield 4.0 percent air voids and the following properties:

Property	Acceptable Range of Values	
	minimum	maximum
Binder Content, % of total mix	2.0 [Virgin]	6.0[Total]
Stability, lb (N), 70 blow	3000 (13,345)	--
Flow, 0.25 mm, 70 blow	--	28
Voids in Mineral Aggregate, %	12.0	--

Use equipment that meets the requirements of a Level 3 Laboratory as specified in Supplement 1041. Ensure that the following equipment is designed and manufactured to prepare and test a Marshall specimen with a 6.0-inch (152.4 mm) diameter and a  $3.75 \pm 0.05$  inch ( $95 \pm 1.3$  mm) height:

1. Specimen mold assembly.
2. Specimen extractor.
3. 22.5-pound (10 kg) compaction hammer.
4. Compaction pedestal specimen mold holder.
5. Marshall test apparatus.

Produce batches of asphalt concrete base in the amount that will result in a compacted specimen  $3.75 \pm 0.05$  inch ( $95 \pm 1.3$  mm) in height. This amount is about 4050 grams.

**B. Compaction of Specimens.** Fill the mold with asphalt concrete base by placing approximately one-half of the batch in the mold and spading it vigorously with a heated spatula or trowel 15 times around the perimeter and ten times over the interior. Place the second half of the batch in the mold and spade the mixture in the same manner.

Compact the specimen on both sides with 70 blows.

**C. Stability Correlation Ratios.** Convert measured stability values for specimens that depart from the standard 3.75-inch (95 mm) thickness to an equivalent 3.75-inch (95 mm) value by multiplying the stability value by the appropriate correlation ratio as follows:

**302.03**

<b>Approximate Thickness of Specimen, inches (mm)</b>		<b>Correlation Ratio</b>
3-1/2	(89)	1.12
3-9/16	(90)	1.09
3-5/8	(92)	1.06
3-11/16	(94)	1.03
3-3/4	(95)	1.00
3-13/16	(97)	0.97
3-7/8	(98)	0.95
3-15/16	(100)	0.92
4	(102)	0.90

**302.03 Mixing.** Conform to the requirements of 301.03.

**302.04 Spreading and Finishing.** Ensure that the compacted depth of any one layer is a minimum of 4 inches (100 mm) and a maximum of 7.75 inches (190 mm). Ensure that the temperature of the mixture when delivered to the paver is a minimum of 250 °F (120 °C) if a hot mix asphalt and 230 °F (110 °C) if a warm mix asphalt according to 402.09. Ensure the temperature of the mixture is sufficient for the roller coverage to be effective in compacting the mixture

**302.05 Spreading and Surface Tolerances.** Conform to the requirements of 301.05.

**302.06 Basis of Payment.** The Department will pay for accepted quantities, complete in place, at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
302	Cubic Yard (Cubic Meter)	Asphalt Concrete Base

**ITEM 304 AGGREGATE BASE**

**304.01 Description**

**304.02 Materials**

**304.03 Before Spreading**

**304.04 Spreading**

**304.05 Compaction**

**304.06 Finished Surface**

**304.07 Method of Measurement**

**304.08 Basis of Payment**

**304.01 Description.** This work consists of furnishing, placing, and compacting one or more courses of aggregate on a prepared surface, including furnishing and incorporating all water required for compaction.

**304.02 Materials.** Furnish materials conforming to 703.17.

**304.03 Before Spreading.** The Engineer will sample the Contractor's stockpile to determine the initial moisture content to be used for compaction. The Engineer will develop a moisture-density curve according to Supplement 1015 to determine the optimum moisture content.

Use material that has a reasonably uniform moisture content. Ensure the moisture content is not less than 2 percent below the optimum moisture content before spreading. Add water to the stockpile if necessary to meet this moisture requirement.

Handle the material in a manner to minimize segregation. If segregation occurs, thoroughly mix or regrade the stockpile.

**304.04 Spreading.** Spread the material on the prepared surface. Do not use frozen material and do not spread on frozen surfaces.

Do not exceed a compacted lift thickness of 8 inches (200 mm) when using vibratory rollers greater than 12 tons (11 metric tons). Do not exceed a compacted lift thickness of 6 inches (150 mm) when using 10 to 12-ton (9 to 11 metric tons) vibratory rollers. Do not exceed a maximum compacted lift thickness of 4 inches (100 mm) when these vibratory rollers are not used.

The Contractor may elect to use a lighter roller if the centrifugal force exceeds the minimum weight. In all cases, submit documentation proving the minimum weight requirements are met.

Place the material in two or more approximately equal lifts when the specified compacted thickness exceeds the maximum allowed.

Place the material with self-propelled spreading machines capable of placing the material true to line and grade. Spreading machines such as spreader boxes or pavers are allowed. Do not use graders or dozers without spreader boxes to spread the material except for areas described in the next paragraph. Spread the material such that it minimizes segregation and requires minimal blading or manipulation. The Department may perform in-place gradation testing in areas that are visually segregated according to Supplement 1090.

The Contractor may use hand-placing methods, dozers or graders when the total area of the material is 2000 square yards (1700 m<sup>2</sup>) or less or in small areas where self-propelled spreading machines are impractical. Small areas include lane widths less than 12 feet (3.7 m) or lengths less than 1000 feet (305 m). The Department will not take in-place gradation tests in these small areas.

The Department may test for in-place gradation after spreading but before compaction testing according to Supplement 1090.

**304.05 Compaction.** The Department will measure compaction according to Supplement 1015.

Add water or dry the material to bring it to within 2 percent of the optimum moisture content before compacting. Maintain the moisture content within this range during all compaction operations. The Engineer will determine the percentage of moisture to apply or to be dried from the material. Uniformly apply the water or dry the material throughout the lift and in a manner that does not

## 304.06

soften or disturb the lower courses. Reduce the moisture content if the material becomes unstable during the compaction operation.

Compact each lift of material immediately after spreading. Use rollers that correspond with the lift thickness as described in 304.04. The Contractor may use light rollers or vibratory equipment in small areas as specified in 304.04 or when heavier rollers are not practical. Approved compaction equipment may consist of vibratory rollers, static rollers, or vibratory equipment.

At the beginning of the compaction operation, construct a test section. The Engineer will determine the density requirements according to Supplement 1015. Use a minimum compactive effort of eight passes to construct the test section. Use and adjust the vibration on the vibratory rollers to maximize the density and stability. Construct a new test section when the material changes or when the supporting materials change appreciably.

The Engineer will use 98 percent of the test section maximum dry density for acceptance of the production material. Use at least the same number of passes and compactive effort used to obtain the test section maximum dry density for the production material. At a minimum, use eight passes in the production area. The Engineer may reduce the minimum passes if the passes are detrimental to compaction.

The Engineer may check the production material density before or after the finishing operations.

Maintain the surface of each lift during the compaction operations in such a manner that the surface texture is reasonably uniform and the material is firmly keyed.

Cover the aggregate base with the next layer of pavement before the end of the construction season. If the aggregate base is not covered up, then assume all liability for contamination of, damage to and instability of the base, subgrade and underdrains.

Provide drainage and maintain the material according to 203.04.A.

**304.06 Finished Surface.** Ensure that the finished surface does not vary more than 3/8 inch (10 mm) from a 10-foot (3 m) straightedge parallel to the centerline or more than 1/2 inch (13 mm) from a template conforming to the required cross-section. Furnish straightedges, templates, or other devices satisfactory to the Engineer, and check the surface for conformance with these requirements.

Do not construct the aggregate base at a consistent depth below the required minimum compacted depth thickness. When the depth is found to be less than the required depth, provide the Engineer with a written corrective action plan for approval.

**304.07 Method of Measurement.** The Department will measure Aggregate Base by the number of cubic yards (cubic meters) computed from the profile grade and typical sections, compacted in place.

Where variable depth is specified, the Department will measure the number of cubic yards (cubic meters) of aggregate base by converting from weight using the following conversion factors:

**TABLE 304.07-1**

<b>Material</b>	<b>Conversion Factor</b>	
Crushed stone	4000 lb/yd <sup>3</sup>	2375 kg/m <sup>3</sup>
Crushed gravel	4000 lb/yd <sup>3</sup>	2375 kg/m <sup>3</sup>
Crushed slag <sup>[1]</sup>		
less than 90 lb/ft <sup>3</sup> (1450 kg/m <sup>3</sup> )	3600 lb/yd <sup>3</sup>	2140 kg/m <sup>3</sup>
90 to 100 lb/ft <sup>3</sup> (1450 to 1600 kg/m <sup>3</sup> )	4000 lb/yd <sup>3</sup>	2375 kg/m <sup>3</sup>
more than 100 lb/ft <sup>3</sup> (1600 kg/m <sup>3</sup> )	4500 lb/yd <sup>3</sup>	2670 kg/m <sup>3</sup>
Granulated slag	2800 lb/yd <sup>3</sup>	1660 kg/m <sup>3</sup>

[1] Based on average dry rodded weight of standard size of slag aggregates on record at the Laboratory. The conversion factors listed are the long gradation weights. These numbers are based on the dry rodded weights of No. 67, 57, or 8 gradation. The Department will determine slag weights based on weights obtained from the original source.

The Department will verify that the moisture content of the delivered material is less than 2 percent above saturated surface dry (SSD). If the moisture content is greater than 2 percent above SSD, then the Department will calculate the number of cubic yards (cubic meters) based on the dry density and dry weight.

The Department will determine the pounds per cubic yard (kilograms per cubic meter) for aggregate mixtures by using 100 percent of the test section maximum dry density obtained in 304.05.

**304.08 Basis of Payment.** The Department will pay for accepted quantities at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
304	Cubic Yard (Cubic Meter)	Aggregate Base

## **ITEM 305 PORTLAND CEMENT CONCRETE BASE**

### **305.01 Description**

### **305.02 Construction**

### **305.03 Method of Measurement**

### **305.04 Basis of Payment**

**305.01 Description.** This work consists of constructing a portland cement concrete base on a prepared surface.

**305.02 Construction.** The requirements of Item 451 apply, except as follows.

Do not comply with the requirements of 451.07.

Provide dowels at transverse contraction joints in mainline pavement, ramps, acceleration/deceleration lanes, or collector/distributor lanes. Dowels for contraction joints in concrete shoulders on mainline pavement, ramps,

**305.03**

acceleration/deceleration lanes, or collector/distributor lanes are not required unless the contraction joint is located within 500 feet (150 m) of a pressure relief joint.

Do not place construction joints within 6 feet (1.8 m) of another parallel joint.

Modify the curing membrane application rate specified in 451.10 to 200 square feet per gallon (5 m<sup>2</sup>/L) of treated pavement surface.

Produce a final surface with a uniform, gritty, longitudinal, or transverse texture using a broom drag in either direction.

Ensure that pavement surface variations do not exceed 1/4 inch in 10 feet (6 mm in 3 m).

Impressing station numbers into the plastic concrete as specified in 451.09 is not required.

**305.03 Method of Measurement.** The Department will measure Concrete Base by the number of square yards (square meters) completed and accepted in place. The width equals the base width shown on the typical cross-section of the plans plus additional widening as the Engineer directs in writing. The Department will field measure the length along the centerline of each roadway or ramp.

**305.04 Basis of Payment.** For base found deficient in thickness, the Department will pay a reduced price according to 451.17.

The Department will not make additional payment over the Contract unit price for any base with an average thickness in excess of that shown on the plans.

The Department will pay for accepted quantities at the contract price as follows.

<b>Item</b>	<b>Unit</b>	<b>Description</b>
305	Square Yard (Square Meter)	Concrete Base

**ITEM 320 RUBBLIZE AND ROLL**

**320.01 Description**

**320.02 Materials**

**320.03 Equipment**

**320.04 Construction Details**

**320.05 Method of Measurement**

**320.06 Basis of Payment**

**320.01 Description.** This work consists of rubblizing and rolling existing concrete pavement before placing an asphalt concrete pavement.

**320.02 Materials.** Furnish filler aggregate conforming to Item 304.

**320.03 Equipment.** Use a self-contained and self-propelled unit of either the resonant frequency type or the multiple head breaker type for rubblizing the exposed concrete pavement.

If using a resonant frequency unit, ensure that it is capable of producing low amplitude, 2000-pound-force (8900 N) blows at a rate of not less than 44 blows per second.

If using a multiple head breaker unit, ensure that it has the capability of rubblizing the full 12-foot (3.6 m) lane width of the pavement in a single pass. Ensure the breaking head consists of 12 to 16 hammers weighing a total of 1000 to 1500 pounds (450 to 680 kg), mounted laterally in pairs with half the hammers in a forward row and the remainder diagonally offset in a rear row. Attach each hammer to a hydraulic lift cylinder that operates as an independent unit, develops 2000 to 12,000 foot-pounds (2700 to 16,000 J) of energy depending on lift height selected, cycles at a rate of 30 to 35 impacts per minute, and has a maximum lift height of 60 inches (1.5 m).

Use a vibratory steel wheel roller having a total weight of not less than 10 tons (9 metric tons).

**320.04 Construction Details.** Make a full depth saw cut or cut load transfer devices at existing joints on ramps or mainline where the rubblizing abuts concrete pavement or approach slabs that are to remain in place permanently or temporarily for maintenance of traffic.

Before the rubblizing operations begin, the Engineer will designate a test section. Rubblize the test section according to this specification. After rubblizing, excavate a test pit, where the Engineer designates, to check for proper particle size throughout the thickness of the concrete. Fill in the test pit using the excavated material and additional filler aggregate as necessary. Compact the test pit as part of the rolling operation. The Engineer may require additional test pits, as necessary, throughout the rubblizing operation.

Adjust the rubblizing procedure to maintain the proper particle sizes. Control the operating speed of the rubblizing equipment such that the existing pavement is reduced into particles ranging from sand sized to pieces not exceeding 6 inches (150 mm) in their largest dimension, the majority being a nominal 1 to 2 inches (25 to 50 mm) in size. Reduce the portion of the concrete slab above the reinforcing steel to 1 to 2 inches (25 to 50 mm) in size.

Before placing the initial asphalt concrete course, compact the rubblized pavement with two passes of the vibratory roller. Operate the roller in the vibratory mode and at a speed not to exceed 6 feet (1.8 m) per second.

Leave steel reinforcement in place in the rubblized pavement. However, cut off any steel reinforcement, exposed at the surface as a result of rubblizing or compaction operations, below the surface and remove it from the site.

Fill depressions 1 inch (25 mm) or greater in depth from that of the immediate surrounding area, resulting from the rubblizing, the compactive effort, or the steel reinforcement removal, with the filler aggregate. Strike off excess aggregate level with the surrounding area. Compact filled depressions with the same roller and compactive effort previously described.

Do not allow traffic on the rubblized pavement before the initial asphalt concrete base and intermediate courses are in place.

**320.05**

Do not allow more than 48 hours to elapse between rubblizing the pavement and placing the initial asphalt concrete course. However, in the event of rain, the Engineer may waive this time limitation to allow sufficient time for the rubblized pavement to dry to the Engineer’s satisfaction. If the Engineer waives the time limitation, cease rubblizing the pavement until the Engineer allows paving to resume.

**320.05 Method of Measurement.** The Department will measure Rubblize and Roll by the number of square yards (square meters). The Engineer will use the actual width of the existing concrete pavement and will measure the length along the centerline of each roadway or ramp.

The Department will measure the Filler Aggregate by the number of cubic yards (cubic meters) furnished, placed, and compacted.

**320.06 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
320	Square Yard (Square Meter)	Rubblize and Roll
320	Cubic Yard (Cubic Meter)	Filler Aggregate

**ITEM 321 CRACKING AND SEATING EXISTING NON-REINFORCED CONCRETE PAVEMENT**

- 321.01 Description**
- 321.02 Equipment**
- 321.03 Construction Details**
- 321.04 Method of Measurement**
- 321.05 Basis of Payment**

**321.01 Description.** This work consists of cracking and seating existing non-reinforced concrete pavement or concrete base before placing an asphalt concrete pavement.

**321.02 Equipment.** Use devices for cracking the concrete capable of producing the desired crack pattern without extensive spalling or excessive shattering. Extensive spalling is spalling over 1-1/4 inches (30 mm) in depth. Do not use whiphammers.

Use watering equipment capable of wetting the cracked surface uniformly to reveal the crack pattern.

Use a 50-ton (45 metric tons) pneumatic tire roller conforming to the requirements of Item 204 for seating the cracked concrete slabs. Use pneumatic tire towing equipment capable of moving the roller forward and backward along predetermined lines.

**321.03 Construction Details.** Demonstrate, to the Engineer’s satisfaction, the ability of the selected equipment and procedures to produce cracking of acceptable

quality by cracking at least three, but no more than five, existing concrete slabs. When cracking the test sections, furnish and apply water to dampen the cracked concrete to enhance visual determination of the cracking pattern. In addition to 107.07, provide positive provision to contain any flying debris during cracking operations.

Crack existing concrete into nominal 4 × 4-foot (1.2 × 1.2 m) segments. In the event existing panels are already cracked into segments, crack these segments further into nominally equal-sized square or rectangular pieces having longitudinal and transverse dimensions not more than 5 feet (1.5 m) and not less than 3 feet (0.9 m), wherever feasible. Do not allow the cracking equipment to impact the slabs within 1 foot (0.3 m) of another break line, joint, or the edge of the concrete.

Furnish and apply water to a check section at least once each day to verify that a satisfactory crack pattern is being maintained. Make adjustments to the energy or striking pattern when the Engineer deems it necessary, based on the check sections.

Roll the cracked concrete until the concrete pieces are firmly seated. Perform rolling with at least two coverages as specified in Item 204. The Engineer will determine the maximum number of coverages of the roller on the test sections to ensure seating without damage to the concrete.

Before placing the asphalt concrete, remove all loose pieces of broken concrete that are not firmly seated. Repair all voids, such as spalls, removed loose pieces, joints, or cracks that, in the Engineer's opinion, will make uniform compaction of the first asphalt concrete course difficult. Repair voids by applying 407 tack coat, filling with asphalt concrete, and compacting as directed by the Engineer.

Do not allow traffic on the cracked concrete before the initial asphalt concrete base and intermediate courses are in place.

**321.04 Method of Measurement.** The Engineer will measure the area of existing non-reinforced concrete pavement or concrete base satisfactorily cracked and seated in square yards (square meters). The Engineer will measure the actual width of the existing concrete, and will measure the length along the centerline of each roadway or ramp.

**321.05 Basis of Payment.** Payment is full compensation for furnishing all labor, equipment, materials, and incidentals necessary to complete this work; for all crack pattern test and check sections including water; and for repairing of joint, cracks, spalls, and voids.

The Department will pay for the accepted quantities at the contract price as follows.

Item	Unit	Description
321	Square Yard (Square Meter)	Cracking and Seating Existing Non-Reinforced Concrete Pavement

**400 FLEXIBLE PAVEMENT****ITEM 401 ASPHALT CONCRETE  
PAVEMENTS—GENERAL**

- 401.01 Description**
- 401.02 Mix Design and Quality Control**
- 401.03 Materials**
- 401.04 Reclaimed Asphalt Concrete Pavement**
- 401.05 Mixing Plants**
- 401.06 Weather Limitations**
- 401.07 Notification**
- 401.08 Asphalt Binder**
- 401.09 Aggregate Preparation**
- 401.10 Mixing**
- 401.11 Hauling**
- 401.12 Spreading Equipment**
- 401.13 Rollers**
- 401.14 Conditioning Existing Surface**
- 401.15 Spreading, Finishing and Night Work**
- 401.16 Compaction**
- 401.17 Joints**
- 401.18 Asphalt Binder Compatibility**
- 401.19 Spreading and Surface Tolerances**
- 401.20 Asphalt Binder Price Adjustment**
- 401.21 Method of Measurement**
- 401.22 Basis of Payment**

**401.01 Description.** This specification is applicable to all types of asphalt concrete pavements irrespective of gradation of aggregate, kind, and amount of asphalt binder, or pavement use. Deviations from these general requirements are covered in the specific requirements for each type according to the appropriate contract item or items.

Work consists of one or more courses of asphalt concrete constructed on a prepared foundation. The asphalt concrete consists of a mixture of uniformly graded aggregate and specified type and grade of asphalt binder.

Control all production processes to assure the Engineer that the mixture delivered to the paving site is uniform in composition, conforms to the specification requirements and that the placed mixture is free of any defect (ex. segregation, tenderness, lack of mixture and texture uniformity, raveling, flushing, rutting, holes, debris etc.) within the Contractor's control at project completion.

The asphalt concrete pavement thickness shown on the plans or stated in the Proposal is for the exclusive use in calculating the weight required to be placed per unit of surface area.

**401.02 Mix Design and Quality Control.** Use an approved Job Mix Formula (JMF). The quality control and acceptance requirements of Item 403 apply unless otherwise specified.

If required to perform the mix design or quality control, provide a laboratory and personnel meeting the requirements of Supplement 1041 to perform mix design and quality control tests.

Calibrate asphalt content nuclear gauges according to Supplement 1043 using personnel with a minimum Level 2 rating according to Supplement 1041. Mix and test the calibration verification sample with a Department employee present.

Provide and dispose of the solvent used for cleaning the asphalt content nuclear gauge pans.

**401.03 Materials.** Furnish materials conforming to:

Asphalt binder	
(asphalt concrete, 401.14, 401.15) .....	702.01
Asphalt material (401.14, 401.18)	
.....	702.01, 702.04, or 702.13
Aggregates (base courses).....	703.04
Aggregates (intermediate and	
surface courses).....	703.05
Mineral filler .....	703.07

Sample aggregate, asphalt binder, asphalt material, and mineral filler according to 106.01.

If 100 percent of coarse aggregate in an asphalt mix design is steel slag, the Contractor may include steel slag as a maximum of up to 50 percent of fine aggregate. If a steel slag source causes bulking (expansion resulting in flushing or material loss) in asphalt concrete courses, the Laboratory will place limits on the amount of steel slag allowed in a mix design. Bulking may occur when a large percentage of an asphalt mix design is steel slag aggregate. Bulking may be shown through testing, such as ASTM D 4792, or through field failure such as, but not limited to, flushing on newer pavement or apparent over-asphalting in production. The Department may require the steel slag processor at any time to perform additional testing to verify steel slag properties. Potential pavement performance problems due to poor control of steel slag aggregate include bulking, poor gradation and specific gravity control resulting in highly variable void properties, excess soft pieces resulting in pock marks, flushing, etc.

Take prompt corrective action if mixture delivered to the paving site is not uniform in composition, does not conform to the specification requirements or is not free of any defect (ex. segregation, tenderness, lack of mixture and texture uniformity, raveling, flushing, rutting, holes, debris etc.) within the Contractor’s control as determined by the Engineer. The Engineer will stop conditional acceptance of the asphalt concrete for failure to correct problems.

**401.04 Reclaimed Asphalt Concrete Pavement.**

Provide reclaimed asphalt concrete pavement (RAP) per the following requirements when choosing to use it in a mix. Failure to follow these requirements will result in a rejection of the Contractor QCP (403.03); restriction of any RAP use at the facility; and/or a change to Unconditional Acceptance at the facility.

**Job Mix Formula.** The Contractor may use a blend of new materials in combination with RAP obtained from verifiable Department or Ohio Turnpike Commission projects. If the RAP is not from the above sources or the source is unknown, process and blend the RAP into a single uniform stockpile, test according to Level 3 Mix Design requirements and obtain District approval for use. Obtain Laboratory written approval for use of unusually large, old RAP stockpiles of unknown content and/or age. Include approved methods in the QCP for ongoing processing and testing of these piles. Ensure no foreign or deleterious material (703.04, 703.05) is present in RAP.

Ensure that the JMF falls within the quality, gradation and asphalt binder content limits of the required mix item. For Contractor designed mixes ensure the JMF submittal includes the percentages of RAP, virgin aggregates, and virgin asphalt binder required for the mix item. Report all RAP test results and an average in the JMF submittal. Identify the RAP in the JMF submittal as to project origin and mix type(s).

Determine RAP properties and uniformity as follows. Determine final RAP gradation and asphalt binder content on a minimum of four separate stockpile (or roadway for concurrent grinding) samples all agreeing within 0.4 percent for asphalt binder content and 5 percent passing the No. 4 (4.75 mm) sieve. If fractionated RAP is used use a suitable sieve for determining gradation uniformity.

**RAP Usage Limits and Requirements.** Process and use RAP by one of the following two methods. Note on the JMF submittal RAP page which of Method 1 or Method 2 methods described below apply to the RAP.

**Method 1 Standard RAP.** Include RAP in a JMF submittal per the Standard RAP Limits Table 401.04-1 unless specified differently in the applicable mix specification. For mixes that will contain up to 10 percent RAP the JMF submittal is not required to include the RAP except when a virgin polymer asphalt binder is used in a surface course. For surface JMFs having polymer asphalt binder only submit at 0 or 10% RAP. If greater than 20 percent RAP is used in a JMF submittal include an analysis of the recovered asphalt binder and blend per Level 3 Mix Design procedures to determine the grade of virgin asphalt binder to use.

**TABLE 401.04-1**  
**METHOD 1 – STANDARD RAP LIMITS**

Asphalt Mix Application	Percent RAP by Dry Weight of Mix	Minimum Virgin Asphalt Binder Content	Comments
Heavy Traffic Polymer Surface Course	10 max		For non-polymer virgin binder allow 20% max RAP
Medium Traffic Surface Course	20 max	5.0	Polymer or non-polymer virgin.
Light Traffic Surface Course		5.2	
Intermediate Course	35 max		Any mix type used as an intermediate course.
Base Course 301	50 max		The Laboratory will establish the asphalt binder content.
Base Course 302	40 (30) max		A lower limit of 30 percent will be required if poor production mixing or coating is evident.

**RAP Processing for Table 401.04-1 Method 1-Standard RAP.** For surface courses process RAP to less than 0.75 inch (19 mm) and place a 0.75 inch (19 mm) screen on the cold feed. For other courses place a 2-inch (50 mm) screen on the cold feed. Ensure that the RAP is the proper size to allow for complete breakdown in the plant. If mixing is incomplete, place a smaller screen on the cold feed.

**Method 2 Extended RAP.** Include RAP in a JMF submittal per the Extended RAP Limits Table 401.04-2 unless specified differently in the applicable mix specification. Only use Method 2 with counter flow drum plants or mini-drum batch plant configurations meeting 402. For mixes that will contain up to 15 percent RAP the JMF submittal is not required to include the RAP unless a virgin polymer asphalt binder is used in a surface course. For JMFs having polymer asphalt binder do not submit at 1 thru 9% RAP.

If greater than 25 percent RAP is used in a JMF submittal include an analysis of the recovered asphalt binder and blend per Level 3 Mix Design procedures to determine the grade of virgin asphalt binder to use. If the blending shows a grade change is required use a PG64-28 for heavy intermediate courses or PG 58-28 or 64-28 for medium intermediate or base courses. No grade change is required with RAP at 26% to 40% if Warm Mix Asphalt (WMA) technology is used in a manner to maintain the mix temperature below 275 °F (135°C). Use WMA technology meeting 402.09. Other WMA technologies must be approved by the Laboratory. If desired, WMA may be used to control plant temperatures when producing mixes using RAP above 40% but a grade change is required if shown necessary by the blending index.

**TABLE 401.04-2  
METHOD 2-EXTENDED RAP LIMITS**

<b>Asphalt Mix Application</b>	<b>Percent RAP by Dry Weight of Mix</b>	<b>Minimum Virgin Asphalt Binder Content</b>	<b>Comments</b>
Heavy Traffic Polymer Surface Course	15 max	5.0	For non-polymer binder allow 25% max RAP and 4.6 min virgin.
Medium Traffic Surface Course	25 max	4.8	Polymer or non-polymer virgin.
Light Traffic Surface Course		5.0	
Intermediate Course	40 max	3.0	Any mix type used as an intermediate course.
Base Course 301	55 max		The Laboratory will establish the asphalt binder content.
Base Course 302	45 (40) max	1.8	A lower limit of 40 percent will be required if poor coating is evident. The virgin requirement of 302.02 does not apply.

**RAP Processing for Table 401.04-2 Method 2-Extended RAP.** Process RAP by means of fractionation or by additional in line processing. Include in the QCP additional methods and procedures to dictate how this is to be accomplished at plants. Specify documentation method for RAP measurement. Fractionation is the process of creating separate piles of RAP from one pile when split over a specific sieve or sieves. Test fractionated piles to show uniformity. For additional in line processing only process RAP from a uniform, tested and approved stockpile by passing the RAP over a double deck screen placed in-line between the RAP cold feed bin and the mixer. Use a 9/16 inch (14.3 mm) screen for surface and intermediate mixes and a 1.5 inch screen for base mixes. Do not use concurrent project RAP in a stream process.

**RAP QC and Management Requirements.** Always note on the daily quality control report how much RAP is actually being used. Apply a tolerance of +/- 5.0% on the amount of RAP used if needed for a quality control adjustment but do not exceed the limits of Table 401.04-1 or Table 401.01-2, whichever applies. If this adjustment is not adequate for maintaining control of the mix submit a new JMF for approval.

Include in the QCP methods to be used to meet Method 1 and Method 2 requirements above and the following requirements:

Provide enough space for meeting all RAP handling requirements at a hot mix facility. Provide a clean, graded base for stockpiles that does not collect water.

Test blended RAP stockpiles to assure uniform gradation and asphalt binder content. Ensure uniform stockpile properties match the JMF submitted RAP properties unless the uniform stockpile will be processed into the asphalt plant using plant cold feed in line processing.

If the uniform stockpile will be processed into the asphalt plant using plant cold feed in line processing determine the processed RAP properties for use in the mix design. Record in the JMF submittal both the uniform stockpile and in line processed RAP properties.

If desired, when applying Method 1 Standard RAP requirements, use concurrent Department project RAP in a stream process in place of stockpiling and testing for uniformity but do so in the following manner. Concurrent project RAP must be taken from one existing mix type on the concurrent project or two existing mix types if both mix types are taken at the same time in one pass of the milling machine. Submit a new JMF for each existing mix type on the project (or each milling pass of two types) desired for use as concurrent project RAP. Include in the QCP methods of validating RAP properties when using concurrent project RAP. If these requirements are not met blend and test for uniformity and apply the stockpile requirements of this specification.

Maintain in the plant lab and control room an up to date and dated site map of all tested and untested RAP stockpiles. Give each stockpile a unique identification. Provide in the plant lab RAP properties for each uniform, blended stockpile cross referenced with its identification. In addition, provide the date the stockpile processing was completed and the stockpile estimated size in tons. The DET may require RAP pile staking for failure to maintain the above. Do not add to a stockpile once it is tested for uniformity. Provide signage at all uniform stockpiles to inform haulers that uniform piles are not to be added to.

Stockpiles and processing methods are subject to inspection and approval by the DET at any time. Rejection of stockpiles can occur for the presence of foreign or deleterious materials, lack of uniformity, incomplete mixing in the asphalt mixture, adding to piles, or moving RAP in a way not traceable thru the QCP records and methods. The Laboratory will resolve disputes over acceptability of RAP.

**401.05 Mixing Plants.** The Department will approve mixing plants before preparation of the mixtures. General requirements for asphalt concrete mixing plants are specified in Item 402.

Set the asphalt binder controls for the computerized plant at the virgin asphalt binder content of the JMF at all times unless change is authorized by the Laboratory.

Asphalt mixtures may be produced using the warm mix asphalt method according to 402.09 except as restricted by specification.

**401.06 Weather Limitations.** Place asphalt concrete only if the surface is dry and if weather conditions are such that proper handling, finishing, and compaction can be accomplished. Never place asphalt concrete if the surface temperature is below the minimum established in Table 401.06-1.

TABLE 401.06-1

Course Thickness	Minimum Surface Temperature	
3.0 inches (75 mm) and over	36 °F <sup>[1]</sup>	(2 °C <sup>[1]</sup> )
1.5 to 2.9 inches (38 to 74 mm)	40 °F	(5 °C)
1.0 to 1.4 inches (25 to 37 mm)	50 °F	(10 °C)
Less than 1.0 inch (25 mm)	60 °F	(16 °C)
Variable Intermediate, 0 to 3.0 inches (0 to 75 mm)	40 °F	(5 °C)

[1] Instead of 36 °F (2 °C), use a minimum air temperature of 40 °F (5 °C) if paving on an aggregate base or subgrade.

In addition to the above surface temperature requirements, do not place surface courses if the air temperature is less than 40 °F (5 °C).

For Type 1H asphalt concrete or any surface course with a polymer modified asphalt binder, ensure that the surface of the existing pavement is at least 50 °F (10 °C) and the air temperature is at least 50 °F (10 °C).

Do not schedule the placement of any Type 1H asphalt concrete or any surface course with a polymer modified asphalt binder after November 1, regardless of pavement or air temperature.

**401.07 Notification.** Notify the Engineer at least 24 hours before starting paving on a project. After starting paving, if paving operations are stopped for 1 week or more, notify the Engineer at least 24 hours before resuming paving on a project.

**401.08 Asphalt Binder.** Heat the asphalt binder and deliver it to the mixer within the temperature range specified in Table 702.00-1. Do not use asphalt binder while it is foaming in a storage tank. Take samples using correct new containers from the binder line between the last piping 'tee' and inlet into the plant unless a different storage method requires a different sampling location.

**401.09 Aggregate Preparation.** Feed aggregates in their proper proportions and at a rate to permit correct and uniform control of heating and drying. Remove all aggregates in the plant that will produce a mix outside the temperature limits or that contain excessive moisture or expanding gases causing foaming in the mixture, and return them to the proper stockpiles.

**401.10 Mixing.** Maintain the temperature of the mix at the plant within the range set by the Laboratory for the JMF or per specification. The Engineer will determine the required temperature of the mixture on arrival at the project site based on the temperature range set for the mix design and heat losses in transit.

For batch plants, after all of the aggregate is in the mixer, add the asphalt binder in an evenly spread sheet over the full length of the mixer. The mixing time is defined as the interval between the start of application of the asphalt binder and the opening of the mixer gate. Discharge all asphalt binder required for one batch in not more than 30 seconds. After the asphalt binder is added, the Laboratory will establish a minimum mixing time, which will not be less than 30 seconds.

**401.11 Hauling.** Use trucks for hauling asphalt concrete that have tight, clean, smooth metal beds from which the entire quantity of mixture is discharged smoothly into the spreading equipment.

Before loading, apply a thin coating of an approved release agent to the inside surfaces of the truck bed to prevent adhesion of mixture to the bed surfaces. The Laboratory maintains a list of approved release agents. Do not use fuel oil for this purpose. Drain truck beds before loading.

Provide a place off the project for cleaning trucks when hauling polymer modified asphalt binder mixes or when excessive sticking of material in truck beds occurs. If the Contractor does not resolve excessive sticking of material in truck beds in a reasonable time and the sticking is in areas of the truck that would indicate excessive cooling of the mix (front corners, bottom, etc.) due to a long haul, the Engineer will require an insulated bed. The Contractor may only make changes in policy regarding release agents for beds or other procedure changes for better mix handling at the discretion of the Laboratory.

Equip each truck with a securely fastened, waterproof cover of suitable material to adequately protect the mixture from wind and weather. At the request of the Engineer, remove covers before dumping into the paver.

If transporting hot asphalt concrete at prevailing air temperatures below 50 °F (10 °C) or if the length of haul exceeds 20 miles (32 km), insulate all truck beds to maintain workable mix temperature, and ensure that all covers are fastened to exclude the wind. Do not exceed a distance of 50 miles (80 km) from the asphalt concrete plant to the paving site except by specific permission of the Department.

**401.12 Spreading Equipment.** Use self-contained spreading equipment of sufficient size, power, and stability to receive, distribute, and strike-off the asphalt concrete at rates and widths meeting the typical sections and other details shown on the plans. Use spreading equipment that has automatic control systems that maintain the screed in a constant position relative to profile and cross-slope references. Ensure control of the screed position is reasonably independent of irregularities in the underlying surface and of the spreader operation. Equip asphalt spreading equipment to prevent the segregation of coarse aggregate from the remainder of the asphalt concrete when the material moves from the hopper to the screed. Use means and methods approved by the asphalt spreader manufacturer consisting of but not limited to any combination of chain curtains, deflector plates, or other such devices.

For the following asphalt spreaders perform the listed modifications:

A. Equip Blaw-Knox asphalt spreaders with the Blaw-Knox Materials Management Kit (MMK) or an alternate equivalent kit. If an alternate kit is used provide documentation showing the Blaw Knox means and methods and that the alternate methods used are equivalent.

B. Only use Cedar Rapids asphalt spreaders manufactured after 1988.

C. Equip Caterpillar asphalt spreaders with deflector plates as identified in the Caterpillar December 2000 Service Magazine entitled "New Asphalt Deflector Kit {6630, 6631 or 6640}".

**401.13**

Provide a letter to the Engineer identifying modified asphalt spreaders to be used and provide a certification statement and signature that the above modifications were implemented on the listed asphalt spreaders.

The Engineer will base final approval of spreading equipment on the demonstrated capability of the equipment to place the mixture to the required cross-section, profile and alignment in an acceptable, finished condition ready for compaction.

Where the use of standard full-scale spreading equipment is impractical due to the size or irregularity of the area to be paved, use specialized equipment or hand methods approved by the Engineer to spread the asphalt concrete.

**401.13 Rollers.** Use only steel wheel and pneumatic tire types of rollers meeting the minimum requirements of the following tables. Conform to manufacturer’s specifications for all ballasting.

**TABLE 401.13-1 ROLLER CAPACITY**

<b>Roller Type</b>	<b>Maximum Capacity square yards per hour (m<sup>2</sup>/hr)</b>
Tandem	700 (600)
Three-Wheel	700 (600)
Trench	15 per inch width (13 per 25 mm width)
Pneumatic Tire, Type 1	1000 (850)
Pneumatic Tire, Type 2	700 (600)
Vibratory, Vibrating Roll	15 per inch width (13 per 25 mm width)
Vibratory, Static Roll (not vibrating)	3 per inch width (3 per 25 mm width)

**TABLE 401.13-2 STEEL WHEEL ROLLERS**

<b>Roller Type</b>	<b>Three- Wheel</b>	<b>Vibratory</b>		
		<b>Tandem</b>	<b>Static</b>	<b>Trench</b>
Total weight, tons (metric tons)	10 (9)	8 to 12 (7 to 11)	8 to 12 (7 to 11)	
Compression rolls, pounds per inch width (kN/m), minimum	300 (53)	200 (35)	120 (21)	300 (53)

**TABLE 401.13-3 PNEUMATIC TIRE ROLLERS**

<b>Type I</b>	
Tire size, minimum	9.00 × 20 in (229 × 508 mm)
Wheel load, minimum	5000 lb (2250 kg)
Average tire contact pressure, minimum	85 psi (590 kPa)
<b>Type II</b>	
Tire size, minimum	7.50 × 15 in (191 × 381 mm)
Wheel load, minimum	2000 lb (900 kg)
Average tire contact pressure, minimum	55 psi (380 kPa)

For pneumatic tire rollers, use self-propelled, reversible units with vertical oscillation on all wheels on at least one axle. Determine the tire inflation pressure necessary to meet the specified minimum contact area and contact pressure requirements. Furnish the tire manufacturer's charts or tabulations to the Engineer for verification of the required inflation pressure. Check tire inflation pressure as the Engineer directs and maintain it within 5 pounds per square inch (35 kPa) of the required pressure.

Provide rolls and wheels with the necessary accessories to prevent adhesion of the mixture, and keep them properly moistened with water, water containing a detergent, or water containing an approved additive. Do not use excess liquid.

**401.14 Conditioning Existing Surface.** Clean the surface on which the asphalt concrete is to be placed, and keep it free of accumulations of materials that would, in the judgment of the Engineer, contaminate the mixture, prevent bonding, or interfere with spreading operations. Where approved subgrade or pavement courses previously constructed under the Contract become loosened, rutted, or otherwise defective, correct the deficiency according to the contract item or items involved before the spreading of a subsequent pavement course.

If a quantity of asphalt concrete is specified for use in spot leveling or patching an existing pavement surface, spread and compact the material needed to effect the corrections as directed by the Engineer.

Paint contact surfaces of curbing, gutters, manholes, and other structures with a thin, uniform coating of asphalt material before placing the asphalt concrete against them.

If placing asphalt concrete against the vertical face of an existing pavement structure, clean the vertical face of foreign material and apply asphalt material that results in a coating of approximately 0.25 gallon per square yard (1 L/m<sup>2</sup>).

Before placing a surface course onto an intermediate course, apply a tack coat to the intermediate course according to 407.06.

In areas where the surface is required to be feathered to meet an adjoining surface, coat the existing surface uniformly with a thin coat of asphalt binder.

**401.15 Spreading, Finishing and Night Work.** Spreading and Finishing. Spread the mixture at a rate calculated using the specified thickness and the compacted width of the pavement course being placed, and the weight-to-volume conversion factors established in 401.21. Maintain the actual rate of spreading the mixture equal to the required calculated rate within the tolerance specified in 401.19. For pavement courses specified for leveling an existing pavement surface, the actual rate of spreading the mixture may vary from the required calculated rate as approved by the Engineer to accomplish the intended purpose.

For intermediate courses, make the maximum compacted depth of any one layer 3 inches (75 mm).

Spread and finish the mixture using approved equipment or methods such that compaction can follow immediately. Preheat screeds before placing any asphalt concrete. Use side plates sufficient to contain the mixture laterally during spreading. If paving in excess of the nominal paver width, use only a permanent extension or an adjustable extension with full auger extensions when matching a previously placed pavement course. Use extensions that have the ability to heat. The Contractor may use strike-off plates on adjacent berm areas. Perform supplemental hand forming and tamping where irregularities develop and where placing the mixture by hand methods.

Take prompt corrective action if placed mixture is not free of any defect (ex. segregation, tenderness, lack of mixture and texture uniformity, raveling, flushing, rutting, holes, debris etc.) within the Contractor's control and as determined by the Engineer. Remove and replace, or otherwise correct, any portion of the pavement course found to be defective in surface texture or composition before or after compaction in a manner satisfactory to the Engineer. Coordinate the spreading operation with the rate of production and delivery of the mixture to attain uniform, continuous progress. Avoid erratic spreader operation due to irregular contact with the hauling vehicle, surging in the feed and distribution of the mixture, or other cause. Maintain sufficient control of the spreading equipment with regard to line and grade references so that the pavement course, when compacted as specified, is in reasonable conformance with the Contract Documents.

Do not displace or damage bridge deck waterproofing membranes during spreading operations on the membranes.

Do not allow traffic on the compacted mixture until it has cooled sufficiently to prevent glazing as determined by the Engineer.

After completion of the surface course, seal gutters with asphalt binder as directed by the Engineer. Apply the material at a uniform width of approximately 4 inches (100 mm) and at a rate just sufficient to fill surface voids.

**Night Work.** Do not start night work or carry on day work into night work without operating an adequate and approved lighting system. Night work is defined as work performed from 30 minutes before sunset to 30 minutes after sunrise.

Operation of adequate lighting system consists of furnishing, installing, operating, maintaining, moving, and removing night time lighting to illuminate construction work areas for night work. Obtain the Engineer's approval of the

lighting at the beginning of the project and before starting the paving operation by measuring the luminance.

Provide an illuminated zone around all operating machinery. Provide an illuminated zone of at least 5 Foot-candles (55 lux) of lighting luminance in the immediate vicinity of pavers, rollers, grinding equipment, material transfer vehicles, etc., and at least 1 Foot-candle (10 lux) at 25 feet (7.6 m) from this equipment. Provide an illuminated zone of at least 5 Foot-candles (55 lux) of lighting luminance in the immediate vicinity of coring equipment and at least 1 Foot-candle (10 lux) at 10 feet (3m). Position the light sources so they don't interfere with or impede traffic in any direction and do not cause glare for motorists or point onto adjacent properties. Provide a photometer capable of measuring the level of luminance on each night project. Take luminance measurements at a height of 20 inches (500 millimeters) above the roadway.

Obtain the luminance level any time requested by the Engineer. Test the illumination levels on the site each time a change in lighting configuration is made. Replace non-functioning lamps immediately. Check the luminaires aiming daily. Clean the luminaires regularly. Correct any deficient lighting within one hour or the Engineer will terminate construction activities.

When the project's night paving is more than 1 continuous (including bridges) lane mile, provide a self-propelled Material Transfer Vehicle (MTV).

Provide a MTV that:

- a. moves independently of the paver
- b. is equipped with mixing augers that continuously reblend the HMA material as it is discharged from the storage hopper during placement eliminates material segregation
- c. has a minimum surge capacity of 15 tons
- d. limits temperature differentials to less than 25° F (14° C).

Use a paver hopper insert with a minimum capacity of 14 tons when using a MTV. Measure and determine the temperature differential transversely across the freshly placed mat as the difference between the highest and lowest temperatures.

**401.16 Compaction.** Immediately after spreading the asphalt concrete and adjusting any surface irregularities, compact the mixture uniformly using rollers conforming to 401.13. Do not use a spreading rate that exceeds the total of the specified capacities of the rollers in use. However, if compacting a mixture spread as an intermediate or pre-leveling course less than 1 inch (25 mm) thick, do not use a spreading rate that exceeds twice the total capacity of the rollers in use.

Coordinate the spreading of the mixture with the required roller coverage, considering the rate of cooling of the mixture as affected by lift thickness and environmental conditions. Complete the required roller coverage during the period of time in which the temperature of the mixture is sufficient for the roller coverage to be effective in compacting the mixture.

#### 401.17

Compact base mixtures using a combination of both steel and Type I pneumatic tire rollers; however, in small areas, compact these mixtures as approved by the Engineer using any of the rollers specified in 401.13.

Compact intermediate and surface mixtures using a three-wheel roller in the breakdown position (roller immediately behind the paver) of the roller train; however, in small areas, compact these mixtures as approved by the Engineer using any of the roller types specified in 401.13.

Compact variable depth courses using a combination of both steel and pneumatic tire rollers; however, in small areas, compact these mixtures as the Engineer approves using any of the roller types specified in 401.13.

For Type 1H asphalt concrete or mixes using a polymer modified asphalt binder, give a copy of the JMF approval letter containing the design compaction temperature to the Engineer before any mix is placed. Ensure that the mix temperature immediately before rolling is not less than 290 °F (145 °C). Pneumatic tire rollers are not recommended for polymer asphalt concrete because of excessive pick up.

Do not use vibratory rollers on courses with a thickness under 1 1/2 inches (38 mm).

If using vibratory rollers, supplement them with three-wheel or pneumatic tire rollers.

Unless otherwise directed, begin rolling at the sides and proceed longitudinally parallel to the centerline at a slow, uniform speed. After each coverage or complete round trip, move the roller towards the crown of the road to begin its next pass, overlapping the previous pass by at least one-half the width of the previous pass. On superelevated curves, begin rolling at the low side and progress toward the high side. Where a longitudinal joint is being made, roll the joint then follow the applicable rolling procedure.

Continue rolling until full coverage of the course is complete and all roller marks are eliminated. Take care to prevent displacement of the edgeline and grade. Where displacement occurs, correct the area immediately in a manner satisfactory to the Engineer.

Along curbs, headers, walls, and in other areas not accessible to rollers, thoroughly compact the mixture with hot, hand tampers or with mechanical tampers. On depressed areas, the Contractor may use trench rollers or rollers fitted with compression strips.

Replace mixture that becomes loose, broken, contaminated, or otherwise defective with fresh, hot mixture. Compact it to match with the surrounding area.

**401.17 Joints.** Place the asphalt concrete mixture as continuous as possible. Set up joints at the proper height above the adjacent construction to receive maximum compaction. Where the edge of the new surface has been significantly rounded by the action of traffic, trim it to a vertical face before placing the adjacent pavement. On projects where traffic is allowed to cross the edge of the new pavement lane, complete the longitudinal joint of the adjacent lane or berm within 24 hours.

Form hot longitudinal joints using pavers operating in contiguous lanes, one just ahead of the other. Maintain the distance between pavers in adjacent lanes such that it does not exceed the distance that a normal size load of mixture will cover. Alternate loads of mixture between the pavers. Do not allow rollers performing the initial rolling operation in one lane closer than 12 inches (0.3 m) to the longitudinal joint until the adjacent lane is placed.

Instead of hot joint construction using multiple pavers, the Contractor may use full width construction with a single unit paver.

Compact all cold longitudinal joints on intermediate and surface courses using a three-wheel roller.

For surface courses, form or cut all transverse construction joints to a vertical.

Seal all cold longitudinal construction joints by coating the entire face of the cold joint with a certified 702.01 PG binder or 702.13 Rubberized Asphalt Emulsion to provide 100 percent coverage of the joint. Overlap the joint edges by at least 1/2 inch (13 mm). Seal all cold transverse construction joints with a certified 702.01 PG binder or 702.13 Rubberized Asphalt Emulsion to provide 100 percent coverage of the joint or with a certified 702.04 asphalt material applied at a rate of 0.25 gallon per square yard (1 L/m<sup>2</sup>).

**401.18 Asphalt Binder Compatibility.** If excess fat spots, regular random areas of flushing, or excess drain down occur on a project that are not attributable to over rolling, plant operation, or mix quality compared to the JMF, the Department will consider the asphalt binder incompatible. The Department will reject any on-hand asphalt binder because of incompatibility. The Department may use its discretion in determining if problem areas can be corrected, but if an unsafe condition exists, remove and replace the area in question. Demonstrate to the Laboratory through reporting actual testing analysis the compatibility of another asphalt binder and that proper equipment is in place in order to be allowed to resume.

**401.19 Spreading and Surface Tolerances.** If a uniform course is specified, make checks and adjustments to maintain the rate of spreading within a tolerance of  $\pm 5$  percent of the required calculated weight per unit of area.

If a variable depth course is specified, place the mixture as shown on the plans.

If a longitudinal profile is specified by elevations on the plans, do not allow the completed pavement surface to deviate more than 1/2 inch (13 mm) from the plan elevation at any point. Before placing the surface course, check the profile of the preceding course at 50-foot (15 m) intervals along the outside edge of each traffic lane and along any additional line described in superelevation tables, and submit a tabulation of all results that includes documentation of all deviations from the above tolerance to the Engineer for approval. Perform corrective work necessary for compliance with the profile tolerance before placing the surface course. The requirements of this paragraph do not apply to small incidental areas of pavement less than 500 feet (150 m) in length.

Do not vary the transverse slope of the surface of the completed course from the specified slope by more than 3/8 inch in 10 feet (10 mm in 3 m).

## 401.20

Do not vary the surface of each completed intermediate or surface course from the testing edge of a 10-foot (3 m) rolling straightedge by more than 1/4 inch (6 mm). Furnish straightedges, straightedges equipped with levels, or other devices such as approved profilers conforming to S1058 and using ProVAL software. Equipment will be satisfactory to the Engineer.

Check the surface course for variations in slope or surface when directed by the Engineer.

Correct variations in excess of slope or surface tolerance by removing mixture to neat lines and replacing, or by surface grinding in a manner satisfactory to the Engineer

**401.20 Asphalt Binder Price Adjustment.** A contract item is eligible for a price adjustment when the contract's proposal specifically includes an Asphalt Binder Price Adjustment note and the contract item meets the quantity limitations of the proposal note.

**401.21 Method of Measurement.** The Contractor is responsible for recording the net weight of each truckload of mixture to the nearest 100 pounds (50 kg) in triplicate on plant ticket forms approved by the Department. If the pay quantities are established by platform scales, provide a tare weight for each truck at the beginning of each day's operation and a minimum of every 4 hours of operation each day. The Engineer may require additional tare weight measurements at any time. The Engineer will have the right to monitor all weighing operations and may require reweighing trucks at any time or location. Correct any discrepancies immediately. Continued non-compliance will result in the Department taking necessary and appropriate action, such as, but not limited to, assigning a Department ticket writer to the plant. Send one copy of the plant ticket with each load delivered to the paver and present it to the Engineer.

The Engineer will convert the total of the weights recorded on the plant tickets representing mixture finished according to contract requirements to cubic yards (cubic meters) using a conversion factor established by the Laboratory. The Laboratory will establish this conversion factor from the approved JMF. However, if a mix design is not available, the Laboratory will use the conversion factors in Table 401.21. If a uniform course is specified, the Department will not pay for a number of cubic yards (cubic meters) that exceeds the quantity calculated from plan lines and dimensions.

TABLE 401.21

Aggregate	lb/yd <sup>3</sup>	(kg/m <sup>3</sup> )
Gravel and stone	4000	(2370)
Slag less than 90 lb/yd <sup>3</sup> (less than 1450 kg/m <sup>3</sup> ) <sup>[1]</sup>	3600	(2135)
Slag 90 to 100 lb/yd <sup>3</sup> (1450 to 1600 kg/m <sup>3</sup> ) <sup>[1]</sup>	4000	(2370)
Slag more than 100 lb/yd <sup>3</sup> (more than 1600 kg/m <sup>3</sup> ) <sup>[1]</sup>	4300	(2550)

[1] Based on average dry rodded weight at the Laboratory.

**401.22 Basis of Payment.** The Department will pay for all work performed and measured as specified above according to the appropriate contract items for each type.

The cost of sealing the joints is included in the unit price bid for the asphalt concrete.

The Department will assess all costs against the Contractor that it incurs as a result of taking necessary and appropriate action due to the Contractor's continued non-compliance.

If an unsafe condition exists, the Department will not pay for removing and replacing incompatible asphalt binder areas.

## ITEM 402 ASPHALT CONCRETE MIXING PLANTS

### 402.01 Description

### 402.02 General

### 402.03 Scales

### 402.04 Thermometers

### 402.05 Storage

### 402.06 Calibration

### 402.07 Computerized Plant System

### 402.08 Polymer Binders

### 402.09 Water Injection System for Warm Mix Asphalt

**402.01 Description.** This specification consists of the minimum requirements for an asphalt concrete mixing plant to produce asphalt concrete mixes according to Department specifications.

Ensure asphalt concrete mixing plants conform to the requirements of ASTM D 995 in addition to the following.

**402.02 General.** If more than one kind of asphalt binder is to be used concurrently, separately store each kind.

Ensure that the adjustments for total and proportional feed are continuously variable and capable of being locked at any position.

### 402.03

Use batch plant hot bins that have an oversized material discharge pipe of not less than 6 inches (150 mm) in diameter. Ensure pipes discharge material at points outside the plant operation and do not create a hazard or discomfort.

In batch plants, use a non-tilting asphalt binder bucket with a loose sheet metal cover. Ensure that the length of the discharge opening or spray bar is not less than three-fourths the length of the mixer and that it discharges directly into the mixer. Ensure that the asphalt binder bucket, its discharge valve or valves, and spray bar are fully jacketed or heated. Use jackets that drain efficiently and ensure that all connections are constructed to not interfere with the efficient operation of the asphalt binder scales. Use an asphalt binder bucket with a capacity of at least 10 percent greater than the weight of asphalt binder required in any batch. Ensure that the plant has an adequately heated, quick-acting, nondrip, charging valve directly over the asphalt binder bucket.

**402.03 Scales.** Use scales and test weights that conform to the regulations of the Ohio Department of Agriculture. Seal scales as often as the Laboratory directs to ensure their continued accuracy. Seal test weights at least every 3 years at places designated by the Ohio Department of Agriculture. Equip the plant with one 50-pound (20 kg) test weight for each 400 pounds (200 kg) of the maximum batch weight with a minimum of ten test weights.

Provide a truck scale or recording batch plant scales for the purpose of obtaining the net weight of each load of asphalt mixture as required in 401.21.

Use truck scales that indicate the total weight within 20-pound (10 kg) increments and have a rated capacity of at least 10 percent greater than the largest load weighed. Provide a platform large enough to receive the largest truck used for a single weighing.

Use batch plant scales that have a capacity of at least 10 percent greater than the largest weight required for any one batch.

**402.04 Thermometers.** Equip the plant with an adequate thermometric instrument, clearly legible from the mixer operator's station, to monitor the temperature of the asphalt binder. Locate the sensing element or unit in the feed line near the charging valve at the mixer. Where a pyrometer is used, connect the indicator to the thermocouple by a weatherproof extension wire.

Also, equip the plant with either an approved dial-scale, mercury-actuated thermometer; an electric pyrometer; or other approved thermometric instrument so placed at the discharge chute of the dryer as to register automatically or indicate the temperature of the heated aggregates.

**402.05 Storage.** Provide storage bins capable of storing hot asphalt concrete mixtures up to 24 hours. Insulate or heat storage bins if mixtures are stored for more than 8 hours. Ensure that the system is capable of maintaining the required temperature without creating hot spots within the stored mixture. In addition, if hot asphalt mixtures are stored from 8 to 24 hours, then introduce a silicone admixture into the asphalt binder at the rate of 1 fluid ounce per 5000 gallons (1 mL/640 L).

**402.06 Calibration.** Calibrate the plant for each combination of aggregate, reclaimed asphalt concrete pavement, and asphalt binder type/content for the mixtures to be produced. Ensure that the calibration is accurate within 1.0 percent.

**402.07 Computerized Plant System.**

**A. General.** Produce all asphalt concrete in a plant with a computerized plant system approved by the Laboratory. Ensure that the computerized plant system's monitoring device for the asphalt binder content is capable of being locked or sealed. After initial calibration of the plant, the Department may lock or seal the asphalt binder content monitoring device.

Ensure that all printouts contain the following information:

1. Date.
2. Time.
3. JMF number.
4. Moisture content of the reclaimed pavement.
5. Percent asphalt binder in the reclaimed pavement to the nearest 0.1 percent.
6. Percent virgin asphalt binder to the nearest 0.1 percent.
7. Percent total asphalt binder calculated to the nearest 0.01 percent.

Ensure that all printouts are preapproved by the Laboratory and are turned over to the DET at the end of the project or the end of the production year.

Ensure that the computerized plant system prints "SIMULATE" on the ticket or printout whenever the computerized plant system is only simulating asphalt concrete production.

Ensure that the computerized plant system has an audible alarm system that notifies the plant operator when the amount of asphalt binder, aggregate, or reclaimed pavement being mixed into the asphalt concrete is outside the tolerances established by the Contractor's Quality Control Manager. Make appropriate adjustments when production is outside the tolerances.

**B. Batch Plants.** In addition to the requirements of 402.07.A, print the information on each weight ticket if the asphalt concrete is directly loaded into the truck or on a separate printout for every 16 tons (15 metric tons) or less of production if the asphalt concrete is loaded into a storage silo. Ensure printouts contain the following additional information:

1. Tare weight of the asphalt binder scale.
2. Tare weight of the aggregate scale.
3. Pounds (kilograms) of virgin asphalt binder.
4. Pounds (kilograms) of virgin aggregate.
5. Pounds (kilograms) of reclaimed pavement measured by a batch scale.

6. Tons per hour (metric tons per hour) of reclaimed pavement measured by a belt scale.

**C. Drum Mix Plants.** In addition to the requirements of 402.07.A, print the information every 5 minutes during production. Ensure printouts contain the following additional information:

1. Tons per hour (metric tons per hour) of virgin asphalt binder.
2. Tons per hour (metric tons per hour) of virgin aggregate.
3. Tons per hour (metric tons per hour) of reclaimed pavement.
4. Moisture content of the virgin aggregate.

**402.08 Polymer Binders.** If an asphalt binder is modified by SBR polymer at an asphalt concrete mixing plant, equip the plant with an SBR polymer flow meter and monitoring system. Obtain the Laboratory's approval of the system before operating. Demonstrate the system calibration to the District. If the District waives the demonstration, provide a letter documenting calibration data for the flow system to the DET for each project.

For drum mix plants, introduce the SBR polymer directly into the asphalt binder line through means of an in-line motionless blender able to provide a homogeneous blend. Locate a sampling valve between the in-line blender and the plant drum.

For batch plants, add the SBR polymer after the aggregate has been completely coated with asphalt binder. Continue mixing for a minimum of 20 seconds after SBR polymer is added and long enough to provide a uniform mixture.

Use a 1-inch (25 mm) magnetic flow meter that employs balanced electrode plane technology. Ensure that the flow meter has two grounding electrodes located in the same measurement plane as the sensing electrodes. The flow meter does not require grounding rings if installed in nonmetallic piping. No straight run is required in piping before or after the flow meter to maintain accuracy, except if located downstream of a pump or modulating valve. Ensure that the totalizer displays a total volume measured and rate indication in any standard engineering units. Ensure that accuracy is  $\pm 2.0$  percent over flow range from 0.8 to 47.5 gallons per minute (3 to 180 L/min). Install the flow meter in the piping downstream of all recirculation lines. Provide a lockable sample valve downstream of the flow meter for calibration purposes. Interface the flow meter with a data logging flow computer. The flow computer shall produce printouts of the logged data every 5 minutes for a drum mix plant or every batch for a batch plant. Include time, date, flow rate, and flow total in the logged data. Flow rate is not necessary for batch plant production.

Balling or wadding of SBR polymer or uncoated aggregate indicates improper mixing. Cease production immediately and until corrected to District satisfaction.

#### **402.09 Water Injection System for Warm Mix Asphalt.**

When allowed by specification use a Department approved water injection system for the purpose of foaming the asphalt binder and lowering the mixture temperature. Only use equipment that has been proven stable and effective thru

project use on non-ODOT projects. Ensure equipment for water injection meets the following requirements:

1. Injection equipment computer controls are in the plant control room and are tied to the plant computer metering.
2. Injection equipment has variable water injection control controlled by the plant operation rate and the water injection can never exceed 1.8% by weight of asphalt binder.
3. Water injection rate cannot be manually overridden by the plant operator once in the computer.
4. Injection equipment stops water flow when a control or equipment failure in the injection system occurs.
5. The water injects into the asphalt binder flow before the asphalt binder spray hits aggregate. Do not allow water to touch aggregate before the binder spray.
6. Injection equipment includes water storage and pump control tied to the injection computer controls.
7. Water storage low water alarm installed in the control room.
8. Provide a PG binder sampling valve between the last piping tee on the tank side of the line and the injection equipment to sample PG binder before water is injected.
9. Provide a PG Binder sampling valve at the injection equipment to sample binder prior to spray.

## **ITEM 403 ASPHALT CONCRETE QUALITY CONTROL AND ACCEPTANCE**

### **403.01 Description**

### **403.02 General**

### **403.03 Quality Control Program (QCP)**

### **403.04 Plant Calibration**

### **403.05 Quality Control Tests**

### **403.06 Verification Acceptance (VA)**

### **403.07 Unconditional Acceptance**

### **403.08 Acceptance Tables for 448 Mixes**

**403.01 Description.** This specification outlines the Contractor requirements for controlling asphalt concrete, asphalt concrete base, or other asphalt mixtures as specified.

**403.02 General.** The Department will determine acceptance by Department Verification Acceptance (VA) tests and monitoring reviews as specified. If the Contractor fails to operate according to its Quality Control Program (QCP), the Department will accept asphalt mixtures by Unconditional Acceptance.

### 403.03

Restoration of VA procedures will be by the Department's Quality Control Qualification Committee (QCQC) based on District recommendation and review of the Contractor problems, resolutions and QCP.

Acceptance does not relieve the Contractor of responsibility for supplying and installing a finished product conforming to all requirements of the Contract.

**403.03 Quality Control Program (QCP).** Create and implement a Quality Control Program (QCP) for each paving season. The QCP will cover processes conducted to provide an asphalt mixture at the paving site that is uniform in composition, conforms to the specification requirements and that when placed is free of any defect (ex. segregation, lack of mixture and texture uniformity, raveling, rutting, holes, debris etc.) within the Contractor's control at project completion. A minimum of 3 weeks before mix production, but no later than February 28, submit the proposed QCP to the Laboratory for review and approval.

Send a copy of the approval letter and approved QCP to the DET in every District in which work is performed. Keep copies of the approval letter and the approved QCP in each Contractor plant laboratory and plant operation control room.

Failure to comply with the approved QCP may result in removal of personnel in accordance with Supplement 1041, removal from VA, and adversely affect the Contractor's Prequalification rating.

The QCP is a reflection of a Contractor's sincerity and ability in producing a quality product. Development of this program beyond the minimum requirements specified below is encouraged and is taken into consideration by the QCQC when reviewing Contractor plant operation for qualification for VA.

Include in the program:

A. The assignment of quality control responsibilities. Quality control includes all efforts required to achieve a product meeting specifications. The QCP will list individuals as required below and note their designated responsibilities to meet QCP requirements. Provide a Quality Control Manager holding a Supplement 1041 Level 3 approval and who is a company employee. Assign Level 2 technicians for all Level 2 QC testing duties only. If Level 2 consultant technicians are used provide a document in the QCP and to them listing designated responsibilities and expected actions (if different from employee expectations). Provide a Field Quality Control Supervisor, holding Supplement 1041 Field Quality Control Supervisor approval and who is a company employee, who is routinely and usually at the paving site during placement of any non-temporary asphalt concrete pavement.

B. Provisions to meet the Department mix specifications.

C. Procedures for extra testing when tests are outside warning band limits of the QCP (e.g., job start, responses to poor test results or field mix problems, aggregate stock testing, reclaimed asphalt concrete pavement checks, moistures) and any other testing necessary to control materials not already defined in these Specifications.

- D. Copies of worksheets, test reports, and forms used in the quality control.
- E. Procedures for record storage, test equipment maintenance, and documentation.
- F. Method of Quick Calibration and documentation for each plant type.
- G. Procedure for random sampling to be used and documentation method.
- H. All procedures to meet the processing, testing and documentation requirements for RAP in 401.04 including test forms, record keeping, technician responsibilities, etc.
- I. Procedure for ensuring that every Contractor employee involved in the testing of asphalt mix and operation of the asphalt plant facility has read the QCP and has on site access to all applicable Department specifications, proposals, policies, and the current approved JMF.
- J. Means to meet the handling and storage requirements of 402.08 and asphalt binder suppliers for all asphalt binders.
- K. Means to meet delivered mixture uniformity/coating and hauling/trucking requirements.
- L. Define the roles and responsibilities of the Field Quality Control Supervisors. List approved Field Quality Control Supervisors.
- M. Signature of the Quality Assurance Manager and, if different, the person in authority to enforce all operations covered by the QCP as outlined in this subsection.
- N. Specify in the QCP warning bands to be used by technicians for all tests and give specific instruction how they will be used for tests in concert with Table 441.10-1 specification requirements.

**403.04 Plant Calibration.** Conform to the requirements of Item 402.

Before manufacturing asphalt concrete, demonstrate to the Monitoring Team that the Contractor's facility adequately meets the specification requirements. Calibrate the plant using procedures approved by the Department. Perform initial calibrations in the presence of the Monitoring Team. The Monitoring Team may request a letter of certification and certified data documenting the calibration results, instead of having the Monitoring Team present.

Verify the calibrations biweekly using a Quick Calibration. However, the Department may request additional Quick Calibrations if there are mix production problems or plant operation concerns. The Quick Calibration is a quality control procedure developed by the Contractor that verifies the accuracy of a facility to proportion materials to meet the current JMF. Include the Quick Calibration procedure and data forms in the QCP. If the difference between current calibration and the Quick Calibration is within  $\pm 2$  percent, then the current calibration is acceptable. If the 2 percent variation is exceeded, perform a recalibration of the facility. Document the Quick Calibration procedure as specified in the QCP and post the procedure and results in plain view in the plant control room and plant

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laboratory for reference by the Monitoring Team. Document all data from calibrations in a format approved by the Laboratory, and retain the data for review by the Monitoring Team.

If asphalt concrete is being produced from a batch type facility, verify the accuracy of the aggregate and asphalt binder weighing devices on a biweekly basis. Include the verification procedure in the QCP. Document the verification procedure as specified in the QCP and post the procedure and results in plain view in the plant control room and plant laboratory for reference by the Monitoring Team. Do not allow the deviation between the plant recorded weights and actual weights to exceed 1 percent. Record all data from verification of weighing devices in a format approved by the Laboratory, and retain the data for review by the Monitoring Team.

**403.05 Quality Control Tests.** Perform quality control tests to control the asphalt concrete mix within the appropriate specifications.

Perform all Item 448 mix testing and quality control according to 441.09. The Contractor may test a 448 Sublot sample instead of the required quality control test provided the sample is tested in the half day in which the Sublot sample mix was produced and is tested for all required quality control properties.

For mixes that do not use Item 448 acceptance (e.g. Items 301, 302, and Supplemental Specification 803), test the mix according to 441.09 for asphalt binder content and gradation (Basic). Other requirements of 441.09 and 441.10 do not apply. Control the Basic mixes as follows:

A. If a single asphalt binder content is more than  $\pm 0.5$  percent beyond the JMF, immediately take and test an additional sample.

B. If two consecutive asphalt binder content tests are more than  $\pm 0.5$  percent beyond the JMF, notify the Monitoring Team and cease production until the problem is corrected.

C. If the Range difference in any three consecutive asphalt binder content tests is greater than 0.7 percent (for 302 mix) or 0.6 percent (Basic mix, other than 302) immediately notify the Monitoring Team.

D. If the Range difference in any three consecutive gradation tests for the No. 4 (4.75 mm) sieve is greater than 10.0 percent, immediately notify the Monitoring Team.

E. If Range deviations as specified continue, cease production.

Range is defined as the difference between the largest and the smallest test result.

**403.06 Verification Acceptance (VA).** The Department will perform VA. If the random Department sampling and testing verifies the accompanying Contractor tests, the results of all the Contractor's quality control tests for each day (for Basic mix) or the Contractor's tests for each Lot (for 448 mix) will determine acceptance.

**A. Sampling.** The Department will perform the VA by testing independent and split samples taken and tested by the Department.

For plant sampling for Basic mixes or 441 quality control testing, the Contractor's technician will randomly select the truck in which to take a sample by using a random number procedure as outlined in the QCP. The Contractor's technician will give no indication to anyone of the time that the sample is to be taken. For other than job start, previous mix production problems, low production tonnage, or as requested by the Monitoring Team, exclude the first three trucks from sampling. Include the random number and sample tonnage location and time of taking on the daily Quality Control Report (Department Form TE-199) with each test. Tests, other than the required random sample tests, are at the Contractor's discretion according to the QCP.

Provide a clean area of sufficient size to perform sample splitting. Split samples by quartering according to AASHTO T 248, Method B and recombining for the Department and Contractor's sample. The Department split sample size required is generally 22 to 27 pounds (10,000 to 12,000 g). Ensure that every quality control or Item 448 Sublot sample taken by the technician has a labeled split for the Department. Wrap and label the Department split samples as to Lot or Sublot, time, location (tonnage), and accompanying Contractor test identification. The Monitoring Team will pick up all Department split samples within 4 workdays. Sample mishandling (careless identification, changing sample size, consistency, or pre-testing) will result in a change to Unconditional Acceptance.

For Item 448 mixes, conform to the procedures of Supplements 1035, 1038, 1039, and 1043 except take samples from a truck at the plant. If workmanship problems continue on the project (segregation, etc.) or if quality control problems persist, the Monitoring Team may require sampling on the road according to Supplement 1035. Lots will be 3000 tons (3000 metric tons), and Sublots will be 750 tons (750 metric tons). However, when production is limited to less than 3000 tons (3000 metric tons), consider the quantity produced as a partial Lot. For partial Lots of 1500 tons or less sample and test at least two sublot samples regardless of the tons produced. Split and test all Sublot sample locations, as selected by the Monitoring Team or project and taken by the Contractor. The Contractor may test a Sublot sample instead of the required random quality control test provided the sample is tested in the half day in which the Sublot sample mix was produced and is tested for all required quality control properties. A change in the location of the Sublot sample must be approved by the District. This allowance does not apply to any other samples including Department VA sample locations selected by the Monitor. Label Department split samples as Sublot or quality control samples.

**B. Reporting.** Report all testing performed and sample identification on a Quality Control Report (Department Form TE-199). Record on the TE-199 if the mixture produced was ran at the asphalt plant as a hot mix asphalt (HMA) or as a warm mix asphalt (WMA) produced according to 402.09 or another approved method. Deliver (fax, e-mail, hand) completed Quality Control Reports by the end of each day in which testing is conducted. If desired by the Monitoring Team and always for unsigned E-mail versions, mail the originals. After startup adjustments, report any plant operation changes on the Quality Control Report. Ensure that

each Quality Control Report contains technician comments as to production quality, input materials received, and condition and includes any other quality control activities as specified in the QCP. Ongoing problems with inadequate, incomplete, or illegible reporting will result in a change to Unconditional Acceptance. The Contractor’s technician must sign each Quality Control Report.

Report test results to the accuracy of the following decimal places. When the figures to be dropped in rounding off are exactly one-half of unity in the decimal place to be retained, round the value up or down to the nearest even number in the decimal place to be retained.

	Single Test	Mean
Asphalt Binder Content	0.1	0.01
No. 200 (75 µm) sieve	0.1	0.01
Other sieves	Whole number	0.1
BSG	0.001	0.001

For Item 448 mixes, track the Item 448 Sublot and Lot tonnages through the project and identify on the Quality Control Report each random Sublot test as to Lot number and Sublot tonnage location. In addition to the Quality Control Report submit the TE-448 Department form with lot identification and actual sieve weights for each Sublot sample from the technician’s gradation worksheets. Attach computerized plant printouts representing samples tested to that day’s report, if desired by the Monitoring Team, or otherwise keep it with the quality control records. Ensure that the technician notes on the accompanying printout in which tonnage the quality control sample was taken with accompanying test results for AC content and percent passing the No. 4 (4.75 mm) sieve. Keep remaining printouts in the plant laboratory for the duration of the project. Keep a copy of all quality control reports for a project in the Contractor’s plant laboratory.

**C. Department Verification Testing and Monitoring.** The Monitor will randomly choose one Department sample in a maximum of every four production days for VA testing to confirm Contractor testing and mix control. More frequent VA samples can be taken when desired. The Department VA sample location will be chosen randomly by the Monitor, including where in the truck to take the sample. The Contractor technician will take the sample from the truck with the monitor witnessing. The Monitor will keep the sample in the Department’s possession until delivered to the District lab or testing is complete. The Monitor will have enough sample taken to split with the Contractor. The Monitor will split the sample in the contractor lab. The Monitor will have the sample tested in the District lab or as noted below. The Contractor will test his split of the VA sample with the Monitor witnessing. The Department will use its VA test result; the Contractor result of the split; as well as the most recent previous contractor quality control and/or subplot test in the comparison for the Department VA testing.

The Monitor may opt to test the Department VA sample in the plant laboratory with the Contractor’s permission, according to the Contractor’s safety practices, and with the restriction of only the Contractor’s technician physically placing a sample pan in the AC Gauge. However, if the Department tests VA samples on contractor equipment 1 in every 5 VA samples must be tested in the

District lab on its own equipment. Record the results and testing location in the District project record. One day may be added to the above Department sample testing frequency for each day production is less than 500 tons (450 metric tons).

For all mixes, the District may increase the VA testing frequency if desired.

All Department VA test results will be given to the Contractor by a reasonable arrangement acceptable to both. Department VA sample testing not completed in a timely manner is of no value in verifying quality control testing quality for Contractor test acceptance and/or investigating problem causes. As such, if not completed in a timely manner, Contractor tests will automatically stand and the District will note the problem in the District's VA record.

<b>TABLE 403.06-1 DEPARTMENT VERIFICATION ACCEPTANCE AND QUALITY CONTROL TEST COMPARISON</b>				
	Percent Asphalt Binder		Percent Passing No. 4 (4.75mm)	
	VA[1]	QC/lot test[2]	VA[1]	QC/lot test[2]
Basic	±0.3	±0.4	±4.0	±5.0
448	±0.3	±0.3	±4.0	±4.0
[1] District VA mix test deviation from Contractor split.				
[2] District VA mix test deviation from QC and/or lot test.				

If the Department VA tests confirm Contractor testing is within the verification tolerances, but a pattern of high or low results exist that suggests mix control is not at the JMF, then investigate with the Monitoring Team's assistance to correct the problem to the Monitoring Team's satisfaction. Direct any questions regarding interpretation of circumstances to the Laboratory.

**D. Contractor Tests are Verified.** Production is acceptable if:

1. the Monitoring Team verifies the Contractor's QCP is being fully followed; and
2. the Department VA tests are within the limits specified in 403.06.C; and
3. for Basic mixes, the remaining sieves do not exceed the limits of the applicable specification.

Failure on the Contractor's part to respond and resolve Monitoring Team concerns may result in a change to Unconditional Acceptance.

Acceptance is based on Table 403.06-2.

TABLE 403.06-2 MIX ACCEPTANCE			
Mix Type	Acceptance Tolerances or Method		
Basic Mixes (no acceptance limits stated in appropriate specification)		Deviation from JMF	Range
	Asphalt Binder Content	± 0.5%	1.0
	No. 4 (4.75 mm) sieve	± 6%	12
Basic Mixes (acceptance limits stated in appropriate specification)	Use acceptance limits in appropriate specification		
448 Mixes	Calculate pay factor according to 403.08		

**E. Contractor Tests not Verified.** If the Department VA test does not verify the accompanying Contractor tests within the verification tolerances, then the Monitoring Team will investigate.

If the deviation between the District and Contractor test is greater than the limits in Table 403.06-3 immediately cease production until resolved. If the deviation is less than the limits in Table 403.06-3 and discrepancies continue, perform additional tests to aid in problem solving.

TABLE 403.06-3 DEVIATION LIMITS		
Property	Mix	Limits
Asphalt Binder Content	All	± 0.5 %
No. 4 (4.75 mm) sieve	All, except 302	± 6.0%
	302	± 7.0%

Additional tests may include any testing necessary to resolve the problem. If the additional testing does not resolve the problem by one-half production day or 1000 tons (1000 metric tons), whichever occurs first, to the Monitoring Team’s satisfaction, stop production, if not already, until problems are resolved. Contact the Laboratory for assistance in resolving problems. If the District testing program is confirmed by the additional tests and Monitoring Team investigation and no reason to question the original test exists, then the original District VA tests will stand.

After the above investigation, one of the three following actions will occur:

**1. Mix Production Compares Well to the JMF.** If the District test and investigation shows mix is actually controlled well compared to the JMF in spite of the Contractor test, the District does not have to test additional samples if the Contractor testing problem is corrected.

**2. Mix Production Does Not Compare Well to the JMF.** If the District tests and investigation shows lack of Contractor mix control compared to the JMF the District will test the remaining Department split samples for the days or Lots represented by the original tests. The District will use the test results to calculate

the acceptance. While working with the District, immediately take steps to correct the problem according to the QCP. Failure to achieve a quick resolution will result in a change to Unconditional Acceptance.

**3. District Testing Problem.** If the District testing program has a problem as confirmed by the additional testing and District review, the District will correct the problem, throw out the original District test results and take new samples from the samples representing the days or Lots in question for the VA tests.

**F. Contractor Removal, Restoration.** If repeated problems with poor comparison of tests are not the District's fault; or poor comparison of Contractor tests to the JMF; or with plant operation, input materials, or any of the other requirements of Department specifications occur in a single project or successive projects, the District will request an opinion from the QCQC before notifying the Contractor of removal from Department VA. The District will immediately notify the Contractor of the removal with a follow up letter from the District Engineer of Tests. Once notified, acceptance of asphalt mixtures is by Unconditional Acceptance. Restoration of the VA procedures may occur on a future project with a District recommendation to the QCQC based on consistent improved plant operation and mix control, a review of the Contractor problems and resolutions, and a review of the QCP by the QCQC.

**403.07 Unconditional Acceptance.** If the Contractor is removed from Department VA, the following will occur.

The Contractor must bring its QCP and operation to a level acceptable to the District and QCQC before production continues. The DET will ensure that the project C-95 (Contractor's Prequalification Rating survey) will reflect the change to Unconditional Acceptance in all of the appropriate C-95 categories. The Department will accept all material for Department projects from the facility under Unconditional Acceptance. While the facility is under Unconditional Acceptance, acceptance of small quantities under the small quantities policy will not apply.

Quality control testing requirements specified in 403.05 are modified as follows:

A. The required number of test series is a minimum of four each per production day or night. If a production day is less than 6 hours, the Department may reduce the frequency but not less than one test series per every 3 production hours.

B. For Basic mixes, if the variation from the JMF for one test is  $\pm 8$  percent passing the No. 4 (4.75 mm) sieve or  $\pm 0.3$  percent asphalt binder content, investigate and correct the problem, then resample and test. Maintain the moving average of three tests within  $\pm 4$  percent passing the No. 4 (4.75 mm) sieve and  $\pm 0.2$  percent asphalt binder content. In addition to the Quality Control Report, maintain control charts according to 441.10 for asphalt binder content and the No. 4 (4.75 mm) sieve. If the Range difference in any three consecutive tests is greater than 0.6 percent for asphalt binder content or 10.0 percent passing the No. 4 (4.75 mm) sieve, notify the Monitoring Team. If Range deviations as specified continue, cease production.

**403.08**

C. Report each day’s testing on a Quality Control Report, according to 446.04. Report all testing performed by the Contractor’s technician on the Quality Control Report. After startup adjustments, report any plant operation changes on the Quality Control Report. Ensure that each Quality Control Report contains technician comments as to production quality, input materials received, and condition and includes any other quality control activities required in the QCP. The Contractor’s technician must sign each Quality Control Report. Attach each day’s computerized plant printouts to that day’s report. The technician must note on the accompanying printout in which tonnage the quality control sample was taken with accompanying test results for asphalt binder content and percent passing the No. 4 (4.75 mm) sieve. Keep a copy of all Quality Control Reports for a project in the Contractor’s plant laboratory.

The District will monitor according to 441.06, except notification for ceasing production does not have to be in writing. Additional samples may be obtained for Department test at any time.

For Basic mixes, if the mean of the Lot or partial Lot acceptance tests for any sieve other than the No. 4 (4.75 mm) sieve exceeds the specification limits, the pay factor is determined as follows:

<b>TABLE 403.07-1 BASIC MIX PAY FACTORS</b>				
Number of Tests	1	2	3	4
Pay Factor	0.98	0.97	0.96	0.95

For Item 448 mixes, the Department will perform acceptance sampling and testing according to 403.06 and 403.08, except the Lot size will be 5000 tons (5000 metric tons) with 1250 ton (1250 metric tons). Sublots and acceptance samples may be taken from the roadway or plant at the Districts discretion. Department testing under Unconditional Acceptance will receive a lower testing priority than other VA projects.

**403.08 Acceptance** Tables for 448 Mixes. A Lot is considered acceptable for gradation and asphalt binder content if the deviation of the mean from the JMF and the Range is no more than the tolerances shown in Table 403.08-1.

**TABLE 403.08-1 DEVIATION FROM THE JMF AND RANGE TOLERANCES[1]**

Mix Property	Deviation from JMF (Percent)	Range (Percent)
Asphalt Binder Content	0.3	1.0
1/2 inch (12.5 mm) sieve	6	15
No. 4 (4.75 mm) sieve	5	15
No. 8 (2.36 mm) sieve	4	15
[1] Based on mean of four Lot Acceptance tests.		

If the mean of the Lot acceptance tests for a particular sieve or sieves, or for asphalt binder content deviates from the JMF by more than the tolerances shown in

Table 403.08-1, but falls within the tolerances shown in Table 403.08-2, then the Lot is considered reasonably acceptable and may remain in place with payment at a reduced pay factor as show in Table 403.08-2.

If the Range of the Lot acceptance tests for asphalt binder content or for any particular sieve, or sieves, exceeds the tolerance shown in Table 403.08-1, the Department will apply a pay factor of 0.95.

**TABLE 403.08-2 448 ACCEPTANCE SCHEDULE [1]**

Mix Property	Pay Factor	2 Tests	3 Tests	4 Tests
Asphalt Binder Content	1.00	0 to 0.47	0 to 0.36	0 to 0.30
	0.98	0.48 to 0.54	0.37 to 0.42	0.31 to 0.35
	0.90	0.55 to 0.61	0.43 to 0.48	0.36 to 0.40
	0.80	0.62 to 0.68	0.49 to 0.54	0.41 to 0.45
	0.60	0.69 to 0.75	0.55 to 0.59	0.46 to 0.50
	[2]	> 0.75	> 0.59	> 0.50
1/2 inch (12.5 mm) sieve	1.00	0 to 8.5	0 to 6.9	0 to 6.0
	0.99	8.6 to 9.9	7.0 to 8.1	6.1 to 7.0
	0.97	10.0 to 11.3	8.2 to 9.2	7.1 to 8.0
	0.94	11.4 to 12.7	9.3 to 10.4	8.1 to 9.0
	0.90	12.8 to 14.1	10.5 to 11.5	9.1 to 10.0
	[3]	> 14.1	> 11.5	> 10.0
No. 4 (4.75 mm) sieve	1.00	0 to 7.1	0 to 5.8	0 to 5.0
	0.99	7.2 to 8.5	5.9 to 6.9	5.1 to 6.0
	0.97	8.6 to 9.9	7.0 to 8.1	6.1 to 7.0
	0.94	10.0 to 11.3	8.2 to 9.2	7.1 to 8.0
	0.90	11.4 to 12.7	9.3 to 10.4	8.1 to 9.0
	[3]	> 12.7	> 10.4	> 9.0
No. 8 (2.36 mm) sieve	1.00	0 to 5.7	0 to 4.6	0 to 4.0
	0.99	5.8 to 7.1	4.7 to 5.8	4.1 to 5.0
	0.97	7.2 to 8.5	5.9 to 6.9	5.1 to 6.0
	0.94	8.6 to 9.9	7.0 to 8.1	6.1 to 7.0
	0.90	10.0 to 11.3	8.2 to 9.2	7.1 to 8.0
	[3]	> 11.3	> 9.2	> 8.0
[1] Based on mean of Lot Acceptance tests from the JMF.				
[2] Remove and replace material				
[3] Engineer will determine if the material may remain in place. Pay factor for material allowed to remain in place is 0.70.				

**407.01**

The Department will determine payment for the Lot by multiplying the contract unit price by the pay factor. When two or more pay factors for a specific Lot are less than 1.00, use lowest pay factor to calculate the payment. The Department will base acceptance of partial Lots on the mean and the Range of the results of tests on the number of samples obtained.

**ITEM 407 TACK COAT**

**407.01 Description**

**407.02 Materials**

**407.03 Equipment**

**407.04 Weather Limitations**

**407.05 Preparation of Surface**

**407.06 Application of Asphalt Material**

**407.07 Method of Measurement**

**407.08 Basis of Payment**

**407.01 Description.** This work consists of preparing and treating a paved surface with asphalt material, and cover aggregate if required.

**407.02 Materials.** Conform to the applicable requirements of 702 for the asphalt material and use one of the following types: 702.04 RS-1, SS-1, SS-1h, CRS-1, CSS-1, or CSS-1h; or 702.13.

Conform to 703.06 for cover aggregate.

**407.03 Equipment.** Provide adequate cleaning equipment, spreader boxes, and distributors.

Use distributors designed, equipped, maintained, and operated to apply asphalt material at the specified rate per square yard (square meter) with uniform pressure over the required width of application. Ensure that the distributor includes a tachometer, pressure gauges, accurate volume measuring devices, or a calibrated tank. Mount an accurate thermometer with a range covering the specified application temperature for asphalt material at approximately center height of the tank with the stem extending into the asphalt material. Ensure that the distributor has a full-circulating system with a spray bar that is adjustable laterally and vertically. Ensure that the spray bar will maintain a constant height above the pavement under variable load conditions. Supply each distributor with suitable charts showing truck and pump speeds and other pertinent application data necessary to obtain the required results.

Do not use equipment that cannot obtain the correct tack application.

**407.04 Weather Limitations.** Do not apply the asphalt material if the surface temperature is below the minimum placement temperature for the pavement course to be placed, as specified in 401.06.

**407.05 Preparation of Surface.** Ensure that the surface is thoroughly clean and dry when the asphalt material is applied. Remove material cleaned from the surface and dispose of it as the Engineer directs.

**407.06 Application of Asphalt Material.** Uniformly apply the asphalt material with a distributor having clean nozzles functioning properly. Obtain the Engineer's approval for dilution with water, if desired to achieve a more uniform application. The Department will not pay for diluted tack used without approval. Ensure any diluted asphalt material used for tack has a minimum viscosity of 20 seconds Saybolt Furol (702.04).

For irregular areas such as driveways and intersections, apply the asphalt material using a method the Engineer approves.

If paving asphalt concrete directly onto portland cement concrete or brick pavement, tack the pavement with rubberized asphalt emulsion conforming to 702.13.

Before placing a surface course onto an intermediate course, apply a tack coat on the intermediate course.

Apply the tack coat in a manner that offers the least inconvenience to traffic and that allows one-way traffic without pickup or tracking. Only apply the tack coat to areas that will be covered by a pavement course during the same day.

Obtain the Engineer's approval for the quantity, rate of application, temperature, and areas to be treated before application of the tack coat. The Engineer will determine the actual application in gallons per square yard (Liters per square meter) by a check on the project. The application is considered satisfactory when the actual rate is within  $\pm 10$  percent of the required rate and the material is applied uniformly with no visible evidence of streaking or ridging. The Engineer will require repairs to equipment when ridging, streaking, or other nonuniform coverage is observed, and a subsequent test strip to demonstrate proper application. If the application is not uniform and not corrected the total square yardage of non uniform application will be considered non specification material. The Engineer will determine the number of gallons (liters) for non-payment by using the approved rate of application times the total square yards (square meters) of non-uniform application.

**407.07 Method of Measurement.** The Department will measure Tack Coat and Tack Coat for Intermediate Course by the number of gallons (liters) of undiluted asphalt material applied for each according to Item 109.

**407.08 Basis of Payment.** The cost of cover aggregate and water to dilute an emulsion is incidental to Tack Coat.

The Department will not pay for non-uniformly applied materials as defined in 407.06.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
407	Gallon (Liter)	Tack Coat
407	Gallon (Liter)	Tack Coat for Intermediate Course

## ITEM 408 PRIME COAT

- 408.01 Description**
- 408.02 Asphalt Material**
- 408.03 Cover Aggregate**
- 408.04 Weather Limitations**
- 408.05 Equipment**
- 408.06 Preparation of Surface**
- 408.07 Application of Asphalt Material**
- 408.08 Application of Cover Aggregate**
- 408.09 Method of Measurement**
- 408.10 Basis of Payment**

**408.01 Description.** This work consists of preparing and treating an existing surface with asphalt material, and cover aggregate if required.

**408.02 Asphalt Material.** Conform to the applicable requirements of 702 for asphalt material and use one of the following types: 702.02 MC-30, MC-70, or MC-250; or 702.03 Primer 20.

**408.03 Cover Aggregate.** Use cover aggregate conforming to No. 9 size or gradation requirements of 703.05 or 703.06.

**408.04 Weather Limitations.** Do not apply asphalt material on a wet surface. Do not apply prime coats for asphalt concrete or surface treatment work when the atmospheric temperature is below 50 °F (10 °C) or when the air temperature within the preceding 24 hours has been 40 °F (5 °C) or lower. Do not apply prime coats on stabilized or granular base courses when the atmospheric temperature is below 40 °F (5 °C).

**408.05 Equipment.** Use equipment conforming to 407.03.

**408.06 Preparation of Surface.** Shape the surface to be primed to the required grade and section. Ensure the surface is free from all ruts, corrugations, segregated material or other irregularities and is smooth and uniformly compacted at the time of application of the asphalt material. Clean the surface in a manner that will thoroughly remove all mud, earth, and other foreign material. Take care to clean the edges of road to be primed to ensure uniform application of the asphalt material directly onto the existing base or pavement surface. Remove material cleaned from the surface and dispose of it as the Engineer directs.

**408.07 Application of Asphalt Material.** Apply asphalt material in a uniform manner spread to the width of the section to be primed by means of a distributor conforming to 407.03. When traffic is maintained, do not treat more than one-half of the width of the section in one application. Take care that the application of asphalt material at the junction of spreads is not in excess of the specified amount. Squeegee excess asphalt material from the surface. Correct skipped areas or deficiencies.

When traffic is maintained, allow one-way traffic on the untreated portion of the road bed. As soon as the asphalt material has been absorbed by the surface and will not be picked up, transfer traffic to the treated portion and prime the remaining width of the section. Obtain the Engineer's approval for the quantity,

rate of application, temperatures and areas to be treated before application of the prime coat.

**408.08 Application of Cover Aggregate.** If, after applying the prime coat, the asphalt material fails to penetrate and traffic must use the roadway, spread cover aggregate in the amount required to absorb any excess asphalt material.

**408.09 Method of Measurement.** The Department will measure Prime Coat by the number of gallons (liters) according to 109.

**408.10 Basis of Payment.** The cost of cover aggregate is incidental to Prime Coat.

The Department will pay for accepted quantities, complete in place, at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
408	Gallon (Liter)	Prime Coat

## **ITEM 409 SAWING AND SEALING ASPHALT CONCRETE PAVEMENT JOINTS**

### **409.01 Description**

### **409.02 Materials**

### **409.03 Construction Details**

### **409.04 Method of Measurement**

### **409.05 Basis of Payment**

**409.01 Description.** This work consists of saw cutting and sealing the finished surface of the asphalt concrete pavement and shoulders directly over and in line with transverse joints in the underlying portland cement concrete pavement.

**409.02 Materials.** Use joint sealant conforming to 705.04 and approved by the Laboratory before shipment to the project. Use a ½ in. (13mm) diameter closed cell foam backer rod that will form and maintain a reservoir of sealant as specified in 409.03.

**409.03 Construction Details.** Saw cut, clean, and seal transverse joints as a continuous operation. If the surface course is not placed within 5 days after the intermediate course is placed, make a 1/8-inch (3 mm) wide saw cut that is one-fourth the depth of the intermediate course over contraction joints and a 1/2-inch (13 mm) wide cut that is one-fourth the depth of the intermediate course expansion joints.

Saw joints in the surface course as soon as the saw can be operated without damaging the asphalt concrete, but no later than 48 hours after the asphalt concrete is placed.

Locate the sawed joints directly over each existing transverse pavement joint, including joints at full-depth pavement repairs. Accurately locate joints with pins or stakes before paving. Pre-mark the saw cut on the new asphalt surface with a chalk line or other acceptable method. Obtain the Engineer's approval of the

409.04

method for locating and accurately marking the proposed saw cuts before starting any resurfacing operations.

Saw all transverse joints and create a joint sealant reservoir according to the following table:

Measurement	Inches (mm)
Saw cut depth	2 (50)
Backer rod diameter	1/2 (13)
Joint sealant Reservoir	
Width	3/8 (10)
Depth	3/4 (19)
Recess below surface course	1/8 (3)

The Contractor may make one pass to achieve the full width and depth of the saw cut. Use either dry or wet cutting.

Clean dry sawed joints with compressed air to remove dirt, dust, or deleterious matter. Use an air compressor with a minimum rated capacity of 100 pounds per square inch (689 kPa) and sufficient hose for continuous cleaning operations.

Clean wet sawed joints with a water blast to remove sawing slurry, dirt, or deleterious matter. Dry wet sawed joints with a propane torch or lance unit capable of producing a blast of hot air at 2000 °F (1093 °C) and with a gas velocity of 2000 feet per second (610 m/s).

Extend the transverse saw cut joints the full width of the asphalt over the concrete pavement and paved shoulders.

Do not allow traffic to knead together or damage the sawed joints before sealing.

Heat joint sealant material in a kettle or melter constructed as a double boiler, with the space between the inner and outer shells filled with oil or other heat transfer medium. Provide positive temperature control and mechanical agitation.

Heat the material according to the manufacturer’s recommendation. Consider the first gallon (4 L) of material that flows out of the applicator wand at the start of the day spoil, and discard it into a container so designated.

After cleaning, place the backer rod in the sawed joints, then immediately seal the joints with hot-poured sealant applied through a nozzle projected into the sawed joint, filling from the bottom up. Ensure that the seal completely fills the joint such that after cooling, the level of the seal is not greater than 1/8 inch (3 mm) below the pavement surface. Fill any depression in the seal greater than 3/16 inch (5 mm) to the specified limit by adding additional hot poured sealant. Do not overfill the joints. Take care in the sealing of the joints so that the final appearance will present a neat line.

**409.04 Method of Measurement.** The Department will measure Sawing and Sealing Asphalt Concrete Pavement Joints by the number of feet (meters) of joints sawed and sealed.

**409.05 Basis of Payment.** The Department will not pay for saw cuts in the intermediate course.

The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
409	Foot (Meter)	Sawing and Sealing Asphalt Concrete Pavement Joints

## ITEM 410 TRAFFIC COMPACTED SURFACE

### 410.01 Description

### 410.02 Materials

### 410.03 Conditioning of the Subgrade

### 410.04 Spreading and Shaping

### 410.05 Maintaining

### 410.06 Method of Measurement

### 410.07 Basis of Payment

**410.01 Description.** This work consists of furnishing and placing an aggregate wearing course on the completed and accepted subgrade or temporary road.

**410.02 Materials.** Furnish materials conforming to 703.18 for the type of material specified (Type A, Type B, or Type C).

**410.03 Conditioning of the Subgrade.** Eliminate wavy and irregular surfaces and maintain the subgrade in this condition until the application of material under this item. If the subgrade is soft due to rain, frost, or snow, place material only as permitted.

**410.04 Spreading and Shaping.** Uniformly spread the material using an approved spreader box or by other methods. Spread the amount of material shown on the plans or as directed by the Engineer. After spreading, blade and shape the materials to the specified cross-sections. Haul the material to its place on the road over the previously spread material. Conduct the hauling to obtain uniform compaction over the entire width of the surface material without rolling.

**410.05 Maintaining.** After shaping the material, blade it as directed by the Engineer. Open the road to traffic immediately after all the material has been spread and shaped.

Correct all holes, ruts, defects, or soft places that occur in the subgrade or surface by adding material and dragging. Maintain the surface, slopes, shoulders, ditches, and drainage structures until the work on this item has been completed and accepted.

**410.06 Method of Measurement.** The Department will measure Traffic Compacted Surface, Type \_\_\_ by the number of cubic yards (cubic meters) or tons (metric tons) of accepted material placed, shaped, and maintained as specified.

**410.07**

The Department will measure the cubic yards (cubic meters) of aggregate used loose in the vehicle at the point of delivery or calculate it by converting from weight using the following conversion factors:

**TABLE 410.06-1**

<b>Material</b>	<b>Conversion Factor</b>	
Gravel, bank run or crusher run	2700 lb/yd <sup>3</sup>	1600 kg/m <sup>3</sup>
Limestone, crusher run	2500 lb/yd <sup>3</sup>	1485 kg/m <sup>3</sup>
Gravel, Size No. 4 and 57	2500 lb/yd <sup>3</sup>	1485 kg/m <sup>3</sup>
Limestone, Size No. 4 and 57	2400 lb/yd <sup>3</sup>	1425 kg/m <sup>3</sup>
Crushed slag <sup>[1]</sup>		
less than 80 lb/ft <sup>3</sup> (1300 kg/m <sup>3</sup> )	2000 lb/yd <sup>3</sup>	1185 kg/m <sup>3</sup>
80 to 90 lb/ft <sup>3</sup> (1300 to 1450 kg/m <sup>3</sup> )	2100 lb/yd <sup>3</sup>	1250 kg/m <sup>3</sup>
90.1 to 100 lb/ft <sup>3</sup> (1451 to 1600 kg/m <sup>3</sup> )	2300 lb/yd <sup>3</sup>	1365 kg/m <sup>3</sup>
100.1 to 125 lb/ft <sup>3</sup> (1601 to 2000 kg/m <sup>3</sup> )	2700 lb/yd <sup>3</sup>	1600 kg/m <sup>3</sup>
more than 125 lb/ft <sup>3</sup> (2000 kg/m <sup>3</sup> )	3000 lb/yd <sup>3</sup>	1780 kg/m <sup>3</sup>
Recycled Portland Cement Concrete	2250 lb/yd <sup>3</sup>	1335 kg/m <sup>3</sup>
Recycled Asphalt Concrete Pavement	2650 lb/yd <sup>3</sup>	1570 kg/m <sup>3</sup>

[1] Based on average dry rodded weight determined by the Laboratory. The conversion factors listed are the long gradation weights. These numbers are based on the dry rodded weights of Nos. 67, 57, or 8 gradation. The Department will determine slag weights based on weights obtained from the original source.

The Department will classify salvaged or mixed materials according to the material that makes up the majority of the mixture.

Ensure that the moistures of the delivered material are less than 2 percent above saturated surface dry condition; if not, the Department will base payment on the dry densities and dry weights.

Furnish freight bills, and weight and volume evidence according to 109.

**410.07 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
410	Cubic Yard or Ton (Cubic Meter or Metric Ton)	Traffic Compacted Surface, Type A or B
410	Cubic Yard or Ton (Cubic Meter or Metric Ton)	Traffic Compacted Surface, Type C

## ITEM 411 STABILIZED CRUSHED AGGREGATE

### 411.01 Description

### 411.02 Materials

### 411.03 Construction Methods

### 411.04 Method of Measurement

### 411.05 Basis of Payment

**411.01 Description.** This work consists of placing a compacted course or courses of crushed aggregate.

**411.02 Materials.** Furnish materials conforming to 703.18.

**411.03 Construction Methods.** Construct the subgrade according to Item 204. Use the spreading and compaction requirements of Item 304, except as modified by the following:

- A. Use a maximum compacted lift thickness of 6 inches (150 mm).
- B. Perform the initial compaction of the material by using crawler type tractors, tamping rollers, trench rollers, suitable pneumatic tire equipment, or other suitable equipment.
- C. Perform final compaction of the surface of the stabilized crushed aggregate by using approved pneumatic tire equipment.

**411.04 Method of Measurement.** The Department will measure Stabilized Crushed Aggregate by the number of cubic yards (cubic meters), computed from the profile grade, cross-sections and typical sections, compacted in place.

When the plans provide for the use of material in variable width or depth of course and the quantity cannot be readily calculated from the profile grade, typical sections and cross-sections, the Department will measure the cubic yards (cubic meters) by converting from weight using the following conversion factors:

**TABLE 411.04-1**

<b>Material</b>	<b>Conversion Factor</b>	
Crushed stone	3800 lb/yd <sup>3</sup>	2250 kg/m <sup>3</sup>
Crushed gravel	3900 lb/yd <sup>3</sup>	2310 kg/m <sup>3</sup>
Crushed slag <sup>[1]</sup>		
less than 90 lb/ft <sup>3</sup> (1450 kg/m <sup>3</sup> )	3600 lb/yd <sup>3</sup>	2140 kg/m <sup>3</sup>
90 to 100 lb/ft <sup>3</sup> (1450 to 1600 kg/m <sup>3</sup> )	4000 lb/yd <sup>3</sup>	2375 kg/m <sup>3</sup>
more than 100 lb/ft <sup>3</sup> (1600 kg/m <sup>3</sup> )	4500 lb/yd <sup>3</sup>	2670 kg/m <sup>3</sup>
Granulated slag	2800 lb/yd <sup>3</sup>	1660 kg/m <sup>3</sup>
Recycled Portland Cement Concrete	3400 lb/yd <sup>3</sup>	2020 kg/m <sup>3</sup>
Recycled Asphalt Concrete Pavement	4000 lb/yd <sup>3</sup>	2375 kg/m <sup>3</sup>

[1] Based on average dry rodded weight of standard size of slag aggregates on record at the Laboratory. The conversion factors listed are the long gradation weights. These numbers are based on the dry rodded weights of Nos. 67, 57, or 8 gradation. The Department will determine slag weights based on weights obtained from the original source.

**411.05**

The Department will classify salvaged or mixed materials according to the material that makes up the majority of the mixture.

Ensure that the moistures of the delivered material are less than 2 percent above saturated surface dry condition; if not, the Department will base payment on the dry densities and dry weights.

Furnish freight bills or certified weight bills according to 109.

**411.05 Basis of Payment.** The Department will pay for accepted quantities at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
411	Cubic Yard (Cubic Meter)	Stabilized Crushed Aggregate

**ITEM 421 MICROSURFACING**

- 421.01 Description**
- 421.02 Materials**
- 421.03 Proportioning**
- 421.04 Weather Limitations**
- 421.05 Mixing Equipment**
- 421.06 Equipment Calibration**
- 421.07 Spreading Equipment**
- 421.08 Surface Preparation**
- 421.09 Test Strip**
- 421.10 Application**
- 421.11 Acceptance**
- 421.12 Method of Measurement**
- 421.13 Basis of Payment**

**421.01 Description.** This work consists of constructing a cold laid polymer modified emulsified asphalt pavement course to fill ruts or provide a leveling and/or surface course for existing pavements. The paving mixture is composed of a polymer modified emulsified asphalt binder, crushed aggregate, mineral filler, water, and other additives.

**421.02 Materials.** Use a polymer modified emulsified asphalt binder (Binder) consisting of the following materials milled together:

- A. One hundred percent natural latex modifier or a synthetic latex modifier conforming to 702.14.
- B. CSS-1h emulsified asphalt conforming to 702.04, except the cement-mixing test is waived.
- C. Other emulsifiers.

Ensure that the Binder has a minimum of 3 percent solids based on the weight of the asphalt binder content of the Binder. Do not use port addition of the polymer to the emulsified asphalt.

Ensure that the Binder has a minimum of 62 percent residue when tested according to AASHTO T 59 at 77 °F (25 °C) for 24 hours in a forced draft oven. Ensure that the residue conforms to the following requirements:

Test	Description	Specification
AASHTO T 53	Softening Point	60 °C minimum
AASHTO T 202	Absolute Viscosity @ 60 °C	8000 poise minimum

Provide a certificate of analysis and a statement of compliance from the manufacturer with each load of Binder to ensure it is the same formulation used in the mix design. If the Design Designation for a project indicates the current year average daily truck traffic is less than 2000, the Contractor may use a CSS-1m emulsified asphalt instead of a CSS-1h emulsified asphalt. If used, ensure the CSS-1m emulsified asphalt conforms to the following:

Tests on emulsion, ASTM D 244, unless otherwise designated:

Viscosity, Saybolt Furol, ASTM D 88, at 25 °C (sec) 20 to 100	
Storage Stability Tests, 24-hr (% difference)	1 maximum
Particle Charge Tests	Positive
Sieve Tests (%) (Distilled Water)	0.10 maximum
Distillation to 260 °C, % by Weight, Residue, min[1] 62	

Tests on distillation residue:

Penetration, 25 °C, 100 g, 5 sec (dmm) ASTM D 5	70 to 90
Ductility, 4 °C 5 cm/min, ASTM D 113	40 minimum
Elastic Recovery, 4 °C, 10 cm (%) [2]	65 minimum
Softening Point, Ring & Ball (°C) ASTM D 36	60 minimum

[1] ASTM D 244, with modifications to include a 400 °F ± 10 °F (204 °C ± 6 °C) maximum temperature to be held for 15 minutes.

[2] Straight molds. Hold at test temperature for 90 minutes. Place in ductilometer and elongate 10 cm at 5 cm/min. Hold for 5 minutes and cut. After 1 hour retract the broken ends to touch and measure the elongation (X) in centimeters. Use the following formula to calculate the elastic recovery:

$$\text{Elastic Recovery (percent)} = \left( \frac{10 - X}{10} \right) \times 100$$

Conform to 703.01 and 703.05 for aggregate, except as follows:

Percent by weight of fractured pieces	100
Sand Equivalence (ASTM D 2419)	45 minimum

Conform to Gradation A for the aggregate for leveling and surface courses and to Gradation B for the aggregate for rut fill courses according to the following:

Sieve Size	Total Percent Passing	
	A	B
3/8 inch (9.50 mm)	100	100
No. 4 (4.75 mm)	85 to 100	70 to 90
No. 8 (2.36 mm)	50 to 80	45 to 70
No. 16 (1.18 mm)	40 to 65	28 to 50
No. 30 (600 $\mu$ m)	25 to 45	19 to 34
No. 50 (300 $\mu$ m)	13 to 25	12 to 25
No. 100 (150 $\mu$ m)	--	7 to 18
No. 200 (75 $\mu$ m)	5 to 15	5 to 18

Screen the aggregate for oversize material prior to use. For mineral filler, use portland cement conforming to ASTM C 150, Type I. Use water conforming to 499.02. Use mix set additives as required.

**421.03 Proportioning.** Submit to the Laboratory a sample of the Binder to be used and a complete mix design prepared by an approved laboratory. Verify the compatibility of the aggregate, Binder, mineral filler, and other additives. Make the mix design with the same materials that will be used on the project.

Ensure that the mix design:

- A. Has aggregate meeting the gradation specified.
- B. Has a residual asphalt by dry weight of aggregate of 7.0 to 8.5 percent for leveling and surface courses or 6.5 to 8.0 percent for rut fill courses.
- C. Has a mineral filler content of 0.25 to 3.5 percent by dry weight of aggregate.
- D. Meets the specified properties of the following International Slurry Seal Association (ISSA) tests:

ISSA Test No.	Description	Specification
TB-139 (1-90)	Wet Cohesion	
	30 minutes min. (set time)	12 kg-cm min.
	60 minutes min. (traffic)	20 kg-cm min or near spin
TB-114 (1-90)	Wet Stripping	90 percent min.
TB-100 (90)	Wet Track Abrasion Loss	
	1-hour soak 6 day soak	450 g/m <sup>2</sup> max. 650 g/m <sup>2</sup> max.
TB-144 (2-89)	Saturated Abrasion Compatibility	3 g loss max.
TB-113 (1-90)	Mix Time @ 25 °C	Controllable to 120 seconds
	Mix Time @ 40 °C	Controllable to 35 seconds

Check the ISSA TB-139 (set time) and ISSA TB-113 (mix time) tests at the highest temperature expected during construction. For the ISSA TB-113 test at 104 °F (40 °C), preheat all ingredients and containers.

Ensure that the final mix design states the following (all percentages are based on the dry weight of the aggregate):

- A. Source of each individual material.
- B. Aggregate gradation.
- C. Percentage of aggregate.
- D. Sand equivalence of the aggregate.
- E. Percentage of mineral filler (minimum and maximum).
- F. Percentage of water (minimum and maximum).
- G. Percentage of mix set additives (if required).
- H. Percentage of Binder and type.
- I. Quantitative effects of moisture content on the unit weight of the aggregate.

**421.04 Weather Limitations.** Apply the mixture only when it is not raining and the existing pavement surface temperature is a minimum of 40 °F (5 °C) and there is no forecast of an atmospheric temperature below 32 °F (0 °C) within 24 hours from the time the mixture is applied. Between September 30 and May 1, do not apply the mixture if the existing pavement surface temperature is less than 50 °F (10 °C).

**421.05 Mixing Equipment.** Produce the mixture in a self-propelled, front feed, continuous loading mixing machine equipped with a conveyer belt aggregate delivery system and an interconnected positive displacement, water jacketed gear pump to accurately proportion aggregate and asphalt emulsion. Locate the mineral filler feed so the proper amount of mineral filler is dropped on the aggregate before discharge into the pugmill. Provide a spray bar to completely prewet the aggregate dropping down to the pugmill with additive and water before introduction of asphalt emulsion. The twin-shaft, multi-blade pugmill will be a continuous flow type and minimum of 49 inches (1.25 m) long. Ensure that the blade size and side clearances meet the equipment manufacturer's recommendations. Introduce the emulsion within the first one-third of the mixer length to ensure proper mixing of all materials before exit from the pugmill.

Equip the machine with opposite side driving stations to allow full control of the machine from either side. Equip the mixer with a remote forward speed control at the back mixing platform so the back operator can control forward speed and level of mixture in the paving or rut box. Provide material control devices that are readily accessible and positioned so the amount of each material used can be determined at any time.

Equip the mixing machine with a water pressure system and nozzle type spray bar to provide a water spray ahead of and outside the spreader box when required. Apply water at a rate that will dampen the surface, but will not create free flowing water ahead of the spreader box.

The Contractor may use truck-mounted machines with a conveyer belt aggregate delivery system and without the front feed, continuous loading feature on project segments of less than 15,500 square yards (13,000 m<sup>2</sup>) or on spot repairs.

**421.06 Equipment Calibration.** Before mix production, calibrate the mixing equipment in the presence of the Engineer. Generate documentation for the Engineer, including individual calibrations of each material at various settings. Perform a new calibration if there is any change in the mix design. Supply all of the equipment, materials, and scales necessary to perform the calibration. Following calibration and adjustments for changes in the mix design, do not make any further calibration adjustments to the mixing equipment without the Engineer's approval.

**421.07 Spreading Equipment.** If a leveling or surface course is specified, apply the mixture uniformly by means of a conventional spreader box.

If a rut fill course is specified, apply the mixture with a V-shaped rut filling spreader box. Equip the rut filling spreader box with a steel strike-off.

Attach either type of spreader box to the mixer and equip it with paddles mounted on an adjustable shaft to continually agitate and distribute the materials throughout the box. Ensure that the equipment provides sufficient turbulence to prevent the mix from setting in the box or causing excessive side build-up or lumps. To prevent loss of the mixture from the box, attach flexible seals, front and rear, in contact with the road. Operate the spreading equipment in such a manner as to prevent the loss of the mixture on super-elevated curves.

For surface courses, attach a secondary strike-off to the spreader.

The Contractor may use burlap drags or other drags, if necessary, to obtain the desired finish. Replace drags having excessive build-up.

**421.08 Surface Preparation.** Before applying the mixture, thoroughly clean the surface.

Apply a tack coat conforming to Item 407, consisting of one part asphalt emulsion and three parts water. Apply the tack coat at a rate of 0.06 to 0.12 gallon per square yard (0.25 to 0.45 L/m<sup>2</sup>).

Remove raised pavement markers according to 621.08. The Contractor may fill the depression caused by the removal of the casting with material meeting this specification.

Remove any existing longitudinal pavement markings 740.03 (polyester), 740.04 (thermoplastic) and 740.07(epoxy) using an abrasion method conforming to 641.10. Protect drainage structures, monument boxes, water valve, etc. during material application.

**421.09 Test Strip.** Construct a test strip for the Engineer to evaluate. Construct this test strip 1000 feet (300 m) long, and include all of the application courses specified. Construct the test strip at the same time of day or night the full production will be applied. The Contractor may construct the test strip in 2 days or nights if multiple course applications are specified.

The Engineer will evaluate the completed test strip after 24 hours of traffic to determine if the mix design is acceptable. The Contractor may begin full production after the Engineer accepts the test strip.

If the microsurfacing is not being applied between September 30 and May 1, the Department will waive the test strip if the Contractor has constructed a Department approved test strip this construction season with the same materials and mix design.

**421.10 Application.** Apply the paving mixture in a manner to fill cracks, shallow potholes, and minor surface irregularities and achieve a uniform surface without causing skips, lumps, or tears. Carry a sufficient amount of material at all times in all parts of the spreader box to ensure complete coverage. Avoid overloading of the spreader box. Do not allow lumping, balling, or unmixed aggregate in the spreader box.

If a rut fill course is specified, apply enough material to fill the wheel paths without excess crowning (overfilling). An excess crown is defined as 1/8 inch (3 mm) after 24 hours of traffic compaction. Apply rut fill courses in widths from 5 to 6 feet (1.5 to 1.8 m) for each wheel path. Provide a smooth, neat seam where two rut fill passes meet. Take care to restore the designed profile of the pavement cross-section. Feather the edges of the rut fill course to minimize the use of excess material.

If a leveling course is specified, apply the paving mixture at  $14 \pm 2$  pounds per square yard ( $7.6 \pm 1.1$  kg/m<sup>2</sup>).

If a surface course is specified and it is placed on another microsurfacing course, apply the paving mixture at  $16 \pm 1$  pounds per square yard ( $8.7 \pm 0.6$  kg/m<sup>2</sup>). If a surface course is specified and it is not placed on another microsurfacing course, apply the paving mixture at a minimum of 18 pounds per square yard (9.8 kg/m<sup>2</sup>).

For leveling and surface courses, provide a smooth, neat seam of 1 to 3 inches (25 to 75 mm) where two passes meet. Immediately remove excess material from the ends of each run.

Construct surface courses wide enough to cover the outside edges of rut fill and leveling courses. Maintain straight edge lines along curbs and shoulders. Do not allow runoff of these areas. Ensure that lines at intersections are straight.

Use squeegees and lutes to spread the mixture in areas inaccessible to the spreader box and areas requiring hand spreading. The Contractor may adjust the mix set additive to provide a slower setting time if hand spreading is needed. Do not adjust the water content to adjust the setting time. If hand spreading, pour the mixture in a small windrow along one edge of the surface to be covered and spread it uniformly by a hand squeegee or lute.

Ensure that the microsurfacing cures at a rate that will permit traffic on the pavement within 1 hour after application without damaging the pavement surface. However, should the contractor have concerns about adequate cure work out an arrangement agreeable to the project before releasing traffic on the pavement.

If there is an excessive streaking problem created by high amounts of oversize material in the mix, stop applying the mixture and take steps to correct the streaking problem. Do not resume work until the Engineer is satisfied the problem has been corrected.

## 421.11

If a section of pavement is not going to be exposed to traffic within 48 hours, compact it with a pneumatic tire roller after curing. Conform the pneumatic tire roller to 401.13, and inflate the tire pressure to 40 to 60 pounds per square inch (275 to 400 kPa).

**421.11 Acceptance.** Maintain continuous control of the Binder to dry aggregate proportioning to conform to the approved mix design within a tolerance of  $\pm 2$  gallons per ton ( $\pm 8.5$  L/metric ton). Control the spread rate to not less than the specified quantity of aggregate per square yard (square meter) on a dry weight basis.

The Engineer will base acceptance of the Binder to dry aggregate proportion and spread rate on the Engineer's summary of quantities used each day. The Engineer will approve and accept a day's application of microsurfacing provided:

A. The Engineer's summary indicates conformance with the above control requirements for proportioning and spread rate and

B. The pavement is free from excessive scratch marks, tears, rippling and other surface irregularities, longitudinal joints and lane edges coincide with any lane lines and edge lines and transverse joints are uniform, neat and provide a smooth transition.

The spread rate requirement does not apply to rut fill courses if the Contractor filled the wheel paths according to this specification.

**421.12 Method of Measurement.** The Department will measure Microsurfacing, Surface Course and Microsurfacing, Leveling Course by the number of square yards (square meters), complete and accepted in place. The Department will base the width of the pavement course on the width shown on the plans, specified in this specification, or directed by the Engineer. The Department will measure the length along the centerline of each roadway or ramp.

The Department will measure the number of raised pavement markers removed.

The Department will measure Microsurfacing, Rut Fill Course by the number of tons (metric tons) of dry aggregate used, complete and accepted in place. The Department will base the weight of the dry aggregate used on the ticket net weight of individual loads from an approved scale.

**421.13 Basis of Payment.** The cost of tack coat is incidental to Microsurfacing.

The cost of any removal of any existing longitudinal pavement markings according to 421.08 is incidental to Microsurfacing.

The Department will pay for removal of existing raised pavement markers according to Item 621 Raised Pavement Markers Removed.

The Department will pay for the construction of accepted test strips at the individual bid prices for the courses constructed.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
421	Square Yard (Square Meter)	Microsurfacing, Surface Course
421	Square Yard (Square Meter)	Microsurfacing, Leveling Course
421	Ton (Metric Ton)	Microsurfacing, Rut Fill Course

## ITEM 422 CHIP SEAL

- 422.01 Description**
- 422.02 Materials**
- 422.03 Equipment**
- 422.04 Weather Limitations**
- 422.05 Test Strip**
- 422.06 Surface Preparation**
- 422.07 Binder Application**
- 422.08 Cover Aggregate Application**
- 422.09 Construction Operation**
- 422.10 Quality Control**
- 422.11 Acceptance**
- 422.12 Method of Measurement**
- 422.13 Basis of Payment**

**422.01 Description.** This work consists of preparing and applying a single or double chip seal.

**422.02 Materials.** Use an RS-2 emulsified binder conforming to 702.04 for projects with an ADT less than 500. Use polymer emulsified binder conforming to 702.16 Type A for projects with an ADT greater than 500. When a project has multiple pavements with ADTs above and below 500 use the polymer emulsified binder, 702.16.A.

Provide cover aggregate for the Chip Seal Job Mix Formula (JMF) of washed limestone or dolomite meeting 703.05 and the following:

Stockpile the material to be used for the chip seal at the aggregate source.

Obtain five (5) samples from the stockpile and perform gradation testing on each sample and determine the percent passing for each sieve size listed in Table 422.02-1

A. Calculate the total range for the No. 8 (2.36 mm) sieve for all five samples. The range will not exceed 6%.

B. Calculate the percent passing the No. 200 (75  $\mu$ m) sieve for each sample. No single sample value will exceed 2.0 percent.

C Calculate the average of each sieve for all five samples. Assure the average value for each sieve is within the requirements of Table 422.02-1.

Submit a letter to the Engineer and DET containing the Job Mix Formula (JMF) gradations and the calculations to show the cover aggregate meets requirements.

If a staging location will be used for the chip seal aggregate first move the initially tested aggregates from the aggregate source stockpile to the staging location and construct a staging stockpile. Then obtain five (5) aggregate samples from the staging location stockpile and perform gradation testing on each sample to determine the percent passing for each sieve size listed in Table 422.02-1.

Evaluate the staging location aggregate samples the same as the aggregate source samples except allow an average for the No. 200 (75 µm) sieve not greater than 1.7 percent.

Submit the Job Mix Formula (JMF) gradations from the staged stockpile and the calculations to show the cover aggregate meets requirements in letter form to the Engineer and DET.

If the chip seal aggregates fail to meet requirements, either at the aggregate source or the staging location, re-wash and/or rework the aggregate materials and retest the new stockpiles.

**TABLE 422.02-1**

Sieve Size	Total Percent Passing
1/2 inch (12.5 mm)	100
3/8 inch (9.5 mm)	85 to 100
No. 4 (4.75 mm)	5 to 25
No. 8 (2.36 mm)	0 to 10
No. 16 (1.18 mm)	0 to 5
No. 200 (75 µm)	1.5 max [1]
[1] Washed gradation value	

The District may obtain and test validation samples of the JMF aggregates at any time. If a single validation sample is either outside the values in TABLE 422.02-1 with the exception that the No. 200 (75 µm) value is not greater than 2.0 percent, the district will obtain five (5) samples and retest to determine if the aggregate JMF falls within the limits of TABLE 422.02-1. If the JMF verification test doesn't meet the source or staging location limits the stockpile is not acceptable.

**422.03 Equipment.** Provide equipment conforming to the requirements of this section. Obtain approval of equipment before starting the job.

Use equipment for binder distribution conforming to 407.03, except ensure that it has a computerized rate control that automatically adjusts the binder pump to the unit ground speed and has a gauge or meter in plain view for reading gallons (liters). Use appropriate spray nozzles for the material and rate specified.

Use Type II pneumatic tire rollers conforming to 401.13, except the maximum capacity shall not apply.

Use self-propelled aggregate spreaders with a variable width aggregate hopper capable of placing from 8 to 16 feet (2.4 to 4.8 m) in any increment and a computerized rate control that automatically adjusts the aggregate output to the unit ground speed. Equip spreaders with pneumatic tires, a screen to remove

oversized material, revolving cylinders, and adjustments necessary to produce a uniform distribution of particles at the specified rate.

Use power sweepers or rotary brooms in initial surface preparation and for removing loose particles. Use pickup type sweepers in areas where the aggregate shoulder does not exist. Do not sweep loose aggregate onto lawns, curbed areas, or intersections.

Furnish accurate thermometers for determining any of the applicable temperature requirements of this specification.

**422.04 Weather Limitations.** Place the chip seal when the pavement and atmospheric temperature is 60 °F (16 °C) or above and the atmospheric temperature is 70 °F (24 °C) or above. Do not schedule the performance of this work for the time period before May 1 or after September 1. Do not place chip seal if any of the following conditions exist:

- A. Impending weather conditions do not allow for proper curing or if temperatures are forecasted below 50 °F (10 °C) within 24 hours from the time of work.
- B. The existing pavement temperature is 140 °F (60 °C) or above.

**422.05 Test Strip.** Construct a continuous 1000-foot (300 m) long by lane width test strip. Do not waive test strips regardless if the same materials have been used on another project.

Determine the initial binder application rates and aggregate application rates for the test strip.

For a single chip seal, an initial target rate of 0.37 +/- 0.03 gallon per square yard (1.68 L/m<sup>2</sup>) is recommended for the test strip. For double chip seal, a target rate of 0.36 +/- 0.03 gallon per square yard (1.54 L/m<sup>2</sup>) for the first course and 0.33 +/- 0.05 gallon per square yard (1.68 L/m<sup>2</sup>) for the second course is recommended for the test strip. Notify the Engineer of the initial target rates.

Calibrate the aggregate spreader and verify the application rates with a one square yard (one square meter) piece of cardboard or other material to collect and weigh the aggregate. Do not over apply cover aggregate relying on vacuum and broom sweeping to pick up all excess. Amounts of loose aggregate that create a nuisance to the public will result in work stoppage. If work is stopped by the Engineer recalibrate the aggregate spreader determining a new application rate and apply cover aggregate at the new rate. Verify the aggregate gradation during the test strip and give results to the Engineer.

The Engineer and Contractor will review the test strip the next workday for streaking, ridging, bleeding, aggregate loss or other problems. If the review shows the test strip meets the requirements of 422.11 and the application rate and quality control tests show all is in control compared to the JMF, then progress with the work. Should problems be noted, the Engineer may require another test strip.

**422.06 Surface Preparation.** Clean the pavement according to 407.05. If necessary, clean areas of the pavement with a hand broom.

#### 422.07

Remove any existing longitudinal pavement markings 740.03 (polyester), 740.04 (thermoplastic) and 740.07 (epoxy) using an abrasion method conforming to 641.10.

For a single chip seal either remove and replace any existing raised pavement markers or protect the existing raised pavement markers from the single chip application process.

For a double chip seal application remove the raised pavement markers according to 621.08.

Do not place material until the Engineer approves the surface.

**422.07 Binder Application.** Before applying binder, ensure that sufficient cover aggregate is available for immediate application. Apply the binder at the target rate(s) established during the test strip.

Maintain the binder temperature from 150 to 185 °F (65 to 85 °C) during construction, including the start of each day. Reheat the binder at a rate of no more than 25 °F (14 °C) per hour, when the binder is allowed to cool below 150 °F (65 °C).

If the target application rates are not the optimum application rates to achieve proper stone embedment during the actual application, immediately notify the Engineer. Proper stone embedment is typically 1/2 to 2/3 of the stone chip height and can be checked by pulling out several chips by hand. Adjust and document the new application rate by stationing. Recheck stone embedment after adjustment and obtain the Engineer's approval of the new rate.

Do not allow the binder to streak on the road surface. If the Engineer determines that streaking is occurring, cease operations until the Engineer is satisfied that streaking has been eliminated.

At the beginning and at the end of a contract section, start and stop the application on a removable protective cover (paper, metal sheets, or other suitable material) sufficiently wide enough to allow full application on the surface being treated. Make transverse and longitudinal laps in such manner to ensure that the texture of the finished surface is uniform and continuous. To prevent lapping at transverse junctions, promptly shut off the binder spray at the end of the application. Before continuing the application, place a removable protective cover a sufficient distance back from the joint on the cover aggregate so the sprayers are operating at full force when the distributor has attained the predetermined speed upon reaching the uncovered surface. Upon completion, remove all removable protective covers.

**422.08 Cover Aggregate Application.** Verify the application rate with a one square yard (one square meter) piece of cardboard or other material to collect and weigh the aggregate before placing binder. Adjust if necessary and re-verify. Record final results and inform the Engineer. Immediately after applying the binder, apply cover aggregate uniformly without ridges or laps at the specified rate adjusted as directed by the Engineer to produce a minimum of excess loose particles. Spread the material in such manner that the tires of the truck or aggregate spreader at no time contact the uncovered and newly applied binder.

Before rolling, correct deficiencies in the application of cover aggregate in a manner satisfactory to the Engineer.

After rolling, protect the surface from traffic damage during the period required for the binder to cure sufficiently and prevent dislodging of the aggregate particles by normal traffic. During this period and as directed by the Engineer, correct deficiencies in cover aggregate by spreading additional aggregate or by light brooming.

Apply cover aggregate at a rate necessary to provide full coverage of the binder and to avoid tracking. Do not over apply cover aggregate relying on vacuum and broom sweeping to pick up all excess. Nuisance to the public amounts of aggregate will result in work stoppage. If work is stopped by the Engineer recalibrate the aggregate spreader determining a new application rate and apply cover aggregate at the new rate. If the target rate needs adjustment due to the gradation of the aggregate or due to existing surface conditions of the pavement, immediately notify the Engineer and document the new rate by stationing.

**422.09 Construction Operation.** Establish stations at 1000-foot (300 m) intervals on the entire project before placing materials. Clearly identify and maintain the stations until project completion.

Keep the binder distributor, aggregate spreader, and rollers as close to each other as possible. Do not allow the binder distributor to be more than 150 feet (45 m) ahead of the aggregate spreader.

Perform rolling immediately after placing the aggregate, but before the binder sets up. Do not leave aggregate unrolled for more than 5 minutes. Perform a minimum of two complete roller passes over the aggregate. A single complete pass is forward and backward over the same path. For each new pass, overlap the previous pass by about one-half the width of the roller. Use a minimum of three rollers, and roll in a longitudinal direction at a speed not greater than 5 miles per hour (8 km/h). Do not operate rollers at speeds that cause pick-up or dislodging of aggregate particles.

After the binder sets, and before placing a second course for double chip seals, and within 4 hours, sweep the pavement using a power broom or pickup sweeper as needed to remove all loose aggregate. If the pavement cannot be swept within the 4-hour period due to problems associated with the stone moisture, binder, breaking, humidity, or other unknown, the Engineer may suspend the operation until the problem is resolved or more suitable conditions are obtained to maintain the 4-hour time frame for sweeping. Extend sweeping 1 foot (0.3 m) beyond the edge of the pavement to help prevent migration of loose aggregate back onto the pavement. Do not re-use aggregate from a chip seal that is swept from the pavement or that is already loose off the pavement edge.

The Contractor is responsible for claims of damage to vehicles until the pavement and shoulders receive a final sweeping immediately before application of permanent pavement markings or a fog seal, if a fog seal is required.

Wait at least 24 hours before placing the second course of a double chip seal. Ensure that the first course meets requirements of this specification and is cured, swept and capable of withstanding construction traffic without damage.

## 422.10

Correct damage to the underlying chip seal before placing the final chip seal.

Place the longitudinal construction joint on a lane line or as directed by the Engineer. For double chip seal, place the longitudinal construction joint for the first course 6 inches (150 mm) off the centerline and place the second course so the longitudinal joint is at the centerline.

Before opening to traffic, post the roadway with “Loose Stone” signs and a “35 mph” speed plaque mounted below the sign. Ensure that signs conform to Item 614. Place these signs at a maximum of 0.5-mile (0.8 km) intervals. Remove the signs as directed by the Engineer.

On two-lane roads or pavements where traffic is maintained on a chip seal constructed that workday, provide a traffic control pilot vehicle operated at no more than 25 miles per hour (40 km/h) in the immediate work area.

Protect all utility castings, monument boxes, and other similar items using tarpaper or other approved material. Remove protection before sweeping and opening to traffic.

### 422.10 Quality Control.

**A. General.** Use the methods described in this section to measure compliance. If test results exceed any of the identified quality control tolerances, stop placement and immediately notify the Engineer and DET. Identify the cause of exceeding any of the identified quality control tolerances and document in detail the corrective action necessary to bring the deficiency into compliance. Obtain the Engineer’s approval before resuming work. Upon resuming work, take another sample and immediately provide the test results to the Engineer. If the tolerances are exceeded, stop the work. Do not resume work until approved by the Engineer and DET. The Department can obtain samples of materials at any time. Aggregate samples can be taken from sources, on-hand stockpiles or the aggregate spreader box. Work can be stopped and materials can be rejected on the basis of poor Department test results.

**B. Binder.** Label and retain one sample per day for the Department. For the binder application rate, as determined by a yield check, do not exceed a tolerance of  $\pm 0.02$  gallon per square yard ( $0.09 \text{ L/m}^2$ ) from the established application rate.

**C. Coarse Aggregate.** At a minimum test one sample taken from the aggregate spreader box at production start and sample and test one sample from the aggregate spreader box randomly during the day. An aggregate spreader box sample may be taken by laying a piece of suitable material under the spreader as it moves forward. Include additional testing when directed to sample and test by the Engineer. Sample and test aggregate according to AASHTO T 2, AASHTO T 248, and Supplement 1004 (AASHTO T 11 where required). Use washed gradations for determining the No. 200 ( $75 \mu\text{m}$ ) sieve. The Contractor may use additional tests. These may include dry gradations for control purposes but acceptance of on-hand aggregate will be based on washed gradations only. Reject and do not use aggregate creating dusting nuisance to the public on the project.

Reject truckloads of aggregate if water is seen coming from the truck bed.

Reject aggregate that does not meet the following requirements:

No. 4 (4.75 mm) sieve from JMF	$\pm 5.0\%$
No. 8 (2.36 mm) sieve from JMF	$\pm 3.0\%$
No. 200 (75 $\mu\text{m}$ ) sieve from JMF	$\pm 1.0\%$ , 2.05% upper limit
Aggregate moisture content (by dry weight)	4.0% max. for aggregates with an Absorption > 2.0%, 3.0% max. for aggregates with an Absorption $\leq 2.0\%$

**D. Documentation.** Provide the Engineer a daily report with the following:

1. Control section, project number, county, route, and Engineer.
2. Date, air temperature, pavement temperature, and humidity.
3. Binder temperature.
4. Beginning and ending stations.
5. Yield checks on binder (three per day, minimum).
6. Yield checks on aggregate (three per day, minimum).
7. Gradation, moisture content, and station (One sample from spreader box at production start, one random sample during the day and any other samples when directed by the Engineer).
8. Length, width, and total area.
9. Condition of “Loose Stone” signs with “35 mph” speed plaques.
10. Contractor representative’s signature.

Provide a bill of lading for binder and aggregate as requested or at project completion.

**422.11 Acceptance.** During the application of the chip seal, inspect the chip seal for deficiencies resulting from poor workmanship, flushing, tracking from equipment, surface patterns, loss of stone, and sweeping. Inspect workmanship for untreated areas, minimum overlap on longitudinal joints, and minimum overlap on construction joints.

Verify the following for daily acceptance:

- A. Finished surface has no more than four tears or untreated areas greater than 1 inch (25 mm) wide and 4 inches (100 mm) long in any 120-square yard (100 m<sup>2</sup>) area.
- B. Joints appear neat and uniform without buildup, uncovered areas, or unsightly appearance.
- C. Longitudinal joints have less than a 2-inch (50 mm) overlap on the adjacent passes.
- D. Transverse joints have no more than 1/4-inch (6 mm) difference in elevation across the joint as measured with a 6-foot (2 m) straightedge.

422.12

E. Chip seal edge is neat and uniform along the roadway lane, shoulder, and curb lines.

F. Chip seal edge has no more than 2-inch (50 mm) variance in any 100 feet (30 m), along the roadway edge or shoulder.

G. Typical stone chip embedment is 1/2 to 2/3 of typical stone chip height.

For project acceptance, the Contractor and Engineer will review the completed work 25 to 35 days after placement. The finished work must meet the following requirements:

Defect[1]	Severity
Surface patterns	Alternate lean and heavy lines (Ridges or streaking over the surface)
Bleeding/flushing	Distinctive appearance (Excess binder on surface)
Loss of cover aggregate	Patches or lines of aggregate lost from surface
[1] No more than 20% of any 120 square yard area can contain any defect. The measurement of the 120 square yard area begins at the start of the defect.	

Perform all corrective work to the satisfaction the Engineer.

**422.12 Method of Measurement.** The Department will measure Single Chip Seal Course or Double Chip Seal Course by the number of square yards (square meters), completed and accepted in place. The Department will determine the width by measuring the actual width of the chip seal. The Department will determine the length along the centerline of each roadway or ramp.

The Department will measure the number of raised pavement markers removed if a Double Chip Seal is specified.

**422.13 Basis of Payment.** The Department will not pay for materials, equipment, or labor to make corrections.

The cost of any removal of any existing longitudinal pavement markings according to 422.06 is incidental to this item.

The cost of any removal or protection of existing raised pavement markers on a single chip seal according to 422.06 is incidental to this item.

The Department will pay for removal of existing raised pavement markers on a Double Chip Seal application according to Item 621 Raised Pavement Markers Removed

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
422	Square Yard (Square Meter)	Single Chip Seal

422            Square Yard            Double Chip Seal  
                  (Square Meter)

**ITEM 423 CRACK SEALING, HOT APPLIED**

- 423.01 Description**
- 423.02 Materials**
- 423.03 Equipment**
- 423.04 Weather Limitations**
- 423.05 Preparation**
- 423.06 Mixing Type II and III**
- 423.07 Application of Sealant**
- 423.08 Opening to Traffic**
- 423.09 Method of Measurement**
- 423.10 Basis of Payment**

**423.01 Description.** This work consists of preparing and sealing pavement cracks with a hot applied crack sealant.

**423.02 Materials.** Furnish hot applied crack sealant, of the type specified, conforming to:

Type I.....	705.04
Type II.....	702.17.B
Type III.....	702.17.C
Type IV.....	702.17.D

Obtain the Laboratory’s approval of Type I crack sealant before shipping to the project. Obtain approval of other crack sealants according to 702.17.

**423.03 Equipment.** Equipment used in the performance of this work is subject to the Engineer’s approval and to the requirements of 108.05.

For Type I crack sealant, heat the sealant in a kettle or melter constructed as a double boiler, with the space between the inner and outer shells filled with oil or other heat-transfer fluid. Use a kettle or melter with positive temperature control of the oil bath, and provide a mixing vat, mechanical agitation, and recirculating pumps. Do not apply direct heat to the sealant.

For Types II, III, and IV crack sealants, heat the sealant in a kettle or melter constructed as a double boiler, with the space between the inner and outer shells filled with oil or other heat-transfer fluid. Use a kettle or melter with separate thermometers for the oil bath and mixing vat. Equip the kettle with a full sweep type agitator. Also, equip the kettle with a 2-inch (50 mm) minimum recirculating pump to provide circulation of the materials when not applying the crack sealant. Do not apply direct heat to the sealant.

For Types I and IV crack sealants, use a mechanical applicator wand capable of continuously feeding the sealant through nozzles shaped to penetrate the cracks. A positive sealant flow shutoff mechanism is required. Ensure that the wand produces a band according to the tolerances of 423.07.

#### 423.04

For Types II and III crack sealants, use a mechanical applicator wand head capable of placing the crack sealant according to the tolerances of 423.07 while filling the cracks. A positive sealant flow shutoff mechanism is required.

Use portable air compressors capable of furnishing at least 100 pounds per square inch (690 kPa) of air pressure at the nozzle. Use compressors equipped with traps that maintain the compressed air free of oil and water.

Use water cleaning equipment capable of delivering water at 2000 pounds per square inch (14 MPa) of pressure from a nozzle to the crack being cleaned.

Use a propane lance unit capable of producing a blast of hot air that operates at 1000 °F (538 °C) and a gas velocity of 2000 feet per second (600 m/s).

Use mechanical and power driven routing and sawing equipment capable of following close to the path of cracks and of widening the cracks to the required dimension without causing excessive spalling or damage to the adjacent pavement. For sawing equipment, use diamond saw blades with a diameter of 8 inches (200 mm) or less.

**423.04 Weather Limitations.** Do not seal cracks if the surface is visibly damp or the temperature is below 45 °F (7 °C).

**423.05 Preparation.** The Engineer will designate the location of the cracks to be sealed.

If routing is specified, rout cracks with an opening less than 3/4 inch (19 mm) to provide a sealant reservoir with a nominal size of 3/4 inch (19 mm) wide by 1 inch (25 mm) deep.

If sawing is specified, saw all cracks to 3/4 to 7/8 inch (19 to 22 mm) wide and 7/8 to 1 inch (22 to 25 mm) deep. Use hand tools or a lightweight chipping hammer to remove all slivers of asphalt concrete less than 1 inch (25 mm) wide remaining along the crack after sawing. Immediately before sealing, sandblast both faces of the sawed crack to remove all contamination and to texture the faces. If the crack below the sealant reservoir is greater than 3/8 inch (10 mm) wide, insert a backer rod into the crack to form the bottom of the reservoir at the proper depth.

Before applying the hot sealant, clean cracks by an approved method or methods to remove dust, dirt, moisture, vegetation, and other foreign material. Keep the cracks clean and dry until all sealing operations are completed.

**423.06 Mixing Type II and III.** Use weigh tickets in determining the specified proportion of fiber to blend into the binder. Add fibers to the binder, and mix thoroughly in the kettle. Do not allow the temperature of the sealant in the field application to exceed the safe heating temperature recommended by the manufacturer. Do not heat Type III crack sealant greater than 295 °F (146 °C).

**423.07 Application of Sealant.** Perform the crack sealing operation within 250 feet (76 m) of the cleaning operation.

Seal only cracks that are wide enough to permit entry of sealant. Seal tightly closed cracks [less than 1/4-inch (6 mm) wide] only if they show signs of raveling

or spalling. Do not seal cracks greater than 1-inch (25 mm) wide, and do not seal spalls or cavities greater than 4 inches (100 mm) wide, unless otherwise directed.

For Types I and IV crack sealants, fill the entire crack reservoir with the sealant from the bottom up to approximately 1/16 inch (2 mm) above the pavement surface. Immediately scrape the filled cracks with a V-shaped or U-shaped squeegee, or similar hand tool, to smooth the overfill. This may require more than one application of sealant. The Engineer will not accept the work if the band of sealant on the pavement surface is greater than 2 inches (50 mm) wide.

For Types II and III crack sealants, place the sealant such that it fills the cracks with a band of sealant within 2 to 4 inches (50 to 100 mm) wide. The Engineer will not accept the work if the thickness on the pavement is greater than 3/16 inches (5 mm).

**423.08 Opening to Traffic.** Do not allow traffic on the sealant until it has cured and the possibility of tracking no longer exists. However, if the Engineer determines it is necessary to allow traffic to pass over the sealant before adequate curing, dust portland cement or other approved material over sealed cracks to eliminate pickup or tracking.

**423.09 Method of Measurement.** The Department will measure Crack Sealing, of the type specified, by the number of pounds (kilograms) of hot applied sealant in place, completed, and accepted.

**423.10 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
423	Pound (Kilogram)	Crack Sealing, Type I
423	Pound (Kilogram)	Crack Sealing with Routing, Type I
423	Pound (Kilogram)	Crack Sealing with Sawing, Type I
423	Pound (Kilogram)	Crack Sealing, Type II
423	Pound (Kilogram)	Crack Sealing, Type III
423	Pound (Kilogram)	Crack Sealing, Type II or III
423	Pound (Kilogram)	Crack Sealing, Type IV

## ITEM 424 FINE GRADED POLYMER ASPHALT CONCRETE

**424.01 Description**

**424.02 Composition**

**424.03 Materials**

**424.04 Mixing**

**424.05 Weather Limitations**

**424.06 Spreading and Finishing**

**424.07 Surface Tolerances**

**424.08 Acceptance**

**424.09 Method of Measurement**

**424.10 Basis of Payment**

**424.01**

**424.01 Description.** This work consists of constructing a surface course of aggregate and polymer modified asphalt binder mixed in a central plant and spread and compacted on a prepared surface. The requirements of 401 apply, except as modified by this specification.

**424.02 Composition.** For Type A mixes use 8.5 percent modified asphalt binder by total mix weight.

For Type B mixes, submit a proposed JMF according to 441.02 to the Laboratory that meets the requirements of a Type 1 surface course, except as follows:

- A. Minimum VMA, 15.0 percent
- B. Minimum total binder content, 6.4 percent
- C. Design air voids, 4.0 percent

**424.03 Materials.** Furnish clean, uncoated aggregate conforming to the applicable requirements of Table 424.03-1 and quality requirements of 703.05.

Use a PG 76-22M asphalt binder or a PG 64-22 asphalt binder modified by adding 5.0 +/- 0.3 percent by weight Styrene Butadiene Rubber (SBR) solids. Provide SBR conforming to 702.14. Provide mineral filler conforming to 703.07. Provide binders conforming to 702.01.

Ten percent asphalt concrete pavement may be used in a Type B mix if all requirements of footnote 3 are met by the reclaimed asphalt concrete. Do not use reclaimed asphalt concrete pavement in a Type A mix.

**TABLE 424.03-1 - MIX GRADATION**

Sieve	Type A (1, 2)	Type B (1, 3, 4)
1/2 inch (12.5 mm)		100
3/8 inch (9.5 mm)	100	95 to 100
No. 4 (4.75 mm)	95 to 100	85 to 95
No. 8 (2.36 mm)	90 to 100	53 to 63
No. 16 (1.18 mm)	80 to 100	37 to 47
No. 30 (600 µm)	60 to 90	25 to 35
No. 50 (300 µm)	30 to 65	9 to 19
No. 100 (150 µm)	10 to 30	--
No. 200 (75 µm)	3 to 10	3 to 8

(1) Gradation includes any mineral filler and is specified in percent passing.

(2) Use natural sand with at least 50 percent silicon dioxide by weight according to ASTM C 146. Include with a JMF submittal certified test data from an AASHTO accredited laboratory showing conformance to the 50 percent silicon dioxide requirement. Ensure data is no more than one year old at time of submittal.

(3) Fine Aggregate - Use natural sand with at least 50 percent silicon dioxide by weight according to ASTM C 146. Include with a JMF submittal certified test data from an AASHTO accredited laboratory showing conformance to the 50 percent silicon dioxide requirement. Ensure data is no more than one year old at time of

submittal. For medium mixes, use no more than 20 percent limestone sand by weight of total aggregate. For heavy mixes, use 20 percent limestone sand or air cooled slag sand by weight of total aggregate. If 10 percent RAP is used the silicon dioxide content of the total natural sand blend must be at least 50 percent.

(4) Coarse Aggregate - For medium mixes, use 10 percent two-faced crushed aggregate by weight of total aggregate. For heavy mixes, use 100 percent two-faced crushed aggregate. Provide two-faced crushed aggregates conforming to ASTM D5821-95.

**424.04 Mixing.** Ensure the mixing plant conforms to 402. Discharge the mix from the plant at temperatures between 335 °F to 370 °F (168 °C to 188 °C) as required for good workability.

**424.05 Weather Limitations.** Do not place the asphalt concrete when the surface of the existing pavement is less than 60 °F or the air temperature is less than 60 °F.

**424.06 Spreading and Finishing.** Do not allow traffic on the compacted mixture until it has cooled sufficiently to prevent damage.

**424.07 Surface Tolerances.** Ensure the completed surface course conforms to 401.19.

Remove raised pavement markers according to 621.08. The Contractor may fill the depression caused by the removal of the casting with material meeting this specification.

**424.08 Acceptance.** For Type A mixes comply with acceptance requirements of 301. For Type B mixes comply with all requirements of 448.

**424.09 Method of Measurement.** For Type A mixes use a unit weight conversion of 1.75 tons/cubic yard (2.08 metric tons/cubic meter).

The Department will measure the number of raised pavement markers removed.

**424.10 Basis of Payment.** The Department will pay for removal of existing raised pavement markers according to Item 621 Raised Pavement Markers Removed.

The Department will make payment for accepted quantities, completed in place, at the contract price as follows:

Item	Unit	Description
424	Cubic Yard (Cubic Meter)	Fine Graded Polymer Asphalt Concrete, Type A
424	Cubic Yard (Cubic Meter)	Fine Graded Polymer Asphalt Concrete, Type B

## ITEM 441 CONTRACTOR MIX DESIGN AND QUALITY CONTROL—GENERAL

### 441.01 Description

### 441.02 Composition

## 441.01

- 441.04 Antistrip Additive
- 441.05 JMF Field Adjustment
- 441.06 Monitoring
- 441.07 Quality Control Program
- 441.08 Testing Facilities
- 441.09 Quality Control Tests
- 441.10 Control Charts
- 441.11 Quality Control Reports
- 441.12 Mixture Deficiencies

**441.01 Description.** This specification includes general requirements applicable to all types of asphalt concrete pavements where the Contractor is responsible for performing the mix design and quality control. Deviations from these general requirements will be covered in the specific requirements for each type. The requirements of Item 401 apply, except as follows.

Control all production processes to assure the Engineer that the mixture delivered to the paving site is uniform in composition, conforms to the specification requirements and that the placed mixture is free of any defect (ex. segregation, tenderness, lack of mixture and texture uniformity, raveling, flushing, rutting, holes, debris etc.) within the Contractor's control at project completion.

**441.02 Composition** Compose the asphalt concrete of approved aggregates, asphalt binder and, if required, other modifiers. Develop a JMF to comply with the mix design criteria and submit it to the Laboratory on approved forms at least two weeks prior to the start of production for preliminary approval. The Laboratory may perform additional tests on lab or plant produced mixtures to ensure adequate mix performance. Based on the results of these tests, the Laboratory may require the Contractor to design a new JMF. Allow time for this additional testing.

Perform the mix design and supply all required data in a manner taught in Level 2 Asphalt Technician school, Level 3 Asphalt Mix Design school and in the Asphalt Institute Manual Series No. 2. Use a 2-hour cure for all mix samples. Ensure the cure temperature and specimen compaction temperature are the same. Select the JMF asphalt binder content using the Design Air Voids and ensure the JMF meets the other requirements of Table 441.02-1. Provide a mix design with at least four asphalt binder content points, including a minimum of two points above and two points below the JMF asphalt binder content. Submit no more than two JMFs for each asphalt concrete pay item per project. Additional submittals are at the discretion of the Laboratory. Submit a 5-pound (2500 g) minimum uncompacted sample (all mixes) representing the JMF. Submit additional samples as requested by the Laboratory.

Do not start mix production without a preliminary JMF approval and 48 hour notification of the District. Final approval of a JMF will be based upon field verification. Per 441.12 the JMF can be rejected for failure to verify in the plant or at the project

Do not apply the gradation requirements of 703.05 for fine aggregate.

If the F/A ratio using total asphalt binder content is greater than 1.0 recalculate it using the effective asphalt binder content. Calculate the effective asphalt binder content according to Chapter 4 of the Asphalt Institute Manual Series No. 2. The value (calculated to the nearest percentage point) of the Fifty to Thirty (F-T) value, is the percent of total aggregate retained between the No. 50 (300  $\mu$ m) and No. 30 (600  $\mu$ m) sieves, minus the percent of total aggregate retained between the No. 30 (600  $\mu$ m) and No. 16 (1.18 mm) sieves.

For Type 1H mixes ensure that a minimum of 50 percent of the virgin fine aggregate is sand manufactured from stone, gravel or air-cooled slag. If the sand is manufactured from gravel, ensure that it is crushed from gravel material retained on the 3/8 inch (9.5 mm) sieve.

Use a PG 70-22M asphalt binder for Type 1H mix. Use a PG 64-28 asphalt binder for Type 2 mix for heavy traffic volume regardless of the amount of reclaimed asphalt concrete pavement. Use a PG 64-22 asphalt binder and Type 1 medium gradation for asphalt concrete for driveways and under guardrails.

Identify the PG Binder supplier, as well as the polymer type if applicable, on the JMF submittal. A change in polymer asphalt binder or polymer source will require a redesign. Provide on one page neatly summarized, dated test results for the requirements of Table 702.01-1. Ensure data is no more than two months old. If SBR polymer is added at the asphalt concrete mixing plant, provide in the JMF data from the SBR polymer supplier for total solids (percent) and ash (percent) according to the 702.14. As well, provide the target amount of SBR polymer greater than or equal to 3.5 percent to achieve the properties specified. Include a letter of certification from the polymer supplier verifying percent butadiene in the SBS or SBR polymer. Report in the JMF submittal results of temperature-viscosity testing for mixing and compaction temperatures. For polymer asphalt binders supplier recommended temperatures may be used in lieu of the temperature-viscosity results, but the temperature-viscosity results must still be reported.

TABLE 441.02-1

Course	Type 1 Surface			
	Traffic	Heavy	Medium	Light
1 1/2 inch (37.5 mm) <sup>[1]</sup>				
1 inch (25.0 mm) <sup>[1]</sup>				
3/4 inch (19.0 mm) <sup>[1]</sup>	100			
1/2 inch (12.5 mm) <sup>[1]</sup>	95 to 100	100		100
3/8 inch (9.5 mm) <sup>[1]</sup>	70 to 85	90 to 100		90 to 100
No. 4 (4.75 mm) <sup>[1]</sup>	38 to 50	45 to 57		45 to 57
No. 8 (2.36 mm) <sup>[1]</sup>	20 to 37	30 to 45		30 to 45
No. 16 (1.18 mm) <sup>[1]</sup>	14 to 30	17 to 35		17 to 35
No. 30 (600 μm) <sup>[1]</sup>	10 to 22	12 to 25		12 to 25
No. 50 (300 μm) <sup>[1]</sup>	6 to 15	5 to 18		5 to 18
No. 100 (150 μm) <sup>[1]</sup>	4 to 10	2 to 10		2 to 10
No. 200 (75 μm) <sup>[1]</sup>	2-6			
Asphalt Binder <sup>[2]</sup>	5.6 to 10.0	5.8 to 10.0		6.0 to 10.0
Virgin Asphalt Binder (min.)		5.0		5.2
F/A Ratio, max. <sup>[3]</sup>	1.2	1.2		1.2
F-T Value <sup>[4]</sup>	+2	+2		
Blows <sup>[5]</sup>	75	50		35
Stability, min., pounds <sup>[5]</sup>	1800	1200		750
(N)	(8006)	(5338)		(3336)
Flow, 0.25 mm <sup>[5]</sup>	8 to 14	8 to 16		8 to 18
Design Air Voids <sup>[6]</sup>	3.5	3.5		3.5
VMA, min. <sup>[7]</sup>	14	16		16
Special Designation	1H			
Coarse Agg Mech Crush <sup>[8]</sup>	65			

[1] Sieve, percent passing  
[2] Percent of total mix  
[3] Using effective asphalt binder content  
[4] Percentage points maximum  
[5] T 245  
[6] Percent, Supplement 1036  
[7] Percent, Supplement 1037  
[8] Percent, two or more fractured faces ASTM D5821

TABLE 441.02-1 (CONTINUED)

Course	Type 1 Intermediate			
	Traffic	Heavy	Medium	Light
1 1/2 inch (37.5 mm) <sup>[1]</sup>				
1 inch (25.0 mm) <sup>[1]</sup>				
3/4 inch (19.0 mm) <sup>[1]</sup>				
1/2 inch (12.5 mm) <sup>[1]</sup>	100	100	100	
3/8 inch (9.5 mm) <sup>[1]</sup>	90 to 100	90 to 100	90 to 100	
No. 4 (4.75 mm) <sup>[1]</sup>	50 to 72	50 to 72	50 to 72	
No. 8 (2.36 mm) <sup>[1]</sup>	30 to 55	30 to 55	30 to 55	
No. 16 (1.18 mm) <sup>[1]</sup>	17 to 40	17 to 40	17 to 40	
No. 30 (600 $\mu\text{m}$ ) <sup>[1]</sup>	12 to 30	12 to 30	12 to 30	
No. 50 (300 $\mu\text{m}$ ) <sup>[1]</sup>	5 to 20	5 to 20	5 to 20	
No. 100 (150 $\mu\text{m}$ ) <sup>[1]</sup>	2 to 12	2 to 12	2 to 12	
No. 200 (75 $\mu\text{m}$ ) <sup>[1]</sup>				
Asphalt Binder <sup>[2]</sup>	5.0 to 10.0	5.0 to 10.0	5.0 to 10.0	
F/A Ratio, max. <sup>[3]</sup>	1.2	1.2	1.2	
F-T Value <sup>[4]</sup>	+2	+2		
Blows <sup>[5]</sup>	75	50	35	
Stability, min., pounds <sup>[5]</sup>	1800	1200	750	
(N)	(8006)	(5338)	(3336)	
Flow, 0.25 mm <sup>[5]</sup>	8 to 14	8 to 16	8 to 18	
Design Air Voids <sup>[6]</sup>	4	3.5	3.5	
VMA, min. <sup>[7]</sup>	16	16	16	
<b>Special Designation</b>				
[1] Sieve, percent passing				
[2] Percent of total mix				
[3] Using effective asphalt binder content				
[4] Percentage points maximum				
[5] T 245				
[6] Percent, Supplement 1036				
[7] Percent, Supplement 1037				

TABLE 441.02-1 (CONTINUED)

Course	Type 2 Surface		
	Traffic	Heavy	Medium
1 1/2 inch (37.5 mm) <sup>[1]</sup>	100	100	100
1 inch (25.0 mm) <sup>[1]</sup>	95 to 100	95 to 100	95 to 100
3/4 inch (19.0 mm) <sup>[1]</sup>	85 to 100	85 to 100	85 to 100
1/2 inch (12.5 mm) <sup>[1]</sup>	65 to 85	65 to 85	65 to 85
3/8 inch (9.5 mm) <sup>[1]</sup>			
No. 4 (4.75 mm) <sup>[1]</sup>	35 to 60	35 to 60	35 to 60
No. 8 (2.36 mm) <sup>[1]</sup>	25 to 48	25 to 48	25 to 48
No. 16 (1.18 mm) <sup>[1]</sup>	16 to 36	16 to 36	16 to 36
No. 30 (600 µm) <sup>[1]</sup>	12 to 30	12 to 30	12 to 30
No. 50 (300 µm) <sup>[1]</sup>	5 to 18	5 to 18	5 to 18
No. 100 (150 µm) <sup>[1]</sup>	2 to 10	2 to 10	2 to 10
No. 200 (75 µm) <sup>[1]</sup>			
Asphalt Binder <sup>[2]</sup>	4.0 to 9.0	4.0 to 9.0	4.0 to 9.0
F/A Ratio, max. <sup>[3]</sup>	1.2	1.2	1.2
F-T Value <sup>[4]</sup>	+2		
Blows <sup>[5]</sup>	75	50	35
Stability, min., pounds <sup>[5]</sup>	1800	1200	750
(N)	(8006)	(5338)	(3336)
Flow, 0.25 mm <sup>[5]</sup>	8 to 14	8 to 16	8 to 18
Design Air Voids <sup>[6]</sup>	4	4	4
VMA, min. <sup>[7]</sup>	13	13	13
<b>Special Designation</b>			
[1] Sieve, percent passing			
[2] Percent of total mix			
[3] Using effective asphalt binder content			
[4] Percentage points maximum			
[5] T 245			
[6] Percent, Supplement 1036			
[7] Percent, Supplement 1037			

TABLE 441.02-1 (CONTINUED)

Course Traffic	Type 2 Intermediate		
	Heavy	Medium	Light
1 1/2 inch (37.5 mm)[1]	100	100	100
1 inch (25.0 mm)[1]	95 to 100	95 to 100	95 to 100
3/4 inch (19.0 mm)[1]	85 to 100	85 to 100	85 to 100
1/2 inch (12.5 mm)[1]	65 to 85	65 to 85	65 to 85
3/8 inch (9.5 mm)[1]			
No. 4 (4.75 mm)[1]	35 to 60	35 to 60	35 to 60
No. 8 (2.36 mm)[1]	25 to 48	25 to 48	25 to 48
No. 16 (1.18 mm)[1]	16 to 36	16 to 36	16 to 36
No. 30 (600 μm)[1]	12 to 30	12 to 30	12 to 30
No. 50 (300 μm)[1]	5 to 18	5 to 18	5 to 18
No. 100 (150 μm)[1]	2 to 10	2 to 10	2 to 10
No. 200 (75 μm)[1]			
Asphalt Binder[2]	4.0 to 9.0	4.0 to 9.0	4.0 to 9.0
F/A Ratio, max.[3]	1.2	1.2	1.2
F-T Value[4]	+2		
Blows[5]	75	50	35
Stability, min., pounds[5]	1800	1200	750
(N)	(8006)	(5338)	(3336)
Flow, 0.25 mm[5]	8 to 14	8 to 16	8 to 18
Design Air Voids[6]	4	4	4
VMA, min.[7]	13	13	13
<b>Special Designation</b>			
[1] Sieve, percent passing			
[2] Percent of total mix			
[3] Using effective asphalt binder content			
[4] Percentage points maximum			
[5] T 245			
[6] Percent, Supplement 1036			
[7] Percent, Supplement 1037			

**441.03 Use of Reclaimed Pavement.** Comply with the requirements of 401.04.

**441.04 Antistriper Additive.** If the proposed JMF contains any gravel coarse aggregate, or contains more than 25 percent natural sand, or contains more than 20 percent reclaimed asphalt concrete pavement containing gravel coarse aggregate, or is designed according to Item 442 conduct the following tests:

- A. Moisture damage potential test according to Supplement 1051.
- B. Washed gradation according to AASHTO T 11 as modified by Supplement 1004.
- C. Adherent fines test for each component according to ASTM D 5711.

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Modify the mix with one of the following antistripping additives if the results of the moisture damage potential test show the Tensile Strength Ratio (TSR) of the asphalt concrete mix to be less than 0.80 for 442 mixes or 0.70 for all other mix types:

- A. **Liquid Antistripping Material.** Include liquid antistripping material at a rate of 0.5 to 1.0 percent by weight of the asphalt binder. However, if 442 is specified, include liquid antistripping material at a rate of 0.50 to 1.25 percent by weight of the asphalt binder. Ensure the TSR of the asphalt concrete mix is greater than or equal to 0.80 after the addition of the liquid antistripping material.
- B. **Hydrated Lime.** Include hydrated lime in the dry form at a rate of 1.0 percent by the dry weight of aggregate for asphalt concrete. Conform to AASHTO M 303, Type 1 for hydrated lime. Ensure the TSR of the asphalt concrete mix is greater than or equal to 0.80 after the addition of the hydrated lime. Provide the Engineer the following information for each shipment of hydrated lime: Letter of certification, Production date, Shipment date, Shipment destination, Batch or lot number and Net weight. The Laboratory may obtain samples of the hydrated lime at any time to verify quality. If the quality of the hydrated lime is in question, the Laboratory may require independent laboratory testing.

Include the antistripping additive in the mix design. Submit the following to the Laboratory with the proposed JMF:

- A. All TSR data (before and after the addition of the antistripping additive).
- B. Rate of addition of the liquid antistripping material, if used.
- C. If using liquid antistripping material submit product information, information on use by other State DOTs using the liquid antistripping material, and a letter of certification. If using hydrated lime submit certified test data showing the hydrated lime conforms to AASHTO M 303, Type 1.
- D. Results of the washed gradation test of the individual components of the mix used in determining the combined gradation.
- E. Results of the adherent fines testing for each component.

The Laboratory may perform additional tests on lab or plant produced mix according to Supplements 1004, 1051, and 1052. If a change in the aggregate production is suspected, the Department may require the Contractor to perform washed gradations on components and calculate adherent fines to determine the need for additional TSR review. Store and introduce antistripping additives into the plant according to Supplement 1053. Obtain Laboratory approval of the antistripping additive storage and feed systems prior to the start of production.

Provide delivery tickets to the Engineer at the end of the project and at the end of each construction year on a multiple year project. The Engineer will verify the number of pounds of antistripping additive used is within 10 percent of the calculated amount of antistripping additive required for the total weight of asphalt binder, based on the JMF, used in the asphalt concrete.

**441.05 JMF Field Adjustments.** During production the Contractor may adjust the JMF gradation within the below limits without a redesign of the mixture.

Limit adjustments of the JMF to conform to actual production, without a redesign of the mixture, to  $\pm 3$  percent passing the 1/2 inch (12.5 mm), No. 4 (4.75 mm), and No. 8 (2.36 mm) sieves and  $\pm 1$  percent passing the No. 200 (75 $\mu$ m) sieve. Do not exceed the limits in Table 441.02-1 in the adjusted JMF. The adjustment on the 1/2 inch (12.5 mm) sieve applies only to Type 1H and Type 2 mixes. Determine the need for any JMF gradation adjustments in the time specified. Should no adjustments be made, the Department will base acceptance on conformance to the original JMF. After the time period specified, the Department will allow no further adjustment of the JMF.

Should a redesign of the mixture become necessary, submit a new JMF according to the requirements for the initial JMF. A new acceptance lot will begin when a new JMF established by a redesign of the mixture becomes effective. Make any adjustment of this new JMF as provided for the original JMF. Record both the design JMF and the adjusted JMF in effect during production of an acceptance lot on the Quality Control Report for that lot. In the event that a new design JMF is proposed and approved, also make a notation on the ticket for the first load produced under the new design JMF.

**441.06 Monitoring.** The Department will establish District Monitoring Teams for the purpose of verifying all Contractor mixture production processes. Verification may be accomplished by obtaining split samples or independent samples from the plant or roadway. If the mixture quality verifies then production may continue. If mixture quality does not verify then the Monitoring Team and Contractor will cooperatively investigate and resolve the problem. Whenever results are disputed the Laboratory will investigate and conduct additional testing to resolve. Based on their review, the Monitoring Team may at any time disallow production to continue.

**441.07 Quality Control Program.** Submit a Quality Control Program (QCP) according to 403.03. Include an example control chart per 441.10 with the QCP. Use quality control technicians working in the plant lab during all mixture production and that are approved by the Department. Technician approval will be according to Supplement 1041.

**441.08 Testing Facilities.** Provide testing facilities at the plant site conforming to Supplement 1041.

**441.09 Quality Control Tests.** Perform quality control tests to control the asphalt concrete mix within the specifications. Ensure that these quality control tests measure the asphalt binder content, gradation, air voids, and Maximum Specific Gravity (MSG) according to the Contractor's approved QCP. Perform each quality control test a minimum of one time each half of a production day or night (two tests per production day or night), or one each 1400 tons (1300 metric tons), whichever is less.

Perform more sampling and testing than the minimum specified at the start of production. Additionally perform more sampling and testing than the minimum during production when the quality control tests show the asphalt concrete being produced is outside the warning bands as shown in the Contractor's approved QCP. Immediately resolve problems indicated by any out of warning band test

and immediately retest to validate corrections have returned the materials to within the warning band limits. The Contractor may determine the method of testing of the asphalt concrete beyond the minimum specified, and will detail the methods technicians will follow in the Contractor's approved QCP.

Should additional testing as required above not be performed the DET, after consultation with the Laboratory, will require the testing frequency be increased to all tests each two hours of production for the remainder of the project. If this occurs, the DET will request an opinion from the QCQC for action(s) against the technician and/or Contractor including but not limited to warning, removal and/or a change of the facility to Unconditional Acceptance.

Record the results of every test performed.

Perform the required quality control tests as follows:

**A. Asphalt Binder Content.** Determine the asphalt binder content of a sample of asphalt concrete by performing an Asphalt Content (AC) Gauge test according to Supplement 1043. Make all printouts available for review by the Monitoring Team at any time. Offset the AC Gauge for each JMF on each project at the project's start. Perform the offset using solvent extraction methods for every QC sample according to Supplement 1038 and the AC Gauge Verification and Offset Record. Use solvent extraction according to Supplement 1038 when an AC Gauge problem exists and for testing cooled samples that cannot adequately be tested in an AC Gauge test.

Total, for each day's production, the flow meter printouts for SBR polymer added at the asphalt concrete mixing plant. Calculate the percent of polymer versus neat asphalt binder in the mix each day and record on the TE-199. Hold calculation worksheets and printouts in the plant laboratory for review by the Monitoring Team. A +/- 0.2 percent tolerance from the target amount of SBR polymer will be used as a guide for an acceptable amount of SBR polymer, but will not be consistently low.

Determine the moisture content of the asphalt concrete for each AC Gauge test. Maintain the moisture content at 0.8 percent or less.

**B. Gradation.** Perform at least one gradation test each production day on aggregate remaining after removing the asphalt binder with a solvent from an asphalt concrete sample used in an AC Gauge test (solvent sample) or on aggregate remaining after removing the asphalt binder with a preapproved asphalt ignition oven according to Supplement 1054 and from an asphalt concrete sample used in an AC Gauge test (ignition oven sample). Use only an asphalt ignition oven to obtain an aggregate sample from an asphalt concrete sample having a polymer modified PG Binder. The DET may make an exception for this for SBS polymer as long as no issues arise. Correct each solvent sample for ash. Perform all other gradations on solvent samples, ignition oven samples, or on samples obtained according to the Contractor's approved QCP.

The gradation results of all the sieves must be representative of the JMF. If the Contractor fails to control the entire gradation, the Laboratory may require a redesign according to 441.02.

When the F-T value is specified for a mix in 441.02 calculate it for each gradation analysis. Maintain the F-T value at +4 percentage points or less for these mixes.

Calculate the F/A ratio for every solvent sample or ignition oven sample analysis. Maintain the F/A ratio so no F/A ratio is greater than 1.2 for all mixes. Use the asphalt binder content determined by the AC Gauge for calculating the F/A ratio. If the F/A ratio is greater than 1.0, recalculate the F/A ratio using the effective asphalt binder content. Calculate the effective asphalt binder content on the calculation sheet using the asphalt binder content determined by the AC Gauge and attach it to the Quality Control Report. Use bulk and effective aggregate specific gravities and remaining values needed in the calculation from the approved JMF. Do not deviate from these values without the Laboratory's approval. If the F/A ratio is greater than 1.0 for ignition oven samples, calculate the F/A ratio using the percent passing the No. 200 (75  $\mu$ m) sieve from a washed gradation of the ignition oven sample according to AASHTO T 30.

**C. Air Voids and MSG.** Determine the air voids of the asphalt concrete by analyzing a set of compacted specimens and a corresponding MSG determination. Use the MSG to calculate the air voids of the compacted specimens. Ensure that the cure temperature and specimen compaction temperature are the same. Use a 1-hour cure for all mix samples used in voids analysis. The Contractor may use a 2-hour cure time if voids are consistently near the low void warning band. In this case, use the 2-hour cure for all voids testing through the remainder of the project. For hot mix asphalt use the JMF lab compaction temperature. For warm mix asphalt according to 402.09 use a lab compaction temperature 30.0 °F (16.7 °C) less than the JMF lab compaction temperature for hot mix asphalt. Use a compaction temperature tolerance of +/- 5.0 °F (3.0 °C). Record on the TE-199 if the mixture produced was ran at the asphalt plant as a hot mix asphalt (HMA) or as a warm mix asphalt (WMA) produced according to 402.09 or another approved method.

Calculate the Voids in Mineral Aggregate (VMA) value for every set of compacted specimens according to Supplement 1037.

Calculate the average of all the MSG determinations performed each production day and report this average on the Quality Control Report. When the range of three consecutive daily average MSG determinations is equal to or less than 0.020 average these three average MSG determinations to determine the Maximum Theoretical Density (MTD). After the MTD is established, compare all individual MSG determinations to the MTD

Whenever compacted specimens are to be made and an MSG determination is to be run, take a sample of sufficient size to run a corresponding AC Gauge test. When the air void and MSG test results are recorded reference them to the AC Gauge test of the sample.

**D. Other Requirements.** Supply proper containers and take two 1 quart (1 liter) asphalt binder samples from the first transport truck load of each different asphalt binder grade of the project before incorporation into the storage tank. Label the samples with binder grade, supplier, project number and date and retain

#### 441.10

them in the plant laboratory for future reference by the Department. Discard the samples at project finaling if not taken by the Monitoring Team.

Retain a split sample for each AC Gauge test and MSG test and all compacted specimens for monitoring by the Department. Maintain MSG samples in the state described in ASTM D 2041, Section 9.2. The Contractor may dispose of the AC Gauge test samples after two days and all other split samples after seven days if the Department does not process the split samples.

Measure the temperature of the mixture and record. Validate the results on the load tickets at least once during each hour of production.

The Contractor may conduct additional testing of any type. Record such additional testing along with all other quality control records and have these records readily available for the Monitoring Team's review. The Laboratory may observe, review, and approve the procedures at any time.

**441.10 Control Charts.** Maintain up to date control charts showing each individual test result and also the moving accumulative range as follows:

A. Plot tests showing the percent passing for the 1/2 inch (12.5 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), and No. 200 (75  $\mu$ m) sieves the percent asphalt binder content, the MSG and the percent air voids. Round all percentages to the nearest whole percent; except, round asphalt binder content, the No. 200 (75  $\mu$ m) sieve, and air voids to the nearest 0.1 percent.

B. Show the out of specification limits specified in Table 441.10-1 and QCP Warning Band Limits on the control charts.

C. Label each control chart to identify the project, mix type and producer.

D. Record the moving accumulative range for three tests under each test point on the chart for air voids and asphalt binder content. Accumulative range is defined as the positive total of the individual ranges of two consecutive tests in three consecutive tests regardless of the up or down direction tests take. If more than the minimum required testing (i.e. two tests per production day or night, 441.09 first paragraph) is performed do not include the result in accumulative range calculations.

**Stop production and immediately notify the Monitoring Team when either A or B occurs:**

A. Any two tests in a row or any two tests in two days are outside OF the specification limits of Table 441.10-1.

B. Any four consecutive moving accumulative ranges greater than specification limits of 2.50 percent for air voids or 0.60 percent for asphalt binder content occur.

Any mixture sent to the paving site without stopping production and notifying the Monitoring Team when required by this specification will be considered non-specification material.

Do not restart production until an adequate correction to remedy problems is in place and the Monitoring Team is satisfied. Following a shutdown restart production in a manner acceptable to the DET. When production problems cannot be solved within one day after a plant shut down a Contractor's representative

holding a Level 3 Asphalt Department approval is required to be at the asphalt plant until a full production day is achieved with results satisfactory to the Monitoring Team.

**TABLE 441.10-1**

<b>Mix Characteristic</b>	<b>Out of Specification Limits</b>
Asphalt Binder Content <sup>[1]</sup>	-0.3% to 0.3%
1/2 inch (12.5 mm) sieve <sup>[1]</sup>	-6.0% to 6.0%
No. 4 (4.75 mm) sieve <sup>[1]</sup>	-5.0% to 5.0%
No. 8 (2.36 mm) sieve <sup>[1]</sup>	-4.0% to 4.0%
No. 200 (75 $\mu$ m) sieve <sup>[1]</sup>	-2.0% to 2.0%
Air Voids <sup>[2]</sup>	2.5 to 4.5
Air Voids <sup>[3]</sup>	3.0 to 5.0
MSG <sup>[4]</sup>	-0.012 to 0.012

[1] deviation from the JMF  
 [2] for Design Air Voids of 3.5%  
 [3] for Design Air Voids of 4.0%  
 [4] deviation from the MTD

**441.11 Quality Control Reports.** Use Department Form TE-199 for the Quality Control Report. Record all test results on the Quality Control Report. Document all decisions regarding responses to test results on the Quality Control Report (referring to the particular test), including reasons why a particular problem may exist what action was taken to correct the problem (plant operation or testing), and what communication with Department personnel took place. Submit one Quality Control Report to the DET no later than specified. Retain copies of all records documenting the quality control inspections and tests throughout the life of the Contract and furnish them to the DET on request.

**441.12 Mixture Deficiencies.** Control all production processes to assure the Engineer that the mixture delivered to the paving site is uniform in composition; within the specification requirements and limits; conforms to the JMF; and that the placed mixture is free of any defect (ex. segregation, tenderness, lack of mixture and texture uniformity, raveling, flushing, rutting, holes, debris etc.) within the Contractor's control. Correct obvious pavement problems according to 401.15. If any suspicion that other mixture composition or pavement problems exist, the Monitoring Team will conduct an initial investigation through review of data and sampling of the asphalt pavement. Should a Department investigation determine that the Contractor's QCP is not controlling the mixture in a manner to achieve mixture quality as described above the Contractor quality control data may be rejected. In that case the Department will conduct a thorough test investigation based on samples from the roadway and use those test results in determining disposition of the non specification material.

A mixture is not uniform in composition if multiple random non-specification individual tests or any four consecutive non-specification moving accumulative ranges exist. The mixture can be rejected, production can be stopped and/or a redesign can be called for by the Department. The Laboratory will not approve

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any redesign it determines is unsatisfactory to provide acceptable mix performance. Submit this new design for approval according to 441.02 and at no additional cost to the Department.

When any out of specification material, based on quality control tests not within the limits of Table 441.01-1, is sent to the paving site the Engineer will determine disposition of the material according to the Department non specification material policy.

**ITEM 442 SUPERPAVE ASPHALT CONCRETE**

- 442.01 Description**
- 442.02 Type A Mix Design**
- 442.03 Type B Mix Design**
- 442.04 Asphalt Binder**
- 442.05 Quality Control**
- 442.06 Compaction**
- 442.07 Acceptance**
- 442.08 Basis of Payment**

**442.01 Description.** This work consists of gyratory mix design, material, and quality control requirements for constructing a Superpave asphalt concrete pavement surface or intermediate course. The asphalt concrete pavement course consists of aggregate, and asphalt binder mixed in a central plant and spread and compacted on a prepared surface.

The requirements of Item 441 apply, except as modified by this specification. Do not use the warm mix asphalt method for 12.5 mm mixtures.

**442.02 Type A Mix Design.** Design the mixture composition for a Type A mix according to 441.02 and the most recent *Asphalt Institute Superpave Mix Design Manual* (SP-2) for design procedures and material properties except as modified by this subsection. Include in the JMF submittal the standard Department cover and summary page; all printouts from the gyratory compactor (all gyratory points not necessary); and analysis covering the required mix properties. Submit one compacted gyratory sample and loose mix for compaction of another sample, in addition to a 5-pound (2000 g) loose sample, for each JMF.

The Contractor may use the Marshall flow test in design as an indicator of potential for excess tenderness.

Supply aggregate according to the lane current average daily truck traffic (Lane ADTT) as follows unless otherwise shown on the plans:

$$\text{Lane ADTT} = \text{Current ADT} \times T_{24} \times 0.45$$

Where:

Current ADT = current average daily traffic count from the plans

$T_{24}$  = percent trucks per day from the plans

**TABLE 442.02-1 GYRATION LEVEL AND MATERIAL REQUIREMENTS**

Lane ADTT	N <sub>ini</sub>	N <sub>des</sub>	N <sub>max</sub>	Coarse Aggregate Angularity	Fine Aggregate Angularity	Flat and Elongated Particles	Sand Equivalent
<4000	7	65	105	95 * /90 **	44	10	45
>4000	7	65	105	100 * /100 **	44	10	50
* Percent fractured (one or more faces) according to ASTM D5821							
** Percent fractured (two or more faces) according to ASTM D5821							

Submit aggregate to be used to the Laboratory for approval a minimum of 3 weeks before submitting a JMF for approval.

If fine aggregate is from crushed carbonate stone or air-cooled blast furnace slag, the Department will not require the fine aggregate angularity (FAA) test. The Department will allow a blend of a material not meeting the FAA with a material that meets the FAA, but calculate the FAA result based on the individual Department FAA results and actual blend percentages. Obtain Department approval of any blends.

The restricted zone does not apply. Use control points according to SP-2, except as specified in Table 442.02-2.

**TABLE 442.02-2 AGGREGATE GRADATION REQUIREMENTS**

Sieve Size	9.5 mm mix (% passing)	12.5 mm mix (% passing)	19 mm mix (% passing)
1 1/2 inch (37.5 mm)			100
3/4 inch (19 mm)		100	85 to 100
1/2 inch (12.5 mm)	100	95 to 100	90 max
3/8 inch (9.5 mm)	90 to 100		
No. 4 (4.75 mm)	70 max		
No. 8 (2.36 mm)	32 to 52	32 to 45	28 to 45
No. 200 (75 µm)	2 to 8	2 to 8	2 to 6

Ensure that the F/A ratio is a maximum of 1.2. Use a 2-hour cure in design process.

If more than 15 percent fine aggregate not meeting FAA is used, perform a loaded wheel test (LWT) according to Supplement 1057. To estimate a LWT sample mix volume, use the bulk density from gyratory specimens at N<sub>des</sub>. Results less than 0.20 inch (5.0 mm) at 120 °F (49 °C) are considered passing.

The Contractor may use reclaimed asphalt concrete pavement according to 401.04. Test design volumetric properties at N<sub>des</sub>. Test N<sub>max</sub> for the required criteria. Ensure that the VMA is not less than the minimum values of Table 442.02-3.

**TABLE 442.02-3 VMA CRITERIA**

Mix	VMA (percent minimum)
9.5 mm	15
12.5 mm	14
19.0 mm	13

**442.03 Type B Mix Design.** Apply the mix design specified in 442.02 for a Type A mix except as modified by this subsection:

Modify the Coarse Aggregate Angularity of Table 442.02-1 according to Table 442.03-1.

**TABLE 442.03-1**

Lane ADTT	Coarse Aggregate Angularity
<4000	65 * /65 **
>4000	75 * /70 **
* Percent fractured (one or more faces) according to ASTM D5821	
** Percent fractured (two or more faces) according to ASTM D5821	

Ensure that at least 50 percent by weight of virgin fine aggregate is aggregate meeting FAA or is crushed carbonate stone or air-cooled blast furnace slag. Modify the No. 8 (2.36 mm) sieve requirement for a 12.5 mm mix in Table 442.02-2 to 34 to 40 percent. Apply an F-T value of +2 according to 441.02 and 441.09.

**442.04 Asphalt Binder.** Use a PG 70-22M asphalt binder for surface courses and a PG 64-28 asphalt binder for intermediate courses.

The minimum total asphalt binder content for a surface course is 5.7 percent.

**442.05 Quality Control.** Conform to 441.09, except as specified in this subsection. Ensure that plant operation and quality control testing conform to the Contractor's Quality Control Program (QCP).

Use a gyratory compactor conforming to the requirements of Superpave. If the gyratory compactor was moved to the plant before production, calibrate it and present the results to the DET. Condition samples for air voids for 2 hours.

Determine bulk gravity for air voids determination on specimens compacted to  $N_{des}$ . Once each day for the first 3 production days compact one set of specimens to  $N_{max}$ . Ensure that density at  $N_{max}$  is less than 98.0 percent of MSG. The Department will not allow production to continue if  $N_{max}$  is greater than or equal to 98.0 percent of MSG unless acceptable corrections and retest are made.

If the design gradation requires an LWT test, take a sample sufficient to run a LWT test once each day for the first 3 days and test it according to Supplement 1057. The Contractor may perform the LWT test in the Contractor's Level 2 laboratory, but must compact the sample the same day the sample was taken, cure it overnight, and test it the following day. Give the test result and sample density to the DET the day of the LWT test. Report the LWT data on the Quality Control Report.

**442.06 Compaction.** Cease production if compaction causes bumps in the mix or the mix is excessively tender.

**442.07 Acceptance.** The Department will base acceptance of the asphalt concrete mix on the item specified in the Contract (i.e., Item 446, Item 448).

**442.08 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, 12.5 mm, Type A (446)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, 12.5 mm, Type B (446)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, 9.5 mm, Type A (446)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, 9.5 mm, Type B (446)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course, 19 mm, Type A (446)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course, 19 mm, Type B (446)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course, 9.5 mm, Type A (448)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course, 9.5 mm, Type B (448)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, 12.5 mm, Type A (448)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, 12.5 mm, Type B (448)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, 9.5 mm, Type A (448)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, 9.5 mm, Type B (448)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course 19 mm, Type A (448)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course, 19 mm, Type B (448)

**ITEM 443 STONE MATRIX ASPHALT CONCRETE**

- 443.01 Description**
- 443.02 Quality Control Program**
- 443.03 Composition**
- 443.04 Mixing**
- 443.05 Storage**
- 443.06 Quality Control**
- 443.07 Construction**
- 443.08 Acceptance**
- 443.09 Basis of Payment**

**443.01 Description.** This work consists of constructing a stone matrix asphalt concrete (SMA) course consisting of aggregate, asphalt binder, and additives.

The requirements of 442 and 446 apply except as follows. Do not use the warm mix asphalt method (402.09) for this item.

**443.02 Quality Control Program.** Update the Quality Control Program meeting 403.03 to include a section for how the quality control, production and placement of SMA will meet this specification. Submit the revised program to the Laboratory with the SMA mix design to be approved.

**443.03 Composition.** Discuss the mix design approach with the Laboratory during the mix design and prior to submittal.

A. Design Limits. Submit a JMF to the Laboratory which meets the requirements of Table 443.03.1 and Table 443.03-2.

**TABLE 443.03-1 MIX GRADATION**

<b>Sieve</b>	<b>Total Percent Passing</b>
3/4 inch (19.0 mm) sieve	100
1/2 inch (12.5 mm) sieve	85 to 100
3/8 inch (9.5 mm) sieve	50 to 75
No. 4 (4.75 mm) sieve	20 to 28
No. 8 (2.36 mm) sieve	15 to 24
No. 50 (300 μm) sieve	10 to 20
No. 200 (75 μm) sieve	8 to 12

**TABLE 443.03-2 MIX PROPERTIES**

Property Description	Specification
Binder, % (1)	5.8 to 7.5
VMA, % (2)	16.0 to 19.0
Draindown Test, % (3)	0.3
Design Air Voids, %	3.5
Design Gyration (4)	65
VCA MIX / VCA DRC (5)	< 1.0
TSR (6)	0.80
F/A	NA

- (1) by total mix
- (2) based on bulk gravity
- (3) AASHTO T305 conducted at mix production temperature (not compaction temperature)
- (4) Nini and Nmax do not apply
- (5) VCA = Volume of Coarse Aggregate (Calculated for mix and dry rodded conditions per AASHTO PP41- 02 or newer version.)
- (6) Unconditioned specimens will have a minimum 65 psi (450 kPa) retained strength.

Compact specimens at 300 °F (149 °C) for PG 70-22M and 310 °F (154 °C) for PG 76-22M.

B. Asphalt Binder. Provide asphalt binder conforming to 702.01.

C. Coarse Aggregate. Use approved coarse aggregates. Ensure coarse aggregates meet 703.05 and Table 443.03-3.

**TABLE 443.03-3 AGGREGATE REQUIREMENTS**

Tests	Description	Specification
ASTM D 4791	% Flat & Elongated Ratio at 3:1, (max. to min.), 5:1, (max. to min.)	20 max 5 max
ASTM D 5821	% Crushed, one / two faces	100 / 90 min
AASHTO T 96	LA Abrasion (stone or gravel)	35 max

D. Mineral Filler. Conform to 703.07. Use mineral filler in the JMF with a plasticity index (AASHTO T 90) not greater than 4 (does not apply to hydrated lime). Reclaimed asphalt concrete pavement passing the 5/8 inch (16 mm) sieve may be used as filler only. Do not account for reclaimed asphalt concrete pavement binder content. Do not use quicklime (CaO). Do not premix filler with another aggregate. Cover mineral filler piles to protect from rain.

Blend the mineral filler, asphalt binder and fiber stabilizer into a homogenous mixture and test the mortar for the following properties of Table 443.03-4.

**TABLE 443.03-4 MORTAR TEST REQUIREMENTS**

Tests	Description	Specification
AASHTO TP5-98	Unaged DSR, G*/ sin (kPa)	5 minimum
AASHTO TP5-98, T240-97	RTFO Aged DSR, G*/ sin (kPa)	11 minimum
AASHTO TP1-98, PP1-98	PAV Aged BBR, Stiffness (Mpa)	1500 maximum

E. Reclaimed Asphalt Concrete Pavement. Do not use reclaimed asphalt concrete pavement except as described in D above.

F. Fiber Stabilizer. Choose and meet the requirements of one of the following fiber stabilizers. Submit with the JMF submittal the fiber manufacturer's most recent actual test data and a certification of compliance for the fiber type to be used. Protect the fiber stabilizer from moisture or other contamination.

Cellulose Fibers. Add the fiber at a dosage rate of 0.3 - 0.4% by weight of the total mix as directed by the Engineer to control draindown in production.

Property Description	Specification
1.Fiber length (max):	0.25 inch (6.35 mm)
2.Sieve Analysis - Alpine Sieve Method	
Passing No. 100 (150 µm) sieve	60-80%
Sieve Analysis - Ro-Tap Sieve Method	
Passing No. 20 (850 µm) sieve:	80-95%
Passing No. 40 (425 µm) sieve:	45-85%
Passing No. 100 (150 µm) sieve:	5-40%
3.Ash Content:	18% non-volatiles (5%)
4.pH:	7.5 (1.0)
5.Oil Absorption:(times fiber weight)	5.0 (1.0)
6.Moisture Content (max):	5.0%

Cellulose Pellets. Cellulose pellets consist of cellulose fiber and may be blended with 0 - 20% asphalt binder. Meet the cellulose fiber requirements above. If no asphalt binder is used, add the pellet at a dosage rate of 0.3 - 0.4% by weight of the total mix as directed by the Engineer to control draindown in production. Adjust the fiber dosage to maintain the desired fiber amount when fiber is pre-blended with binder.

1. Pellet size: 1/4 cubic inch (maximum)
2. Binder: 25 - 80 pen.

Mineral Fiber. Use mineral fibers made from virgin basalt, diabase, or slag treated with a cationic sizing agent to enhance disbursement of the fiber as well as increase adhesion of the binder to the fiber surface. Add the fiber at a dosage rate of 0.3 - 0.4% by weight of the total mix as directed by the Engineer to control draindown in production.

1. Average Fiber length (max): 0.25 inches (6.35mm)

Average Fiber thickness (max) : 0.0002 inches(0.005mm)

2. Shot content (ASTM C612)

Passing No. 60 (250  $\mu\text{m}$ ) sieve: 90 - 100%

Passing No. 230 (63  $\mu\text{m}$ ) sieve: 65 - 100%

3. Degradation (max)\*: 30%

\* (GeorgiaDOT-124/McNett ) - copy available from the Office of Materials Management, Asphalt section.

**443.04 Mixing.** Conform to the following additional requirements.

A. Fiber Stabilizer. Furnish feeder equipment specifically manufactured to uniformly feed fiber into the plant and that is automated through connection with plant controls. Include a low level and no-flow indicator and print out the feed rate of the feeder supply system and include a transparent pipe section for observing flow consistency. The Engineer will approve the fiber feed system by a trial load of SMA and inspection of the bag house collected material prior to the start of production. Conduct and document a weekly quick check of the fiber feed calibration according to the Quality Control Plan. Conduct a daily check of fiber usage by calculating and documenting on the TE 199 that fiber usage is within 10% of the intended usage.

In drum plants, add the fibers in loose form, by an automated calibrated feed system, such that the fibers are coated by asphalt binder before being caught in the drum air flow.

In batch plants, distribute the fiber uniformly before injecting asphalt binder and increase mixing time a minimum of 5 seconds.

B. Mineral Filler. Filler may be fed through a hopper if consistency of flow is achieved. If a problem in feeding consistency occurs a pneumatic system will be required. Feed filler into the weigh hopper or pug mill of a batch plant, or at a point away from the flame on a drum plant.

**443.05 Storage.** Do not store the SMA at the plant for more than 2 hours. Do not exceed a mix temperature of 350 °F (180 °C). Provide SMA at a minimum of 300 °F (148 °C) when it arrives at the paver, unless otherwise approved by the Laboratory. If draindown occurs shorten the storage time and increase the fiber dosage.

**443.06 Quality Control.** Ensure an employee of the Contractor with a Level 3 rating is at the plant or construction site during production of the SMA for any test strips and through at least one full production day satisfactory to the District.

Perform quality control tests every 3 hours of production. The increased frequency of quality control testing may require additional quality control personnel at the plant. Determine the asphalt binder content, gradation, moisture content, air voids, VMA, and MSG of the SMA. For each test series calculate the VCAMIX / VCADRC. If the limit of 1.0 is exceeded stop production until resolved. Perform a draindown test once each day of production and raise fiber dosage 0.1% if the test limit is exceeded. Do not exceed the No. 200 (75  $\mu\text{m}$ ) sieve design bands by the moving average of three tests. Compact specimens at 300 °F (149 °C) for PG 70-22M and 310 °F (154 °C) for PG 76-22M. Due to

443.07

sample variability with SMA, a larger than usual sample size from which material is obtained for the various tests is required.

**443.07 Construction.** At least 24 hours prior to beginning a test strip meet with the Engineer and DET and provide a written summary of steps taken to assure mix quality and construction practices account for the special needs of SMA production and placement. Send a copy of the written summary to the Laboratory.

A. Test Strips and JMF Adjustment. Do not begin full production of the SMA until receiving authorization from the District. This authorization will be based on the successful construction of one or more test strips. Test strips consist of 50 to 100 tons of SMA produced and placed in accordance with these specifications. Cease SMA production that day unless another test strip is needed. Place test strips in one continuous mat. The test strip will be included in the first lot for determining density for payment. Test strips are incidental to the pay item.

During the construction of a test strip, perform 1 set of quality control tests as described above and obtain and test 3 random cores of the compacted pavement. Within 1 working day after a test strip is completed, the District, the Laboratory and the Contractor's Level 3 employee will determine if any changes in the SMA JMF, production, or placement procedures are needed. A redesign of the JMF or another test strip may be required. The Laboratory will notify the District of any JMF adjustments. Do not start production until notified by the District.

B. Compaction. Start compaction immediately after the SMA has been placed by the paver. Use only steel wheel rollers. Vibratory rollers in vibratory mode, set at a high frequency and low amplitude, can be used as the breakdown roller only. Always operate the breakdown roller immediately behind the paver. If isolated, small fat spots develop, apply sand immediately during compaction. If continuous and/or large fat spots develop, cease production until resolved. Do not compact SMA that is below 230 °F (110 °C).

C. Hauling. Do not allow trucks to dump any mix on the project mat after delivering mix to the paver. Provide a suitable place for bed cleaning off of the mat.

**443.08 Acceptance.** After accepting the test strips, the Department will accept SMA according to 446.05.

**443.09 Basis of Payment.** The Department will pay for accepted quantities of Stone Matrix Asphalt Concrete, complete in place, including test strip, at the contract price as modified by 446.05, as follows:

Item	Unit	Description
443	Cubic Yard (cubic Meter)	Stone matrix asphalt concrete, 12.5mm, PG70-22M, (446)
443	Cubic Yard (cubic Meter)	Stone matrix asphalt concrete, 12.5mm, PG76-22M, (446)

## ITEM 446 ASPHALT CONCRETE

### 446.01 Description

### 446.02 JMF Field Adjustments

### 446.03 Monitoring

### 446.04 Reports

### 446.05 Density Acceptance

### 446.06 Joints

### 446.07 Basis of Payment

**446.01 Description.** This work consists of constructing a surface course or an intermediate course of aggregate and asphalt binder mixed in a central plant and spread and compacted on a prepared surface. The Department will base acceptance of the compacted mixture in place on the level of density attained as sampled by the Contractor and analyzed by the Department.

The requirements of Item 441 apply, except as modified by this specification.

**446.02 JMF Field Adjustments.** Determine the need for any JMF gradation adjustments, provided for in 441.05, in the first 3 days or first 3000 tons (3000 metric tons) of production, whichever comes last. Give the DET written notice of JMF adjustments no later than the end of the following day's production.

For projects smaller than the above JMF field adjustment period give the DET written notice of any JMF gradation adjustments within 1 workday following the last day of production.

**446.03 Monitoring.** If there is poor comparison between the Department's comparison samples and the Contractor's quality control tests, the Monitoring Team may at any time disallow production to continue under Item 446. In this case, conform to Items 448 and 446. The Department will notify the Contractor in writing to stop production.

**446.04 Reports.** Submit the Quality Control Report according to 441.11 on the workday following the production day of the material represented by the report.

**446.05 Density Acceptance.** The requirements of 401.13 do not apply. However, rollers must fully and satisfactorily provide the required compaction, be mechanically sound, and meet Hot Mix Asphalt industry standards. The Department retains the right to reject the use of rollers which are not in good repair, or are not designed to do the work required. A three-wheel roller per 401.17 is not required.

Obtain 10 cores for the Department to test to determine the in-place density of the compacted mixture as a percentage of the average Maximum Specific Gravity (MSG) for the production day the material was placed. Compact shoulders using the same equipment and procedures as used on the mainline pavement. The requirements of 401.16, except for the last four paragraphs, are waived.

Payment for compaction of the completed mainline pavement and ramps is by Lot, based upon the degree to which density is attained. Payment for shoulders depends on the degree to which the density is obtained on the adjacent mainline

pavement lane or ramp. However, when a cold longitudinal joint is made between a mainline pavement lane and an adjoining shoulder, payment for the shoulder will be based on the degree to which the density is obtained on the shoulder.

A Lot consists of an area of pavement placed during a production day, including the shoulders. If less than 400 tons (400 metric tons) is produced in a production day, then that production day is combined with the next production day into a single Lot. If greater than 250 tons (250 metric tons) and less than 400 tons (400 metric tons) is produced on the last day of production for the project, then the day's production is a separate Lot. If less than 250 tons (250 metric tons) is produced on the last production day for the project, it is part of the previous Lot for acceptance, provided the previous Lot was placed within 3 days; otherwise, it is a separate Lot.

Within 48 hours after the pavement is placed, obtain ten cores for each Lot at random locations the Engineer determines. The Engineer will divide a Lot into five equal sublots and calculate two random core locations in each subplot as described below using an acceptable random number selection method. Both mainline pavement and ramps will be included in Lot determinations. The Engineer will not give the Contractor random core locations early in the Lot placement. The Engineer will tell the Contractor the method used to determine random locations as noted below before project start and will use the same method for all Lots.

For each Lot three cores will be taken as follows from cold longitudinal joints and seven cores will be taken from the mat not including the joints. If locations not according to this specification are given, immediately inform the Engineer. Do not take cores from ramp joints. Take joint cores from the first, last and randomly from one of the three middle sublots. Determine the longitudinal location of the joint core within the subplot randomly and also randomly determine whether or not the cold longitudinal joint core is to be taken from a confined or unconfined joint if both exist in the mat to be cored. Do not take cores on the sloped face of a wedge before the adjoining lane is placed. Take joint cores such that the core's closest edge is six inches (150 mm) from the edge of the joint upper notch of a wedge joint or 4 inches (100 mm) from the vertical face of a confined vertical face joint. If a nine inch or wider wedge joint is used take the core three inches from the upper wedge joint notch. Take the seven random mat cores that are not for the joint coring such that the core's closest edge is at least twelve inches from the cold longitudinal joint wedge joint upper notch or vertical face edge. If taken, locate cores for the Contractor's quality control (sister core) longitudinally from and within four inches (100 mm) of the random core.

The Department will determine the pay factor for each Lot cored by the pay schedule in Table 446.05-1 for Lots with three cold longitudinal joint cores and Table 446.05-2 for Lots with less than three cold longitudinal joint cores. The Department will verify the MTD if the MSG determination has a deviation from the MTD of less than or equal to 0.020. If the MTD is not verified, establish a new MTD according to the procedures established in 441.09. If less than 10 cores are available for determining the mean, the Laboratory will determine disposition of the Lot.

Fill core holes by the next workday. Before filling, ensure the holes are dry and tack them with asphalt material conforming to 407.02. Properly compact the asphalt concrete used for filling the hole and leave it flush with the pavement.

**TABLE 446.05-1**  
**FOR LOTS WITH 3 COLD JOINT CORES**

Mean of Cores[1]	Pay Factor	
	Surface Course	Intermediate Course
98.0% or greater	[2]	[2]
97.0 to 97.9%	0.94	[2]
96.0 to 96.9%	1.00	0.94
93.4 to 95.9%	1.04 [4]	1.00
92.4 to 93.3%	1.00	1.00
91.4 to 92.3%	0.98	1.00
90.4 to 91.3%	0.90	0.94
89.4 to 90.3%	0.80	0.88
88.4 to 89.3%	[3]	[3]
Less than 88.4%	[2]	[2]
[1] Mean of cores as percent of average MSG for the production day.		
[2] For surface courses, remove and replace. For other courses, the District will determine whether the material may remain in place. If the District determines the course should be removed and replaced, the Contractor will remove and replace this course and all courses paved on this course. The pay factor for material allowed to remain in place is 0.60.		
[3] The District will determine whether the material may remain in place. If the District determines the course should be removed and replaced, the Contractor will remove and replace this course and all courses paved on this course. The pay factor for such material allowed to remain in place is 0.70.		
[4] No incentive will be paid if any single cold joint core is less than 91.0%.		

**TABLE 446.05-2  
FOR LOTS WITH LESS THAN 3 COLD JOINT CORES**

Mean of Cores[1]	Pay Factor	
	Surface Course	Intermediate Course
98.0% or greater	[2]	[2]
97.0 to 97.9%	0.94	[2]
96.0 to 96.9%	1.00	0.94
94.0 to 95.9%	1.04 [4]	1.00
93.0 to 93.9%	1.00	1.00
92.0 to 92.9%	0.98	1.00
91.0 to 91.9%	0.90	0.94
90.0 to 90.9%	0.80	0.88
89.0 to 89.9%	[3]	[3]
Less than 89.0%	[2]	[2]
[1] Mean of cores as percent of average MSG for the production day.		
[2] For surface courses, remove and replace. For other courses, the District will determine whether the material may remain in place. If the District determines the course should be removed and replaced, the Contractor will remove and replace this course and all courses paved on this course. The pay factor for material allowed to remain in place is 0.60.		
[3] The District will determine whether the material may remain in place. If the District determines the course should be removed and replaced, the Contractor will remove and replace this course and all courses paved on this course. The pay factor for such material allowed to remain in place is 0.70.		
[4] No incentive will be paid for lots where 3 joint cores are required to be taken but less than 3 cores are taken.		

**446.06 Joints.** Construct joints according to 401.17. Make a hot longitudinal joint between the mainline pavement lane and the adjoining shoulder and all ramps and the adjoining shoulders. If a hot longitudinal joint is specified between the mainline pavement lanes, the Contractor may construct a cold longitudinal joint between the mainline pavement lanes and the adjoining shoulders. Cold longitudinal joints in mainline pavement will be tested according to 446.05.

**446.07 Basis of Payment.** The Department will pay for accepted quantities, completed in place, at the contract prices, as modified by 446.05, as follows:

Item	Unit	Description
446	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course, Type ____
446	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, Type ____

**ITEM 448 ASPHALT CONCRETE****448.01 Description****448.02 JMF Field Adjustments****448.03 Density****448.04 Reports****448.05 Acceptance****448.06 Basis of Payment**

**448.01 Description.** This work consists of constructing a surface course or an intermediate course of aggregate and asphalt binder mixed in a central plant and spread and compacted on a prepared surface. The Department will determine acceptance of the mixture by Lot, based on the composition of random samples taken and tested by the Contractor and verified by the Department.

The requirements of Item 441 apply, except as modified by this specification.

**448.02 JMF Field Adjustments.** Determine the need for any JMF gradation adjustments, provided for in 441.05, from the results of quality control and Department verification tests of the first two acceptance lots. Following adjustment, the Department will apply the adjusted JMF, for acceptance purposes, to the entire production including the first two lots. Give the DET written notice of JMF adjustments no later than the end of the first workday following the notification of verification test results of the second acceptance lot.

For projects with less than two acceptance lots or for any JMF that will no longer be used on a project, give the DET written notice of any JMF gradation adjustments within 1 workday following the notification of acceptance test results.

**448.03 Density.** Conduct density gauge quality control testing on the asphalt mat according to Supplement 1055 (S 1055). Conduct density gauge testing on uniform courses of 1.0 in (25mm) or more plan thickness. Conduct density gauge testing on projects of two adjacent lanes or more and with at least one continuous mile (1.6 kilometers) of paving (excepting bridges, intersections etc.).

When Supplement 1055 density gauge testing is required, the requirements of 401.16, except the last four paragraphs, are waived. The requirements of 401.13 do not apply. However, rollers must fully and satisfactorily provide the required compaction, be mechanically sound, and meet Hot Mix Asphalt industry standards. The Department retains the right to reject the use of rollers which are not in good repair, or are not designed to do the work required. A three-wheel roller per 401.17 is not required.

**448.04 Reports.** Refer to Item 403 for reporting requirements of asphalt mixtures tested at the asphalt plant. Report density gauge QC testing results according to S 1055.

**448.05 Acceptance.** Refer to Item 403 for acceptance requirements. If a project includes 448.03 Density, acceptance will include any density deductions according to S 1055.04.

**448.06**

**448.06 Basis of Payment.** The Department will pay for accepted quantities, completed in place, at the contract prices, or at the contract price as modified in 448.05, as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
448	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course, Type ____
448	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, Type ____

## 450 RIGID PAVEMENT

### ITEM 451 REINFORCED PORTLAND CEMENT CONCRETE PAVEMENT

- 451.01 Description
- 451.02 Materials
- 451.03 Equipment
- 451.04 Setting Forms
- 451.05 Fine Grading of Subgrade or Subbase
- 451.06 Placing Concrete
- 451.07 Placing Reinforcement
- 451.08 Joints
- 451.09 Finishing
- 451.10 Curing
- 451.11 Removing Forms
- 451.12 Surface Smoothness
- 451.13 Profile Grinding
- 451.14 Pavement Grooving Corrections
- 451.15 Sealing Expansion Joints
- 451.16 Opening to Traffic
- 451.17 Pavement Thickness
- 451.18 Method of Measurement
- 451.19 Basis of Payment

**451.01 Description.** This work consists of constructing a pavement composed of reinforced portland cement concrete on a prepared surface.

**451.02 Materials.** Furnish materials conforming to:

Concrete, Class C .....	499
Joint sealer.....	705.04
Preformed filler .....	705.03
Curing materials .....	705.05, 705.06, 705.07 Type 2
Tiebar steel, epoxy coated .....	709.00
Reinforcing steel .....	709.09, 709.10, 709.12
Dowel bars and basket assemblies .....	709.13

**451.03 Equipment.** Furnish self-propelled spreading and finishing machines capable of consolidating and finishing the concrete and producing a finished surface meeting the requirements specified.

Construct pavement using either fixed forms or slip form paving equipment that conforms to the following:

**A. Fixed Form Construction.** Spread, screed, and consolidate concrete using one or more machines between previously set side forms. Furnish an adequate number and capacity of machines to perform the work at a rate equal to the concrete delivery rate. Furnish machines capable of uniformly distributing and consolidating the concrete without segregation.

Provide machines capable of operating on two side forms, on adjacent lanes of pavement and one side form or on two adjacent lanes as necessary. When placing concrete adjacent to an existing pavement lane, take measures to protect the adjacent pavement from damage. Remove from the work any machine that causes displacement of the side forms from the line or grade or causes undue delay, as determined by the Engineer, due to mechanical difficulties.

Finish small or irregular areas that are inaccessible to finishing equipment using other methods as approved by the Engineer. Accomplish vibration of these areas using hand held or machine mounted internal vibrators. Continue vibration to achieve adequate consolidation, without segregation, for the full depth and width of the area placed.

Use straight edge side forms made of steel and of a depth equal to the specified pavement thickness. Do not use bent or damaged side forms or forms with damaged joint locks or pin pockets. Clean and oil all forms each time they are used. Provide forms in sections not less than 10 feet (3 m) in length, with horizontal joint and base width equal to the depth of the forms. If the radius of the circular pavement edge is 100 feet (30 m) or less, use flexible or curved forms of a design acceptable to the Engineer. Provide adequate devices to securely set forms and withstand operation of the paving equipment. Do not use built-up forms except to construct pavement of a specified thickness whose total area for the project is less than 2000 square yards (1650 m<sup>2</sup>). Provide forms with adequate joint locks to tightly join ends of abutting form sections together.

**B. Slip Form Construction.** Place concrete using a slip form paver or combination of pavers designed to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine and with a minimum of hand finishing to provide a dense and homogeneous pavement.

Consolidate the full width and depth of concrete pavement placed by a single pass of a series of approved internal vibrators operating at a frequency range of 7000 to 11,000 impulses per minute. Attach vibrators to either the spreading or finishing equipment in such a manner that they do not come in contact with preset dowel basket assemblies, the subgrade, reinforcing mesh or side forms. Do not operate vibrators in a manner to cause a separation of the mix ingredients (segregation); i.e., either a downward displacement of large aggregate particles or an accumulation of laitance on the surface of the concrete. Avoidance of segregation of the concrete mix may require reduction in the vibration frequency within the range specified when forward motion of the paver is reduced. Connect the power to all vibrators so that they cease when the machine motion is stopped. Stop paving operations if any vibrator fails to operate within the above specified range.

Provide an electronic monitoring device that displays the operating frequency of each internal vibrator on all paving machines used on mainline and ramp paving. The monitoring device shall have a readout display near the paver operator's controls that is visible to the operator and the Engineer. Operate the monitoring device continuously while paving and display all vibrator frequencies with manual or automatic sequencing among individual vibrators. Using the monitoring system record the following minimum information: time of day, station location, paver

track speed, and the frequency of each individual vibrator. Make recordings after each 25 feet (8 m) of paving or after 5-minute intervals of time. If not using a monitoring system with a recorder, make and record readings every 30 minutes. If requested by the Engineer, provide a record of the data.

Electronic vibration monitoring devices are not required for paving machines used to construct shoulders and gores or for any construction project with a total of less than 10,000 square yards (8000 m<sup>2</sup>) of pavement. When electronic monitoring devices are not required, use a tachometer or similar device to demonstrate to the Engineer the paving equipment vibration meets specification.

Operate the slip form paver with as nearly a continuous forward movement as possible, and coordinate all operations of mixing, delivering, and spreading concrete to provide uniform progress with minimal stopping and starting of the paver. If for any reason it is necessary to stop the forward movement of the paver, immediately stop the tamping elements. Unless controlled from the machine, do not apply any other tractive force to the machine.

Accurately control the finish grade of the pavement from a pre-set grade line parallel to the finish grade using equipment with controls that will trace the grade line and automatically adjust the grade of the screeds or extension meters.

In areas where adjoining concrete pavement is to be constructed, ensure that the surface at the edge of the pavement on either side of the longitudinal joint does not vary more than 1/4 inch (6 mm) below the typical section. Ensure that the outside edges of the pavement does not vary more than 1/2 inch (13 mm) below the typical section. Ensure that all pavement edges are nearly vertical with no projections or keyways exceeding 1/2 inch (13 mm).

In the area of construction joints placed at the end of the days run, the Engineer will allow a reduction of approximately 2 inches (50 mm) in overall width.

**451.04 Setting Forms.** Set all forms in conformance to the required grade and alignment and support the entire length of forms on thoroughly compacted material during the entire operation of placing and finishing of the concrete. Set side forms with the top face of the form varying not more than 1/8 inch in 10 feet (3 mm in 3 m) from true plane, and the vertical face varying not more than 1/4 inch in 10 feet (6 mm in 3 m) from true plane. Test the forms for variations from the above requirements and reset the forms as necessary. Do not use loose earth, pebbles, etc., to shim the forms. Immediately before placing concrete, the Engineer will approve the alignment and grade of all forms set.

#### **451.05 Fine Grading of Subgrade or Subbase.**

**A. Fixed Form Construction.** After side forms have been set to line and grade and securely fastened, use a subbase or subgrade planer to remove a slight amount of material and bring the subgrade or subbase to final grade and to a smooth dense condition. Check the subgrade or subbase using a multiple pin template operated on the forms or other methods approved by the Engineer. Correct and retest all high or low spots.

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Instead of the above operation, the Contractor may place forms on subbase or subgrade prepared according to 451.05.B.

**B. Slip Form Construction.** After the subgrade or base is placed and compacted to the required density, use an automatic subgrading machine to cut the areas for pavement and the areas that will support the paving machine to the plan elevation. Construct the grade sufficiently in advance of placing the concrete to permit the Engineer to check the grade.

**451.06 Placing Concrete.** When constructing on subbase or subgrade, immediately before placing concrete, bring the subgrade or subbase to a thoroughly moistened condition by sprinkling with water at such times and in such manner as directed by the Engineer.

When constructing on asphalt concrete, coat the asphalt concrete with curing membrane at least one day prior to placing concrete. Apply the curing membrane at a minimum rate of 1 gallon (1 L) for each 150 square feet (3.7 m<sup>2</sup>) of surface treated using an approved self-propelled mechanical sprayer. Provide an adequate shield to protect the fog spray from the wind. Thoroughly agitate the curing material before use.

Deposit concrete on the grade in a manner that requires as little rehandling as possible. Do not allow workers to walk in the freshly mixed concrete unless wearing clean boots or shoes free of earth or any foreign material.

At expansion and contraction joints, deposit concrete near the joints to ensure the dowel basket assemblies are not disturbed. Do not allow concrete to discharge onto any dowel basket assembly unless the hopper is well centered on the assembly. Use a separate internal vibrator to consolidate concrete around dowel basket assemblies.

Provided the curing compound damage caused by sawing is repaired according to 451.10 and to the Engineer's satisfaction, the Contractor may operate the sawing equipment necessary to saw joints on the newly constructed pavement. Do not operate other mechanical equipment upon existing lane of pavement for seven days or until specimen beams attain a modulus of rupture of 600 pounds per square inch (4.2 MPa). If only finishing equipment is carried on an existing lane, paving may be permitted after that lane has been in place for at least 3 days and after specimen beams shall have attained a modulus of rupture of 500 pounds per square inch (3.5 MPa).

When the width of pavement being placed in one operation is 12 feet (3.6 m) or more and the total area of any given width of pavement on the project exceeds 10,000 square yards (8300 m<sup>2</sup>), use a separate standard manufacture, self-propelled concrete placer/spreader that receives concrete into a hopper adjacent to the area to be paved and delivers the concrete in front of the slipform paver and uniformly spreads the concrete at the proper thickness for the full width being paved. When a slipform paver is equipped with a dowel bar inserter the separate placer/spreader requirement may be waived provided the concrete is delivered in front of the slipform paver at a consistent and uniform thickness for the full width being paved and the slipform paver is capable of spreading, consolidating, screeding, and float

finishing the freshly placed concrete. Provide the Engineer documentation that the slipform paver will meet this specification.

Do not mix, place, or finish concrete after dark without operating an adequate and approved lighting system.

When the air temperature is 35 °F (2 °C) or below, assure the concrete has a temperature of between 50 and 80 °F (10 and 27 °C) at the point of placement.

When the air temperature is greater than 35 °F (2 °C) before placing, maintain a concrete temperature of not more than 90 °F (32 °C).

Do not place concrete on any surface that is frozen or has frost.

Make two test beams from each 7500 square yards (6300 m<sup>2</sup>) of concrete or fraction thereof incorporated in the work each day.

**451.07 Placing Reinforcement.** Place pavement mesh of the size and at the locations within the concrete slab shown on the standard construction drawings. When placing reinforced concrete pavement in two layers, strike off the entire width of the bottom layer to a length and depth that allows laying the mat of reinforcement on the concrete and in its final position without further manipulation. After installing reinforcement directly upon the concrete, place, strike off, and screed the top layer of concrete. When reinforced concrete pavement is placed in one layer and in advance of placing concrete, position and securely anchor the reinforcement to the underlying base or pavement. As an alternative, after spreading the concrete and while it is in a plastic condition, use mechanical or vibratory means to place reinforcement in the concrete.

Where reinforcement is overlapped, securely fasten mats of reinforcement together at the edges of the sheets and at two additional points along the lap. Use reinforcing steel free from dirt, oil, paint, and grease.

**451.08 Joints.** Unless otherwise directed, construct all transverse joints normal to the centerline of the pavement lane and of the type, dimensions, and at locations specified.

Determine contraction and longitudinal joint sawing time limits to protect the concrete from early cracking by using HIPERPAV software. Obtain the software according to Supplement 1033.

Twenty four (24) hours before placing concrete pavement create a HIPERPAV project date file according to Supplement 1033.

Provide the completed file and the printout to the Engineer. When HIPERPAV predicts early age slab cracking will occur, whether due to standard construction practices, joint sawing methods, mix design or curing, either do not start construction until modifications have been made to eliminate HIPERPAV's predicted slab cracking or do not pave.

Perform a HIPERPAV analysis for each pour.

If software analysis determines joint sawing could exceed twenty four (24) hours, assure all joints are sawed by the 24th hour.

A HIPERPAV analysis showing paving can proceed does not eliminate the requirements of 451.16.

**A. Longitudinal Joint.** Construct longitudinal joints between simultaneously placed lanes by sawing.

When a standard (water cooled diamond bladed) concrete saw is used to make the longitudinal joint between simultaneously placed lanes, saw the joint within the timeframe provided in the HIPERPAV output. For pavement less than or equal to 10 inches (255 mm), saw the joint to a minimum depth of one-fourth the specified pavement thickness. For pavements greater than 10 inches (255 mm) thick, saw the joint to a minimum depth of one-third the specified pavement thickness. Saw joints  $1/4 \pm 1/16$  inch ( $6 \pm 1.6$  mm) wide measured at the time of sawing.

When using early-entry (dry cut, light weight) saws to make the longitudinal joint between simultaneously placed lanes, only use saw blades and skid plates as recommended by the saw manufacturer for the coarse aggregate type being used in the concrete. Perform the early entry sawing after initial set and before final set. Saw the joint  $1/8$  inch (3 mm) wide and  $2 \ 1/4$  to  $2 \ 1/2$  inches (56 to 63 mm) deep.

Place deformed epoxy coated steel tiebars or the epoxy coated hook bolt alternate (wobble bolt) with epoxy coated coupling, in longitudinal joints during consolidation of the concrete. Install them at mid-depth in the slab by approved mechanical equipment. As an alternate procedure, rigidly secure them on chairs or other approved supports to prevent displacement. Provide tie bars or wobble bolts of the size and spaced as shown on the standard construction drawings. If used, securely fasten hook bolts or wobble bolts with couplings to the form at the longitudinal construction joint as shown on the standard construction drawings.

**B. Load Transfer Devices.** For all transverse joints, install round, straight, smooth, steel dowel bars of the size shown in Table 451.08-1.

TABLE 451.08-1 DOWEL SIZE	
Thickness of Pavement (T)	Diameter of Steel Dowel
Less than 8 1/2 inches (215 mm)	1 inch (25 mm)
8 1/2 to 10 inches (215 to 255 mm)	1 1/4 inches (32 mm)
Over 10 inches (255 mm)	1 1/2 inches (38 mm) or as shown on the plans

Use dowel basket assemblies conforming to the standard drawings to hold the dowels in a position parallel to the surface and centerline of the slab at mid-depth of the slab thickness.

Preset all dowel basket assemblies before the day’s paving unless the Engineer determines complete presetting is impractical.

Completely install dowel basket assemblies before shipping and spacer wires are removed.

Within 2 hours prior to placing concrete around the dowels, coat the full length of all preset dowels with a thin uniform coat of new light form oil as a bond-breaking material.

Immediately before paving, remove all shipping and spacer wires from the dowel basket assemblies; check the dowel basket assemblies are held firmly in place; check the dowels are parallel to the grade and parallel to centerline of pavement.

The Contractor may place dowels in the full thickness of pavement by a mechanical device (dowel bar inserter) approved by the Engineer. Immediately before inserting the dowels, coat the dowels with a thin uniform coat of new light form oil as a bond-breaking material.

When using a dowel bar inserter, initially demonstrate that the inserted dowel bars in the completed concrete pavement are parallel to the surface and centerline of the slab and are located at mid depth of the slab thickness. On each production day, re-demonstrate to the Engineer inserted dowel bars in the completed pavement are being installed parallel to the surface and centerline of the slab at mid depth of the slab thickness.

For each joint assembly used to hold dowels in position, provide a continuous assembly between longitudinal joints or between the longitudinal joint and pavement edge. Drive at least eight 1/2-inch (13 mm) diameter steel pins a minimum of 18 inches (460 mm) long at an angle to brace the assembly from lateral and vertical displacements during the placing of concrete. Drive two of these pins opposite each other at each end of the assembly, and drive the remaining pins in staggered positions on each side of the assembly. Where it is impractical to use the 18-inch (460 mm) length pins, such as where hardpan or rock is encountered, and provided the assembly is held firmly, the Engineer may authorize use of shorter pins. Where the dowel basket assembly is placed on granular material that may allow settlement or distortion, anchor the assembly with a combination of pins and steel plates, or by some other means satisfactory to the Engineer to prevent settlement.

When concrete pavement is placed on an existing concrete pavement or on a stabilized base, secure dowel basket assemblies from lateral and vertical displacement during concrete placement using power-driven fasteners and appropriate clips or pins driven in predrilled holes of a diameter slightly less than the pin diameter. Use either of the above methods or a combination of the two in sufficient numbers to adequately secure the basket assemblies.

Beginning 6 inches (150 mm) from the longitudinal joint, space dowels at 12-inch (300 mm) centers. Where widths other than 12 feet (3.6 m) are specified, the Contractor may use standard dowel basket assemblies with dowel spacings adjusted as follows. Maintain 6-inch (150 mm) dowel spacing at the longitudinal joint and increase the spacing at the outer edge of the lane up to 12 inches (300 mm). Where an odd width of lane occurs and if the standard dowel basket assembly would provide for a space exceeding 12 inches (300 m), place a dowel 6 inches (150 mm) from the outer edge of the lane). Hold such a dowel rigidly in proper position by a method satisfactory to the Engineer or cut and splice a dowel basket assembly of greater length than required to attain the required length

**C. Expansion Joints.** Where a pressure relief joint is not provided adjacent to a bridge structure, construct expansion joints at the first two regularly spaced joint locations adjacent to the bridge approach slab on each side of the bridge. If the

pavement is constructed in two or more separately placed lanes, construct the transverse expansion joints in a continuous line for the full width of the pavement and shoulders.

Construct expansion joints according to the standard construction drawings. Install the face of the expansion joint perpendicular to the concrete surface except when expansion joint is installed at a skewed bridge approach slab.

Use round, straight, smooth, steel dowels, and within 2 hours of placing concrete, coat the dowels with a thin uniform coat of new light form oil as a bond-breaking material to provide free movement. After coating the dowel, install a sleeve of metal or other approved material approximately 3 inches (75 mm) long, with crimped end, overlapping seams fitting closely around the dowel, and a depression or interior projection to stop the dowel a sufficient distance from the crimped end to allow 1 inch (25 mm) for longitudinal dowel movement with pavement expansion on one free end of each dowel. If approved by the Engineer, use other means to allow for 1 inch (25 mm) of expansion.

Punch or drill proper size dowel holes into the preformed expansion joint filler to assure a tight fit around each dowel.

Form a 1-inch (25 mm) wide and 1-inch (25 mm) deep opening on top of the expansion joint filler and seal this opening with 705.04 joint sealers.

**D. Contraction Joint.** For pavement less than or equal to 10 inches (225 mm) thick, saw contraction joints with a standard (water cooled diamond bladed) concrete saw to a minimum depth of one-fourth of the specified pavement thickness. For pavement greater than 10 inches (255 mm) thick, saw contraction joints to a minimum depth of one-third the specified pavement thickness. When cutting joints using a standard (water cooled diamond blade) saw assure the joint is  $1/4 \pm 1/16$  inch ( $6 \pm 1.6$  mm) wide when measured at the time of sawing.

When using the option of early-entry (dry cut, light weight) saws, only use saw blades and skid plates as recommended by the saw manufacturer for the coarse aggregate type being used in the concrete. Perform the early entry contraction joint sawing after initial set and before final set. Saw the contraction joint 2-1/4 to 2-1/2 inches (56 to 63 mm) deep. Ensure any early entry saw joints are approximately 1/8 inch (3 mm) wide at the time of sawing.

If the pavement is constructed in two or more separately placed lanes, install the joints continuous for the full width of the pavement. Saw the pavement with sawing equipment approved by the Engineer as soon as the saw can be operated without damaging the concrete. Provide saws with adequate guides, blade guards, and a method of controlling the depth of cut. After wet sawing, clean the joint using a jet of water. After dry sawing clean the joint using air under pressure. During sawing of contraction joints, maintain a standby saw in working condition with an adequate supply of blades.

**E. Construction Joints.** Install dowelled construction joints at the end of each day's work and when work is suspended for a period of more than 30 minutes.

Use dowels in transverse construction joints. Within 2 hours of placing concrete, coat the free half of all dowels with a thin uniform coat of new light form

oil. Use an adequate bulkhead, with openings provided for dowel bars spaced as specified and shaped to fit the typical section of the pavement, to form a straight joint. During placing of concrete, hold dowels rigidly in position.

Locate construction joints at or between contraction joints. If located between contraction joints, construct the construction joint no closer than 10 feet (3 m) to the last contraction joint.

**451.09 Finishing.** Use 10-foot (3 m) straightedges to continually check the finished concrete surface for trueness. If the pavement surface is dragged with a diagonal pipe float machine, occasionally check the surface while the concrete is plastic. Do not add water to aid finishing.

Before the concrete initially sets, round the edges of the pavement along each side of each slab and on each side of transverse expansion joints to the radius specified using an approved edging tool. Before texturing the surface, eliminate tool marks left by the edging tool.

Texture the surface in the longitudinal or transverse direction using a broom to produce a uniform, gritty, texture. Immediately following the broom drag texture, tine the pavement in the transverse direction using an approved device that produces a random pattern of grooves [0.05 inch (1.3 mm) to 0.08 inch (2.0 mm) deep and 0.10 inch (3 mm) wide] spaced at 3/8 to 1-3/4 inches (10 to 45 mm), with 50 percent of spacings less than 1 inch (25 mm).

Longitudinal tining of pavement will only be approved by the Director and may require experimental feature designation. If longitudinal tining is authorized the tine spacing will be a uniform 3/4 inches wide (19 mm), 1/8 inch deep (3 mm) and 1/8 inch wide (3 mm). Do not tine within 3 inches (75 mm) of pavement edges or longitudinal joints. Only use equipment that will tine the full width of the pavement in one operation and uses stringline controls for line and grade to assure straight tining texture.

Demonstrate to the Engineer methods to assure the groove depth meets this specification.

Before the concrete finally sets, impress complete station numbers into the pavement every 100 feet (50 m), e.g., 1+00 (2+050). Mark station equations in the pavement as shown on the plans. Ensure that the numerals are 3 to 4 inches (75 to 100 mm) high and 1/4 inch (6 mm) deep. Place the station numbers parallel with and facing the right edge of the pavement, and centered 12 inches (0.30 m) in from the right edge. On divided highways, provide station numbers on both pavements. When placing concrete shoulders with the traveled lane, place station numbers 12 inches (0.30 m) in from the outside edge of the shoulder and facing the pavement.

**451.10 Curing.** Immediately after the finishing operations have been completed and after all free water has dissipated, spray and seal all exposed concrete surfaces with a uniform application of curing membrane in such a manner as to provide a continuous uniform film without marring the surface of the concrete. Apply a minimum of 1 gallon (1 L) of material for each 150 square feet (3.7 m<sup>2</sup>) of surface treated using an approved self-propelled mechanical sprayer. Provide an adequate shield to protect the fog spray from the wind. Before each use, thoroughly agitate the curing material.

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On pavement with integral curb or small and irregular areas that are inaccessible to the mechanical spray machine, apply the curing material by a hand-held sprayer.

As soon as the forms have been removed, immediately correct all honey-comb areas and coat the edges of the pavement with the curing material.

Respray all areas of curing material film damaged during the sawing of joints.

The Contractor may water cure concrete with wet burlap cloth, waterproof paper, or polyethylene sheeting. Apply curing as soon as possible and without marring the concrete surface. Unless the specimen beams have attained a modulus of rupture of 600 pounds per square inch (4.2 MPa) keep the entire surface of the top and sides of the newly placed concrete covered for seven days. Protect concrete from freezing until beams attain a strength of 600 pounds per square inch (4.2 MPa).

The above requirements for curing are minimum requirements only. Repair or replace all concrete showing injury or damage due to noncompliance to curing requirements at no additional cost to the Department.

**451.11 Removing Forms.** Remove forms in a manner that doesn't damage the pavement.

**451.12 Surface Smoothness.** After final concrete curing and cleaning the pavement surface, test the pavement surface for smoothness using a 10-foot (3 m) rolling straightedge. Provide a two or four-wheeled device 10 feet (3 m) in length with an indicator wheel at the center which detects high and low areas in the pavement surface. Provide equipment which actuates a pointer scale, an audio alert, or marks the pavement with paint or dye when encountering any high or low areas in excess of a preset tolerance. Tow the 10-foot (3 m) rolling straightedge or walk the equipment over the completed pavement. Test all wheel paths in the presence of the Engineer. Locate wheel paths parallel to the pavement centerline and approximately 3 feet (1 m) measured transversely inside all lane edges. Maintain alignment of the 10-foot (3 m) rolling straightedge with reference to the pavement edge at all times. Other devices such as approved profilers conforming to S1058 and using ProVAL software may be used with approval of the Engineer.

Correct all surface variations so indicated to within the specified tolerance and in a manner that provides a surface texture conforming to 451.09. For corrective grinding provide equipment conforming to 451.13. Ensure pavement surface variations do not exceed 1/8 inch in a 10-foot (3 mm in a 3 m) length of pavement. For ramp pavements and for those pavements with curvature greater than 8 degrees, or with grades exceeding 6 percent, ensure the surface variations do not exceed 1/4 inch in 10 feet (6 mm in 3 m).

Repair or replace sections of pavement containing depressions that cannot be corrected by grinding as directed by the Engineer.

**451.13 Profile Grinding.** To correct surface variations exceeding tolerances specified in 451.12 use grinding equipment conforming to Item 257.

**451.14 Pavement Grooving Corrections.** When pavement tining locations are found out of conformance with 451.09 restore the tining using power driven,

self propelled machines specifically designed to groove concrete pavement with diamond impregnated blades or diamond impregnated cylinder rings. Furnish blades or cylinder rings mounted on an arbor head so that the resulting grooves comply with 451.09. Furnish grooving equipment with a depth control device that will detect variations in the pavement surface and enable adjustment of the cutting head to maintain the specified groove depth.

If a pavement area was diamond ground to bring the pavement's surface smoothness within the tolerances of 451.12 that pavement area does not require tining restoration conforming to 451.09.

Vary from these requirements only for small areas and only with written permission from the Engineer.

**451.15 Sealing Expansion Joints.** As soon as feasible after completing sawing, but before the pavement is open to construction equipment and traffic, seal expansion joints with material conforming to 705.04. Just before sealing, thoroughly clean each joint of all foreign material, using approved equipment. Ensure the joint faces are clean and dry when the seal is installed.

**451.16 Opening to Traffic.** When 7 days have elapsed, the Contractor may use the completed pavement for traffic, including construction traffic. If a modulus of rupture of 600 pounds per square inch (4.2 MPa) has been attained, the Contractor may open the pavement to traffic when 5 days have elapsed. If necessary to open a portion of the pavement in less than 5 days, with the proviso that the pavement will be cured for a minimum of 3 days, use high early strength concrete according to 499.03 C and obtain a modulus of rupture of 600 pounds per square inch (4.2 MPa).

**Pavement Repairs before Department Acceptance.** Repair transverse or diagonally cracked full depth pavement; longitudinally cracked full depth pavement; spalled pavement surfaces and any portland cement concrete pavement panels with cement balls or mudballs; at no cost to the Department.

Repair transverse or diagonally cracked PCC pavement with a full depth repair according to Item 255 and applicable standard construction drawings. Repair cracks by replacing the pavement the full width between longitudinal joints, perpendicular to the centerline and at least 6 feet (1.8 m) longitudinally. Install smooth dowel bars at the interface between the original pavement and the replaced pavement section. Locate and size the repairs to ensure that the repair limits are at least 7 feet (2.1 m) away from any transverse joint.

Repair longitudinal cracks within 15 inches (380 mm) of a tied longitudinal joint by routing and sealing the crack according to Item 423. For other longitudinal cracks, repair the same as for transverse or diagonal cracks stated above.

Repair spalled pavement with Item 256 Bonded Patching of Portland Cement Concrete Pavement.

Repair cement balls or mudballs by coring out the area, full depth, with a diamond core bit and replacing the removed concrete with the same concrete as in the pavement. Remove and replace any pavement panel with 5 or more cement

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balls or mudballs. Locate the limits of the repair along the longitudinal joints and at least 1-foot (0.3 m) past the transverse joints to remove any existing dowel bars. Install smooth dowel bars at the transverse limits of the repairs. Install Type D (Drilled Tied Longitudinal) Joint along the longitudinal limits.

### 451.17 Pavement Thickness.

**A. General.** As determined by measurement of cores cut as specified in this section, construct the concrete not more than 0.2 inch (5 mm) less than the specified thickness. Core pavement at the direction of the Engineer and at locations the Engineer determines according to Supplement 1064. The Engineer will measure core length according to AASHTO T 148.

For the purpose of coring, the Department will consider the entire pavement area of a specified thickness a unit. To determine the number of cores, each pavement unit will be divided into Lots. A Lot consists of 2000 square yards (1650 square meters) of a pavement unit or major fraction thereof.

Take one random core for each Lot but not less than 3 cores for any pavement unit cored. If a core shows a deficiency in thickness of more than 1/2 inch (13 mm) from the specified thickness take additional cores to determine the limits of the deficiency. Follow the procedures below:

1. Take a core five (5) feet (1.5 m) longitudinally on both sides of the deficient core. If both the cores are less than 1/2-inch (13 mm) deficient in thickness the zone of deficiency has been determined.

2. If either or both 451.17.A.1 cores are more than 1/2 inch (13 mm) deficient in thickness, cut a core 50 feet (15 m) longitudinally from the deficient core(s). If the 50 foot (15 m) core(s) is more than 1/2 inch (13 mm) deficient, cut additional cores at 100 foot (30 m) longitudinal intervals until a core is less than 1/2 inch (13 mm) deficient; until the pavement ends; or until overlapping an adjacent pavement Lot's core in the same lane.

3. If a pavement Lot has cores more than 1/2 inch (13 mm) deficient in thickness and the lot's constructed width is greater than 12 feet (3.6 m) obtain cores transverse to the location of the more than 1/2 inch (13 mm) deficient cores. Obtain transverse cores at a location 1/2 the distance from the deficient core to the furthest edge of pavement. Obtain a transverse core for each core more than 1/2 inch (13 mm) deficient.

4. The Engineer will use the cores that measure less than 1/2 inch (13 mm) deficient in thickness to define the limits of the deficiency.

If any deficient core is greater than 1 inch (25 mm) deficient in thickness determine the limits of over 1 inch (25 mm) deficiency by following 451.17.A.1 thru 4 to determine the limits. Remove and replace those areas greater than 1 inch (25 mm) deficient in thickness.

The Engineer will calculate average thickness of concrete pavement placed as follows:

When zones of deficient thickness greater than 1/2 inch (13 mm) to 1 inch (25 mm) are allowed to remain in place, the Engineer will calculate two average thicknesses. A Project Average Thickness (PAT) including all cores not more than 1/2 inch (13 mm) deficient. Cores that exceed the specified thickness by more than 1/2 inch (13 mm) will be considered as the specified thickness plus 1/2 inch (13 mm) when calculating the PAT. A second Deficient Zone Average (DZA) will include all cores with thickness deficiency greater than 1/2 inch (13 mm) to 1 inch (25 mm). The pavement represented by each of the two averages, PAT or DZA, will be calculated and paid separately.

Determine and apply deductions to each separately placed width of pavement.

For any pavement areas removed and replaced, re-core those areas replaced following this section of the specifications. Include those core values into the calculations for average pavement thickness.

Unless the Director requests, do not core any widening less than 5 feet (1.5 m) in width or any pavement area less than 2000 square yards (1650 square meters).

Fill all core holes with concrete of the same proportions and materials used in the pavement.

**B. Price Adjustments.** Based on the pavement average thickness payment will be made as specified in Table 451.17-1.

**TABLE 451.17-1 CONCRETE PAVEMENT DEFICIENCY**

<b>Deficiency in Thickness as Determined by Cores</b>	<b>Proportional Part of Contract Price</b>
0.0 to .2 inch (0.0 to 5 mm)	100 percent
0.3 to 0.5 inch (6 to 13 mm)	Ratio $\left[ \frac{PAT}{PST} \right]^6$
0.6 to 1.0 inch (15 to 25 mm)*	Ratio $\left[ \frac{DZA}{PST} \right]^6$
Greater than 1.0 inch (25 mm)	Remove and replace

\* The District Construction Engineer will determine whether pavement areas from 0.6 inch (15 mm) up to 1 inch (25 mm) deficient in thickness will be allowed to remain in place at the reduced price or must be removed and replaced.

PAT = Project Average Thickness

PST = Plan Specified Thickness

DZA = Deficient Zone Average

**451.18 Method of Measurement.** The Department will measure Reinforced Concrete Pavement by the number of square yards (square meters) completed and accepted in place. The width equals the pavement width shown on the typical

**451.19**

cross-section of the plans plus additional widening as the Engineer directs in writing. The Department will field measure the length along the centerline of each roadway or ramp. The Department will determine the area based on the above width and length.

**451.19 Basis of Payment.** Payment is full compensation for furnishing and placing all materials including reinforcing steel, dowels, and joint materials; for furnishing the 10-foot (3 m) rolling straightedge; and for coring the pavement. For pavement found deficient in thickness, the Department will pay a reduced price according to 451.17.

The Department will not pay extra for pavement with an average thickness in excess of that shown on the plans.

The Department will pay for accepted quantities at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
451	Square Yard (Square Meter)	Reinforced Concrete Pavement

**ITEM 452 NON-REINFORCED PORTLAND CEMENT CONCRETE PAVEMENT**

**452.01 Description**

**452.02 Construction**

**452.03 Method of Measurement**

**452.04 Basis of Payment**

**452.01. Description.** This work consists of constructing a non-reinforced portland cement concrete pavement on a prepared surface.

**452.02 Construction.** The requirements of Item 451 apply, except as follows.

Do not comply with the requirements of 451.07.

Provide dowels at transverse contraction joints in mainline pavement, ramps, acceleration/deceleration lanes, or collector/distributor lanes. Dowels for contraction joints in concrete shoulders on mainline pavement, ramps, acceleration/deceleration lanes, or collector/distributor lanes are not required unless the contraction joint is located within 500 feet (150 m) of a pressure relief joint.

Space contraction joints according to the standard construction drawings. If Item 452 pavement is specified for shoulders and is tied longitudinally to Item 451 or 305 pavement, match the joints in the shoulder pavement to the spacing and alignment of the adjacent pavement.

Do not place construction joints within 6 feet (1.8 m) of another parallel joint.

**452.03 Method of Measurement.** The Department will measure Non-Reinforced Concrete Pavement by the number of square yards (square meters) completed and accepted in place. The width equals the pavement width shown on the typical cross-sections of the plans plus additional widening as the Engineer

directs in writing. The Department will field measure the length along the centerline of each roadway or ramp.

**452.04 Basis of Payment.** Payment is full compensation for furnishing and placing all materials, for surface testing, and for coring the pavement. For pavement found deficient in thickness, the Department will pay a reduced price according to 451.17.

The Department will not make additional payment over the contract unit price for any pavement with an average thickness in excess of that shown on the plans.

The Department will pay for accepted quantities at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
452	Square Yard (Square Meter)	Non-Reinforced Concrete Pavement

## **ITEM 499 CONCRETE—GENERAL**

### **499.01 Description**

### **499.02 Materials**

### **499.03 Proportioning**

### **499.04 Proportioning Options for Portland Cement Concrete**

### **499.05 Additional Classes of Concrete for Rigid Replacement**

### **499.06 Equipment**

### **499.07 Handling, Measuring, and Batching Materials**

### **499.08 Batch Plant Tickets**

### **499.09 Mixing Concrete**

**499.01 Description.** This specification consists of proportioning and mixing portland cement concrete.

**499.02 Materials.** Furnish materials conforming to:

Portland cement .....	701.01, 701.02, 701.04 <sup>[1]</sup>
.....	701.05 and 701.09 <sup>[2]</sup>
Microsilica .....	701.10
Ground granulated blast furnace slag (GGBFS).....	701.11
Fly ash .....	701.13
Fine aggregate <sup>[3]</sup> .....	703.02
Coarse aggregate.....	703.02, 703.13 <sup>[4]</sup>
Air-entraining admixture .....	705.10
Chemical admixture for concrete <sup>[5]</sup> .....	705.12

[1] Use only 701.04 cement in all High Performance Class concrete.

[2] The Contractor may use 701.09, Type I(SM) only between April 1 to October 1 and when 705.10 air-entraining admixture is added at the mixer. Do not use Type I(SM) with Options 1 and 3 or with any Class HP concrete.

[3] 703.02 natural sand or sand manufactured from stone as specified in Item 703.02.A.3 is required in 255, 256, 451, 452, 526, and 511 deck slabs.

**499.03**

[4] Applies only to 305, 451 and 452 concrete.

[5] Admixtures shall contain no more than 50 parts per million chloride ions by weight of cement.

For concrete, use water free from sewage, oil, acid, strong alkalis, organic matter, clay, and loam. Potable water is satisfactory for use in concrete.

**499.03 Proportioning.** Proportioning of the concrete mixtures contained in this section is based on a predetermined cement content. Except as otherwise provided below, the yield calculation determines if the specified weight of cement is contained in each cubic yard (cubic meter) of concrete. Ensure that the yield is within 1 percent of the theoretical yield in cubic feet (m<sup>3</sup>) detailed in the mix design tables. Do not exceed the maximum specified water-cement (or water-cementitious) ratio.

**A. Slump.**

**1. Classes C, F, and S Concrete.** Maintain slump for Classes C, F, and S concrete within the nominal slump range in Table 499.03-1. If below the maximum water-cement ratio, then adjust the quantity of water to meet slump requirements. Do not use concrete with a slump greater than the maximum shown in Table 499.03-1. When the slump exceeds the nominal slump limit but is below the maximum limit, the Contractor may use an occasional load of concrete in this condition, provided the mixture of succeeding loads is immediately adjusted to reduce the slump to within the nominal range. Conduct tests on the plastic concrete for pavement at the point of placement or at an Engineer-designated location.

**TABLE 499.03-1 CONCRETE SLUMP**

Type of Work	Nominal Slump inch (mm)[1]	Maximum Slump inch (mm)[2]
Concrete pavement (305, 451, 452, 615)	1 to 3 (25 to 75)	4 (100)
Structural Concrete (511, 610, 622)	1 to 4 (25 to 100)	5 (125)
Class S, Superstructure concrete (511, 526)	2 to 4 (50 to 100)	4 (100)
Non-reinforced concrete (601, 602 603, 604, 608, 609, 622)	1 to 4 (25 to 100)	5 (125)
[1] This nominal slump may be increased to 6 inches (150 mm), provided the increase in slump is achieved by adding a chemical admixture conforming to the requirements of 705.12, Type F or G.		
[2] This maximum slump may be increased to 7 inches (180 mm), provided the increase in slump is achieved by adding a chemical admixture conforming to the requirements of 705.12, Type F or G.		

**2. High Performance Concrete (Classes HP1, HP2, HP3, and HP4).** Provide a maximum concrete slump of 8 inches (200 mm) at the placement site for all HP Classes. Conduct tests for structure concrete on concrete samples obtained from the point of placement in the forms.

**B. Air Content.** Ensure that the air content in all concrete at the point of placement is within the percentage range specified in the Concrete Tables.

**C. Concrete Classes.** Using the Concrete Tables, the Engineer will determine the weights of fine and coarse aggregate. The Concrete Table aggregate weights were calculated using the following Saturated Surface Dry (SSD) specific gravities: natural sand and gravel 2.62, limestone sand 2.68, limestone 2.65, and slag 2.30. The assumed specific gravities of portland cement, fly ash, ground granulated blast furnace slag and micro-silica are 3.15, 2.30, 2.90 and 2.20, respectively. For aggregates with specific gravities differing more than  $\pm 0.02$  from these, the Engineer will adjust the table design weights as specified in 499.03.D.3.

If high early strength concrete is specified, the Contractor may use high early strength cement, additional cement, approved chemical admixtures, or a combination of these materials to achieve a modulus of rupture of 600 pounds per square inch (4.2 MPa) in 3 days or less. If high early strength concrete is not specified, but is desirable to expedite the work, the Contractor may use these same materials at no additional cost to the Department. Do not waive concrete curing periods specified for the item of work in which the concrete is used.

The concrete proportioning is based on developing a concrete compressive strength at 28 days of 4000 pounds per square inch (28.0 MPa) for Class C, 3000 pounds per square inch (21.0 MPa) for Class F and 4500 pounds per square inch (31.0 MPa) for Class S.

**TABLE 499.03-2 CLASSES C, F, AND S CONCRETE  
(USING NO. 57 OR 67 SIZE COARSE AGGREGATE)**

<b>Quantities Per Cubic Yard (Cubic Meter)</b>					
<b>Provide concrete with an air content of <math>6 \pm 2\%</math></b>					
Aggregate Type	SSD Aggregate Weight		Cement Content lb (kg)	Water-Cement Ratio Maximum	Design Yield Cubic Feet (m3)
	Fine Aggregate lb (kg)	Coarse Aggregate lb (kg)			
<b>Class C (Using No. 57 or 67 Size)</b>					
Gravel	1150(682)	1720(1020)	600 (356)	0.50	27.04 (1.00)
Limestone	1270(753)	1610(955)	600 (356)	0.50	26.98 (1.00)
Slag	1330(789)	1340(795)	600 (356)	0.50	26.95 (1.00)
<b>Class F (Using No. 57 or 67 Size)</b>					
Gravel	1270 (753)	1810 (1074)	470 (279)	0.55	26.99 (1.00)
Limestone	1360 (807)	1750 (1038)	470 (279)	0.55	27.06 (1.00)
Slag	1390 (825)	1480 (878)	470 (279)	0.55	26.97 (1.00)
<b>Class S (Using No. 57 or 67 Size)</b>					
Gravel	1070(635)	1660(985)	715 (424)	0.44	27.00 (1.00)
Limestone	1240 (736)	1510 (896)	715 (424)	0.44	27.02 (1.00)
Slag	1235(733)	1320 (783)	715 (424)	0.44	27.02 (1.00)

Use Class C concrete using No. 57 or 67 size coarse aggregate for 305, 451 or 452 pavement and provide quantities per cubic yard (cubic meter) according to the above Concrete Table. If No. 7, 78, or 8 size coarse aggregate allowed by 703.13 for 305, 451 or 452 pavement is used, provide concrete according to Table 499.03-3.

**TABLE 499.03-3 CLASS C CONCRETE  
(USING NO. 7, 78, OR 8 SIZE COARSE AGGREGATE)**

<b>Quantities Per Cubic Yard (Cubic Meter)</b>					
<b>Provide concrete with an air content of 8 ± 2%</b>					
Aggregate Type	SSD Aggregate Weight		Cement Content lb (kg)	Water-Cement Ratio Maximum	Design Yield Cubic Feet (m3)
	Fine Aggregate lb (kg)	Coarse Aggregate lb (kg)			
Class C (Using No. 7, 78, or 8 Size)					
Gravel	1320 (783)	1460 (866)	600 (356)	0.50	27.02 (1.00)
Limestone	1380 (819)	1410 (837)	600 (356)	0.50	26.99 (1.00)

Use Table 499.03-4 for High Performance (HP) Concrete Classes when specified and comply with the listed notes.

TABLE 499.03-4 CLASS HP CONCRETE

Quantities Per Cubic Yard (Cubic Meter) for High Performance (HP) Concrete Mixes Aggregates Weights (SSD) Provide 8-inch (200 mm) maximum slump concrete at placement site for all Class HP concrete mixes[1] Provide concrete with an air content of $7 \pm 2\%$							
<b>Class HP1 (Fly Ash)</b>							
Aggregate Type	Fine Aggregate lb (kg)	#8 Coarse Aggregate lb (kg)	Cement[2] Content lb (kg)	Fly Ash [3] lb (kg)		Water-CM Ratio Maximum [4]	Design Yield Cubic Feet (m <sup>3</sup> )
Gravel	1310(777)	1470(872)	530 (314)	170 (101)		0.38	27.04 (1.00)
Limestone	1310(777)	1480(878)	530 (314)	170 (101)		0.38	27.00 (1.00)
Slag	1310(777)	1290(765)	530 (314)	170 (101)		0.38	27.03 (1.00)
<b>Class HP2 (GGBF Slag)</b>							
Aggregate Type	Fine Aggregate lb (kg)	#8 Coarse Aggregate lb (kg)	Cement[2] Content lb (kg)	GGBF Slag lb (kg)		Water-CM Ratio Maximum [4]	Design Yield Cubic Feet (m <sup>3</sup> )
Gravel	1330(789)	1480 (878)	490 (291)	210 (125)		0.38	26.99 (1.00)
Limestone	1335 (792)	1495 (887)	490 (291)	210 (125)		0.38	27.01 (1.00)
Slag	1335 (792)	1295 (768)	490 (291)	210 (125)		0.38	27.00 (1.00)
<b>Class HP3 (Fly Ash + Microsilica)</b>							
Aggregate Type	Fine Aggregate lb (kg)	#8 Coarse Aggregate lb (kg)	Cement[2] Content lb (kg)	Fly Ash[3] lb (kg)	Micro-silica lb (kg)	Water- CM Ratio Maximum [4]	Design Yield Cubic Feet (m <sup>3</sup> )
Gravel	1340(795)	1460(866)	480 (285)	150 (89)	30 (18)	0.40	27.01 (1.00)
Limestone	1350(801)	1480(878)	480 (285)	150 (89)	30 (18)	0.40	27.03 (1.00)
Slag	1340(795)	1290(765)	480 (285)	150 (89)	30 (18)	0.40	27.01 (1.00)
<b>Class HP4 (GGBF Slag + Microsilica)</b>							
Aggregate Type	Fine Aggregate lb (kg)	#8 Coarse Aggregate lb (kg)	Cement[2] Content lb (kg)	GGBF Slag lb (kg)	Micro-silica lb (kg)	Water-CM Ratio Maximum [4]	Design Yield Cubic Feet (m <sup>3</sup> )
Gravel	1370 (813)	1475 (875)	440 (261)	190 (113)	30 (18)	0.40	27.03 (1.00)
Limestone	1370 (813)	1490 (884)	440 (261)	190 (113)	30 (18)	0.40	27.02 (1.00)
Slag	1370 (813)	1290 (765)	440 (261)	190 (113)	30 (18)	0.40	27.00 (1.00)
[1] Use a high range water reducer, conforming to 705.12, Type F or G and approved by the Laboratory, to achieve the desired slump at the specified water cement ratio. The probability of higher than normal dosage rates of the Types F and G admixtures is likely. The need for chemical admixtures or aggregates or both, different from the Contractor's normal sources is a distinct possibility. Add a Type A or D chemical admixture, conforming to 705.12 to the concrete at the plant. Add the majority of the water reducer at the plant.							
[2] Use 701.04 cement only for Class HP concrete mixes.							
[3] Use only Class C fly ash meeting 701.13 in HP concrete mixes.							
[4] Calculate the water-cement ratio based upon the total cementitious material. Cementitious material includes portland cement, fly ash, GGBF slag and microsilica (solids). GGBF = ground granulated blast furnace slag; CM = cementitious material.							

1. Adjust the proportions of coarse and fine aggregate to provide the maximum amount of coarse aggregate possible and still provide a workable and finishable mix. The Contractor may modify the mixes shown by adjusting the

coarse and fine aggregates up to 100 pounds (50 kg) each, unless otherwise approved by the Engineer.

2. Provide the coarse aggregate with a moisture content above the saturated surface dry (SSD) condition immediately prior to batching. Maintain the cement content and ensure that the maximum water cement ratio is not exceeded.

3. Remove all wash water by reversing each truck drum at the plant immediately prior to reloading.

4. Add and mix a Type F or G admixture according to the manufacturer's recommendations. Furnish a volumetric dispenser for the Type F or G admixture or ensure that there is a gage on each truck-mounted Type F or G admixture dispensing tank. If Type F or G admixture is added at the job site, mix the load for a minimum of 5 minutes at mixing speed.

5. The Engineer will reject concrete loads, if during placement of any concrete, cement or microsilica balling is observed. Revise the mixing process and/or loading sequence to prevent further balling.

6. If slump loss occurs before placement of the concrete, the concrete may be "replasticized" with the admixture to restore plasticity. The Engineer will recheck the slump range and air content to ensure conformance to the specifications. If after "replasticizing" the components of the load are segregated, the Department will reject the load. Completely discharge the concrete from each delivery truck within 90 minutes after combining the water and the cementitious material.

7. Perform sufficient advance testing to ensure conformance with this specification before placing the concrete.

8. Sampling and testing for air content and slump will be measured at the point of placement in the forms.

9. Prior to placing Class HP concrete mixes, obtain and present to the Engineer a written statement from the manufacturers of the chemical admixtures to be used in the concrete verifying the compatibility of the combination of materials and the sequence in which they are combined. The manufacturers will further designate a technical representative from its company or the ready-mix concrete supplier to be in charge of the dispensing of the admixture products. The technical representatives will act in an advisory capacity and will report to the Contractor and the Engineer any operations and procedures which are considered by the representative as being detrimental to the integrity of the placement. The manufacturer's technical representative will be present during concrete placement unless waived by the Engineer.

10. Class HP Concrete Blended Cement Options conforming to Supplement 1086 may be used as alternate mix designs.

**D. Concrete Mix Adjustments.** At any time during the concrete placement, the Engineer may vary the relative weights of fine and coarse aggregate from the relative weights determined from Table 499.03-1 through Table 499.03-4 in order to ensure a workable mix within the slump range and to control the yield.

However, do not change the total weight of aggregate per cubic yard (cubic meter) except, as allowed by the following conditions.

1. Correct SSD aggregate weights described above to compensate for moisture contained in the aggregates at the time of use.

2. If it is impossible to prepare concrete of the proper consistency without exceeding the specified maximum water/cement ratio, use a water-reducing admixture conforming to 705.12 or increase the cement content. Adjust the absolute volume of the aggregates if the cement content is increased. The Department will not provide additional compensation for the admixture or additional cement required by this adjustment.

3. If, during the work, the specific gravity of an aggregate changes more than  $\pm 0.02$  from those specified in 499.03.C, adjust the design weight to conform to the new specific gravity.

4. Make unit weight determinations in order to calculate and maintain the yield according to ASTM C 138. Based on these determinations, adjust the batch weights when necessary. Maintain the specified cement content within a tolerance of  $\pm 1$  percent and do not exceed the maximum water-cement ratio.

5. Adjust the amount of water added at the mixer based on the moisture contained in the aggregate and the moisture that the aggregates will absorb.

6. Use an approved set-retarding admixture conforming to 705.12, Type B or D when the concrete temperature exceeds a nominal temperature of 75 °F (24 °C).

**499.04 Proportioning Options for Portland Cement Concrete.** The Contractor may substitute one of the following options for each respective class of concrete given in Table 499.03-2 and Table 499.03-3. Use the same air content specified in Table 499.03-2 and Table 499.03-3. Comply with slump requirements of Table 499.03-1.

Submit requests to use any of the following optional mix designs to the Engineer for approval before use. The SSD weights specified in Table 499.04-1 through Table 499.04-3 were calculated using the specific gravities in 499.03.C. Make adjustments to the mix design when specific gravities differ by more than  $\pm 0.02$ . Make other adjustments allowed in 499.03.D and approved by the Engineer.

Do not use option mixes in concrete mixes designed or intended to obtain high early strength.

The following option mixes only apply to Classes C, S, and F concrete mixes.

**A. Proportioning Option 1.** Reduce the cement content 15 percent by weight and substitute an equivalent weight of fly ash conforming to 701.13. Base the water-cementitious materials (water-cm) ratio on the combined weight of cement and fly ash. Meet the concrete mix design requirements of Table 499.04-1 for Option 1.

**TABLE 499.04-1 OPTION 1 CONCRETE  
(CEMENT AND FLY ASH)**

Quantities Per Cubic Yard (Cubic Meter)						
Aggregate Type	SSD Aggregate Weight		Cement Content lb (kg)	Fly Ash lb (kg)	Water-CM Ratio Maximum	Design Yield Cubic Feet (m <sup>3</sup> )
	Fine Aggregate lb (kg)	Coarse Aggregate lb (kg)				
Class C Option 1 (Using No. 57 or 67 Size)						
Gravel	1140 (676)	1700 (1009)	510 (303)	90 (53)	0.50	27.02 (1.00)
Limestone	1260 (748)	1595 (946)	510 (303)	90 (53)	0.50	27.00 (1.00)
Slag	1320 (783)	1330 (789)	510 (303)	90 (53)	0.50	26.99 (1.00)
Class F Option 1 (Using No. 57 or 67 Size)						
Gravel	1260 (748)	1800 (1068)	400 (237)	70 (42)	0.55	27.00 (1.00)
Limestone	1350 (801)	1730 (1026)	400 (237)	70 (42)	0.55	27.00 (1.00)
Slag	1380 (819)	1475 (875)	400 (237)	70 (42)	0.55	27.00 (1.00)
Class S Option 1 (Using No. 57 or 67 Size)						
Gravel	1060 (629)	1640 (973)	608 (361)	107 (63)	0.44	27.02 (1.00)
Limestone	1230 (730)	1490 (884)	608 (361)	107 (63)	0.44	27.03 (1.00)
Slag	1220 (724)	1300 (771)	608 (361)	107 (63)	0.44	27.02 (1.00)
Class C Option 1 (Using No. 7, 78, or 8 Size) per 703.13 [2]						
Gravel	1310 (777)	1440 (854)	510 (303)	90 (53)	0.50	27.01 (1.00)
Limestone	1350 (801)	1410 (837)	510 (303)	90 (53)	0.50	26.97 (1.00)
[1] CM = cementitious material.						
[2] 8% +/- 2% entrained air content						

**B. Proportioning Option 2.** If an approved water-reducing admixture conforming to 705.12, Type A or D is used at the manufacturer's recommended dosage, reduce the cement content of the Standard Class C, F, or S concrete mixes by 50 pounds per cubic yard (30 kg/m<sup>3</sup>), and substitute an equivalent volume of aggregate.

Meet the concrete mix design requirements of Table 499.04-2 for Option 2.

**TABLE 499.04-2 OPTION 2 CONCRETE  
(CEMENT REDUCTION OF 50 LB W/ 705.12, TYPE A OR D)**

Quantities Per Cubic Yard (Cubic Meter)					
Aggregate Type	SSD Aggregate Weight		Cement Content lb (kg)	Water-Cement Ratio Maximum	Design Yield Cubic Feet (m <sup>3</sup> )
	Fine Aggregate lb (kg)	Coarse Aggregate lb (kg)			
Class C Option 2 (Using No. 57 or 67 Size)					
Gravel	1190 (706)	1780 (1056)	550 (326)	0.50	26.99 (1.00)
Limestone	1320 (783)	1670 (991)	550 (326)	0.50	27.00 (1.00)
Slag	1385 (822)	1395 (828)	550 (326)	0.50	27.02 (1.00)
Class F Option 2 (Using No. 57 or 67 Size)					
Gravel	1315 (780)	1880 (1115)	420 (249)	0.55	27.00 (1.00)
Limestone	1410 (837)	1810 (1074)	420 (249)	0.55	27.03 (1.00)
Slag	1440 (854)	1540 (914)	420 (249)	0.55	27.00 (1.00)
Class S Option 2 (Using No. 57 or 67 Size)					
Gravel	1120 (664)	1710 (1015)	665 (395)	0.44	27.00 (1.00)
Limestone	1290 (765)	1560 (926)	665 (395)	0.44	27.02 (1.00)
Slag	1270 (753)	1370 (813)	665(395)	0.44	27.01 (1.00)
Class C Option 2 (Using No. 7, 78, or 8 Size) per 703.13 [1]					
Gravel	1370 (813)	1510 (896)	550 (326)	0.50	27.01 (1.00)
Limestone	1420 (842)	1480 (878)	550 (326)	0.50	27.00 (1.00)
[1] 8% +/- 2% entrained air content					

**C. Proportioning Option 3.** Reduce the cement content of standard Class C, F, or S concrete mixes by 50 pounds per cubic yard (30 kg/m<sup>3</sup>) and use an approved water-reducing admixture conforming to 705.12, Type A or D at the manufacturer's recommended dosage. Substitute an equivalent volume of aggregate for the cement reduction. The remaining cement content is proportioned, by weight, of a minimum of 70 percent 701.04 or 701.01 portland cement and a maximum of 30 percent ground granulated blast furnace slag (GGBFS), conforming to 701.11. Base the water-cementitious (water-cm) ratio on the combined weight of the cement and the GGBFS.

Meet the concrete mix design requirements of Table 499.04-3 for Option 3.

**TABLE 499.04-3 OPTION 3  
(CEMENT REDUCTION AND USE OF GGBFS)**

Quantities Per Cubic Yard (Cubic Meter)						
Aggregate Type	SSD Aggregate Weight		Cement Content lb (kg)	GGBF Slag lb (kg)	Water-CM Ratio Maximum	Design Yield Cubic Feet (m <sup>3</sup> )
	Fine Aggregate lb (kg)	Coarse Aggregate lb (kg)				
Class C Option 3 (Using No. 57 or 67 Size)						
Gravel	1185 (703)	1775 (1053)	385 (228)	165 (98)	0.50	27.00 (1.00)
Limestone	1310 (777)	1670 (991)	385 (228)	165 (98)	0.50	27.01 (1.00)
Slag	1385 (822)	1385 (822)	385 (228)	165 (98)	0.50	27.02 (1.00)
Class F Option 3 (Using No. 57 or 67 Size)						
Gravel	1320 (783)	1870 (1109)	294 (174)	126 (75)	0.55	27.02 (1.00)
Limestone	1400 (831)	1810 (1074)	294 (174)	126 (75)	0.55	27.02 (1.00)
Slag	1440 (854)	1535 (911)	294 (174)	126 (75)	0.55	27.02 (1.00)
Class S Option 3 (Using No. 57 or 67 Size)						
Gravel	1105 (656)	1715 (1017)	465 (276)	200 (119)	0.44	27.00 (1.00)
Limestone	1280 (759)	1555 (923)	465 (276)	200 (119)	0.44	27.02 (1.00)
Slag	1270 (753)	1360 (807)	465 (276)	200 (119)	0.44	27.02 (1.00)
Class C Option 3 (Using No. 7, 78, or 8 Size) per 703.13 [2]						
Gravel	1370 (813)	1500 (890)	385 (228)	165 (98)	0.50	26.99 (1.00)
Limestone	1410 (837)	1480 (878)	385 (228)	165 (98)	0.50	27.01 (1.00)
[1] Use only 701.04 or 701.01 cement with this option. [2] 8% +/- 2% entrained air content GGBF = ground granulated blast furnace slag; CM = cementitious material.						

Restrict the use of coarse aggregate in portland cement concrete pavements according to 703.13.

Use compatible admixtures in the concrete mixture, and dispense admixtures according to manufacturer’s recommendations.

If portland cement with fly ash as an additive is used as described under Option 1 or if ground granulated blast furnace slag is used under Option 3, only use the mix designs between April 1 and October 15 unless otherwise authorized by the Director. Do not schedule the use of mix designs utilizing fly ash or ground granulated blast furnace slag for the time period before April 1 or after October 15. These date restrictions do not apply to Class HP concrete mixes. If Option 1 is used and the nominal concrete temperature exceeds 75 °F (24 °C), use an approved set-retarding admixture conforming to 705.12, Type B or D. If Option 2 or 3 is used and the nominal concrete temperature exceeds 75 °F (24 °C), use an approved water-reducing, set-retarding admixture conforming to 705.12, Type D. Unless otherwise authorized by the Engineer, use only one source of fly ash or GGBFS in any one structure. Store bulk fly ash and GGBFS in waterproof bins.

**499.05 Additional Classes of Concrete for Rigid Replacement.** Proportion the concrete materials to conform to the requirements of each class of full depth

rigid pavement removal and rigid replacement concrete specified. Use any one of the following coarse aggregate sizes: No. 57, 6, 67, 7, 78, or 8. Use an entrained air content of  $8 \pm 2$  percent with No. 7, 78, or 8 size coarse aggregate. Otherwise, use an entrained air content of  $6 \pm 2$  percent.

The Engineer will base approval of the concrete mix design on submitted proportions and the requirements of this item.

**A. Class FS.** This class is a fast-setting portland cement concrete for accelerated setting and strength development. Use a minimum cement content of 900 pounds per cubic yard ( $534 \text{ kg/m}^3$ ) and a maximum water-cement ratio of 0.40. Open the rigid replacement to traffic 4 hours after the concrete is placed provided that test beams have a modulus of rupture of 400 pounds per square inch (2.8 MPa).

Use an admixture conforming to 705.12, Type B or D, according to manufacturer's recommendations to keep the concrete plastic until the surface can be textured.

Just before placement, add and mix calcium chloride with each batch of concrete. If using calcium chloride with 94 to 97 percent purity, add 1.6 percent by weight of the cement. If using calcium chloride with 70 to 80 percent purity, add 2.0 percent by weight of the cement. When using a calcium chloride and water solution, consider the water as part of the concrete mixing water and make appropriate adjustments for its inclusion in the total concrete mixture.

Use any other approved accelerating admixture at the dosage rate per cubic yard (cubic meter) recommended by the manufacturer, provided the accelerating mixture produces the required strength.

Immediately after applying the curing compound, cover the replacement concrete with polyethylene sheeting and with building board according to ASTM C 208. Wrap the building board in black polyethylene sheeting, place the building board tight against the surrounding concrete, and weigh down the board to protect the fresh concrete from the weather.

**B. Class MS.** This class is a moderate-setting portland cement concrete for accelerated strength development. Use a minimum cement content of 800 pounds per cubic yard ( $475 \text{ kg/m}^3$ ) and a maximum water-cement ratio of 0.43. Open the rigid replacement to traffic 24 hours after concrete is placed provided that test beams have attained a modulus of rupture of 400 pounds per square inch (2.8 MPa).

**499.06 Equipment.** Provide batching and mixing equipment meeting the following requirements:

**A. Batching Plants.** Operate each plant so that aggregate materials are not segregated and there is no intermingling of the materials before batching. Use weighing mechanisms that allow a visible means of checking weights and produce a printed record. Use dispensing mechanisms for water and admixtures that allow a visible means of checking quantities and produce a printed record.

Use cement and aggregate weighing mechanisms that are accurate to within  $\pm 0.5$  percent of the correct weight. Ensure that devices for weighing or metering water are accurate to  $\pm 1.0$  percent throughout the range used.

Maintain a certification from a Sealer of Weights and Measures or a scale servicing company attesting to the accuracy of the weighing and metering devices. Have this service performed within a 12-month period before use of the plant. A Certificate of Performance issued by the National Ready Mixed Concrete Association may be used instead of the Sealer of Weights and Measures or a scale servicing company.

Maintain the services of a scale servicing company or ten standard test weights to reach a capacity of 500 pounds (227 kg) for testing the weighing devices at the batch plant. The Ohio Department of Agriculture will seal all device-testing weights every 3 years.

The Engineer will test weighing and dispensing devices as often as deemed necessary to ensure continued accuracy.

**B. Mixers.** Provide mixers and agitators conforming to AASHTO M 157, Sections 10, 11.2, 11.5, and 11.6, except that the Department will allow mechanical counters.

For bodies of non-agitating concrete hauling equipment, provide smooth, mortar-tight, metal containers capable of discharging the concrete at a satisfactory controlled rate without segregation. Provide covers when required by the Engineer. The Engineer will allow trucks having dump bodies with rounded corners and no internal ribs or projections for non-agitating hauling.

**499.07 Handling, Measuring, and Batching Materials.** Do not stockpile aggregates from different sources or different gradations together. The Engineer may direct reworking or cleaning, or may reject aggregates that have become segregated or mixed with earth or foreign material. Maintain coarse aggregate with a uniform moisture content.

Separately weigh the amounts of fine aggregate and coarse aggregate, as determined by the Engineer and outlined in 499.03. Use a separate weighing device for cementitious materials.

Conduct batching such that the weight of cement is within a tolerance of  $\pm 1.0$  of the weight required and the weight of each aggregate batched is within  $\pm 2.0$  percent of the weight required. Measure water by weight or volume to within a tolerance of  $\pm 1.0$  percent of the required amount. Dispense admixtures to within a tolerance of  $\pm 3.0$  percent of the required amount.

The Engineer will approve methods and equipment used to add admixtures into the batch. Add air-entraining admixture at the time of batching.

**499.08 Batch Plant Tickets.** Furnish a concrete batch plant ticket to the Engineer for each load of concrete delivered for use on the project. Use handwritten, computer generated, or a combination of computer generated and handwritten batch tickets. At a minimum, include the information listed in Table 499.08-1 on each ticket:

**TABLE 499.08-1 EVERY BATCH TICKET**

Name of ready-mix batch plant	
Batch plant No.	
Batch plant location	
Serial number of ticket	
Date	
Truck number	
Class of concrete	
JMF Number	
Time the load was batched	
Size of batch	yd <sup>3</sup> (m <sup>3</sup> )
Actual weights of cementitious material:	
Cement	lb (kg)
Fly ash	lb (kg)
Ground granulated blast furnace slag	lb (kg)
Microsilica	lb (kg)
Other	lb (kg)
Actual weights of aggregates:	
Coarse	lb (kg)
Fine	lb (kg)
Other	lb (kg)
Actual weight of water	lb (kg)
Actual volume of admixtures:	
Air-entrainer	fl oz (mL)
Superplasticizer	fl oz (mL)
Water-reducer	fl oz (mL)
Retarder	fl oz (mL)
Other	fl oz (mL)
Aggregate moisture contents:	
Coarse aggregate	%
Fine aggregate	%
Water-cement ratio, leaving the plant	

Provide the information in Table 499.08-2 with batch tickets for each day's first load of concrete and for each JMF. Include Table 499.08-2 information on the batch ticket or furnish the information on a separate computer-generated or handwritten form attached to the batch ticket.

If during the concrete manufacturing process any of the information listed in Table 499.08-2 changes, resubmit Table 499.08-2 information with the first batch ticket supplied with the changed concrete.

**TABLE 499.08-2 FIRST TICKET EACH DAY, EACH JMF**

Cementitious Materials:	Source:	Grade or Type:
Cement		
Fly ash		
Ground granulated blast furnace slag		
Microsilica		
Other		
Admixtures:	Brand:	Type:
Air-entrainer		
Retarder		
Superplasticizer		
Water-reducer		
Other		

The provided concrete batch ticket information is according to ASTM C 94/C 94M, Section 13.

The Engineer may require supporting data to validate the basis for furnished aggregate moisture contents.

Include the cost for generating and supplying the information of this section and the concrete batch tickets in the individual concrete items.

**499.09 Mixing Concrete.** Use a central mix plant or in truck mixers to mix the concrete.

When using a central mix plant, mix the concrete for not less than 60 seconds. Begin the mixing time when all materials are in the drum and end the mixing time when discharge begins. Include transfer time in multiple drum mixers in the mixing time. Remove the contents of an individual mixer drum before a succeeding batch is emptied into the drum.

When concrete is mixed using a truck mixer for complete mixing, mix each batch of concrete at the rotation rate designated on the mixer as mixing speed for not less than 70 revolutions of the drum. Transport mixed concrete from the central mixers in truck mixers, truck agitators, or trucks having non-agitating bodies. Within 60 minutes after cement and water are combined, deliver and completely discharge concrete. If an approved set-retarding (705.12, Type B) or water-reducing and set-retarding (705.12, Type D or G) admixture is used at no expense to the Department, complete discharge within 90 minutes after combining the water and the cement.

When concrete is delivered in transit mixers and before discharging any of a batch, the Engineer may allow adding water within the specified water-cement ratio limits. Perform sufficient mixing, a minimum of 30 revolutions at mixing speed, to adjust the slump and to regenerate the specified air content throughout the batch. Adding water will not extend the above 60 and 90-minute time limitations.

When approved by the Engineer, the Contractor may use approved admixtures (705.12, Type F or G) for rettempering the load to adjust the slump after the start of discharge. Mix for a minimum of 30 revolutions at mixing speed after addition of the admixture.

Use admixtures containing no more than 50 parts per million chloride by weight of cement only when specified in the Contract Documents or with the Engineer's written permission.

The procedure to make and test concrete beams for the modulus of rupture is Supplement 1023.

Until discharged in the work, ensure that the temperature of all concrete does not exceed 90 °F (32 °C).

## 500 STRUCTURES

### ITEM 501 STRUCTURES—GENERAL

#### 501.01 General

#### 501.02 Verification of Dimensions

#### 501.03 Notification of Fabricator

#### 501.04 Shop Drawings

#### 501.05 Submittal of Working Drawing and Calculations

#### 501.06 Test Reports

**501.01 General.** This specification includes the general requirements for building the various items that constitute the completed structure.

Perform the work, including fabrication, erection, and construction, so that the entire structure and all its component parts will function as designed.

**501.02 Verification of Dimensions.** Verify that all dimensions established by the Engineer are correct.

**501.03 Notification of Fabricator.** When furnishing materials under Items 513, 515, 516, 517, and 518, select a fabricator from the pre-qualified fabricators list in effect the date of the Contract letting. Before or at the preconstruction conference, provide a written notification to the DCE and Office of Materials Management of the selected steel fabricators and precast concrete fabricators.

**501.04 Shop Drawings.** Provide shop drawings detailing structural steel, metal structural elements, prestressed concrete members, precast concrete structural elements, and other similar materials requiring either shop or field fabrication according to the appropriate *AASHTO Standard Specifications for Highway Bridges* and Item 501.

**A. Contractor Acceptance of Shop Drawings for Items 513 and 515.** After preparing the shop drawings for Items 513 and 515, submit the drawings to the Director at least 7 days before the pre-fabrication meeting, or before the start of fabrication on Item 513, UF Level. Department approval of these shop drawings is not required.

For structures carrying railroad traffic, submit four copies of the prepared shop drawings at least 40 days prior to the pre fabrication meeting to each railroad company involved for review and approval. Resolve all railroad comments prior to supplying the letter of written acceptance to the Department. The acceptance submission to the Department shall include one set of shop drawings approved by each railroad company involved; copies of all documentation between the railroad(s) and the Contractor; and four sets of Contractor accepted shop drawings for each railroad company involved.

Include in the shop drawing submission a written acceptance letter and four copies of each drawing, unless additional copies are requested. For structures carrying railroad traffic, furnish 4 additional sets of shop drawings for each railroad company involved. Also, furnish the fabricator's quality control specialist with one additional set of these drawings before the pre-fabrication meeting.

Prepare the shop drawings by or under direct supervisory control of an Ohio Registered Engineer having personal professional knowledge of *AASHTO Standard Specifications for Highway Bridges*, and Items 513 and 515. The Registered Engineer shall seal and date each drawing. Have all questions and comments addressed before submitting the shop drawings.

The Contractor's written acceptance letter shall document acceptance of the shop drawings including confirmation of field verification, as required, and descriptions of issues resolved between the Contractor, the fabricator, or the Department.

By accepting these shop drawings, the Contractor represents to the Department that all dimensions and elevations of existing conditions shown on the plans have been field measured and verified, and that these shop drawings comply with all the materials requirements, construction requirements, contract requirements, and performance criteria. The Contractor further represents that these drawings have been coordinated and verified with the details of the work to be performed by other fabricators and entities on the project. The Department will not make any allowance for additional cost or delays to the Contractor for incorrect fabrication as a result of failure to coordinate or perform this acceptance.

If the Department requests changes on these shop drawings, or the Contractor makes changes in addition to those expressly requested, ensure that the shop drawings are accepted as above with suitable revision marks to identify the changes.

Schedule the pre-fabrication meeting after the Director receives the drawings. Fabrication may begin after the pre-fabrication meeting is complete or after receipt of Item 513, UF Level drawings.

**B. Fabricator Coordination of Shop Drawings for Items 516, 517, and 518.** The Contractor and fabricator must coordinate these shop drawings. Ensure that shop drawings meet requirements for materials, field measurements, construction requirements, contract requirements, performance criteria, and similar data. The coordination must also include details of the work to be performed by other fabricators and entities on the project. The Department will not make allowance for additional cost or delays to the Contractor for incorrect fabrication as a result of failure to coordinate or perform this coordination.

Submit two copies of the shop drawings to the Engineer with the materials delivered to the project. Do not incorporate material into the work until after submitting the drawings. Department approval of these shop drawings is not required.

**C. Shop Drawing General Requirements.** Specific requirements are specified in Item 513, 515, 516, 517, or 518.

Make the prints from tracings, neatly and accurately drawn on 22 × 34-inch (559 × 864 mm) sheets.

After all fabrication is completed for Item 513 and 515, furnish, to the Director, a copy of each final Contractor accepted shop drawing on a digital media storage device according to Supplement 1002. For structures carrying railroad

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traffic, furnish an additional digital media storage device or, at the option of each railroad, furnish a set of full-size drawings on Mylar.

**501.05 Submittal of Working Drawings and Calculations.** Design and perform all procedures as directed by the AASHTO STANDARD SPECIFICATIONS or the AASHTO LRFD BRIDGE except as modified below:

Perform daily inspections to ensure the work governed by the working drawing is functioning as designed. Report malfunctioning work to the Engineer immediately.

**A. Projects with Railroad Involvement.** Prepare and provide working drawings listed in this section as follows:

Have an Ohio Registered Engineer prepare, sign, seal and date each working drawing. Submit working drawings to all involved railway companies at least 50 days before construction begins. Obtain acceptance from all involved railroad companies. Furnish the Engineer copies of all correspondence with the railroad, documentation of railroad acceptance and the working drawings accepted by the railroad. Department acceptance is not required.

Perform all work in accordance with the accepted working drawings. Immediately cease all operations that deviate from the accepted working drawings. If a deviation is necessary, furnish the Engineer a copy of a revised working drawing including documentation of acceptance from all involved railroad companies as least 24 hours before construction on deviated work begins. The revised working drawing shall be sealed and dated by an Ohio Registered Engineer. Department acceptance of revised working drawings is not required. The Department will consider delays resulting from working drawing deviations as non-excusable in accordance with 108.06.E.

This section applies to working drawings for the following:

1. Bracing adjacent to the railroad tracks. Perform work according to 501.05.B.1.
2. Demolition of structures over or within 14 feet of railroad tracks. Perform work according to 501.05.B.2.
3. Erection of structural members over or within 14 feet of railroad tracks. Perform work according to 501.05.B.4.

**B. Projects without Railroad Involvement.** Prepare and provide working drawings listed in this section as follows:

Have an Ohio Registered Engineer prepare, sign, seal and date each working drawing. Have a second Ohio Registered Engineer check, sign, seal and date each working drawing. The preparer and checker shall be two different Engineers.

Submit the working drawing to the Engineer at least 7 days before construction begins. Department acceptance is not required.

Perform all work in accordance with the prepared working drawings. Immediately cease all operations that deviate from the prepared working drawings. If a deviation is necessary, furnish the Engineer a copy of a revised working

drawing at least 24 hours before construction on the deviated work begins. The revised working drawing shall be signed, sealed and dated by an Ohio Registered Engineer and checked, signed and sealed and dated by a Second Ohio Registered Engineer. Department acceptance of revised working drawings is not required. The Department will consider delays resulting from working drawings deviations as non-excusable in accordance with 108.06E.

This section applies to working drawings for the following:

1. Excavation Bracing ,adjacent to active traffic, except when a complete design is already shown in the plans. Perform all work as specified below:
  - a. Locate Excavation Bracing per contract, if shown.
  - b. Maintain temporary horizontal and vertical clearances per contract.
  - c. Include the effects of AASHTO live and dead load surcharges as necessary.
  - d. Design Excavation Bracing in accordance with the latest AASHTO Guide Design Specifications for Bridge Temporary Works, Section 4
2. Demolition of structures over or adjacent to active traffic. Perform all work as specified below:
  - a. Provide temporary devices or structures necessary to protect traffic during all demolition activities. Provide traffic protection when demolition is located less than 12' horizontally from active traffic on structures of less than 25' vertical clearance. Increase the 12' minimum horizontal distance 1 foot for each 2 feet of additional height greater than 25'.
  - b. Never lift the portions of structure being removed over active traffic. Before releasing traffic make the remaining structure stable.
  - c. Design traffic protection devices or structures for a minimum load of 50 pounds per square foot plus the weight of equipment, debris and any other load to be carried. Include any portion of the deck that cantilevers beyond the fascia beams or girders.
  - d. In lieu of temporary devices or structures required in "a" above, provide a vertical barrier. Design the vertical barrier with rigid or flexible materials specifically designed for demolition containment. Extend the enclosure up to the bottom of the deck and down to the ground. Maintain all materials free of tears, cuts and holes.
  - e. Maintain temporary horizontal and vertical clearances per contract.
  - f. Locate structural members to be reused before performing any removal operations.
  - g. Do not damage structural members being reused during any removal operation.

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h. Perform work so that all members are stable during all operation and loading conditions.

i. Perform work per 501.05.B.6.

3. Falsework for cast-in-place concrete slab bridges . Perform all work per 508 and as specified below:

a. Provide a camber table to account for the deflection of the falsework loaded with its self weight and the weight of wet concrete. Also include in the table, the specified camber to compensate for slab deflection after the falsework is released.

b. Maintain temporary horizontal and vertical clearances per contract.

c. As a minimum design falsework over waterways for a five year flood or with 75% of the effective waterway opening of the proposed structure. The Contractor is responsible for any damages caused by upstream flooding due to insufficient temporary structure size or the accumulation of debris or sediment in the channel.

d. Support falsework foundations located within the ten year flood limits on rock, shale or piles driven to a minimum depth of 15 feet, and to sufficient penetration to carry superimposed loads or until refusal on rock.

e. The incorporation of structural steel shapes, used as temporary support members, into a finished concrete slab superstructure is prohibited.

f. Design falsework in accordance with the latest AASHTO Guide Design Specifications for Bridge Temporary Works, Section 2.

4. Erection of steel or precast concrete structural members as specified below:

a. Never lift structural members over active traffic. Before releasing traffic make structural members stable.

b. Supply any temporary supports or braces necessary to maintain structural stability and prevent lateral movement until completion of all construction activities.

c. Perform work per 501.05.B.6, 513 or 515.

d. Do not field weld temporary members to permanent steel members.

e. Maintain temporary horizontal and vertical clearances per contract.

f. Provide drawings with at least the following information:

i. Site Plan of the work area showing permanent support structures (piers and abutments); roads; railroad tracks; waterways; overhead and underground utilities; and other information pertinent to erection.

ii. Erection sequence for all members, noting any temporary support conditions, such as holding crane positions, temporary supports, falsework etc. Member reference marks, when reflected on the erection plans, should be the same used on the shop drawings.

iii. Primary member delivery location and orientation.

iv. Maintenance of Traffic during erection operations.

v. Location of each crane for each primary member pick, showing radius and crane support (barges, mats, etc.).

vi. Capacity chart for each crane configuration and boom length used in the work.

vii. Center of gravity locations for primary member.

viii. Rigging weights, capacity and arrangement for primary member picks.

ix. Lifting weight of primary member picks, including all rigging and pre-attached elements.

x. Details of any temporary lifting devices to be bolted or welded to permanent members, including method and time (shop or field) of attachment; capacity; and method, time, and responsibility for removal.

xi. Blocking details for bridge bearings.

g. Provide calculations for the following:

i. Load capacity and stability of temporary supports and crane(s) for each pick and release.

ii. Structural adequacy and stability of members for each step of erection.

iii. Capacity of fabricated rigging, such as lift beams, welded lugs, spreader beams, beam clamps, etc. Submit manufacturers' certifications of catalog cuts for pre-engineered devices.

#### 5. Jacking and support of existing structures as specified below:

a. Support the structure on temporary supports and brace as necessary to maintain structural stability and prevent lateral movement until completion of the permanent supports. Do not use jacks alone to support the structure except during the actual jacking operation. Remove all temporary supports upon completion of the jacking procedure.

b. Maintain a maximum differential jacking height of 1/4 inch between any adjacent beam lines.

c. Maintain a maximum differential jacking height of 1 inch between any adjacent abutments or piers.

d. Place jacks and any load plates at least 2 inches from the edges of any concrete substructure seats.

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e. Do not field weld temporary members to permanent steel members.

f. Maintain temporary horizontal and vertical clearances per contract.

6. Placing or moving equipment having a gross weight in excess of 60,000 pounds (27,000 kg) on or across a structure as follows:

a. Do not allow equipment having a gross weight in excess of the posted limit to be placed on or driven across a structure.

b. Do not allow erection and construction methods, or use or move erection or construction equipment on or across the uncompleted or completed structure, to subject any part of the structure to unit stresses that exceed by more than one-third the allowable unit stresses, as given in AASHTO STANDARD SPECIFICATIONS.

7. Structures for maintaining traffic in accordance with Item 502.

a. For structures located over or within 14 feet of railroad tracks, submit plans in accordance with 501.05.A.

b. Perform work per 501.05.B.6.

**C. Welded Attachments.** Prepare and provide a detailed request showing weld size, length, type and location for welding permanent or temporary attachments to main structural members not shown or permitted by contract. Submit request to the Office of Structural Engineering for acceptance at least 20 days before construction begins. Perform work per 501.05.B.6 and 513.

**D. Corrective Work.** Unless otherwise noted, before performing corrective work on structure items, 507,511,513,515,516,517 and 524, prepare a Corrective Work Plan (CWP) including supporting calculations. Submit three copies of the CWP to the Engineer for acceptance at least 30 days before construction begins. Have an Ohio Registered Engineer prepare, sign, seal and date each CWP. Obtain Department acceptance before beginning corrective work.

Perform all work in accordance with the accepted CWP. Immediately cease all operations that deviated from the accepted CWP. If a deviation is necessary, furnish the Engineer three copies of a revised CWP. The revised CWP shall be signed, sealed and dated by an Ohio Registered Engineer. Obtain Department acceptance of revised CWP prior to performing corrective work.

Perform all corrective work, including the preparation of the CWP and revisions at no expense to the Department. The Contractor shall reimburse the Department for all CWP review costs of the Designer of Record. The Department will consider delays resulting from all corrective work as non-excusable in accordance with 108.06E.

### 501.06 Test Reports.

**A. Contractor Acceptance of Materials for Item 513.** Submit certified test data to the Director showing compliance with the requirements of Item 711.

Accompany all certified test data with copies of mill shipping notices or invoices showing the quantity and size of material being accepted.

Check this material data and provide a letter of written acceptance. Submit the material data and letter of written acceptance to the Director so that the Director receives them at least 7 days before final shop inspection Item 513, Levels 1 through 6 or before final shop inspection Item 513, UF Level.

Submit a single copy of this material data for each structure, except where the structure carries railway traffic. Submit one additional copy to each railway company involved.

Additionally for Item 513, Levels 1 through 6 structural steel members, submit one copy of main material, certified test data with a letter documenting the QCFS acceptance to the QA shop inspector before the material passes check point one.

The Department will not accept materials for final inspection at the fabrication shop until the Director receives the Contractor accepted material data.

**B. Fabricator Certification of Materials for Items 516, 517, and 518.** Ensure that a letter of certification accompanies the fabricated material shipped to the job site, in a format approved by the Director, stating all materials conform to contract requirements. For these materials, the fabricator must retain certified test data, copies of mill shipping notices, or invoices showing the quantity and size of material being accepted. This data shall provide complete traceability to the producing mill and proof of domestic origin, as required by ORC 153.011.

Do not deliver materials to the project without the certification letter.

## **ITEM 502 STRUCTURES FOR MAINTAINING TRAFFIC**

### **502.01 Description**

### **502.02 Design and Construction**

### **502.03 Maintenance**

### **502.04 Removal**

### **502.05 Basis of Payment**

**502.01 Description.** This work consists of preparing plans, providing, maintaining, and subsequently removing temporary structures.

**502.02 Design and Construction.** As a minimum, design the temporary structure for a 5-year flood or with 75 percent of the effective waterway opening of the proposed structure. The Contractor is responsible for any damages caused by upstream flooding due to insufficient temporary structure size or the accumulation of debris or sediment in the channel. Provide a clear roadway width of at least 23 feet (7.0 m) measured from face to face of guardrails. If the existing structure or approaches or both have sidewalks provide at least one sidewalk at least 5 feet (1.2 m) wide with adequate connections to existing walks and in compliance with accessibility standards.

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Design the temporary structure according to the AASHTO LRFD Bridge Design Specifications except that the design live loading, HL-93 may be reduced by 25 percent.

Submit working drawings in accordance with 501.05.

Drive piling to sufficient penetration to carry the superimposed loads according to Item 507, but not less than 24 tons (24 metric tons) per pile. Perform dynamic load testing to determine required blow count if piles are not driven to rock.

If the plans state that the existing superstructure may be used instead of new construction, do not alter it to meet either the above width or strength requirements. Instead, move or dismantle and re-erect with sufficient care to avoid any reduction of capacity. If the superstructure has been restricted by posting to loads less than permitted by statute, move the posting signs to the temporary road, unless the superstructure is strengthened to a legal load capacity. If planning to use the existing superstructure on the temporary road, notify the Engineer at least 3 days before the superstructure is moved to allow the Department to establish a detour. Complete the bridge within 48 hours after traffic has been routed over the detour.

**502.03 Maintenance.** Maintain all portions of the temporary structure in good condition with respect to both safety and smoothness for travel as long as it is needed for maintenance of traffic. Satisfactorily maintain the channel and waterway opening.

**502.04 Removal.** If the temporary structure is no longer needed, take ownership and remove it from the site according to Item 202.

**502.05 Basis of Payment.** Payment is full compensation for erection, maintenance, performing dynamic load testing, and subsequent removal of temporary structures.

The Department will pay for accepted quantities at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
502	Lump Sum	Structure for Maintaining Traffic

**ITEM 503 EXCAVATION FOR STRUCTURES**

- 503.01 Description**
- 503.02 Classification**
- 503.03 Cofferdams and Excavation Bracing**
- 503.04 Protection for Excavation**
- 503.05 Footings in Rock**
- 503.06 Approval of Foundations**
- 503.07 Disposal of Excavated Material**
- 503.08 Backfill**
- 503.09 Method of Measurement**
- 503.10 Basis of Payment**

**503.01 Description.** This work consists of designing cofferdams and excavation bracing, and excavating materials not removed under other items of work that must be removed to enable construction of bridges, and other structures. Included in this work are:

- A. constructing, maintaining, and subsequently removing cofferdams and excavation bracing;
- B. dewatering and backfilling the excavation;
- C. protecting the excavation against collapse; and
- D. disposing of materials not required or suitable for backfill.

**503.02 Classification.** Excavation is classified as unclassified excavation, unclassified excavation including rock (or shale), or rock (or shale) excavation.

**503.03 Cofferdams and Excavation Bracing.** This item includes the preparation of a working drawing according to 501.05 for all cofferdams and excavation bracing and the construction, maintenance, and subsequent removal of all cofferdams and excavation bracing. A cofferdam is an enclosure within a water environment constructed to allow dewatering for the purpose of creating a dry work environment. Excavation bracing is that required to safely support the sides of excavations, embankments, adjacent buildings, tracks, or other premises.

Construct cofferdams and excavation bracing such that support members clear the top of the footings by at least 1 foot (0.3 m). If this is not practical, support members shall be structural steel and left in place. If bracing is to be left in place and the ends would not be visible when the structure is completed, burn off the steel ends flush with the concrete surface. If ends would be visible, form a 6 inch (150 mm) deep recess around the steel embedment and remove the external portion of the embedment to provide at least 3 inches (75 mm) of clearance to the finished concrete face. Completely fill the resulting recess with concrete.

Where water is not encountered, the Contractor may place excavation bracing at the plan dimension of the footing and use it as formwork for footing concrete. Leave this sheeting in place at least to the top of the footing, or properly separate it from the footing concrete so that it may be removed without damaging the concrete.

Where water is encountered, and cofferdams are necessary, construct them practically watertight before excavating below water level. Make provisions outside the footing to drain, collect, and remove water. When placing concrete, keep the excavation dewatered until the concrete is above the prevailing water level. Effectively protect footing concrete from erosion. If using a concrete seal to stop the flow upward from the bottom of a cofferdam, place the seal below the planned footing and consider it as a part of the cofferdam. The Department will not pay for a seal unless it is shown on the plans.

Unless otherwise shown in the plans, design and construct cofferdams to accommodate a water elevation 3 feet (1.0 m) above the ordinary high water mark shown on the plans. If the actual water elevation exceeds 3 feet (1.0 m) above the stated ordinary high water mark, the Department will reimburse the Contractor for any resulting damage to the work protected by the cofferdam provided the

#### 503.04

Contractor has exercised normal due diligence. If the actual water elevation exceeds 3 feet (1.0 m) above the ordinary high water mark and causes a delay to the project, the Department will grant the Contractor an excusable, non-compensable delay in accordance with 108.06.B.

Establish a monument upstream of all proposed cofferdams to visually monitor the water elevation in the waterway. Maintain the monument throughout the project. Provide a visual mark on the monument that identifies the required high water elevation as defined above. Ensure that the monument can be read from the bank of the waterway. Have this elevation set and certified by an Ohio Registered Surveyor.

Cofferdams may be designed and constructed to accommodate a lower water elevation; however, the Department will not reimburse the Contractor for repairs to work damaged nor grant additional time unless the water elevation exceeds 3 feet (1.0 m) above the ordinary high water mark shown on the plan.

Submit any request for reimbursement for repair to work damaged or for delay to the Engineer with information substantiating that the water elevation was more than 3 feet (1.0 m) above the ordinary high water mark shown on the plans.

**503.04 Protection for Excavation.** Protect all excavations from caving. Do not disturb the material below the bottom of footings. Perform blasting in a manner that avoids damage to the material supporting the structure vertically or laterally and that avoids subsequent slides that damage the structure, road, or adjacent property. If the material below the bottom of footings not supported by piles is disturbed, remove it and fill the entire space with concrete at no expense to the Department. Under footings supported on piles, replace and compact the over-excavated or disturbed material as the Engineer directs. If backfilling is necessary to correct caving or slides, backfill according to 503.08.

Excavation adjacent to railroad tracks are subject to the supervision of the involved railway company. Provide sufficient bracing to ensure the proper support of the roadbed and tracks.

**503.05 Footings in Rock.** Where rock or shale excavation is a separate pay item, fill the portion of the excavation into rock or shale that is below the top of footing with concrete.

If removing rock or shale as part of Unclassified Excavation and the footing is designed to be keyed into the bedrock, confine the excavation into bedrock for the minimum specified depth of keying within the area bounded by the outer edge of the footing. Fill excavation outside these limits and within and below the keyed depth with concrete.

**503.06 Approval of Foundations.** Notify the Engineer when the excavation is to be completed to the depth shown on the plans. Do not place footings until the Engineer has approved the subfoundation.

**503.07 Disposal of Excavated Material.** Dispose of excavated material not needed or not suitable according to 105.16 and 105.17. Use other suitable excavation material for backfill.

**503.08 Backfill.** Backfill under this item includes all replaced excavation and new embankment adjacent to structures. Use backfill embankment materials conforming to 203.02.R, except behind the abutments below the approach slabs use material conforming to Item 203 Granular Material Type B. Place and compact the backfill materials according to 203.06 and 203.07, except as modified by this subsection.

Do not place backfill material against any structural element until the Engineer has approved the element.

In bridge abutment areas compact backfill material to meet the compaction requirements in 203.07. Elsewhere, compact backfill material to 95 percent of the maximum laboratory dry density.

When a test section method is used for compaction acceptance: Use compaction equipment with a total weight or a centrifugal force of least 1 ton (0.9 metric tons). Supply the manufacturers' information to verify this information. Use at least six passes to construct the production areas. Use at least 97 percent of the test section maximum dry density for acceptance of the production areas.

The Contractor does not have to place backfill material around piers that are not within the embankment area or adjacent to a roadway or a railway in thin layers or compact it, but should leave the backfill material in a neat condition with a compensating allowance made for settlement.

Backfill in front of abutments and around piers to the ground lines shown on the plans.

Backfill all structural foundation units as soon as practical after the required conditions of this subsection are met to avoid the ponding of surface water and the accumulation of debris. Simultaneously backfill in front of and behind abutments, piers, wing walls, and retaining walls.

Carefully backfill against waterproofed surfaces to avoid damage to the waterproofing material.

**503.09 Method of Measurement.** After the requirements of Items 201, 202, and 203 have been met, the Department will measure excavation by the number of cubic yards (cubic meters) as follows:

**A. Bounded on the bottom.** Bounded bottom plane of the footing, crossbeam, or wall.

**B. Bounded on the top.**

1. In cut sections, by the surface of the remaining ground.
2. In fill sections:
  - a. If excavation is performed before embankment is placed, by the surface of the original ground.
  - b. If excavation is performed after embankment is placed, by the surface of the embankment.

**C. Bounded on the sides.**

## 503.10

1. For Unclassified Excavation, 1 foot (0.3 m) outside the outer edge of the footing, crossbeam, or wall.

2. For Rock Excavation or Shale Excavation:

a. If Rock Excavation is included in the Contract, by the outer edge of the footing or wall.

b. If rock or shale is removed as part of Unclassified Excavation Including Rock and/or Shale:

(1) Above the minimum specified depth of keying, the same as described in 503.09.C.1.

(2) For the remainder of the excavation, the same as described in 503.09.C.2.a.

For abutment excavation quantities, the Department will include material removed above the bench (if any), in front of the vertical plane described in 503.09.C.1, and by the finished slope of the cut or embankment.

For keys below footings, the Department will determine the volume of keys by the number of cubic yards (cubic meters) shown on the plans.

The Department will measure Unclassified Excavation on a lump sum basis when shown on the plans.

The Department will measure Cofferdams and Excavation Bracing on a lump sum basis.

### **503.10 Basis of Payment.**

If an Item for Cofferdams and Excavation Bracing is not included in the Contract for payment, perform work according to 503.03 and the Department will pay for Cofferdams and Excavation Bracing under the contract unit price for excavation.

The elevations shown on the plans for the bottoms of footings are considered as approximate. When excavation below plan elevation for footings is required, the Department will pay for the 3 feet (0.9 m) immediately below the plan elevation within the lateral limits described in 503.09.C.1 at the unit price bid for the class of excavation.

The Department will consider additional excavation to a maximum depth of 1 foot (0.3 m) within the lateral limits described in 503.09 as incidental to the lump sum price. Excavation deeper than 1 foot (0.3 m) below plan elevation may be provided for as Extra Work, as described in 109.05.

If Cofferdams and Excavation Bracing is a separate pay item, the lump sum price includes any extra cost involved for cofferdams for additional depth up to 3 feet (0.9 m) below plan elevation. Excavation deeper than 3 feet (0.9 m) below plan elevation and the additional cofferdams necessitated by this excavation may be provided for as Extra Work, as described in 109.05. The Contractor shall provide additional fill material and subsequent excavation to

provide the minimum cover over culverts to accommodate heavy earth moving equipment at no expense to the Department.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
503	Lump Sum	Cofferdams and Excavation Bracing
503	Cubic Yard (Cubic Meter)	Unclassified Excavation
503	Lump Sum	Unclassified Excavation
503	Cubic Yard (Cubic Meter)	Unclassified Excavation Including Rock
503	Cubic Yard (Cubic Meter)	Unclassified Excavation Including Shale
503	Cubic Yard (Cubic Meter)	Unclassified Excavation Including Rock and/or Shale
503	Cubic Yard (Cubic Meter)	Rock Excavation
503	Cubic Yard (Cubic Meter)	Shale Excavation

## ITEM 504 SHEET PILING LEFT IN PLACE

### 504.01 Description

### 504.02 Materials

### 504.03 Driving

### 504.04 Method of Measurement

### 504.05 Basis of Payment

**504.01 Description.** This work consists of furnishing and driving steel sheet piling to be left in place, including furnishing and installing any specified anchors or other attachments to structures.

**504.02 Materials.** Furnish new sheet piling conforming to 711.03. The Contractor may use used sheet piling in good condition that conforms to project requirements provided it is inspected and approved by the Engineer.

**504.03 Driving.** Drive steel sheet piling to the tip elevation shown on the plans.

**504.04 Method of Measurement.** The Department will measure Steel Sheet Piling Left In Place [Minimum Section Modulus of \_\_\_\_ cubic inches per foot (\_\_\_\_ mm<sup>3</sup>/m)] of Wall by measuring the number of square feet (square meters) in the plane of the face of the sheeting, completed and accepted in place.

**504.05 Basis of Payment.** The Department will pay for accepted quantities at the contract price as follows:

505.01

Item	Unit	Description
504	Square Foot (Square Meter)	Steel Sheet Piling Left In Place [Minimum Section Modulus of____ cubic inches per foot (____ mm <sup>3</sup> /m)] of Wall

**ITEM 505 PILE DRIVING EQUIPMENT MOBILIZATION**

**505.01 Description**

**505.02 Basis of Payment**

**505.01 Description.** This work consists of mobilizing pile driving equipment to and from the project site and, as necessary, to install the required piling.

This work includes the fixed costs that are related to the installation of the required piling.

**505.02 Basis of Payment.** The Department will pay for accepted quantities, after the first service pile is installed, at the contract price as follows:

Item	Unit	Description
505	Lump Sum	Pile Driving Equipment Mobilization

**ITEM 506 STATIC LOAD TEST**

**506.01 Description**

**506.02 General**

**506.03 Application of Load**

**506.04 Basis of Payment**

**506.01 Description.** This work consists of applying a static load to a driven pile and furnishing instruments and facilities to obtain load-settlement data required to determine the ultimate bearing value of the pile. When subsequent static load tests are specified, the Office of Structural Engineering will determine whether subsequent static load tests are to be performed and the location of all piles to be tested.

**506.02 General.** Use the hammer selected for driving the test pile to drive all piles represented by the test. If the Contractor finds it necessary to use a different hammer, the Office of Structural Engineering will determine if an additional static load test is necessary.

If using anchor piles to apply the load to the test pile, locate the anchor piles not closer than 7 feet (2.1 m) center-to-center from the test pile. If possible, install anchor piles parallel to the axis of the test pile. The Contractor may use battered piles as anchor piles; provided the horizontal forces in the anchor system are balanced and excessive bending stresses are not induced in the piles. The Contractor may also use bearing piles meeting these requirements as anchor piles. After the test has been completed, remove or cut off at least 1 foot (0.3 m) below the bottom of the footing or finished surface of the ground all anchor piles outside the limits of the footing. Cut off anchor piles, other than bearing piles, within the

limits of the footing 3 inches (75 mm) above the bottom of the footing. Redrive all bearing piles used as anchor piles that are displaced upward during the application of the test load according to the plan requirements.

Furnish a calibrated load cell to determine the load applied and a recent verification of the calibration of the gages and devices by a reliable agency equipped to do the testing.

For the duration of the test, provide adequate facilities to record load and settlement readings 24 hours per day. To avoid column buckling of the pile, ensure that tested piles are substantially vertical and that the load is applied to the pile at a point as near the ground surface as possible.

Determine if piles on the plan order list for cast-in-place reinforced concrete piles have a pile wall thick enough to withstand the maximum required static test load of twice the ultimate bearing value. The minimum pile wall thickness to support twice the ultimate bearing value is:

$$t = \frac{2R}{113000D} \quad \left( t = \frac{2R}{780D} \right)$$

Where:

$t$  = pile wall thickness in inches (mm)

$R$  = ultimate bearing value in pounds (N)

$D$  = diameter of pile in inches (mm)

If the pile wall thickness for the test pile is less than  $t$ , before performing the static load test, either drive a test pile with a thicker pile wall, or fill the pile with concrete and allow the concrete to cure for 5 days. The static load test is unacceptable if the pile fails internally during the test due to improper installation or procedure by the Contractor.

**506.03 Application of Load.** Apply the load at least 5 days after placing concrete in the pile or 72 hours after driving both the test pile and the anchor piles.

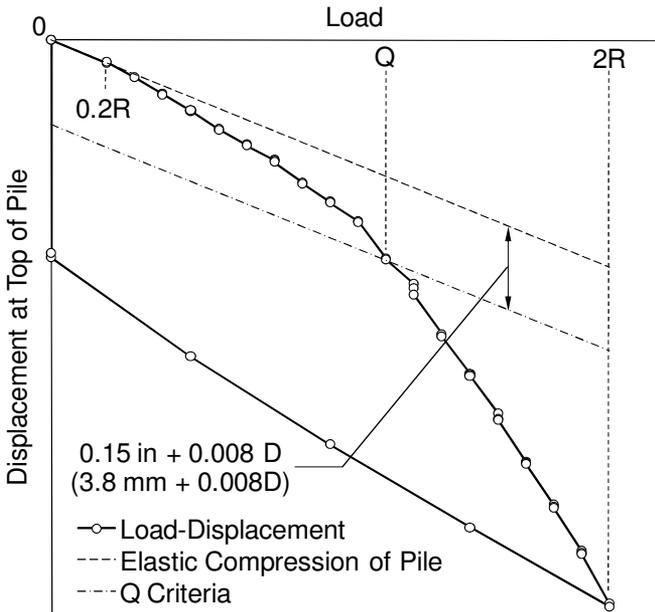
Apply a concentric load using a method that allows definite determination and control of the load acting on the pile at all times. Furnish a backup system for measuring the settlement of the pile being tested.

For the initial loading, use approximately one-fifth of the ultimate bearing value shown on the plans. For subsequent loadings, use increments of approximately one-tenth the plan ultimate bearing value, and apply these increments 1 hour after all measurable settlement due to the previous load increment has ceased. Measurable settlement is defined as 0.01 inch (0.3 mm) or more in a 20-minute time interval.

The Engineer will record all settlement readings.

Increase the test load until it reaches two times the plan ultimate bearing value or until the test pile reaches the failure load where the test pile experiences plunging failure. Plunging failure is defined as a settlement rate of 0.03 inch per ton (0.8 mm/9000 N) for the load increment applied.

To determine the load test ultimate bearing value ( $Q$ ), first plot the settlement versus load on the pile. Next, draw a line parallel to the slope line through the zero (0) point and the initial load reading ( $0.2R$ ) but offset by the settlement formula,  $0.15 \text{ inch} + 0.008D$  ( $3.8 \text{ mm} + 0.008D$ ). The test load ultimate bearing value ( $Q$ ) is the load corresponding to where the offset slope line crosses the load-settlement curve.



If plunging failure is reached before the total applied load exceeds 1.5 times the plan ultimate bearing value, apply an additional increment of load to ensure that the failure load has been reached. If the amount of settlement per increment is repeated or increased, stop applying the load. If the amount of settlement per increment is not repeated or increased, continue applying the load increments until the failure load is reached or until a total applied load of two times the plan ultimate bearing value is applied. If the failure load has not been reached after applying the last required load increment, continue applying the total load for at least 1 hour after all measurable settlement has ceased. Unload the pile in 25 percent decrements every 5 minutes.

The Engineer will continue to obtain settlement recovery measurements for 3 hours after totally unloading the pile.

If it is necessary to remove and reapply the load, use the same loading procedures to reapply the loads except apply load increments 15 minutes after all measurable settlement has ceased.

**506.04 Basis of Payment.** If the Contractor subsequently finds it necessary to use a different hammer, the Office of Structural Engineering will determine if an additional static load test is necessary; the Contractor shall complete any such additional test at no additional cost to the Department.

The cost of furnishing test piles with thicker pile walls is included under Static Load Test.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
506	Lump Sum	Static Load Test
506	Each	Subsequent Static Load Test

## ITEM 507 BEARING PILES

### 507.01 Description

### 507.02 General

### 507.03 Materials

### 507.04 Driving of Piles

### 507.05 Determination of Required Driving Criteria

### 507.06 Cast-in-Place Reinforced Concrete Piles

### 507.07 Steel H-Piles

### 507.08 Timber Piles

### 507.09 Splices

### 507.10 Defective Piles

### 507.11 Prebored Holes

### 507.12 Method of Measurement

### 507.13 Basis of Payment

**507.01 Description.** This work consists of furnishing and driving bearing piles.

**507.02 General.** Install piles of the specified type, length, and sizes shown on the plans. Furnish the piles according to the itemized order list shown on the plans. If additional length is needed to obtain bearing, furnish the additional length as determined by the Engineer. The length of the piles given in the order list is not necessarily based on available or practical lengths, but the estimated length from the bottom of each pile to the elevation of the cutoff. The Contractor may increase or decrease the pile lengths to suit the lengths available, to facilitate the method of operation, which may involve providing fresh heading as a result of hammer misalignment or a worn hammer cushion, or to provide lengths determined practical to have delivered to the project site and driven.

**507.03 Materials.** Furnish materials conforming to the following:

Reinforcing steel .....	509
Concrete, Class C.....	511
Chemical admixture for concrete, Type F.....	705.12
Steel H-piles .....	711.03

507.04

Steel pile points .....	711.01 or 711.07
Steel for reinforced concrete piles.....	711.03
Galvanized steel .....	711.02
Timber .....	711.26

Provide a concrete slump from 6 to 8 inches (150 to 200 mm) with the use of a superplasticizer.

**507.04 Driving of Piles.** Drive piles to refusal on bedrock; until obtaining the required ultimate bearing value, which may include a modification for scour, set-up, or negative skin friction; or to the minimum penetration pile tip elevation shown on the plans.

If piles begin to crush, immediately cease driving and repair or replace the pile. The counting of blows will cease until the crushed pile is either repaired or replaced.

For piles subject to scour, notify the DGE if the required ultimate bearing value is obtained before the pile has penetrated 80 percent of its estimated depth before appreciably overdriving the pile. The DGE will study the conditions and determine the final penetration, the driving requirements, the use of another pile type, and the use of prebored holes.

All piles raised during the driving of adjacent piles shall be driven down again.

Use a hammer that will achieve the required ultimate bearing value for the pile and large enough to permit a dynamic load test to verify that the ultimate bearing capacity shown on the plans can be achieved.

The ram of an air-operated or diesel hammer shall weigh at least 2700 pounds (12,000 N).

The ram of a drop hammer for permanent piles shall weigh at least 3000 pounds (13,300 N). The height of fall for drop hammers shall not exceed 7 feet (2.1 m). Do not use drop hammers to drive piles that are to be driven to an ultimate bearing value in excess of 70 tons (620 kN).

When using open ended diesel hammers, provide equipment for the Engineer's use to accurately measure each stroke within 6 inches (150 mm).

Attach a gage to closed end diesel hammers, accessible to the Engineer, to monitor the pressure in the bounce chamber. Include a graph with the gage to convert pressure to energy.

Attach an impact energy monitor, or a method to accurately measure the stroke within 2 inches (50 mm) to hydraulic hammers, accessible to the Engineer, to monitor the energy of each blow.

Use securely anchored driving leads and a cap device with sliding jaws to engage the leads to guide the pile and maintain the pile alignment with the stroke of the hammer. Accurately align the travel of the hammer with the axis of the pile.

Cushion the hammer and pile to prevent the impact of driving forces from damaging the top of the pile. Shape the cap and pile top to uniformly distribute the hammer blow to the top surface of the pile.

Do not use a follower unless approved by the Office of Structural Engineering. If the Office of Structural Engineering does approve the use of a follower, account for the increased energy loss when determining the required driving criteria.

If a static load test is required, the Contractor may not drive piles except the test and anchor piles before conducting the test and the required depth of penetration has been determined.

Do not use water jets.

After being driven, cut off the piles at the elevation and angle shown on the plans.

**507.05 Determination of Required Driving Criteria.** Determine the required driving criteria to achieve the ultimate bearing value of a driven pile as if the pile was a single isolated pile using the results of dynamic pile testing as specified in Item 523. The driving criteria may consist of a minimum blow count with a minimum hammer stroke, a minimum depth of penetration, or both.

**507.06 Cast-in-Place Reinforced Concrete Piles.** Provide cast-in-place reinforced concrete piles conforming to one or more of the types described below. Measure the pile diameter as follows:

- A. Plain cylindrical casing, the outside diameter.
- B. Cylindrical casings with vertical fluting, the diameter of a circle circumscribing the outermost points or ridges.
- C. Cylindrical casing with circumferential corrugations, the average of the outside diameters measured at the bottom and top of the corrugations or continuously welded helical corrugations with diameters measured at tops of the corrugations.
- D. Tapered piles, the top diameter as determined in 507.06.A, 507.06.B, or 507.06.C, but the pile tip diameter shall not be less than 8 inches (200 mm).

Ensure that the pile casings are watertight after being driven. If furnished, shoes or points shall not project more than 1/4 inch (6 mm) outside the vertical surface of the casing.

For plain cylindrical casings, the minimum pile wall thickness,  $t$ , is the greater of either 0.250 inches (6.66 mm) or the thickness determined using the following formula:

$$t \text{ (in inches)} = \frac{R}{900,000} \quad \left( t \text{ (in mm)} = \frac{R}{157606} \right)$$

Where:

$R$  = Ultimate bearing value in pounds (newtons) corresponding with the ultimate bearing capacity as shown on the plans

For fluted piles, the minimum pile wall thickness shall be  $t/1.4$ .

For cast-in-place piles containing reinforcing steel, place reinforcing steel as stated in the second and third paragraph of 524.09 and place concrete per 524.11.

## 507.07

After installation, cover the tops of driven casings until the concrete is placed. Before placing concrete, remove accumulated water or other foreign matter in a driven casing. Maintain a minimum radius of 15 feet (4.5 m) between simultaneous work of placing concrete and driving pile casings. If concrete is placed within the 15-foot (4.5 m) radius, suspend driving operations until the concrete has cured for 5 days. Place concrete for cast-in-place piles using methods that prevent voids, however, do not vibrate the concrete.

**507.07 Steel H-Piles.** Steel H-piles shall consist of structural steel shapes of the kind and size specified.

The Engineer may allow installation of steel piles of the specified type, which the Contractor has from previous projects or stock, if the Contractor furnishes mill certifications and the pile sections are identified with the material specification number, grade, and heat number. This identification may be in the form of information painted on the steel piles or a tag physically attached to the steel.

**507.08 Timber Piles.** Provide timber piles of sufficient length to remove broomed or split portions caused by driving. Symmetrically trim piles right truncated cone at the tip. If steel shoes or points are specified, carefully shape the tip of the pile so that the steel shoe or point fits snugly and symmetrically.

Handle and store timber piles to prevent warping.

If specified, provide creosoted piles conforming to 712.06.

**507.09 Splices.** To the fullest extent practical, avoid splicing steel casings and structural shapes. Splice pile casings and structural shapes either before or after driving a segment. If spliced after driving a segment, splice the piles at least 3 feet (1 m) above the ground and inspect the splice while the pile is driven a minimum of 150 blows.

Align segments to make the axis of all segments common.

Use full penetration butt welds to splice structural shapes according to 513.21, except delete the requirement to use temporary extension bars.

Do not splice timber piles.

**507.10 Defective Piles.** Piles entirely underground are defective if the pile location at the ground surface is more than the 1 foot (0.3 m) from the location shown on the plans.

Piles projecting above the ground are defective if the pile location at the ground surface is more than 3 inches (75 mm) from the location shown on the plans.

Pipe piles are defective if not water tight or if damage reduces the cross-sectional area by more than 20 percent. Provide the Engineer with a light that allows inspection of the entire length of the interior of a driven casing.

Replace, repair, or drive a substitute pile beside the defective pile. The location tolerance for underground piles does not apply to substitute piles beside defective underground piles. The off-location limits do apply to the substitute pile that project above the ground. If a defective pile is removed, fill the hole remaining in the ground with sand. Cut off a defective pile left in place under a footing 3 inches

(75 mm) above the elevation of the bottom of the footing. Cut off a defective pile left in place but not under a footing at least 1 foot (0.3 m) below ground level. Fill defective pipe piles left in place with concrete.

When the outside rows of bearing piles are not located within tolerances specified above, increase the size of the footing to provide a minimum distance between the pile and footing edge of at least 75 percent of that shown on the plans.

**507.11 Prebored Holes.** Locate prebored holes as shown on the plans. Provide augured hole diameters:

A. For round piles, from 2 inches (50 mm) less to 4 inches (100 mm) more than the pile diameter.

B. For steel H-piles, from 6 inches (150 mm) less to 2 inches (50 mm) more than the pile's diagonal dimension but shall be such as to produce satisfactory pile driving results.

Backfill voids between the pile and the prebored hole with a granular material satisfactory to the Engineer.

**507.12 Method of Measurement.** The Department will measure piles driven by the number of feet (meters). The Department will determine the sum as the lengths of all non-defective piles measured along the axis of each pile from the bottom of each pile to the elevation of cutoff. Unless a separate pay item is specified in the Contract, the Department will include Steel Points or Shoes in the measured length of driven piles. If a separate pay item is specified in the Contract, the Department will measure Steel Points or Shoes by the number of each.

The Department will measure piles furnished by the number of feet (meters) of plan specified order length plus any additional order length specified by the Engineer. The Engineer will include the length of undriven piles as furnished, but the Contractor will not receive additional compensation for hauling the piles off the project.

For plan specified prebored holes, the Department will measure Prebored Holes by the number of feet (meters) of prebored hole lengths for non-defective piles measured from the surface of ground at the time of boring to the bottom of the hole. The Department will not measure preboring to facilitate the pile driving operation.

**507.13 Basis of Payment.** Include the cost of preboring when the Contractor elects to prebore to facilitate the pile driving operation, the cost for preboring shall be included in the unit price bid for piles driven.

The Department will consider the cost of furnishing and installing the reinforcing steel to be included in the unit price bid for piles driven.

The Department will not pay for any splices due to the Contractor furnishing pile lengths shorter than plan order lengths.

The Department will not pay for increased pile lengths made by the Contractor unless the Engineer determines that the additional lengths are needed to achieve bearing.

**508.01**

If additional penetration is necessary in order to achieve the required bearing, the Department will pay for required splices at a negotiated price.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
507	Foot (Meter)	Steel Piles HP ____×____, Furnished
507	Foot (Meter)	Steel Piles HP ____×____, Driven
507	Foot (Meter)	____" (____ mm) Cast-In-Place, Reinforced Concrete Piles, Furnished
507	Foot (Meter)	____" (____ mm) Cast-In-Place, Reinforced Concrete Piles, Driven
507	Foot (Meter)	Timber Piles, Creosoted
507	Foot (Meter)	Timber Piles, Untreated
507	Foot (Meter)	Prebored Holes
507	Each	Steel Points or Shoes

**ITEM 508 FALSEWORK AND FORMS**

**508.01 Description**

**508.02 Falsework**

**508.03 Forms**

**508.04 Oiling Forms**

**508.05 Basis of Payment**

**508.01 Description.** This work consist of designing and building of falsework and forms for the purpose of holding concrete in place until it has set up.

**508.02 Falsework.** Provide substantial and rigid falsework that does not unduly obstruct any waterway, highway, or railway. Arrange intermediate supports in the completed structure to produce the camber necessary to conform to the plan profile of the roadway.

Do not allow the maximum deflection in the longitudinal falsework members at the edges of the concrete deck to exceed 1/2 inch (13 mm) or the amount obtained by the following formula, whichever is greater.

$$d = \frac{S+100}{1000} \quad \left( d = \frac{S+2540}{1000} \right)$$

where:

*d* = the maximum deflection in inches (millimeters)

*S* = the distance between supports in inches (millimeters)

For transverse falsework members, and for longitudinal falsework members other than those near the edges of the deck, increase the permissible deflection obtained from the above formula by 75 percent.

To compensate for falsework deflection, build camber into the falsework. In addition to falsework deflection, build the following amounts of camber into the falsework to compensate for slab deflection after falsework is released:

- A. Equal to  $1/800$  of the span for continuous spans.
- B. Equal to  $0.000018 S^3$  ( $0.016 S^3$ ) for simple spans, where  $S$  is the length of the slab span in feet (meters) for camber expressed in inches (millimeters).

Provide camber to conform to the profile grade.

If the falsework does not rest in rock, shale, or other firm foundation material, support falsework on piling driven to sufficient penetration to carry the superimposed loads according to Item 507, but not less than 16 tons (16 metric tons) per pile. Perform dynamic load testing to determine required blow count if piles are not driven to rock. Do not use expansion anchors to support falsework on piers or abutments. Use double hardwood wedges as necessary to facilitate vertical adjustment.

Remove and replace any part of the structure made unsatisfactory by incorrect camber, settlement or form deformation.

Construct falsework for arches so it may be released gradually.

Remove falsework only after the concrete conforms to 511.16 and before final acceptance of the structure. Cut off or pull falsework piling. Cut off piles to at least the slope line, riprap line, or stream bed.

Locate the lower contact point of overhang falsework within 8 inches (200 mm) of the top of the rolled beam or steel girders bottom flange.

Submit falsework plans for cast-in-place concrete slab superstructures according to 501.05.

If a thickened edge is shown on the plans, the Contractor may develop the edge by sloping the bottom of the slab for a minimum of 9 feet (2.7 m) from the edge, instead of the section shown.

Do not place spandrel walls, decks of arches, sidewalks and curbs, or any superimposed concrete to be completed after constructing the main supporting member or the deck until the falsework for the main supporting member has been removed or released.

For continuous concrete slab or beam superstructures, do not place concrete on a span until the falsework and forms are complete for the adjacent spans. Do not release or remove falsework from a span until the concrete in adjacent spans has been placed a sufficient length of time to meet all requirements for the removal of falsework as set forth in 511.16.

**508.03 Forms.** Place all concrete in proper forms. Do not use unprotected sides of the excavation, instead of forms, unless as specified in 503.04 for rock or hard shale excavation. For dry excavation specified in 503.03, the Contractor may use the sheeting as forms for footings.

Construct substantial, unyielding, and mortar tight forms, designed to produce a finished concrete conforming to the proper dimensions and contours. Make forms

#### 508.04

for exposed surfaces of approved material requiring a minimum number of joints or of dressed lumber of uniform thickness using form liner approved by the Engineer. Use forms and form liners to reduce the joints showing on the finished surface to a minimum. Arrange joints to coincide with rustication grooves shown on the plans. Properly brace or tie forms together using approved form ties that do not allow metal within 2 inches (50 mm) of an exposed surface of the finished structure after the forms are removed. For ties in the region of exposed surfaces, use an approved insert. Remove all forms and do not allow material, except reinforcing supports specified in 509.08, to remain in the concrete.

For concrete decks separated by an open median or temporarily separated by a closure section, construct falsework and forms for each deck or section of deck independent of the adjacent structure or remaining superstructure.

Immediately before placing concrete, provide temporary openings at the base of column and wall forms and in the bottom of all narrow, deep members where necessary to facilitate cleaning or inspection.

Provide a 3/4-inch (20 mm) bevel on all exposed edges using a triangular strip built into the forms.

If rustication is used, fasten molding that is surfaced on all sides to the forms in such a manner that the molding remains in the concrete when the forms are removed. Do not remove this molding until the concrete has set sufficiently to prevent damage to the edges of the concrete.

If weep holes through abutments or retaining walls are shown on the plans, form weep holes to obtain a smooth circular opening between 3 and 4 inches (75 and 100 mm) and a straight gradient of 0.08 through the wall.

**508.04 Oiling Forms.** Before placing reinforcing steel, coat the inside of forms with non-staining mineral oil or other approved material.

**508.05 Basis of Payment.** The Department will not separately pay for falsework and forms. The cost of this work is included for payment in the price bid for the item for which falsework and forms are used.

The Department will not pay for removal and replacement of any part of the structure made unsatisfactory by settlement or form deformation.

The Department will not pay for dynamic load testing required to determine blow count if piles are not driven to rock.

### ITEM 509 REINFORCING STEEL

**509.01 Description**

**509.02 Materials**

**509.03 Care of Material**

**509.04 Method of Placing**

**509.05 Bending**

**509.06 Approval of Placing**

**509.07 Splicing**

**509.08 Supports**

**509.09 Epoxy Coated Reinforcing Steel****509.10 Method of Measurement****509.11 Basis of Payment**

**509.01 Description.** This work consists of furnishing and placing supports, mechanical connectors, tie wires, and reinforcing steel of the quality, type, size, and quantity designated, including steel dowels.

**509.02 Materials.** Furnish materials conforming to:

Epoxy coated reinforcing steel.....	709.00
Reinforcing steel, deformed bars.....	709.01, 709.03, 709.05
Spiral reinforcing steel.....	709.01 or 709.08
Bar mats and wire fabric.....	709.09, 709.10, 709.12
Plastic supports.....	709.15

For metal bar supports used at or near the surface of the concrete, furnish either galvanized steel, stainless steel, epoxy coated steel or plastic coated steel.

Provide sufficient additional reinforcing steel to replace reinforcing steel removed by the Department for sampling. Replace random samples in the structures with additional steel, spliced according to 509.07.

When providing reinforcing steel for spiral cages, galvanized steel conforming to ASTM A767, Class 1, may be provided only for the spiral reinforcing steel in lieu of epoxy coated reinforcing steel. The galvanized coated reinforcing steel will meet all other requirements of 509. Where a sample splice is needed use the lap length requirements for epoxy coated. The Galvanized coating will be applied after the reinforcing has been fabricated. If the galvanized surface becomes damaged during handling in the field, repairs will conform to ASTM A780. Use bar supports and tie wires which are plastic coated or epoxy coated. Only suppliers certified under S1068 may provide this reinforcing.

**509.03 Care of Material.** Upon delivery to the project and before use, stack reinforcing steel off the ground and keep it free from dirt, oil, grease, or avoidable rust. Before placing in the concrete, ensure the reinforcing steel is clean and free of loose rust.

**509.04 Method of Placing.** Place reinforcing steel in the positions shown on the plans, and firmly secure the steel during the placing and setting of concrete. Tie bars in the superstructure at all intersections, except tie bars at alternate intersections where bar spacing is less than 1 foot (0.3 m) in any direction. The Contractor may place up to 25 percent of the upper longitudinal bars in a bridge deck slab beneath the upper transverse bars to support the top mat. Do not drive or force reinforcing steel into concrete after its initially set.

Welding on reinforcing is prohibited, except as permitted by 709.10 and 709.12. The Engineer will allow the Contractor to fabricate reinforcing bar cages for prestressed beams if fabrication is done in a manner satisfactory to the Director.

Install reinforcing steel with at least the following clearances from the concrete surface:

- A. 2 1/2 inches (65 mm) to the top of sidewalks.

**509.05**

- B. 3 inches (75 mm) at the faces of footings placed against rock or earth.
- C. 1 1/2 inches (38 mm) to the bottom of a cast-in-place deck slab.
- D. 2 inches (50 mm) at all other surfaces.
- E. 2 1/4 to 2 1/2 inches (60 to 65 mm) between the reinforcing steel and the top surfaces of cast-in-place concrete deck slabs.

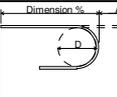
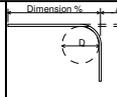
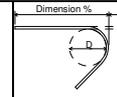
**509.05 Bending.** Bend reinforcing steel to the dimensions shown on the plans and in Table 509.05-1 (509.05-1M). Reject reinforcing steel showing transverse cracks.

**TABLE 509.05-1 STANDARD BENDS**

Bar		Dimension %		Dimension %		Dimension %		Dimension %	
		180° Bend		90° Bend		135° Bend		135° Bend	
Bar	Diameter	Area	Weight	D	A	D	A	D	A
Size	in	in <sup>2</sup>	lb/ft	in	in	in	in	in	in
3	0.375	0.11	0.376	2 1/4	5	2 1/4	5	1 1/2	4
4	0.500	0.20	0.668	3	6	3	7	2	4 1/2
5	0.625	0.31	1.043	3 3/4	7	3 3/4	8 1/2	2 1/2	5 1/2
6	0.750	0.44	1.502	4 1/2	8	4 1/2	10		
7	0.875	0.60	2.044	5 1/4	10	5 1/4	12		
8	1.000	0.79	2.670	6	11	6	13 1/2		
9	1.128	1.00	3.400	9 1/2	15	9 1/2	15 1/2		
10	1.270	1.27	4.303	10 3/4	17	10 3/4	18		
11	1.410	1.56	5.313	12	19	12	20		
14	1.693	2.25	7.65	18 1/4	27	18 1/4	25		
18	2.257	4.00	13.60	24	36	24	33		

Tolerances: For diameter of bends, "D", the tolerance may be plus or minus the diameter of the bar. Standard fabricating tolerances shall be in accordance with the CRSI Manual of Standard Practice. No weight allowances will be made for tolerances.

**TABLE 509.05-1M STANDARD BENDS**

									
Bar									
Nominal Dimensions				180° Bend		90° Bend		135° Bend	
Bar	Diameter	Area	Weight	D	A	D	A	D	A
Size	mm	mm <sup>2</sup>	kg/m	mm	mm	mm	mm	mm	mm
#10M	9.5	71	0.560	60	130	60	130	40	105
#13M	12.7	129	0.994	75	155	75	180	50	115
#16M	15.9	199	1.552	95	180	95	215	65	140
#19M	19.1	284	2.235	115	205	115	255		
#22M	22.2	387	3.042	135	255	135	305		
#25M	25.4	510	3.973	150	280	150	345		
#29M	28.7	645	5.060	240	380	240	395		
#32M	32.3	819	6.404	275	430	275	455		
#36M	35.8	1006	7.907	305	485	305	510		
#43M	43.0	1452	11.38	465	685	465	635		
Tolerances: For diameter of bends, "D", the tolerance may be plus or minus the diameter of the bar. Standard fabricating tolerances shall be in accordance with the CRSI Manual of Standard Practice. No weight allowances will be made for tolerances.									

**509.06 Approval of Placing.** Before placing concrete, obtain the Engineer's approval of reinforcing steel in place.

**509.07 Splicing.** Splice reinforcement only as specified or determined by the Engineer. Splice spiral reinforcement by lapping 1 1/2 turns. Do not replace spiral reinforcement removed for a material sample if the sample is from the end of the spiral and less than or equal to 30 inches (0.8 m) long.

Mechanical connectors shall be capable of developing 125 percent of the yield strength of the connected bars. The total slip of the bar within the splice sleeve of the connector after loading in tension to 30.0 ksi (207 MPa) and relaxing to 3.0 ksi (21 MPa) shall not exceed the following measured displacements between gage points clear of the splice sleeve:

- A. For bar sizes up to No. 14: 0.01 in. (0.25 mm)
- B. For No. 18 bars: 0.03 in. (0.76 mm)

Splice Nos. 14 and 18 (Nos. 45M and 55M) reinforcing steel bars with mechanical connectors.

The Department will not permit lap splices for these size bars.

Splice Nos. 14 and 18 (Nos. 45M and 55M) reinforcing steel bars with mechanical connectors. The Department will not permit lap splices for these size bars.

Splice additional steel used to replace random samples as follows:

TABLE 509.07-1		
Bar Size	Lap Length (inches)	
	Uncoated	Epoxy Coated
4	22	27
5	29	35
6	34	41
7	43	52
8	57	69
9	72	87
10	92	111
11	113	137

TABLE 509.07-1M		
Bar Size	Lap Length (mm)	
	Uncoated	Epoxy Coated
13M	560	690
16M	740	890
19M	870	1040
22M	1090	1320
25M	1450	1750
29M	1830	2210
32M	2340	2820
36M	2870	3480

**509.08 Supports.** Use precast mortar blocks, metal supports, or plastic supports of adequate strength, of the proper depth, and in sufficient number to support reinforcing steel. Space supports for reinforcing steel no more than 4 feet (1.2 m) apart transversely and longitudinally. Metal supports shall have a shape that is easily enveloped by the concrete.

Mortar blocks may only be used to support the lower mat of reinforcing steel in concrete that is cast directly against bedrock or soil.

**509.09 Epoxy Coated Reinforcing Steel.** Use plastic coated or epoxy coated bar supports and tie wires to protect the epoxy coating from physical damage, as specified in 709.00, during placement and to prevent electrical coupling between mats. Carefully handle and install bars to perform minimal patching at the job site. Repair physical damage to the epoxy coating with a patching material all damaged coating areas greater than 1/4-inch (6 mm) square or 1/4-inch (6 mm) diameter; approximately 1/8-inch (3 mm) square or 1/8-inch (3 mm) diameter if the opening is within 1/4-inch (6 mm) of an equal or larger opening; or, a length of 6 inches (150 mm) regardless of area. Coating damage in cases where the damaged area is less than specified above, need not be repaired. Use patching material of the same composition and quality as the original coating. Prepare the surface to a near white metal.

If repair is required, clean and repair the damaged areas and allow adequate cure time before placing concrete. The Engineer will approve the installation once patching has been done as outlined above.

**509.10 Method of Measurement.** The Department will measure Epoxy Coated Reinforcing Steel by the number of pounds (kilograms) shown on the plans. Additional measurements or calculations are not required.

If the Contractor believes the pay weight, as shown on the plans, is in error, the Contractor is responsible to prove this discrepancy by recalculating the total weight for the reference number involved. The Contractor shall submit its figures to the Engineer for review and approval. The number of pounds (kilograms) of reinforcing steel shall be the actual number of pounds (kilograms) of the various sizes incorporated in the concrete as shown on the plans, completed and accepted.

If the weight of the reinforcing steel is recalculated, determine the number of pounds (kilograms) from the number, length, and weight of the bars as shown on the steel list of the plans, based on the weight per foot (meter) shown in the Table 509.05-1 (509.05-1M) with deductions for bars not used, and addition for extra bars used as directed by the Engineer.

**509.11 Basis of Payment.** The Department will not include the supports, mechanical connectors, and tie wires in the calculated weights but will consider them incidental to the price bid.

The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
509	Pounds (Kilograms)	Epoxy Coated Reinforcing

## ITEM 510 DOWEL HOLES

### 510.01 Description

### 510.02 Materials

### 510.03 Drilling of Holes

### 510.04 Placement

### 510.05 Curing and Loading

### 510.06 Basis of Payment

**510.01 Description.** This work consists of drilling holes into concrete or masonry, and furnishing and placing grout into the holes. The furnishing and placing of steel for dowels is included in Item 509.

**510.02 Materials.** Cement grout consists of one part of hydraulic cement conforming to Item 701 and three parts sand conforming to 703.03, by volume, and water.

Furnish nonshrink, nonmetallic grout conforming to 705.20.

**510.03 Drilling of Holes.** Drill holes at the location and the depth shown on the plans without spalling the concrete.

**510.04**

Drill holes for cement grout at least 1/2 inch (13 mm) larger in diameter than the dowel bar. Drill holes diameters for nonshrink, nonmetallic grout at least 1/16 inch (1.5 mm) larger in diameter than the dowel bar. Drill hole for encapsulated type nonshrink, nonmetallic grout as recommended by the manufacturer.

Instead of drilling holes, the Contractor may install formed holes with laitance removed.

**510.04 Placement.** Do not install grout if the temperature of the concrete into which the grout is being placed is below 40 °F (4 °C). Force dowel bars into the holes, to the specified depth, spreading the grout around the bar and solidly filling the hole.

Before installing cement grout and dowels, saturate cement grout dowel holes with water then blow out all excess water. Place enough cement grout to completely fill the holes during dowel installation. If cement grout does not completely fill the hole, remove the dowel, pour additional grout into the hole, and reinstall the dowel.

Before installing nonshrink, nonmetallic grout and dowel, clean and dry the grout holes. Immediately after mixing, place a sufficient amount of nonshrink, nonmetallic grout to provide complete coverage around the dowel to ensure anchorage. If nonshrink, nonmetallic grout does not completely fill the hole, pour additional grout in until the hole is filled flush.

Obtain the correct protrusion of the anchors or dowels, and hold dowels in the plan position within the holes until the grout has initially hardened.

If horizontal holes are specified, provide a means of retaining the grout in the hole flush with the vertical face and remove this material after the grout has hardened. Do not use material for retaining the grout that bonds to the grout.

**510.05 Curing and Loading** Before applying any stresses to dowels, cure nonshrink, nonmetallic grout as follows:

Daily Minimum Ambient Temperature	Minimum Curing Time
33 to 50 °F (1 to 10 °C)	3 hours
51 to 68 °F (11 to 20 °C)	1 1/2 hours
above 68 °F (above 20 °C)	1 hour

**510.06 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
510	Each	Dowel holes with cement grout
510	Each	Dowel holes with nonshrink, nonmetallic grout

**ITEM 511 CONCRETE FOR STRUCTURES**

**511.01 Description**

**511.02 Materials**

- 511.03 Proportions**
- 511.04 Mix Options for Class HP.**
- 511.05 Class HP Test Slab**
- 511.06 Concrete Test Specimens**
- 511.07 High Early Strength Concrete**
- 511.08 Mixing of Concrete**
- 511.09 Slump**
- 511.10 Placing Concrete**
- 511.11 Slipform Construction of Bridge Railing**
- 511.12 Construction Joints**
- 511.13 Work Stoppage**
- 511.14 Depositing Concrete Under Water**
- 511.15 Depositing and Curing Concrete During Cold Weather**
- 511.16 Removal of Forms**
- 511.17 Curing and Loading**
- 511.18 Surface Finish**
- 511.19 Roadway Finish**
- 511.20 Bridge Deck Grooving**
- 511.21 Sidewalk Finish**
- 511.22 Sealing Joints and Cracks**
- 511.23 Class HP Concrete Testing**
- 511.24 Method of Measurement**
- 511.25 Basis of Payment**

**511.01 Description.** This work consists of providing falsework and forming, furnishing, placing, consolidating, finishing, and curing portland cement concrete. This work also includes diamond saw cutting transverse grooves into the surface of superstructure concrete. Construct falsework and forms as required in Item 508.

**511.02 Materials.** Furnish materials conforming to 499.02, except as modified below.

Use the same kind and color of aggregate for all concrete above the ground line in a given substructure unit and for all concrete in a given superstructure.

Use high molecular weight methacrylate resin sealer conforming to 705.15.

Use curing materials conforming to 705.05; 705.06 (white opaque); or 705.07; Type 1 or 1D.

Use 1/4-inch (6 mm) gray sponge joint filler conforming to 711.28, or use preformed filler conforming to 705.03.

Use preformed elastomeric compression joint seals conforming to 705.11.

**511.03 Proportions.** Proportion concrete for structures according to 499.03, using Class C, S, or HP as specified in the Contract.

At least 3 days before placing Class HP, including the test slab, submit, in writing, the mix design and batching sequence to the Engineer. The Engineer will review the mix design for conformance to proportion requirements, otherwise the mix design is for the Engineer's information.

## 511.04

**511.04 Mix Options for Class HP.** Except for parapet concrete, use Class HP 3 or 4 for all superstructure concrete unless specific concrete mixes are specified. If using Class HP 3 for the deck, use Class HP 1 or 3 for all other superstructure concrete. If using Class HP 4 for the deck, use Class HP 2 or 4 for all other superstructure concrete.

For Class HP, the Engineer will waive Item 499 calendar time restrictions regarding the use of fly ash.

**511.05 Class HP Test Slab.** Produce a trial batch of concrete equal in size to the batch required for the concrete superstructure and conforming to the mix design. Ensure that the trial batch is workable and able to be finished.

Place an 8 ft × 4 ft × 4-inch (2.4 m × 1.2 m × 0.1 m) test slab when the atmospheric conditions approximate the conditions anticipated for placing the superstructure. Finish and texture the test slab according to this section, however, the Contractor is not required to texture the concrete using a saw.

If the Engineer determines that the trial batch is not workable or not able to be properly finished, modify the mix design or batching sequence. Submit the revised mix design and batching sequence to the Engineer, and place another test slab. Repeat the submittal and test slab process until producing a trial batch that is both workable and able to be finished. Do not place any Class HP until the Engineer accepts the test slab pour.

**511.06 Concrete Test Specimens.** The Engineer will make test cylinders as follows:

- A. Structures over 20-foot (6.1 m) span. Two test cylinders from each 200 cubic yards (150 m<sup>3</sup>) of concrete, or fraction thereof that is incorporated into the work each day.
- B. Structures of 20-foot (6.1 m) span or less. At least two test cylinders for each 50 cubic yards (35 m<sup>3</sup>) of concrete.

The Engineer will make and test concrete test beams according to Supplement 1023 when the Contractor plans to remove falsework early as specified in 511.16.

**511.07 High Early Strength Concrete.** If it is desirable to expedite the work, the Contractor may use high early strength cement, additional cement, approved chemical admixtures, or a combination of these materials at no additional cost to the Department. Cure and load concrete according to 511.17.

**511.08 Mixing of Concrete.** Mix concrete according to 499.09.

When mixed, all concrete shall have a temperature of not more than 90 °F (32 °C). Maintain the concrete under this temperature until concrete is deposited in the work.

When an air temperature of 60 °F (16 °C) or higher prevails at the time of placing concrete in a bridge superstructure over 20-foot (6.1 m) span, add a chemical admixture conforming to 705.12, Type B or D to the concrete. Use 705.12 Type, A or D for Class HP concrete in lieu of 705.12, Type B or D.

**511.09 Slump.** Within the slump ranges specified in 499.03, provide a slump that produces concrete that is workable in the required position, flows around reinforcing steel, and coats individual particles of coarse aggregate with mortar containing the proportionate amount of sand.

The Engineer will measure the slump according to ASTM C 143.

**511.10 Placing Concrete.** Submit to the Engineer a description of proposed placing procedures and notify the Engineer at least 24 hours in advance of placing concrete.

Place superstructure concrete when the ambient air temperature is 85 °F (30 °C) or less and not predicted to go above 85 °F (30 °C) during the concrete placement; and when evaporation rates, determined according to Figure 1 in ACI 308, do not exceed the following:

Class	Evaporation Rate
S	0.2 pound per square foot per hour (1.0 kg/m <sup>2</sup> /hour).
HP	0.1 pound per square foot per hour (0.5 kg/m <sup>2</sup> /hour).

Determine and document the ambient air temperature, concrete temperature, deck surface temperature, relative humidity, and wind velocity, subject to verification by the Engineer. Measure data required in Figure 1 from within 10 feet (3 m) of the area where the superstructure concrete is placed.

Figure 1 does not apply to substructure items and poured parapets. Figure 1 applies to slip-formed parapets.

To meet favorable atmospheric conditions, may require the Contractor to place concrete at night. At least 24 hours before placing concrete at night, submit a lighting plan for the work area to the Engineer. Obtain the Engineer's approval of the lighting plan before placing the concrete. Direct lights so that approaching traffic is not affected or distracted.

Before placing a concrete deck on continuous steel beams or girders, complete all of the main beam or girder splices at least two piers beyond the pier or piers supporting the concrete.

Before placing concrete for backwalls above the approach slab seat with steel expansion joints, backfill the abutments to within 2-foot (0.6 m) of the bridge seat elevation, place superstructure concrete in the adjacent span, and either erect structural steel or prestressed concrete beams. Use the steel expansion joint as a template for the top of the backwall. If temporary bolts are used to support the backwall portion of an expansion device during the placing of the backwall concrete, remove the bolts after the concrete has taken its initial set and before a change in temperature causes superstructure movement sufficient to damage the backwall.

Before placing concrete, assure the Engineer of an adequate and uniform source of supply of concrete to allow proper placing and finishing, and of the availability of coverings to protect the concrete from rain.

Do not add or apply water to the concrete after it has left the truck and before applying curing materials according to 511.17.

## 511.10

Before placing concrete, thoroughly clean all forms and structural steel that contact the concrete and ensure that the space to be occupied by the concrete is free of laitance, silt, dirt, shavings, sawdust, loose and built-up rust, and other debris.

Deposit concrete using methods that ensure reinforcing steel is completely enveloped in concrete mortar and that allow inspection of concrete enveloping the reinforcing steel. Use a method or device to convey the concrete from the mixer to the work that prevents coarse aggregate separating from the mortar. If depositing concrete in shallow members, such as slabs, place it with as short a vertical drop as possible. Place the concrete over a section to maintain a practically horizontal surface. If using a chute, slope the chute to allow concrete to flow without segregation. Place concrete as near as possible to its final position.

Drop concrete into the forms with a free-fall distance of 5 feet (1.5 m) or less. As necessary, use drop chutes to limit the free fall to 5 feet (1.5 m) and to ensure the delivery ends as vertical as possible.

Deliver and distribute the concrete at a uniform and adequate rate no more than 10 feet (3 m) directly in front of the finishing machine by suitable mechanical equipment. For structures with a skew angle greater than fifteen (15) degrees, orient the finishing machine according to 511.19. For structures with a skew angle greater than fifteen (15) degrees and up to fifty (50) degrees, load the concrete at the skew angle. For structures with a skew angle greater than fifty (50) degrees, load the concrete as close to the skew angle of the structure as possible, but do not allow the leading edge of the concrete placement to exceed twenty (20) feet (6.1 m) ahead of the finishing machine.

Place concrete in structures using vibration. Furnish and use sufficient vibration equipment of the type and size approved by the Engineer to properly compact the concrete immediately after it is placed in the forms. The vibrators shall generally be of a type that is applied directly to the concrete and have a frequency of at least 4500 impulses per minute. If the concrete is inaccessible for this method of vibration, apply the vibrators to the outside of the forms.

Do not move concrete using a vibrator. Vibrate freshly deposited concrete at the point deposited. Slowly insert and withdraw the vibrators vertically into the concrete until the concrete is thoroughly compacted but not segregated. During vibration, do not disturb partially hardened concrete.

As necessary, spade along form surfaces, in corners, and in locations impossible to reach with vibrators to ensure smooth surfaces and dense concrete. Closely observe the results obtained on the first concrete placed, and, if necessary, modify the mix according to this specification to secure the best results.

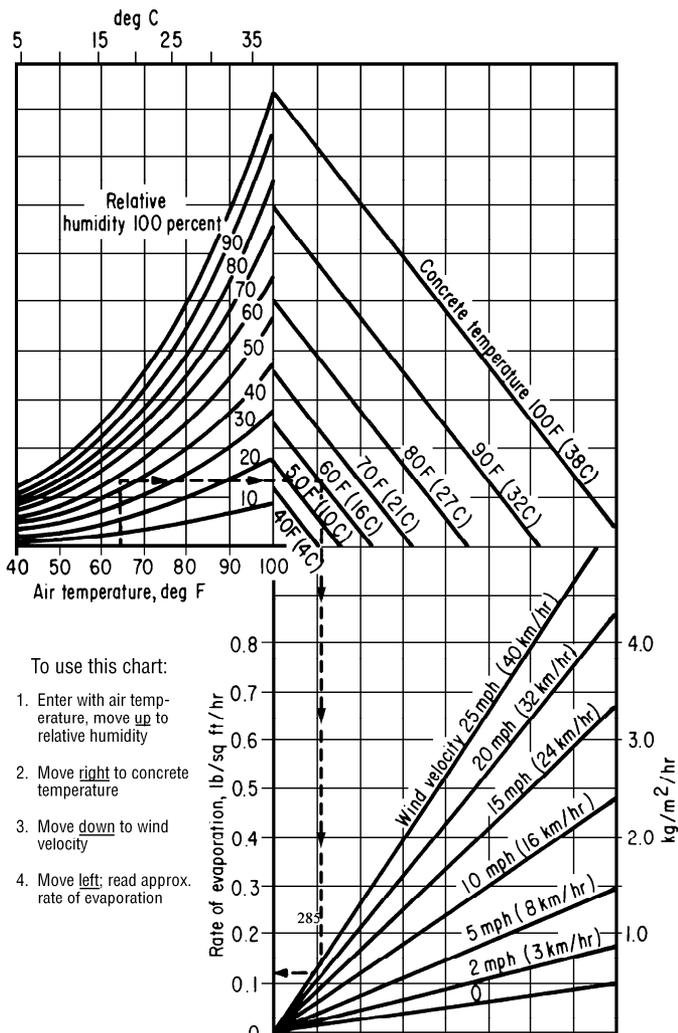


FIGURE 1 ACI 308-81

**511.11 Slipform Construction of Bridge Railing.** If Class HP concrete is specified, the Contractor may replace up to two-thirds of the No. 8 size coarse aggregate with No. 57 size coarse aggregate. The Engineer will submit the approved slipform concrete mix design to the Laboratory for record purposes.

If slipforming, provide finished concrete conforming to the following tolerances from plan dimensions:

511.12

Reinforcing steel cover	-1/2 inch, +1/2 inch (-13 mm, +13 mm)
Top width dimension	-0, +1/4 inch (+6 mm)
Bottom width dimension	-0, +1/2 inch (+13 mm)
Surface flatness	1/4 inch in 10 feet (6 mm in 3 m)
Vertical alignment (Deviation from a line parallel to the grade line)	1/2 inch in 20 feet (13 mm in 6 m)

Tie all joints and splices in bridge railing reinforcing steel. Before placing concrete, perform a slipforming dry run to verify reinforcing clearance and rigidity of the reinforcing cages. Adjust and stabilize the cage as necessary to establish the required clearances and to ensure the cage will not move during slipforming. The Contractor may add any additional diagonal reinforcing steel between the front and rear vertical reinforcing faces to establish the required rigidity.

Repair or patch honeycombing, cracking, tearing, and other defects immediately after concrete exits the slipform equipment. Completely fill defects with concrete without using water to smooth or close the surface.

After the concrete initially sets, but before any shrinkage cracks develop, saw control joints 1 1/4 inches (32 mm) deep into the perimeter of the parapet. Generally, initial set is within 6 hours of batching of the concrete. Ensure that all joints are sawed within 24 hours of placement. Saw control joints using an edge guide, fence, or jig to ensure that the joint is straight, true, and aligned on all faces of the parapet. The joint width shall be the width of the saw blade, a nominal 1/4 inch (6 mm). Caulk the control joints with a polyurethane or polymeric material conforming to ASTM C 920, Type S.

Slip formed concrete requires different slumps than those listed in Item 499 or other plan specified concrete. Provide a slump such that the concrete exiting the slipform does not pull but is stiff enough to prevent waviness and sags in the finished surfaces. Cure slipform concrete according 511.17, Method A. Because slipformed concrete has a low water-cement ratio, timely application of the water cure is critical in helping control shrinkage cracks.

Furnish platforms as necessary to protect traffic passing under the bridge from falling debris during the slipforming operation, to allow access for completing the finishing operation, and to allow the Engineer access to the outside of the parapet.

The Engineer will inspect the slipformed surface for horizontal cracking no earlier than 21 days after completion of the slipforming operation. Repair all horizontal cracks by epoxy injection. If a concrete sealer was applied, repair damage to the sealer after completing the epoxy injection.

**511.12 Construction Joints.** If construction joints are shown on the plans, place all concrete between consecutive joints in a continuous operation. Do not place concrete against a joint for at least 12 hours, or as required by 511.17.

Obtain the Director’s approval before placing any construction joint not shown on the plans or required by 511.10.

Before placing concrete, determine the location where the day’s concrete placing ends. If practical, end placing the day’s concrete perpendicular to the lines

of principal stress and in regions of small shear. Do not install horizontal joints in concrete girders and beams.

Form construction joints using bulkheads with keyways. Locate keyways clear of exposed surfaces by approximately one-third the thickness of the joint.

Where practical, avoid horizontal joints in piers, abutments, and retaining walls, otherwise locate horizontal joints 2 feet (0.6 m) or more above the normal water level.

For construction joints not shown on the plans and above ordinary low water, in abutments, and in retaining walls that retain earth fills, install a 36-inch (1 m) strip of Type B waterproofing according to Item 512 to the back of the joint.

Avoid joints in cantilevered members.

Dampen the surface of the concrete of the horizontal construction joints immediately before placing adjoining concrete.

Place and protect horizontal construction joints between bridge slabs and superimposed curbs, parapets, sidewalks, and median strips in the same manner as the remainder of the slab. Cure the construction joints according to 511.17.

Avoid disturbing the bond between protruding reinforcing steel and the deck concrete. If using the curb areas to place the deck, tie and brace the reinforcing steel to prevent its movement.

Where walls or columns support slabs or beams, place concrete in wall or column to the bottom of the slab or beam and allow the concrete to settle for at least 2 hours before placing concrete in the slab or beam.

**511.13 Work Stoppage.** If the work is unexpectedly interrupted by breakdowns, storms, or other causes, rearrange the freshly deposited concrete to provide a suitable construction joint. If this joint occurs at a section with shear stress, prevent a plane of weakness by providing an adequate mechanical bond across the joint by forming a keyway, inserting reinforcing steel, or by some other means satisfactory to the Engineer.

**511.14 Depositing Concrete Under Water.** Except for cofferdam seals and drilled shafts, do not place concrete under water.

**511.15 Depositing and Curing Concrete During Cold Weather.** If placing concrete when the atmospheric temperature is 32 °F (0 °C) or less, or if weather forecasts predict these temperatures during the curing period, follow the procedures of this subsection.

Heat the water or aggregate, or both, as necessary to produce concrete with a temperature when placed of at least 50 °F (10 °C) but not greater than 70 °F (21 °C).

Place concrete against materials with a temperature of greater than 32 °F (0 °C). If necessary, heat the forms, reinforcing steel, and foundation materials before placing the concrete.

Maintain the concrete surface temperature between 50 and 100 °F (10 and 38 °C) for a period of not less than 5 days, except as modified in 511.15.C. After the

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minimum cure period of 5 days, reduce the concrete surface temperature at a rate not to exceed 20 °F (11 °C) in 24 hours until the concrete surface temperature is within 20 °F (11 °C) of atmospheric temperature.

Install sufficient high-low thermometers to readily determine the concrete surface temperature. For deck slabs, install high-low thermometers to measure deck bottom surfaces, deck fascia surfaces, and deck top surfaces.

Maintain the concrete curing temperature using a heated enclosure, insulated forms, or by flooding, except cure deck slabs less than 10 inches (250 mm) thick using more than just insulated forms.

Remove falsework and open cold weather concrete to traffic according to 511.17.

**A. Heated Enclosure.** Construct the heated enclosure to surround the top, sides, and bottom of the concrete. Construct strong and wind proof enclosures that contain adequate space to allow free circulation of air around the forms and concrete.

Before placing concrete, construct the enclosure and heating devices to the extent allowed by the concrete operation. As the concreting operation progresses and as soon as possible after placing concrete, complete construction of the enclosures and apply heat. Supply heat by a method that continuously maintains a reasonably uniform temperature throughout the enclosures and does not discolor the concrete.

Vent combustion-type heating devices outside the enclosure.

If dry heat, other than free steam, maintains the enclosure temperature, immediately cover exposed concrete with two thicknesses of burlap. Continuously wet the burlap and, except for required rubbing of the concrete, do not remove the burlap during the heating period.

If wood forms without liners are left in place more than 2 days after the placing of concrete, thoroughly wet the forms at least once each day for the remainder of the heating period. If forms are removed during the heating period, thoroughly drench the concrete with water and, for the remainder of the heating period, cover and wet the concrete with burlap as specified above.

**B. Insulation.** Install sufficient thermometers to readily determine the concrete surface temperature. If the surface temperature approaches 100 °F (38 °C), loosen or otherwise vent the forms or insulation to keep the surface temperature within the limits specified above. If insulation does not maintain the minimum required temperature, promptly enclose the concrete as specified in 511.15.A or flood the concrete as specified in 511.15.C.

Use a wind and water resistant insulating material. Ensure edges, corners, and other points of extreme exposure are adequately insulated. Place a tarpaulin or other Engineer approved waterproof cover over the insulation to protect the concrete top surface.

**C. Flooding with Water.** The Contractor may flood the concrete with water provided flooding does not damage the concrete. Heat the water to a temperature

from 50 to 100 °F (10 to 38 °C). The Contractor may stop using heated water after 48 hours if the concrete remains flooded to a depth of 1 foot (0.3 m) above its highest elevation for at least the next 120 hours.

**511.16 Removal of Forms.** To facilitate finishing, remove forms from vertical surfaces that receive a rubbed surface finish as soon as the concrete has hardened sufficiently that rubbing will not damage it.

**511.17 Curing and Loading.** Remove falsework and open structures to traffic after the concrete has cured for the time specified by Table 511.17-1.

<b>TABLE 511.17-1</b>			
	Span[1]	Age of Concrete in Days	
		No Beam	Beam Test [2]
Removing Falsework	Over 10 feet (3 m)	14	5
	10 feet (3 m) or less and all pier caps	7	3
Traffic [3]	Any	14	7
[1] Span is defined as the horizontal distance between faces of the supporting elements when measured parallel to the primary reinforcement.			
[2] Applicable only when the average modulus of rupture for two tests is not less than 650 psi (4.5 MPa).			
[3] When placing Class HP concrete for a superstructure between October 15 and March 15, open the deck to traffic no sooner than 30 days after placement.			

If the air temperature surrounding the concrete is maintained between 32 and 50 °F (0 and 10 °C), and if the provisions of 511.15 do not apply, maintain the concrete above 32 °F (0 °C) for 7 days or until a successful beam test, except this time shall not be less than 5 days.

If a beam test is not performed, maintain the air temperature surrounding the concrete above 50 °F (10 °C) for 7 days. Extend the 7-day period and the times for removing falsework and opening to traffic one hour for each hour the temperature of the air surrounding the concrete is below 50 °F (10 °C) and until the concrete has experienced 7 days, or 168 hours, of temperature above 50 °F (10 °C). Cure concrete as follows:

<b>Location</b>	<b>Curing Method [1]</b>
Superstructure concrete	Method A
Concrete to which sealer is applied	Method A
Construction joints	Method A
Top surface of Class HP concrete deck superstructure concrete	Method A followed by Method B
Concrete with waterproofing	Method A or Method B
All other concrete	Method A or Method B
[1] Method A is water curing. Method B is membrane curing. If using Method B on areas to be waterproofed, remove the curing membrane.	

Do not install compression rings on pier columns or similar items of construction for supporting falsework or subsequent construction until after a 72-hour curing period.

Do not apply loads to or perform work on new concrete until workers and materials will not damage the concrete or interfere with its curing. Allow at least 36 hours or until the average of two beam tests is greater than 650 pounds per square inch (4.5 MPa) before working on new concrete, but do not interfere with curing of new concrete.

Concrete curing methods are as follows:

**A. Method A, Water Curing.** With the exception of the top surface of deck superstructure concrete, protect surfaces not covered by forms immediately after final finishing with two thicknesses of wet burlap. Keep burlap wet for at least 7 days by the continuous application of water. If forms are removed before 7 days, immediately drench the exposed concrete with water and cover it with burlap. Continuously apply water to the burlap for the remainder of the curing period.

Instead of continuous application of water, with the exception of the top surface of deck superstructure concrete, the Contractor may cover the wet burlap with white polyethylene sheeting or plastic coated burlap blankets conforming to 705.06. Place plastic coated burlap blankets wet and with the burlap side against the previous layer of wet burlap. Sufficiently lap and secure adjoining plastic coated blankets or polyethylene sheets at the laps and edges to form a seal that maintains the concrete wet at laps and edges. Cover white polyethylene sheeting or plastic coated blankets containing holes or tears with an additional covering of plastic sheeting or blankets as directed by the Engineer.

Cover the top surface of deck superstructure concrete with a single layer of clean wet burlap after it is bull floated if necessary, and finished. Keep the burlap wet by a continuous flow of water through soaker hoses and cover the hoses with a 4 mils (100  $\mu\text{m}$ ) white opaque polyethylene film for 7 days. After 7 days, allow the surface of the deck to dry.

After curing the top surface of Class HP deck superstructure concrete for 7 days, remove the burlap and standing water. Within 12 hours after removing the burlap, apply a curing membrane and cure the concrete according to Method B.

**B. Method B, Membrane Curing.** Immediately after the free water has disappeared on surfaces not protected by forms, apply curing material conforming to 705.07, Type 1 or 1D. If forms are removed before the end of the 7-day curing period, apply curing material on the concrete exposed by removing the forms.

Thoroughly agitate curing material immediately before use. Apply the membrane curing material at the rate of at least 1 gallon per 200 square feet (1 L/5  $\text{m}^2$ ) of surface and in a fine mist to provide a continuous, uniform, and water impermeable film without marring the concrete surface. If the film is broken or damaged during the specified curing period, apply curing material as specified above to the damaged or affected areas.

Do not allow workers, materials, and equipment on the concrete during the curing period, unless adequately protecting the membrane curing material from damage.

**511.18 Surface Finish.** Immediately after removing forms, clean, dampen, and fill with mortar all cavities produced by form ties, honeycomb spots, broken

corners or edges, and other defects. Use a mortar of the same proportions used in the concrete being finished. Substitute sufficient white cement for the regular cement in the mortar used to fill holes and perform other corrective work to produce finished patches of the same color as the surrounding concrete. Finish other contiguous exposed surfaces on the structure in a similar manner and to the extent required to produce a uniform appearance.

On all exposed surfaces, remove fins and irregular projections with a stone or power grinder, taking care to avoid contrasting surface textures.

**A. Grout Cleaning.** If grout cleaning is shown on the plans or necessary for corrective work, wet the concrete surface and then uniformly cover the concrete with a grout consisting of one part cement, 1 1/2 parts fine sand conforming to 703.03, and sufficient water to produce a mortar with the consistency of thick paint. In the quantity determined by the Engineer necessary to match the color of the concrete, use white portland cement in the grout. Uniformly apply the grout with brushes or spray guns, completely filling air bubbles and holes. Immediately after applying the grout, vigorously scour the concrete surface with a cork or other suitable float. While the grout is still in a plastic condition and while the grout does not pull from the holes or depressions, finish the surface with a sponge rubber or other suitable float, removing excess grout. After the grout thoroughly dries, vigorously rub the surface with a dry burlap, removing dried grout until there is no visible film of grout remaining on the surface. Perform the entire cleaning operation of each area on the same day. Remove dark spots or streaks that remain after the cleaning operation using a fine grained silicon carbide stone. Stop rubbing with the silicon carbide stone before the surface texture changes. Unless otherwise directed by the Engineer, perform grout cleaning during the final project clean up.

**B. Rubbed Finish.** If a rubbed finish is shown on the plans, if possible, remove forms within 2 days after placing concrete. Finish the surface as specified above to correct defects. After the mortar used for finishing is thoroughly set, and for a minimum of 2 hours before starting the rubbed finish, thoroughly saturate the concrete with water.

Rub surfaces to be finished with a medium coarse silicon carbide stone until all form marks, projections, and irregularities are removed, all voids are filled, and a uniform surface is obtained. Leave the paste produced by rubbing in place. Other than water, do not apply additional material to the surface. After placing concrete above the finishing area, obtain the final finish by rubbing the concrete with a fine silicon carbide stone and water until the entire surface is of a smooth texture and uniform in color. Protect surfaces with a rubbed finish from damage caused by subsequent construction operations. If damaged, clean and refinish the surface as specified above.

**511.19 Roadway Finish.** Finish and test concrete deck slabs according to 451.12. Do not groove or broom finish a strip of surface 9 to 12 inches (220 to 300 mm) wide adjacent to curbs and barriers. Provide a broom drag finish on concrete deck slabs in the longitudinal or transverse direction.

The Engineer will approve the finishing machine. Provide a self-propelled machine with forward and reverse drive mechanisms that enable precise control of

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machine velocity in both directions. The machine shall have two rotating rollers, leveling augers, and either a vibrating pan or vibrating rollers. Field verify that the vibrating frequency of the pans or rollers are from 1500 to 5000 pulses per minute. Do not use vibrating rollers that have fins protruding more than 1/4 inch (6 mm) from the roller. Use a finishing machine capable of finishing transversely while traveling in both directions across the deck. Provide screeds capable of rising above the concrete surface. Provide a finishing machine capable of finishing the full width of the decks between curbs or parapet walls. The wheels of the finishing machine shall run on temporary riding rails adequately supported on the structural steel or falsework of the deck. Make the rail and rail supports of steel and arrange the rail and rail supports so that the weight of the finishing machine and the operator cause zero vertical deflection while traveling across the deck. Ensure the rail is straight, with no sections exceeding a tolerance of 1/8 inch in 10 feet (3 mm in 3 m) in any direction. Elevate support rails a sufficient distance above the slab to allow the simultaneous hand finishing of areas not machine finished. Fabricate and install rail supports to allow removal to at least 2 inches (50 mm) below the top of the slab. Fill holes formed by the removal of rail supports during the final finishing of the slab.

For structures with a skew angle greater than fifteen (15) degrees and up to fifty (50) degrees, place the finishing machine within 5° of the skew angle of the structure. For structures with a skew angle greater than fifty (50) degrees, place the finishing machine at fifty (50) degrees.

**511.20 Bridge Deck Grooving.** After Class S concrete has cured, saw transverse grooves into the deck.

After water curing Class HP concrete and either before applying curing compound or some period after applying curing compound and before opening the bridge to traffic, saw transverse grooves into the deck. If sawing grooves after applying the curing compound, and concrete deck is less than 30 days old, reapply the curing compound after removing standing water, within 12 hours after sawing grooves in the deck.

The grooving of both Class S concrete and Class HP concrete shall be performed as specified below.

Use diamond blades mounted on a multi blade arbor on a self-propelled machine that was built for grooving of concrete surfaces. The groove machine shall have a depth control device that detects variations in the pavement surface and adjusts the cutting head height to maintain the specified depth of the groove. The grooving machine shall have devices to control alignment. Do not use flailing or impact type grooving equipment.

Begin and end grooves 9 to 12 inches (220 to 300 mm) from curbs, parapet toes, or deck edges, and saw grooves perpendicular to the bridge centerline.

Provide an experienced technician to supervise the location, alignment, layout, dimension, and grooving of the surface.

Saw grooves in a continuous pattern across the surface. Stop sawing 9 to 12 inches (220 to 300 mm) from any device in place in a bridge deck, such as scuppers or expansion joints. Stop sawing 2 inches to 2 feet from skewed

expansion joints. Saw grooves in a random pattern spaced at 3/8 to 1 3/4 inch (10 to 45 mm), with 50 percent of spacings less than 1 inch (25 mm). Saw grooves approximately 0.15 inches (4 mm) deep and 0.10 inches (3 mm) wide.

At the beginning of each work shift, furnish a full complement of grooving blades with each saw that are capable of cutting grooves of the specified width, depth, and spacing.

If during the work, a single grooving blade on a machine becomes incapable of cutting a groove, continue work for the remainder of the work shift. The Contractor is not required to cut the groove omitted because of the failed blade. Should two or more grooving blades on a machine become incapable of cutting grooves, cease operating the machine until it is repaired.

Continuously remove all slurry and remaining residue from the grooving operation and leave the deck surface in a clean condition. Prevent residue from grooving operations from flowing across shoulders or across lanes occupied by public traffic or from flowing into gutters or other drainage facilities. Remove solid residue before the residue is blown by passing traffic or by wind.

Provide water as necessary to saw grooves according to this subsection.

**511.21 Sidewalk Finish.** After placing, strike off the concrete with a template and finish the concrete with a float to produce a sandy texture.

**511.22 Sealing Joints and Cracks.** After completing all curing operations and allowing the deck to thoroughly dry, seal the following areas with a high molecular weight methacrylate (HMWM) sealer as specified in Item 512 before opening the deck to traffic:

- A. Transverse joints in the deck.
- B. Joints between the concrete deck and steel end dams.
- C. Longitudinal joints in the deck.
- D. Longitudinal joints between the deck and safety curb, barriers, and parapets, etc.
- E. Cracks discovered in the deck that will be checked on the top and bottom surface before opening the deck to traffic.

**511.23 Class HP Concrete Testing.** If included as a separate pay item, perform the following tests on the concrete.

**A. Rapid Chloride Permeability Tests.** Perform test according to AASHTO T 277. Take a minimum of three tests for decks containing less than 100 cubic yards (75 m<sup>3</sup>) of superstructure concrete. For all other decks, take six tests. Test deck superstructure concrete samples obtained from the actual concrete used.

Provide the Engineer with results of rapid chloride permeability tests at 28, 56, and 90 days.

**B. Drying Shrinkage Tests.** Perform test according to ASTM C 157 and at the frequency specified for rapid chloride permeability tests.

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Provide the Engineer with results of drying shrinkage tests at 4, 7, 14, 28, 56, and 90 days.

**C. Heat of Hydration Testing.** Perform testing to determine the potential for length change due to thermal expansion and contraction. Immediately after placing the deck, install three thermometers into the fresh concrete at a location that is accessible for readings and representative of the overall deck pour. Locate the thermometer bulbs at 1 inch (25 mm) below the surface of the concrete, at approximately mid-slab, and at 1 inch (25 mm) above the bottom deck form. Leave the thermometers in place throughout the testing time. The Contractor may lubricate and place the thermometers in a thin plastic sheath to facilitate eventual removal.

Record temperatures at the following intervals:

Test Intervals	Time
2 hours	first 12 hours
3 hours	second 12 hours
4 hours	second day
8 hours	third thru fifth day

Record ambient air temperatures when taking concrete temperatures. Ensure that all testing is performed by a testing laboratory regularly inspected by the Cement and Concrete Reference Laboratories (CCRL). Furnish a copy of the last CCRL inspection report to the Engineer before the test slab pour.

If the Contractor uses Class HP 1 or 2 for parapets or substructures, perform three additional chloride permeability and drying shrinkage tests for the parapets or substructure concrete. If used for parapets, perform a heat of hydration test as described above with one thermometer located at 1 inch (25 mm) below the top of the parapet and a second thermometer located 19 inches (500 mm) below the top of the parapet, approximately midway between the front and back faces of the parapet. The Engineer will not require additional testing for units constructed with the same concrete mix option as the deck.

Tabulate test results on the attached form and forward the form to the Laboratory no later than 10 days following the completion of the tests.

After removing thermometers, drill out and fill the holes as approved by the Engineer.

**511.24 Method of Measurement.** The Department will measure the appropriate concrete item by the number of cubic yards (cubic meters) determined by calculations from plan dimensions, in place, completed and accepted.

The Department will make deductions for portions of primary structural members embedded in concrete. The Department will not make deductions for the volume of reinforcing steel, conduits or embedded piles.

Superstructure concrete includes the concrete in deflective parapets not having a metallic railing.

The Department may measure deck concrete by either volume or area using plan dimensions.

**511.25 Basis of Payment.** The Department will not pay for Class HP concrete Testing until the Laboratory receives all test results.

The Department will not pay for additional test slabs resulting from proportioning or batching sequence modifications for the Class HP.

If the contractor elects to use high early strength concrete, the Department will not pay additional costs associated with the use of these materials even if use is desirable to expedite the work.

The Department will not pay for additional reinforcing steel required to adequately stabilize the cages.

The Department will not pay for repairs to horizontal cracks by epoxy injection or, if a concrete sealer was applied, for repairs to the sealer after the completing the epoxy injection.

The Department will not pay extra for any type of surface finish specified in 511.18, the cost being considered as included in the price bid for concrete.

If the Contractor elects to saw the deck after applying the curing compound, the Department will not pay to reapply the curing compound.

All costs for sealing as specified in 511.22 is incidental to the appropriate concrete item. The Department will not make separate payment for sealing.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
511	Cubic Yard (Cubic Meter)	Class ___ Concrete, ___
511	Cubic Yard (Cubic Meter) Square Yard (Square Meter)	Class S Concrete, Bridge Deck
511	Cubic Yard (Cubic Meter)	Class HP, Concrete Bridge Deck
511	Square Yard (Square Meter)	Class HP, Concrete Bridge Deck
511	Cubic Yard (Cubic Meter)	Class HP, Concrete Bridge Deck (Parapet)
511	Cubic Yard (Cubic Meter)	Class HP, Concrete Substructure
511	Lump Sum	Class HP Concrete Test Slab
511	Lump Sum	Class HP Concrete Testing

## **ITEM 512 TREATING CONCRETE**

**512.01 Description**

**512.02 Materials**

**512.03 Sealing of Concrete Surfaces**

**512.04 Sealing Concrete Bridge Decks with HMWM Resin**

512.01

**512.05 Soluble Reactive Silicate (SRS) Concrete Treatment**

**512.06 Treating Concrete Bridge Decks with Gravity-Fed Resin**

**512.07 Sealing Cracks by Epoxy Injection**

**512.08 Waterproofing**

**512.09 Method of Measurement**

**512.10 Basis of Payment**

**512.01 Description.** This work consists of sealing and treating concrete surfaces, sealing cracks in concrete, and applying waterproofing to structures.

**512.02 Materials.** Furnish materials conforming to:

- Asphalt cement.....702.01 (PG 64 - 22)
- Asphalt primer for ..... 702.02 (RC-70 or RC-250),  
waterproofing ..... 702.05
- HMWM Resin ..... 705.15
- Epoxy-Urethane Sealer .....705.23.A
- Non-epoxy Sealer .....705.23.B
- Soluble Reactive Silicate(SRS) ..... 705.24
- Gravity Fed Resin ..... 705.25
- Epoxy injection Materials ..... 705.26
- Sand..... 703 with the following exceptions:  
Maximum moisture content of 0.5 of the percent of absorption when treated according to California Test 226.

Grading:

SIEVE SIZE	% PASSING MAX.
No. 4 (4.5mm)	100
No. 8 (2.36mm)	90 - 100
No. 20 (850µm)	5 - 15
No. 50 (300µm)	0 - 5

- Emulsified asphalt primer, ..... 702.04 (MS-2, SS-1)
- Asphalt for waterproofing ..... 702.06
- Hot applied joint sealer ..... 705.04
- Type 3 membrane primer ..... 705.04
- Waterproofing fabric ..... 711.24
- Sheet Type 2 membrane waterproofing..... 711.25
- Sheet Type 3 membrane waterproofing..... 711.29

**512.03 Sealing of Concrete Surfaces.** This work consists of applying an approved sealer on existing and new concrete surface areas after the concrete is cured and repairs completed and cured. Apply the sealer to locations described in the plans. Apply the sealer listed in the pay item description. Choose a type of sealer if no sealer is listed in the pay item description.

**A. Equipment.** Use application equipment recommended by the sealer manufacturer. Use spray equipment, tanks, hoses, brooms, rollers, coaters, squeegees, etc., that are clean, free of foreign matter, oil residue and water.

**B. Mixing.** Mix the sealer according to the manufacturer's recommended procedures. Furnish the Engineer with the manufacturer's application instructions.

Do not mix or apply the sealer until the manufacturer's written recommendations are supplied to the Engineer. Mix and maintain materials at a uniform consistency during application.

**C. Storage.** Store all sealer components in tightly sealed containers, in a dry location, and as recommended by the manufacturer. Deliver unopened drums or containers of the sealer or sealer components to the job site with the manufacturer's numbered seal intact.

**D. Application submittals.** At least five (5) days before sealing, provide the Engineer the sealer manufacturer's written requirements for application equipment, mixing equipment, mixing procedures, mixing time, storage requirements, recoat times and temperatures, and MSDS sheets.

**E. Surface Condition.** Only apply sealers to surfaces which are dry, free from dust, dirt, oil, wax, curing compounds, efflorescence, laitance, coatings and other foreign materials. Visually inspect all surfaces before applying sealer. Repair any structurally unsound surfaces, weak sections or spalled areas before applying any sealer. Cure repaired areas for at least seven (7) days.

Air dry all concrete surfaces for at least ten (10) days after completion of required curing.

For accelerated cure of precast concrete, obtain the required 28 day strength and air dry the surfaces at least ten (10) days after completing accelerated cure. Follow the requirements of the above paragraphs for any repaired areas on the precast concrete.

**F. Surface Preparation.** Remove dust, dirt, oil, wax, curing compounds, efflorescence, laitance, coatings and other foreign materials from surfaces to be sealed.

Use one or both of the following methods to produce a surface that feels and looks like 100 grit sandpaper or coarser. Provide the Engineer sandpaper for comparison

1. Water blast at 7,000 psi (48 MPa) minimum, or
2. Abrasive blast, followed by air brooming or power sweeping, to remove dust and sand from the surface and opened pores.

Install suitable traps, filters, drip pans and other separation devices in the cleaning equipment so oil and other foreign material are not deposited on the surface.

If the concrete surface had curing compound applied, acid test the surface after blasting to see if the curing compound was removed. Perform the acid test for every 500 square ft (47 square meters). Use a solution of 1 part 20° Baume muriatic acid and 2 parts water. Apply 4 to 5 drops to the concrete surface. If foaming/fizzing occurs the curing compound is removed. Rinse the tested location with an ammonia solution to neutralize the concrete area tested (1 cup ammonia to 5 gallons water).

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[NOTE: Muriatic acid and ammonia can be bought in a hardware store. Muriatic acid is used to clean masonry. Only dilute by pouring the acid into the water. DO NOT pour the water into the acid.]

When surfaces show intermittent or no foaming, use chemicals or other cleaning compounds to remove the curing compounds. Only use products approved by the sealer manufacturer. Furnish the Engineer documentation of the sealer manufacturer's approval and method to test if materials are removed.

After re-cleaning perform the acid test to confirm removal of the curing compound.

**G. Application and Coverage.** Apply the sealer between twelve (12) hours and 48 hours after surface preparation. Do not apply sealer if rain is anticipated within six (6) hours after application. Clearly mark where the sealer application stops if not continuous.

### 1. Epoxy - Urethane sealers.

a. Apply the epoxy coat of the epoxy-urethane sealer at the coverage rate of 120 square feet per gallon (2.9 square meter per liter). Use a coverage rate of 150 square feet per gallon (3.6 square meter per liter) when the Laboratory's qualified products list for the epoxy authorizes it. Apply the Urethane coat of the epoxy-urethane sealer at a rate of 200 square feet per gallon (4.8 square meter per liter). When surfaces are not smooth and flat, adjust the given coverage rates by the following-formulas to determine the correct coverage rate.

(1) For surfaces using large stone liners and standard concrete = specified coverage rate (sq ft/gal [sq m/l]) x 0.8

(2) For surfaces using large stone liners and porous concrete = specified coverage rate (sq ft/gal [sq m/l]) x 0.7

(3) For surfaces using fluted liners and standard concrete = specified coverage rate (sq ft/gal [sq m/l]) x 0.5

b. Only apply sealer when the surface temperature is 50 °F (10 °C) or above

c. Apply with a brush, squeegee, roller or spraying equipment and as recommended by the manufacturer.

d. Apply one coat of epoxy and one coat of the urethane top coat. Time between coats shall meet the manufacturer's written recommendation provided to the Engineer during 512.03.D. Use epoxy and urethane from the same manufacturer. Achieve specified coverage regardless of the number of passes per coat.

e. Tint so the final color is Federal Color Standard No. 17778 - Light Neutral. Pigment content shall be limited so as not to reduce sealing effectiveness of the second coat. Refer to the plans for colors for specific projects.

f. Sags and runs are not acceptable in the sealer.

g. For sealed sidewalks or other horizontal surfaces with repetitive foot traffic or vehicular traffic, integrate 1-1/2 lbs. per square yard (0.8 kg/m<sup>2</sup>) of silica sand into the surface of the second coat to produce a non-skid surface satisfactory to the Engineer.

## 2. Non-epoxy sealer.

a. Apply the sealer according to the manufacturer's recommended mode of application and under the observation of the Engineer.

b. Coverage.

I. Surfaces subject to abrasive wear (bridge decks, bridge deck shoulders and sidewalks); Minimum, one gallon (3.875 liter) of sealer for each 100 square feet (9.0 square meter);

II. Curbs, vertical surfaces of beams and deck slabs subject to direct roadway drainage; Minimum, one gallon (3.875 liter) for each 125 square feet (11.5 square meter)

III. Other surfaces (for example, parapets, abutments, pier caps and median dividers); Minimum, one gallon (3.875 liter) for each 150 square feet (14.0 square meter)

Stone or fluted formed concrete surfaces may require additional sealer materials for coverage.

c. Apply sealer on horizontal surfaces in a one-pass operation at the required coverage. An acceptable application procedure consists of saturating the surface and waiting a few seconds for the sealer to completely penetrate the concrete surface. Broom in the sealer if recommended by the manufacturer.

d. Apply sealer on vertical surfaces to saturate the surface. The surface is saturated when runs of 6 to 12 inches develop. Apply additional passes in 10 to 15 minute intervals until the coverage rate is achieved. Apply sealers with brush or roller if recommended by the manufacturer.

e. After 10 to 15 minutes, squeegee off excess material on smooth finished or dense concretes where the required coverage is not absorbed.

f. For sealed sidewalks or other horizontal surfaces with repetitive foot traffic or vehicular traffic, integrate 1-1/2 lbs. per square yard (0.8 kg/m<sup>2</sup>) of silica sand into the sealer application to produce a non-skid surface satisfactory to the Engineer.

g. Tint clear non-epoxy sealers with a vanishing dye that will not damage the concrete.

h. Do not apply sealer if the ambient temperature is below 40 °F (5 °C) or will fall below 32 °F (0 °C) within 12 hours after application.

**H. Test Site/Application.** Apply epoxy-urethane or non-epoxy sealer to measured coverage areas, both on horizontal and vertical surfaces, and on different concrete types, demonstrating:

1. The project's visual effects for the epoxy-urethane sealer application at the required coverage rate.

2. Visually, the absorption necessary to achieve the specified coverage rate for the non-epoxy sealer. Use at least ½ gallon (2 liter) of sealer, following the

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manufacturer's recommended method of application, for the total of the test surfaces.

3. Apply to the deck, safety curb or sidewalk for the horizontal test surfaces and use an abutment parapet or pier face for the vertical test surface so different textures are tested.

**I. Appearance.** Epoxy/Urethane sealers. Uniform appearance and the final color shall visually match the test section. Re-coating, removal and re-application or other methods recommended by the manufacturer will be required to correct final appearance. Non Epoxy Sealers. The sealer shall result in a uniform appearance.

**J. Traffic.** Allow traffic on deck shoulder areas after 12 hours of drying time for an epoxy/urethane sealer. Keep traffic off a non-epoxy sealer until the sealer is dry.

**K. Safety Precautions.** Follow precautions defined on the manufacturer's MSDS. Provide the Engineer a copy of the MSDS sheet for information before any work commences.

**L. Protection of Adjoining Surfaces and the Public.** Protect the public during all operations, especially when applying sealer to the fascia or the underside portions of a bridge that spans an area used by the public.

During sealing, mask off, or use other means of protection, for surfaces not being sealed. Protect asphalt and mastic type surfaces from spillage and heavy overspray. Do not apply sealers to joint sealants which have not cured according to the manufacturer's instructions. Joint sealants, traffic paints and asphalt overlays may be applied to the treated surfaces 48 hours after the sealer has been applied. Protect nearby steel, aluminum or glass surfaces when non-epoxy overspray could be deposited on those surfaces.

**M. Environmental Requirements.** Protect plants and vegetation from overspray by covering with drop cloths.

**512.04 Sealing Concrete Bridge Decks with HMWM Resin** This work shall consist of preparing and treating the concrete wearing surfaces of bridge decks with a penetrating sealer in accordance with these specifications, in reasonably close conformity with the plans and the manufacturer's recommendation and as directed by the Engineer.

**A. Limitations.** Do not perform this work during the period beginning November 1st and ending March 31st.

**B. Surface Preparation.** Remove roadway dirt and debris from the area of the deck to be treated. Sweep, sandblast, then with the use of a manual or power broom sweep and blow with compressed air so that the surfaces to which the sealer is to be applied is dry and free of dust and dirt. Use high pressure compressed air to blow all loose material from visible cracks. Fit the cleaning equipment with suitable traps, filters, drip pans, driers and other devices to prevent oil and other foreign material from being deposited on the surface. Do not allow traffic on the clean surface prior to application of the sealer. Remove existing pavement

markings according to Section 641.10 of the Specifications. Remove all traces of asphalt or petroleum products and concrete curing seals by abrasive blasting prior to air sweeping.

**C. Installation.** Provide a compatible promoter/initiator system capable of providing the same physical qualities of the hardened resin as if promoted/initiated with 2% cobalt naphthanate (6%) and 2% cumene hydroperoxide. Store materials at 65-80 °F (18-27 °C). Provide a system that has a resin gel time of not less than 40 minutes to not more than 1½ hours at the time and temperature of application.

Adjust the gel time to compensate for the change in temperature throughout the day. The temperature of the surfaces to be treated may range from 50 °F (10 °C) to 120 °F (49 °C). Arrange to have a technical representative on site to provide mixing proportions equipment suitability, and safety advice. Any conflict between these provisions and representative's advice shall be resolved at the job site. The technical representative shall remain at the job site until such time as he and the Engineer agree that the Contractor is qualified in all aspects of the application of the sealer.

Do not allow the promoter and initiator, if supplied separate from the resin, to contact each other directly. Do not store containers of promoter or initiators together in a manner that will allow leakage or spillage from one to contact the containers or materials of the other.

Machine application of the resin may be performed by using a two-part resin system utilizing a promoted resin for one part and an initiated resin for the other part. This two-part resin system may be combined at a spray bar through positive displacement atomization of the resin. Do not use compressed air to produce the spray.

Use appropriate cleaning and flushing of equipment, tools, etc., with an appropriate solvent, as approved by the Engineer, in such a manner to minimize personal and environmental hazards. Advise workman that the resin will soften gum rubber soles, and a face-mask should be used to protect from accidental splashes. Clothing and leather saturated with resin will harden and become useless.

Prior to resin application the surface to be treated shall be visibly dry and its temperature between 50° F (10° C) and 120° F (49° C). Do not apply the resin within 24 hours after a rain or when rain is forecast within 12 hours or when the ambient air temperature is below 50° F (10° C). Pre-mark the deck to control mixed material usage and to provide a rate of application of approximately 100 square feet per gallon (2.45m<sup>2</sup>/L). The exact rate shall be determined by the Engineer prior to commencing full-scale deck treatment operations.

Before using the material submit to the Director copies of the manufacturer certified test data showing that the material complies with the requirements of this specification. The test data shall be developed by an independent approved testing laboratory, and shall include the brand name of the material, name of manufacturer, number of the lot tested and date of manufacture. When the material has been approved by the Director, further testing by the manufacturer will not be required unless the formulation of manufacturing process has been changed, in which case new certified test results will be required. The manufacturer shall

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certify that the formulation is the same as that for which data has been submitted. The state reserves the right to sample and test delivered lots for compliance.

Flood the deck surfaces resin, allowing penetration into the concrete and filling of all cracks. Limit the initiated mix of promoted resin to 5 gallons (19L) at a time for manual application. A significant increase in viscosity shall be cause for rejection. Apply the treatment within 5 minutes after complete mixing. Redistribute excess material by squeegee or brooms within 10 minutes after application.

Take all steps necessary to prevent the resin from flowing into lanes open to traffic. Broadcast sand over the entire treated area of the bridge deck by mechanical means to affect a uniform coverage of 0.80 to 1.2 pounds per square yard (0.43 kg/m<sup>2</sup> to 0.65 kg/m<sup>2</sup>). The sand shall be uniformly graded aggregate conforming to the quality requirements of 703 and shall conform to the following limits for grading:

<b>Sieve Size</b>	<b>% Passing Max.</b>
No. 4 (4.75mm)	100
No. 8 (2.36mm)	90-100
No. 20 (850µm)	5-15
No. 50 (300µm)	0-5

It is the intention of the specification to allow the use of commercially available blast sands applied by a common lawn broadcast type seeder/spreader. Place sand between 10 to 15 minutes behind the resin spreading front and before any jelling of the resin occurs. If the surface contains large deep cracks, the low-viscosity liquid could run completely through the concrete slab. Apply a second coat in these areas after the first coat has started to cure.

Before the monomer hardens, fill imperfections or spalls with standing liquid with commercial quality concrete or sandblast sand, and finished to a uniform surface. The sand shall have a maximum moisture content of 0.5 of the percent of absorption when tested in accordance to a California Test 226.

Do not permit traffic and equipment on the tested deck until it is tack free and a minimum of 6 hours have elapsed since treatment and the sand cover adheres sufficiently to resist brushing by hand. Protect the treatment from moisture for not less than 4 hours after placement.

**512.05 Soluble Reactive Silicate (SRS) Concrete Treatment** This item consist of the necessary labor, materials and equipment to prepare and treat portland cement concrete surfaces with a reactive silicate sealer meeting these specifications.

**A. Equipment.** Use application equipment that is recommended by the manufacturer. Use spray equipment, tanks, hoses, brooms, rollers, coaters, squeegees, etc., that are thoroughly clean, free of foreign matter, oil residue and water prior to applying the treatment.

**B. Cleaning and Surface Preparation.** Insure that surfaces which are to be treated meet the approved product’s requirements for surface condition. Do not begin sealing until all concrete repairs have been completed and cured. Furnish the

Engineer with written instructions for surface preparation requirements and have a representative of the manufacturer present to assure the surface condition meets their requirements.

At a minimum, thoroughly clean the surface to remove dust, dirt, oil, wax, curing components, efflorescence, laitance, coatings and other foreign materials. Obtain the approval of the manufacturer or its representative before the use of chemicals and other cleaning compounds to facilitate the removal of these foreign materials. Apply the treatment within 48 hours following surface preparation.

Fit cleaning equipment with suitable traps, filters, drip pans and other devices to prevent oil and other foreign material from being deposited on the surface.

**C. Test Application.** Treat a measured test coverage area on horizontal and vertical surfaces of the different components of the structure to be treated for the purpose of demonstrating the desired physical and visual effect of an application or of obtaining a visual illustration of the absorption necessary to achieve the specified coverage rate prior to final application. In the latter case, use at least ½ gallon (2 liter) of treatment following the manufacturer's recommended method of application for the total of the test surfaces. Locate horizontal test surfaces on the deck and on the safety curb or sidewalk and locate vertical test surfaces on an abutment parapet and pier face so that the different textures are displayed.

**D. Application.** Apply the concrete treatment to concrete surfaces as designated on the plans. Apply the SRS by thoroughly saturating the concrete surfaces at an application rate specified by the manufacturer.

Apply the SRS when the concrete surface temperature is above 35° F (2° C). Use a surface thermometer on the concrete to establish the temperature of the concrete if the air temperature at the time of application is 45° F (7° C) or below.

Spread the SRS from puddles to dry areas.

If unable to complete the entire application continuously, note and clearly mark the location where the application was stopped.

**E. Protection of Adjoining Surfaces and the Public.** Protect by masking off or by other means adjoining surfaces of the structure which are not to be sealed when applying a treatment. Make provision to protect the public when treating the fascia of a bridge and/or portions of the underside of the deck of a bridge that spans an area used by the public.

Protect asphalt and mastic type surfaces from spillage and heavy overspray. Do not apply joint sealants, traffic paints and asphalt overlays to the treated surfaces until 48 hours after the treatment has been applied. Cover adjoining and nearby surfaces of aluminum or glass where there is a possibility of the treatment being deposited on the surfaces.

Protect plants and vegetation from overspray by covering with drop cloths. Follow precautions as indicated on the manufacturer's MSDS.

**F. Opening to Traffic.** Only allow traffic on a deck after a treated area does not track.

**512.06 Treating Concrete Bridge Decks with Gravity-Fed Resin.** This work shall consist of preparing and treating the concrete bridge deck with a gravity-fed crack welding system in accordance with these specifications in reasonably close conformity with the plans and the manufacturer's recommendations and as directed by the Engineer.

**A. Limitations.** Do not perform this work during the period beginning November 1st and ending March 31st.

Prior to resin application insure that the surface to be treated is visibly dry with a temperature between 40 °F (4 °C) and 100 °F (38 °C). Do not apply the resin within 24 hours after a rain, during rain, when rain is forecast within 12 hours or when the ambient air temperature is below 40 °F (4 °C).

**B. Surface Preparation** First remove roadway dirt and debris from the area to be treated. Sweep abrasive blasted surfaces to which the sealer is to be applied, then manual or power broom swept and blown with compressed air so that they are dry and free of dust and dirt. Use high pressure compressed air to blow all loose material from visible cracks. Use a high pressure water blast followed by an air blast if particles are highly embedded in the cracks, to clean cracks. Fit the cleaning equipment with suitable traps, filters, drip pans, dryers and other devices to prevent oil and other foreign material from being deposited on the surface. Do not allow traffic on the clean surfaces prior to application of the sealer. Remove existing pavement marking according to section 641.10. Remove all traces of asphalt or petroleum products and concrete curing by the abrasive blasting prior to air sweeping.

**C. Application** Pre-mark the deck to control mixed material usage and to provide a rate of application of approximately 100-150 square feet per gallon (2.45m<sup>2</sup>/L-3.68m<sup>2</sup>/L). The Engineer will determine the exact rate but will not exceed 150 square feet per gallon (3.68m<sup>2</sup>/L). Flood the area to be sealed with resin. Allow the resin to penetrate into the concrete and fill all cracks. Mix the resin to a limit of 5 gallons (191) at a time for manual application. Reject resin with a significant increase in viscosity. Redistribute excess material by a squeegee within 10 minutes after application. Front and back movement with the squeegee is recommended over cracks and patch perimeters to enhance penetration. Take all steps necessary to prevent the resin from flowing into lanes open to traffic. Broadcast sand over the entire sealed area of the bridge deck by mechanical means to effect a uniform coverage of 1 pound (0.45kg) per 2-3 square foot (0.1858-0.2787 square meter).

Protect the treatment from moisture for not less than 6 hours after placement.

**D. Traffic.** Do not permit traffic on the treated deck until the resin is tack free, a minimum of 6 hours has elapsed since treatment, and the sand cover adheres sufficiently to resist brushing off by hand.

**512.07 Sealing Cracks by Epoxy Injection.** This specification covers the repair of dry, moist or wet cracks or fractures that are 2 to 100 mils (50 to 2500 micrometers) in thickness in reinforced concrete members. The repair is by means of an epoxy injection system. This system shall consist of a paste epoxy used to seal the surface cracks and an injection epoxy used under low pressure,

200 psi (1400kPa) max., to penetrate and fill the cracks and bond the crack surfaces together. Material for each epoxy shall consist of a two-component modified resin bonding system. The unmodified resin shall be known as Component A and the hardener as Component B.

Arrange to have a manufacturer's representative at the job site to familiarize him and the Engineer with the epoxy materials, application procedures and recommended pressure practice. This representative shall direct at least one complete crack or area injection and be assured prior to his departure from the project that the personnel are adequately informed to satisfactorily perform the remaining repairs.

Furnish the Engineer a copy of the manufacturer's comprehensive preparation, mixing and application instructions which have been developed especially for use with the proposed epoxy injection system. Ensure that any significant changes to these instructions which are recommended by the representative for an unanticipated situation have been approved by the Engineer prior to the adoption of such changes.

Clean concrete surfaces adjacent to the cracks to be sealed only to the extent necessary to achieve an adequate bond with the paste epoxy, and only by procedures which will not cause abrasive grits or concrete dust to penetrate the cracks. Do not permit the use of solvents or thinners in cracks or on bonding surfaces.

Install injection ports or tees in cracks to be injected. Space injection ports or tees at 6 to 12 inches (150 to 300 mm) vertically and 6 to 18 inches (150 to 450 mm) horizontally but in no case closer together than the thickness of the concrete member if full depth penetration is desired unless otherwise specified or directed. Set ports or tees in dust free holes made either with vacuum drills or chipping hammers. Seal all surface cracks in the area to be repaired, after injection ports or tees have been inserted into the holes, with paste epoxy between ports to ensure retention of the pressure injected epoxy within the confines of the member. The Department will allow an alternative procedure of sealing the cracks before the injection holes have been made. Limit the application of paste epoxy to clean and dry surfaces. Limit substrate temperatures to not less than 45 °F(7 °C) during epoxy applications.

Begin the epoxy injection at the bottom of the fractured area and progress upward using a port or tee filling sequence that will ensure the filling of the lowermost injection ports or tees first.

Establish injection procedures and the depths and spacings of holes at injection ports or tees. Use epoxy with flow characteristics and injection pressure that ensure no further damage will be done to the member being repaired. Ensure that the epoxy will first fill the innermost portion of the cracked concrete and that the potential for creating voids within the crack or epoxy will be minimized.

Remove the injection ports or tees flush with the concrete surface after the fractured area has been filled and the epoxy has partially cured (24 hours at ambient temperature not less than 60 °F (16 °C), otherwise not less than 48 hours).

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Roughen the surfaces of the repaired areas to achieve uniform surface texture. Remove any injection epoxy runs or spills from concrete surfaces.

Obtain two 4-inch (100 mm) diameter core samples in the first 100 linear feet (30 m) of crack repaired and one core for each 100 linear feet (30 m) thereafter. Take the core samples from locations determined by the Engineer and for the full crack depth. Cores will be visibly examined by the Engineer to determine the extent of epoxy penetration. Repair the core holes in the concrete with material specified in 705.21.

### 512.08 Waterproofing

**General.** Apply an even and uniform coating of asphalt materials using brushes, squeegees, or spray equipment.

If using spray equipment, provide portable power pressure type spraying equipment capable of being moved to the location of the waterproofing operation.

Protect concrete surfaces not covered with waterproofing from overspray, spilling, or otherwise marring of the surface with the asphalt materials.

Ensure that the edge of any exposed application is sharply defined true to line with a uniform exposure.

#### Preparation of Surface.

**Asphalt Materials.** Remove concrete projections. Using wire brushes and clear water, remove dirt and the outside film of cement. Before applying asphalt materials, ensure that the concrete is clean and dry and the concrete temperature is at least 40 °F (4 °C).

**Membranes.** Remove protrusions from the concrete. Sweep off dirt and dust, and blow the concrete clean. Fill joints or cracks greater than 3/8 inch (10 mm) wide with portland cement mortar. In addition to the above, remove oil and grease from surfaces for Type 3 membranes using water and a detergent designed to remove oil and grease from concrete. Flush residual detergent from the surface. Do not allow traffic on the cleaned surface.

**Primer Coat.** Apply the primer coat at the rate of 0.10 to 0.15 gallon (0.50 to 0.70 L) of asphalt material per square yard (square meter).

For primer coats applied between June 1 and September 1, use asphalt primer for waterproofing or emulsified asphalt primer conforming to 512.02.

For primer coats applied between September 1 and June 1, use asphalt primer for waterproofing conforming to 512.02.

If practical, apply asphalt emulsion using spray equipment.

If subjected to traffic, spread sand on the primer coat for protection. Broom off excess sand before applying asphalt waterproofing.

**Type A Waterproofing.** This type of waterproofing consists of one primer coat and at least two coats of asphalt material conforming to 702.06 to provide a total of at least 1 gallon (5 L) of asphalt per square yard (m<sup>2</sup>) on flat areas and at least 1/2 gallon per square yard (3 L/m<sup>2</sup>) on vertical or sloping surfaces. Start

applying the waterproofing at the lowest point, and progress to a higher elevation. Uniformly cover the surface except apply more asphalt in corners and over construction joints. Apply the asphalt material at a temperature from 250 to 350 °F (121 to 177 °C).

**Type B Waterproofing.** This type of waterproofing consists of one primer coat, three coats of asphalt material conforming to 702.06, and two layers of waterproofing fabric conforming to 711.24 applied as follows:

1. On a clean, dry, and well-primed surface, apply a thorough coating of asphalt at a temperature from 250 to 350 °F (121 to 177 °C).

2. Apply the coating at a rate of at least 1/3 gallon per square yard (1.5 L/m<sup>2</sup>) of surface.

3. While the asphalt is hot enough to penetrate the fabric, lay the fabric according to the following:

a. Surfaces Wider than Normal Fabric Strip. For the first strip, lay a half-width [normally 18 inches (0.5 m) wide] strip of fabric. For the second strip use a full-width strip of fabric, and lap the entire width of the first strip. Lap each succeeding strip 2 inches (50 mm) more than half its full width. Lap the fabric strips in the direction of water flow.

b. Surfaces with Same Width as Fabric Strip. For the first strip, lay a full-width strip. For the second strip, lay another full-width strip, covering the first.

Lay each strip without wrinkles, folds, or pockets. Thoroughly coat the strip with asphalt for the full width of the lap before laying the succeeding strip. Each application shall entirely conceal the texture of the fabric.

4. Apply a final coat of asphalt to provide a thorough covering for the fabric.

5. For all three coats, use a total of at least 1 gallon (5 L) of asphalt waterproofing material per square yard (m<sup>2</sup>).

Lap ends of fabric strips at least 12 inches (0.3 m), and stagger the end joints.

**Type D Waterproofing.** This type of waterproofing consists of one primer coat, one layer of waterproofing fabric conforming to 711.24 over joints, three coats of asphalt material conforming to 702.06, and two shingled plies of asphalt saturated waterproofing fabric conforming to 711.24.

Prime the surface to be waterproofed and allow the primer to dry. Fill joints and irregularities in the surface with asphalt cement. Lay a layer of fabric extending at least 9 inches (230 mm) on both sides of all joints. Leave the underside of this layer unbonded to the concrete surface.

Apply the asphalt at a temperature from 250 to 350 °F (121 to 177 °C) and conceal the texture of each layer of fabric with the asphalt. Use at least 1/3 gallon (1.5 L) of asphalt per square yard (m<sup>2</sup>) of surface for each application. Begin applying the asphalt and fabric at the low side or sides of the surface, and proceed toward the apex or high side so that water runs over and not against or along the laps of the fabric. Lay the fabric without wrinkles, folds, or pockets. Lap ends of fabric strips at least 12 inches (0.3 m), and stagger the end joints.

Start applying waterproofing by mopping asphalt on a surface slightly wider than half the width of the fabric strip. Immediately lay a half-width strip of the fabric onto the asphalt. Mop asphalt on this strip and an adjacent surface slightly wider than half the width of the fabric, and lay a full width of fabric that entirely covers the first strip. Mop asphalt on the second half of this second strip and an adjacent concrete surface and lay a third strip of fabric that laps the first strip at least 2 inches (50 mm). Continue this process of applying asphalt and laying fabric until the entire surface is covered and each strip of fabric laps the next to last strip already placed by at least 2 inches (50 mm). Finish laying fabric with a partial-width strip and mop the entire surface with asphalt.

**Type 2 Membrane Waterproofing.** This type of waterproofing consists of a rubberized asphalt and peel-and-stick waterproofing membrane 711.25. If the ambient temperature is below 50 °F (10 °C), use a manufacturer recommended primer coat for vertical surface application. After installing the primer coat, if required, remove the membrane's release liner and place the adhesive side on the prepared concrete surface. Lay the membrane smooth and free of wrinkles. Lap joints in membranes by at least 1 inch (25 mm). Store membrane materials indoors at temperatures not to exceed 120 °F (49 °C).

For precast concrete three- and four-sided structures, install Type 2 membrane on the exterior vertical and exterior top horizontal surfaces.

**Type 3 Membrane Waterproofing.** This type of waterproofing consists of a primer coat conforming to 705.04 and a waterproofing membrane consisting of a high density asphalt mastic between two layers of polymeric fabric conforming to 711.29.

Keep membrane and primer materials dry before installation.

Heat the membrane primer in an oil primer heated, double-jacket kettle. Use a kettle that is clean and free of other materials with any obvious buildup scraped out. The Contractor may use a single-jacket kettle if the primer is capable of being heated in direct fire to the application temperature. Heat primers within the manufacturer's recommended temperatures.

On bridges with curbs, apply the primer and membrane 3 inches (75 mm) up the curb face. On prestressed box beam bridges with no approach slab, apply the primer and membrane 6 inches (150 mm) over the ends of the beams. On prestressed and slab bridges with approach slabs, apply the primer 2 feet (600 mm) out onto the approach slab.

If the plans require a Type 3 membrane on the top exterior surface of precast concrete three- or four-sided structures, apply the primer and membrane to overlay the vertical exterior sides of the structure by 12 inches (300 mm).

Apply primer no further than 5 feet (1.5 m) in front of the membrane using a squeegee to fill all voids and imperfections. Apply membrane from the low to the high side of the surface. Apply an extra bead of primer at the edge of the membrane. Lap joints in membranes by at least 3 inches (75 mm). After installing the membrane over the entire surface, seal joints in the membrane by applying primer and smoothing with a V-squeegee.

**512.09 Method of Measurement.** The Department will measure Waterproofing, of the type specified, by the number of square yards (square meters) or on a lump sum basis.

The Department will measure sealing of concrete surfaces by the number of square yards (square meters) of coated area projected to a two-dimensional surface.

The Department will measure the sealing of concrete bridge decks with HMWM resin and treating concrete bridge decks with SRS as the actual area in square yards (square meters ) of surfaces treated.

The Department will measure the actual length in linear feet (meters) of crack repaired by epoxy injection.

**512.10 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

The Department will consider the cost for the obtaining and repairing the two cores used by the Engineer to determine the extent of the epoxy penetration as incidental to the work of repairing the concrete by epoxy injection.

<b>Item</b>	<b>Unit</b>	<b>Description</b>
512	Square yards (square meter)	Sealing of concrete surfaces
512	Square yards (square meter)	Sealing of concrete surfaces (non-epoxy)
512	Square yards (square meter)	Sealing of concrete surfaces (epoxy urethane)
512	Square yards (square meter)	Sealing of concrete bridge decks with HMWM resin
512	Square yards (square meter)	Treating concrete bridge decks with SRS
512	Square yards (square meter)	Treating concrete bridge decks with Gravity-Fed Resin
512	Linear feet (meters)	Concrete repair by epoxy injection
512	Square Yard (Square Meter) Lump Sum	Type A Waterproofing
512	Square Yard (Square Meter), or Lump Sum	Type B Waterproofing
512	Square Yard (Square Meter), or Lump Sum	Type D Waterproofing
512	Square Yard (Square Meter), or Lump Sum	Type 2 Waterproofing
512	Square Yard (Square Meter), or Lump Sum	Type 3 Waterproofing

## ITEM 513 STRUCTURAL STEEL MEMBERS

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**513.01 Description.** This work consists of preparing shop drawings, furnishing and fabricating structural steel members, nondestructive testing, fabricator performed quality control, documentation, cleaning, shop coating, and erecting structural steel and other structural metals. The work also includes any work required to move existing steel structures to the plan location, making necessary repairs and alterations, and connecting or joining new and old construction.

The terms “main,” “secondary,” or “detail,” as referred to in Item 513, are defined as follows: “main” refers to material, members, and fasteners that are primarily stressed by live load and structure weight; “secondary” refers to material, members, and fasteners that do not directly support live load or main members; “detail” refers to essential non-structural material, members, and fasteners.

**513.02 Fabricator Approval Procedure.** Select fabricators that are listed by the Department before the Contract letting date as evaluated by the Office of Materials Management and pre-qualified according to Supplement 1078.

The Office of Materials Management may accept subletting of processes that require specialized machinery or knowledge. Submit written requests for subletting to the Office of Materials Management. The Office of Materials Management will determine if the process is uncommon and will evaluate the qualifications of the proposed sublet fabricator. The fabricator's quality control staff shall witness and perform quality control of the sublet work.

**513.03 Levels of Fabricator Qualification.** There are eight levels of fabricator qualification. The Office of Materials Management will classify each fabricator at the highest level of fabrication it is qualified to perform.

Level	Description of Capabilities
SF	Standard fabricated members described and paid for as Item 516, 517, and 518 and detailed by standard bridge drawings. Material and fabrication acceptance by certification with random Department audits of the work and documentation.
UF	Unique fabricated members not covered by standard bridge drawings and not designed to carry tension live load. Examples include curb plates, bearings, expansion joints, railings, catwalk, inspection access, special drainage, or other products. Examples also include retrofit cross frames, retrofit gusset plates, retrofit lateral bracing, or other miscellaneous structural members not included in Levels 1 through 6. Quality assurance of shop drawings, material test reports, and inspection according to Item 513, UF Level.
1	Single span, straight, rolled beam bridges without stiffeners. Secondary and Detail materials designed to carry tension live loads such as retrofit moment plates. Case II Loading. Quality assurance of shop drawings, material test reports, and inspection according to Item 513, Levels 1 through 5.
2	Multiple span, straight, rolled beam bridges without stiffeners. Case II loading. Quality assurance of shop drawings, material test reports, and inspection according to Item 513, Levels 1 through 5.
3	Single or multiple span, straight, dog legged, or curved, rolled beam bridges including stiffeners. Case I or II Loading. Quality assurance of shop drawings, material test reports, and inspection according to Item 513, Levels 1 through 5.
4	Straight or bent welded plate girder bridges. Case I or II loading. Quality assurance of shop drawings, material test reports, and inspection according to Item 513, Levels 1 through 5.
5	Straight, curved, haunched, or tapered welded plate girder bridges. Case I or II loading. Quality assurance of shop drawings, material test reports, and inspection according to Item 513, Levels 1 through 5.
6	Truss bridges, fracture critical bridges, fracture critical members, or fracture critical components new or retrofitted. Case I or II loading. Quality assurance of shop drawings, material test reports, and inspection according to Item 513, Level 6.

**513.04 General.** Item 501 includes general information pertaining to structural steel fabrication and erection. Shop painting shall conform to Item 514.

Perform all steel fabrication including the shop application of coatings in a pre-qualified structural steel fabricating shop consisting of adequately sized permanent

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buildings with equipment, heat and light, and experienced personnel to satisfactorily perform all necessary operations. Perform flame cutting, air carbon-arc gouging, cambering, welding, cleaning, and painting inside permanent buildings that are maintained at the required environmental conditions. The fabricator may perform shop assembly of large pieces for fit-up of field connections outdoors. These provisions will not apply to steel requiring fabrication at the bridge site in the repair, alteration or extension of an existing structure.

If repairing, extending, or altering existing structures, take measurements of the existing structure as required to accurately join old and new work. Include these measurements on shop drawings. Measurements shown on the plans that indicate the extent and nature of repair, alterations or extension shall not relieve the Contractor of this responsibility.

At least two weeks before starting shop fabrication, the fabricator shall notify the Office of Materials Management and furnish a proposed fabrication schedule for the work.

Unless the Office of Materials Management provides a written waiver of a hold or witness point inspection, the fabricator shall store members completed during the inspector's absence in a manner that allows the inspector to completely and safely inspect the finished work.

The fabricator shall not ship fabricated members performed under Item 513, UF Level or Levels 1 through 6 from the shop without prior hold point inspections unless the Office of Materials Management waives the inspection. The Office of Materials Management will not conduct the scheduled final inspection until the fabricator completes and inspects with documentation, final fabrication and shop coatings and the Contractor documents approval of shop drawings and material test reports.

The Office of Materials Management will not conduct a final fabrication inspection of SF Level members. Instead, the Office of Materials Management will conduct random inspections during the fabricator's work.

The fabricator shall provide an office with the following attributes:

- A. A minimum floor area of 120 square feet (11 m<sup>2</sup>).
- B. A minimum ceiling height of 7 feet (2.1 m).
- C. Adequate working and storage facilities with one locking file cabinet for the exclusive use of the Department's inspector, lighting, and electrical outlets.
- D. Provisions for heating to a minimum temperature of 68 °F (20 °C) and adequately ventilated.
- E. A telephone with direct access to an outside trunk line for the exclusive use of the inspector.

If using steel stamps for identification purposes, use the "mini-stress" or "stressless" type.

**513.05 Fabricator Documentation Responsibility.** The fabricator shall keep and maintain documentation records as specified in Supplement 1078.

At the Department's request, provide access to the above documents for audit, inspection, and copying.

**513.06 Shop Drawing.** Provide shop drawings conforming to 501.04 and the following requirements:

Include details, dimensions, size of materials, match mark diagrams for field connections, a diagram identifying, by some unique mark, each area of a welded splice to be covered by a single radiograph, and other information necessary for the complete fabrication and erection of the metal work.

For multiple span beam and girder bridges, include an overall layout with dimensions showing the relative unloaded vertical and horizontal position of beam or girder segments with respect to a full length base or work line. Account for camber and horizontal curvature of the beams or girders, and the effect of deck surface profile in this layout. Show required offsets for vertical and horizontal curvature at approximately each one-fourth of span length, at field splices, and at bearing points. For horizontally curved members, show the offset to a baseline strung from end to end of the member, every 10 feet (3 m) of length.

Identify the grade (ASTM designation), CVN, fracture critical, or any special testing requirements for each piece of steel. Identify pieces made of different grades of steel with different assembling or erecting marks, even if the pieces have identical dimensions and detail.

Identify the welding procedure by the WPS number at each joint and the location and identification numbers of all radiograph tests.

Detail structural steel to fit under full steel dead load and prior to deck placement with the webs of primary members plumb.

**513.07 Levels 1 through 6, Pre-Fabrication Meeting.** After providing the notice and schedule required by 513.04 and at least 7 days after the Department receives shop drawings, conduct a pre-fabrication meeting at the fabricator's facilities, or another location agreed to by all parties. The fabricator and its quality control specialists for fabrication and painting, the inspector, and the Contractor, or its designated representative, shall attend the meeting. The purpose of this meeting is to review any fabrication issues, including information on shop drawings, inspection, hold or witness points, unique fabrication items, special processes, and both the fabrication and project schedule. The fabrication quality control specialist shall conduct the meeting and record and distribute meeting minutes that document all issues discussed. Fabrication may begin after the pre-fabrication meeting is complete.

**513.08 Materials.** Furnish materials conforming to 501.06.

**513.09 Material Control.** Identify and mark each piece of steel according to the shop drawings and the following requirements.

## 513.10

Immediately after removing steel that is furnished in tagged lifts or bundles, mark the individual pieces of steel with the ASTM A 6/A 6M specification identification color code and heat number.

The fabricator may furnish material from stock that is marked with the heat number and mill test report.

If separated from the full-size piece furnished by the supplier, mark excess material placed in stock for later use with the heat number and, if provided, with the ASTM A 6/A 6M specification identification color code.

During fabrication, clearly and legibly mark the specification identification color code and heat number on each piece of steel.

Before cutting steel into smaller size pieces, clearly and legibly mark each smaller size piece with the ASTM A 6/A 6M specification identification color code and heat number.

Unless otherwise approved by the inspector, mark pieces of steel that will be subject to fabricating operations such as blast cleaning, galvanizing, heating for forming, or other operations that may obliterate paint color code and heat number markings with steel stamps or with a substantial tag firmly attached to the piece of steel. At locations acceptable to the Office of Materials Management, stamp the heat numbers into main material tested for CVN.

Issue cutting instructions by cross-referencing the assembly marks shown on the shop drawings with the corresponding item covered on the mill purchase order. The fabricator's system of assembly-marking individual pieces of steel and issuing cutting instructions shall provide a direct reference to the appropriate mill test report.

The fabrication quality control specialist shall provide the Engineer with a letter documenting that the fabricator performed material control according to this specification.

**513.10 Care of Material.** Store structural material at the shop or field above the ground, upon platforms, skids, or other supports. Use straight structural steel with clean and dry surfaces before working it in the shop. Before using, clean all rusted or corroded material. Only use this material if it conforms to ASTM A 6/A 6M thickness tolerances after cleaning.

**513.11 Workmanship and Straightening.** If necessary to straighten rolled material, use methods that will not damage the member. If carefully planned and supervised, apply localized heat for straightening. Do not allow the temperature of the heated area to exceed 1150 °F (620 °C) as controlled by pyrometric stick or thermometers. Do not quench to accelerate cooling. Do not kink or offset the material if using mechanic or hydraulic force to camber or strengthen material. Do not cold bend fracture critical materials.

Camber rolled beams as shown on the plans in the pre-qualified fabricating shop using heat or hydraulic jacks. Control heating as specified above and follow a formal shop heating procedure. Camber plate girders by trimming web plates

before assembly. During fabrication, shipping, and erection, support and handle members to maintain camber.

Fabricate structural steel to within the dimensional tolerances specified by Articles 3.5 of the AASHTO/AWS *Bridge Welding Code*, with the following modifications:

- A. Waviness, the deviation of the top or bottom surface of a flange from a straight line or plan curvature, shall not exceed 1/8 inch (3 mm) when the number of waves in a 10-foot (3 m) length is four or less, or 1/16 inch (1.6 mm) when more than four, but sharp kinks or bends shall be cause for rejection.
- B. For the measurement of camber during lay down, position the bearing points both horizontally and vertically to plan dimensions  $\pm 1/8$  inch ( $\pm 3$  mm).
- C. Measure camber as the vertical offset between the steel and the common base line extending from abutment bearing to abutment bearing. The maximum camber tolerance at mid-span shall be 0 inch (0 mm) and the greater of +3/4 inch (+19 mm) or the designed haunch height. Prorate the maximum camber tolerance at mid-span between the center of the span and each adjacent bearing to provide a smooth unbroken curve.
- D. Permissible difference in horizontal curvature of top and bottom flange at any point on centerline of member, when measured as specified in 3.5.1.4, shall not exceed 3/8 inch (10 mm)

**513.12 Finish.** Plane sheared edges of all main material to a minimum depth of 1/4 inch (6 mm) except for ASTM A 709/A 709M, Grade 36 (250) steel having a thickness of 5/8 inch (16 mm) or less. Remove fins, tears, slivers, and burred or sharp edges from steel members by grinding. If these conditions appear during the blasting operation, re-grind and re-blast the steel members to the required surface profile.

The fabricator may flame cut structural steel. Provide a smooth surface, free from cracks and notches, and use a mechanical guide to provide an accurate profile. Roll and flame cut surfaces according to the AASHTO/AWS *Bridge Welding Code*, as amended by Supplement 1011.

Provide a surface finish for bearing and base plates and other bearing surfaces that contact each other or concrete according to ANSI B46.1, Surface Roughness, Waviness and Lay, Part I.

<b>ANSI B46.1</b>	
Steel slabs	2000 mil (50.0 $\mu\text{m}$ )
Heavy plates in contact in shoes to be welded	1000 mil (25.0 $\mu\text{m}$ )
Milled ends of compression members, milled or ground ends of stiffeners and fillers	500 mil (12.5 $\mu\text{m}$ )
Bridge rollers and rockers	250 mil (6.4 $\mu\text{m}$ )
Pins and pin holes	125 mil (3.2 $\mu\text{m}$ )
Sliding bearings	125 mil (3.2 $\mu\text{m}$ )

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**513.13 Stiffeners.** Place the bearing end of bearing stiffeners flush and square with the web and in a manner so at least 75 percent of the area of the bearing end is in contact with the inner surface of the flange. The other end of the bearing stiffener shall have a tight fit as defined below. Position bearing stiffeners to be vertical after erection. Weld intermediate stiffeners that are not used in pairs to the compression flange, and provide a tight fit for the tension flange. Weld intermediate stiffeners connected to cross frame angles to the top and bottom flange.

A tight fit is defined as the contact between the stiffener and flange over some portion of the end of the stiffener and having no gap greater than 1/16 inch (1.6 mm).

Clip stiffeners 2 1/2 inches (65 mm) along the web and 1 inch (25 mm) along the flange to clear flange-web welds and fillet or rolled shapes.

When attaching stiffeners to the web and flanges, do not extend welds to the edge of the stiffeners or into the clip area. Terminate these welds  $1/4 \pm 1/8$  inch at the flange connections and  $1/2 \pm 1/4$  inch at the web connection.

**513.14 Fillers.** Detail the shop drawings to show fill plates that compensate for the misalignment of abutting elements due to differences in thickness of flanges and webs at the splice locations. Detail the fill plates to the nearest 1/16 inch (1.6 mm) in thickness, but not less than 1/8 inch (3 mm) thick. However, in the final shop assembly, furnish fills of sufficient thickness to compensate for misalignment of abutting elements due to standard rolling mill tolerances or due to differences in thicknesses of flanges and webs at the splice location. The actual fills used shall compensate for differences in total thickness or relative positions of more than 1/16 inch (1.6 mm) but with no fills less than 1/8 inch (3 mm) thick. Provide fill plates in bolted joints that are flush with the perimeter of the splice plates.

**513.15 Horizontally Curved Beams and Girders.** If members are to be heat curved, submit the detailed procedure, including necessary calculations, to the Office of Materials Management. Obtain the Office of Materials Management's acceptance of the procedure before starting this work.

Curve beams and girders using heat according to *AASHTO Standard Specifications for Highway Bridges*, except that the fabricator may cut flanges for girders to obtain the required alignment.

**513.16 Joints and Splices.** In bolted construction where tension or flexural members are spliced, maintain a clearance of not more than 1/4 inch (6 mm) between the abutting surfaces of spliced members. For spliced compression members, face the abutting surfaces to provide a uniform bearing when properly aligned and completely bolted.

In welded construction, prepare abutting surfaces as shown on the shop drawings. Verify the preparation for field welded butt joints in main members by a complete shop assembly according to 513.24.

**513.17 Pin Holes.** Bore pin holes after the member is fabricated and true to size, at right angles to the axis of the member and parallel to each other. Pin holes

for up to 5-inch (127 mm) diameter pins shall not exceed the pin diameter by more than 0.020 inch (0.51 mm) and pin holes for larger pins shall not exceed the pin diameter by more than 0.031 inch (0.79 mm).

**513.18 Pins and Rollers.** Use pins and rollers made from cold rolled steel, accurately turned to size, straight and smooth, and entirely free from flaws. Pins over 9 inches (230 mm) in diameter shall be annealed. In pins larger than 9 inches (230 mm) in diameter, bore a hole not less than 2 inches (50 mm) in diameter the full length of the axis. Furnish one pilot and one driving nut for each size of pin.

**513.19 Holes for High-Strength Bolts and Bearing Bolts.** Provide cylindrical holes, perpendicular to the member, clean cut, and free of ragged edges. Remove burrs by countersinking not more than 1/16 inch (1.6 mm) or by grinding. Provide finished holes with a diameter not larger than the nominal diameter of the bolt plus 1/16 inch (1.6 mm). The hole diameter shall not vary by more than 1/32 inch (0.8 mm) from a true circle for 85 percent of the holes in a contiguous group, and not more than 1/16 inch (1.6 mm) for the remainder.

Punch holes using a die with a diameter not exceeding that of the punch by more than 1/16 inch (1.6 mm). Ream and drill holes using twist drills and twist reamers. Wherever possible, direct the reamer by mechanical means.

Sub-drill holes 3/16 inch (5 mm) less in diameter than the nominal diameter of the bolt, and ream the holes to size with the parts assembled, except:

A. The fabricator may sub-punch main material conforming to ASTM A 709/A 709M, Grade 36 (250) steel that is less than 3/4 inch (19 mm) thick, and Grade 50 (345) or 50W (345W) steel that is less than 5/8 inch (16 mm) thick.

B. The fabricator may drill full-size holes in materials assembled and adequately clamped together.

C. The fabricator may punch full-size holes in secondary and detail material conforming to ASTM A 709/A 709M, Grade 36 (250) steel that is less than 3/4 inch (19 mm) thick, and Grade 50 (345) or 50W (345W) steel that is less than 5/8 inch (16 mm) thick.

D. The fabricator may make assemblies such as floor beams connected to girders and rolled beam spans connected by diaphragms through steel templates.

Place all sub-punched or sub-drilled holes with sufficient accuracy such that after assembling (before reaming) a cylindrical pin 1/8 inch (3 mm) smaller than the nominal size of the punched hole may be entered perpendicular to the face of the member without drifting in not less than 75 percent of the contiguous holes in the same plane. All holes shall allow a pin 3/16 inch (5 mm) smaller than the nominal size of the punched holes to be inserted in the above manner.

Do not plug located holes without written approval from the Office of Materials Management.

Provide steel templates with hardened bushings in holes that are accurately located in relation to the centerline of the connection as inscribed on the template. The fabricator is not required to use hardened bushings when using a roto-broach, shell drill, or other similar tool, to make the holes.

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Ream and drill holes through multiple piles only if the plies of the joint are held tightly together with bolts or clamps and if sub-punched or sub-drilled, only if the joint is pinned. Disassemble and clean the piles of burrs and shavings before final assembly.

The Contractor may drill or punch bolt holes full sized in unassembled pieces or connections, including templates for use with matching sub-sized and reamed holes, using suitable numerically controlled (N/C) drilling or punching equipment. If using N/C drilling or punching equipment, demonstrate the accuracy of the drilling or punching procedure to the inspector according to 513.24.

After holes are reamed or drilled full size, 85 percent of the holes in any contiguous groups shall have no offset greater than 1/32 inch (0.8 mm) between adjacent plies. The remainder of the holes shall not be offset more than 1/16 inch (1.6 mm) between adjacent plies.

If requested in writing, the Office of Materials Management may consider other methods of preparing holes for high-strength bolts.

**513.20 High-Strength Steel Bolts, Nuts, and Washers.** Provide high-strength steel bolts, nuts, and washers conforming for all bolted connections including erection bolts for cross frames and lateral bracing to 711.09.

**A. General.** Provide the Engineer with access to the work for observing the installation and the tightening and checking of the bolts.

Determine the required bolt length by adding the value from Table 513.20-1 to the grip. The table values include an allowance for manufacturing tolerances and provide a bolt length for threads to protrude through the nut. Add 5/32 inch (4 mm) for each hardened flat washer used and 5/16 inch (8 mm) for each beveled washer used. Adjust the length, as determined by Table 513.20-1, to the next longer 1/4 inch (6 mm); when installed, the end of the bolt shall be flush with or project several thread lengths outside the face of the nut.

**TABLE 513.20-1**

<b>Bolt Size (inches)</b>	<b>To determine required bolt Length, add to grip[1] (inches)</b>
1/2	11/16
5/8	7/8
3/4	1
7/8	1 1/8
1	1 1/4
1 1/8	1 1/2
1 1/4	1 5/8
1 3/8	1 3/4
1 1/2	1 7/8

[1] Total thickness of all connected material excluding washers.

TABLE 513.20-1M

Bolt Size (mm)	To determine required bolt length, add to grip[1] (mm)
M16	24
M20	28
M22	31
M24	35
M27	38
M30	41
M36	47
[1] Total thickness of all connected material excluding washers.	

Use bolts, nuts, and washers with a residual coating of lubricant when received. Bolts, nuts, and washers without their original lubrication shall not be used.

**B. Preparation.** With the exception of metalizing, galvanizing, and both organic zinc and inorganic zinc primers, remove coatings from joint surfaces, including surfaces adjacent to the bolt heads, nuts, and washers. Remove lacquer, dirt, oil, loose scale, rust, burrs, pits, and other substances or defects that prevent solid seating of the parts or interfere with the development of complete frictional contact. Do not place gaskets or other yielding material between joint surfaces.

**C. Installation.** For each bolt, place a hardened washer under the element (nut or bolt head) turned in tightening. If an outer face of the bolted parts has a slope of more than 1:20 with respect to a plane normal to the bolt axis, use a smooth beveled washer to compensate for the lack of parallelism.

If necessary, the Contractor may clip washers, at one location, not closer than seven-eighths of the bolt diameter from the center of the washer.

During final assembly of the parts to be bolted, first install a sufficient number of drift pins to provide and maintain accurate alignment of holes and parts, then a sufficient number of bolts tightened to a snug tight condition to bring all the parts of the joint into complete contact. Replace any bolts that were installed before installing drift pins. Before releasing the member from the hoisting equipment, fill half the holes with drift pins and bolts tightened to a snug tight condition in at least 50 percent of the holes (preferably, half pins and half bolts) but use at least two drift pins in each flange and web of each beam or girder. Install bolts starting at the most rigidly fixed or stiffest point and progress toward the free edges.

Use cylindrical drift pins that are not more than 1/32 inch (0.8 mm) smaller than the hole diameter.

Bolts are snug tight when an impact wrench begins to impact the nut or when a man applies full effort using an ordinary spud wrench.

Install bolts in the remaining open holes and tighten the bolts to a snug tight fit, after which all bolts shall be tightened completely by the turn-of-nut method.

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Where difficulty is experienced with the fit of the connection and the bolts are used to draw the elements into contact, check all bolts in the affected portion of the connection for a sustained snug tight condition.

Replace drift pins with completely tightened bolts only after all the remaining holes are filled with completely tightened bolts.

Do not field ream holes drilled full size during fabrication.

After bolts are snug tight, the wrench operator shall match-mark the outer face of the nut with the flush or protruding portion of the bolt using a crayon or paint. The Engineer will use the match-marks to determine the relative rotation between the bolt and nut during final tightening using the turn-of-the-nut method.

Commence tightening at the most rigidly fixed or stiffest point and progress toward the free edges, both in the initial snugging up and in the final tightening. If required because of wrench operation clearances, tightening may be done by turning the bolt. If used, provide impact wrenches of adequate capacity to perform the required tightening each bolt in approximately 10 seconds.

Do not reuse galvanized A 325 bolts. Re-tightening previously tightened bolts that became loose by tightening adjacent bolts is not reuse.

Follow the additional bolting requirements in 513.26.

**D. Bolt Tension.** When all bolts in the joint are tight, the minimum bolt tension for each bolt size is shown in Table 513.20-2.

**TABLE 513.20-2**

<b>Bolt Size (inches)</b>	<b>Bolt Tension[1] (kips), minimum A 325</b>
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

[1] Equal to 70 percent of specified minimum tensile strengths of bolts, rounded off to the nearest kip.

**TABLE 513.20-2M**

<b>Bolt Size (mm)</b>	<b>Bolt Tension[1] (kN), minimum A 325M</b>
M16	91
M20	142
M22	176
M24	206
M27	267
M30	327
M36	475

[1] Equal to 70 percent of specified minimum tensile strengths of bolts, rounded off to the nearest kN.

**TABLE 513.20-3 NUT ROTATION FROM SNUG TIGHT CONDITION**

Bolt Length (as measured from underside of head to extreme end of point)	Disposition of Outer Faces of Bolted Parts		
	Both faces normal to bolt axis	One face normal to bolt axis and other face sloped not more than 1:20 (bevel washer not used)	Both faces sloped not more than 1:20 from normal to bolt axis (bevel washer not used)
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 diameters	2/3 turn	5/6 turn	1 turn

Attain the bolt tension specified in Table 513.20-2 by tightening all bolts, the applicable amount of nut rotation specified in Table 513.20-3 by the turn-of-nut method.

Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. Tighten bolts requiring 1/2 turn and less within  $\pm 30$  degrees and tighten bolts requiring 2/3 turn and more within  $\pm 45$  degrees.

#### **E. Inspection.**

1. The Engineer will inspect the first completed connection of each bridge according to 513.20.E.2 below and subsequent connections the Engineer deems necessary. Thereafter, where the Engineer has approved the joint compactness and snug-tight condition of bolts prior to bolt tightening by the turn-of-nut method, the bolt tension as required in Table 513.20-2 shall be considered as attained if the amount of nut rotation specified by Table 513.20-3 is verified by the required match-marking.

2. Furnish and use manual torque wrenches to inspect bolts. Perform test to the satisfaction of the Engineer. Calibrate the inspection torque wrenches at least once each workday using a device, approved by the Engineer, and capable of

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indicating bolt tension. Use three bolts, placed and tensioned individually, representative of the grade, size, length, and condition used in the structure to determine the job inspection torque according to 513.20.E.3. Place a washer under the part being turned.

3. Tighten each of the three representative bolts, using any convenient manner, to the tension shown in Table 513.20-2. Then, using the inspection wrench, apply a slow steady pull to the tightened bolt and measure the torque required to turn the nut or head 5 degrees, approximately 1 inch (25 mm) at a 12-inch (300 mm) radius in the tightening direction. Use the average torque measured in the tensioning of the three bolts as the job inspection torque.

4. With the Engineer present, randomly select for inspection two bolts or 10 percent of the bolts, whichever is greater, from each connection represented by the 3-bolt sample described in 513.20.E.2. Using the inspection wrench, apply the job inspection torque in the tightening direction. The Engineer will accept the connection if the job inspection torque does not turn the nut or bolt head. If the job inspection torque turns a nut or bolt head, apply the job inspection torque to all the bolts in the connection and reinspect the connection as described above.

**F. Calibration Devices.** The manufacturer of the calibration device or a qualified testing laboratory shall periodically examine each calibration device at least once each year and other times if requested by the Engineer. After calibration, the manufacturer or testing laboratory shall certify that each calibration device accurately indicates the actual bolt tension.

**513.21 Welding.** Perform welding by the shielded metal-arc, submerged arc, flux cored arc, or stud welding process. Only shielded metal arc (stick) welding is prequalified. All other welding processes require testing and approval by the Office of Materials Management. Consideration will be given to other methods of metal-arc welding if a written request is submitted to the Office of Materials Management.

In other respects, the AASHTO/AWS *Bridge Welding Code*, as amended by Supplement 1011, shall govern the work.

Post copies of the shop welding procedures at each welding location.

Weld only fracture critical and main members when the fabrication quality control specialist and inspectors are physically at the facility. The fabricator shall not perform fracture critical welding without prior scheduling with the fabrication quality control specialist and the inspector. The fabrication quality control specialist shall witness the minimum percentages specified in Supplement 1078 and shall check all welding processes.

For non-fracture critical welds, the fabrication quality control specialist shall perform frequent inspections, and check all welding processes.

**513.22 Stud Shear Connectors.** Perform stud welding according to the AASHTO/AWS *Bridge Welding Code*, as amended by Supplement 1011, and this subsection.

In addition to the stud bend tests of Article 7.6.6.1 of the AASHTO/AWS *Bridge Welding Code*, perform bend tests of stud shear connectors at the start of

each workday, when welding has been interrupted for an hour or more, when changing grounds, when changing weld settings, and when changing cable loop due to arc blow. Do not weld more than 500 studs without the welds being field bend tested in accordance with the specified procedure. The Contractor may leave in the bent position tested studs that show no sign of failure, as determined by the Engineer.

Weld stud shear connectors to the top flanges of beams or girders after the steel has been erected and suitable scaffolding or deck forming has been provided. Studs may be welded to beam or girder webs, end dams, bearing plates, or to other secondary members and detail material in the shop.

**513.23 Threads for Bolts and Pins.** Threads for pins shall conform to the Unified Standard Series ANSI B1.1-UNC (ANSI B1.13M) Class 2A (6g) for external threads and Class 2B (6H) for internal threads, except that pin ends having a diameter of 1 3/8 inches (35 mm) or more shall be threaded 6 threads to the inch (4.23 mm/thread).

**513.24 Shop Assembly.** Remove paint, grease, oil, rust, loose mill scale, and protruding edges or burrs from all contact surfaces. Unless waived by the Office of Materials Management, do not assemble and weld flanges and webs to form girders or other similar members and do not accomplish fabrication or assembly that interferes with the repair of a butt weld until the fabrication quality control specialist for the A rated fabricators or the inspector for B and C rated fabricators examines and approves radiographs of all butt welds in the component parts.

Perform fit-up work with the members assembled in unloaded positions as shown on the shop drawing layout required by 513.06. During shop assembly, adequately support members, especially at joints, to prevent misalignment or deflection and designate supports that prevent settlement during the fit-up, reaming or drilling of connections. The fabrication quality control specialist shall maintain records of the actual horizontal and vertical dimensions and relative positions of each assembly for each offset required by 513.06 and, upon request, furnish a copy to the inspector. Reposition members that become a part of two assemblies for the second assembly to the dimensions recorded for the first assembly.

Using steel stamps, match-mark all connecting parts assembled in the shop for the purpose of reaming or drilling of holes for field connections or for fit-up of field welded connections before disassembly. Punch mark bearing centerlines.

Continuous beam and plate girders, including sections adjacent to hinged, pin connected, sliding, or rocker bearing joints, shall have at least three adjacent segments assembled, and holes reamed or drilled while assembled. Check the fit-up of field welded connections by similar shop assembly.

Shop assemble longitudinal or transverse beams and girders that are either framed or connected by diaphragms and floor beams to check fit-up of connections to be field welded, or to ream or drill holes for bolted connections. Assemble trusses in lengths of at least three abutting panels before drilling or reaming field connections.

Include deck plates in the final shop assembly of bridges that involve railroad deck plates, even if welding of these deck plates takes place in the field.

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If the fabricator elects to use numerically controlled drilling or punching, the required assembly shall be performed as specified above. The Office of Materials Management will consider the Contractor's written request to use other methods of checking hole alignment and match marking. If the Office of Materials Management does not consider, or disapproves the fabricator's proposed methods of assembly, perform the work according to 513.19 and 513.24.

After fabrication, shop assemble deck expansion devices to check fit-up, straightness, and roadway cross-slope changes. Full width assembly is required with phased construction if expansion devices have interlocking fingers or have mechanical devices that require exact field alignment.

The fabricator may fabricate part-width deck segments without the required shop assembly under the following conditions:

- A. The plans require a phased construction sequence.
- B. Shop drawings incorporate a lay down, similar to 513.06, defining vertical offset dimensions from a full length common baseline to all roadway changes including sidewalks, rounding, crowns, and field splice points of the expansion device.

Secure parts not completely assembled in the shop with temporary bolts to prevent damage in handling and shipping. In the shop, bolt field splice plates into final position shift the splice plates laterally with respect to their final position so that the ends of the plates are flush with the ends of the member. Without the Office of Materials Management's written acceptance, do not weld or tack-weld to bolted assemblies. Perform authorized welding according to 513.21.

**513.25 Nondestructive Testing.** Nondestructive testing shall conform to the AASHTO/AWS *Bridge Welding Code*, as amended by Supplement 1011 and as specified below.

As the Engineer directs, perform ultrasonic or radiographic inspection of field welded repairs in main members for thick scabs, deep kerfs or nicks, and similar gross flaws. Ensure that all examined welds and base metal adjacent to a welded joint conform to the quality requirements specified in 513.21. Submit radiographs, field sketches showing specific locations, lengths and depths of the repair, and two copies of the radiographic or ultrasonic technical reports to the Office of Materials Management for acceptance. Receive the Office of Materials Management's acceptance before performing construction activities making welds inaccessible for repair.

The Contractor or fabricator shall notify the Department at least 48 hours before performing nondestructive testing. Provide this notice even if specific hold or witness point inspections are not required by Supplement 1078.

The Office of Materials Management has the final authority to accept welds and will resolve controversies regarding the interpretation of radiographs, magnetic particle indications, or the acceptability of welds.

**A. Radiographic Inspection of Welds.** Before inspection, grind welds smooth. Grind web splices only where radiographed, except grind outside fascia surfaces the full length. Inspect the following welds:

1. The full length of all butt welds in flange material of plate girders or rolled beams. One hundred percent of butt welds in back up bars that remain in the structure.
2. The top and bottom one-third of transverse web splices in plate girders or rolled beams and show any cope holes. If an unacceptable weld occurs, radiograph an adjoining 12-inch (300 mm) length of weld not previously inspected. If unacceptable flaws are found in this adjoining segment, radiograph the remainder of the weld.
3. Butt welds in longitudinal stiffeners attached to tension areas of webs.
4. Twenty-five percent of each longitudinal web splice as selected by the inspector.
5. Full length of field flange cut repairs.
6. Other welds specified in the Contract or AASHTO/AWS *Bridge Welding Code*.

Use a steel stamp to make the radiograph identification mark shown on the shop drawing layout in the area marked "Weld Identification" of Figures 6.1A through 6.1D of the AASHTO/AWS *Bridge Welding Code* in a manner to make it visible in the radiograph of the area without resorting to superimposed like markings. Place steel stamped identification marks on flange plates so that after girder assembly the marks are on the inside of flange and outside the area fastened to the web. Identify films of repaired welds by the letter "R". Do not place steel stamped identification numbers within the weld area. Use superimposed characters to make other required markings.

Use film locations or a technique employed that will show the top and bottom images of the plate edge. Use films  $4\frac{1}{2} \times 17$  inches ( $114 \times 432$  mm) where practical and a minimum film size of  $4\frac{1}{2} \times 10$  inches ( $114 \times 254$  mm).

Supply a technical report for the RT testing similar to Annex III Form III-5 of the AASHTO/AWS *Bridge Welding Code*, and include the following: Project identification, member piece mark, description of the repairs made, and the qualification level of the technician.

The Department will take ownership of contact films. For main material repairs, provide sketches that clearly show specific locations, lengths and depths of field cuts, or damages repaired by field welding.

**B. Magnetic Particle Inspection of Welds.** Before magnetic particle inspection (MPI), complete welding required to fabricate each beam or girder, correct all visual defects, and clean the weld. If the fabricator's quality control plan is acceptable to the Department and additional processing does not produce a potential for cracking, the Department may allow the Contractor to perform MPI before complete welding.

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Inspect welds using the procedure and techniques for the dry powder magnetic-particle examination of welds using the prod or the yoke method according to AWS 6.7.6. The prod test equipment shall have a functioning ammeter. Provide a prod magnetizing current of 100 amperes per inch (25 mm) of prod spacing but not less than 400 amperes. Use only aluminum prods.

Inspect at least 1 foot (0.3 m) for every 10 feet (3 m), or fraction thereof, for each size of weld in the following:

1. Flange-to-web welds, including ends of girder after trimming.
2. Moment plate to flange welds.
3. Bearing stiffener welds.
4. Other welds specified in the Contract or AASHTO/AWS *Bridge Welding Code*.
5. Field weld repairs as directed by the Engineer.

The inspector or the fabrication quality control specialist will select random test sections. Unless waived by the Office of Materials Management, the inspector will observe inspection by C-rated fabricators. Position test sections as necessary for the inspection and after considering the safety and convenience to the inspecting personnel.

If a test section contains unacceptable defects, test 5-foot (1.5 m) segments on both sides of the test section, or, if less than 5-foot (1.5 m) segments are on both sides of the test section, test the full length of the weld. Retest welds requiring repair after repairs are complete. If the fabricator's quality control plan is acceptable to the Department and additional processing does not produce a potential for cracking, the (WHO) may allow the Contractor to perform MPI before complete welding.

MPI will not locate all surface defects of Article 9.21 of the AASHTO/AWS *Bridge Welding Code*. Unacceptable welds have MPI results that indicate defects exceed the above quality standards.

For each unacceptable defect, the fabricator shall record the piece mark, the location of the defect on the member, the defect description, and the proposed repairs.

**C. Ultrasonic Testing of Welds.** Perform ultrasonic inspection of the following welds:

1. Complete joint penetration flange-to-web, T, or corner joint welds: 25 percent for non-FCM, 25 percent compression or shear FCM, and 100 percent tension FCM.
2. Complete penetration butt welds: 100 percent tension FCM and 25 percent compression FCM.
3. Other welds: as specified in the Contract or AASHTO/AWS *Bridge Welding Code*.

The fabrication quality control specialist shall provide the Engineer with specified certification, sketches, technician reports, and a letter documenting that the Contractor performed nondestructive testing according to this specification.

**513.26 Shipping, Storage, and Erection.** Repair or replace, at the discretion of the Office of Materials Management, members damaged by improper handling, storing, or erection.

During transportation, place adequate blocking between members to prevent movement and facilitate unloading. Unless reinforced by additional plates, angles, or other material bolted in place, do not use field connection holes for tie-down. Band together bearing components.

Place material stored in the fabricating shop or in the field on skids or blocks to prevent the metal from contacting the ground. Place and shore girders and beams in an upright position for shipping, and field and shop storage. Field splice plates shall be bolted with temporary bolts, which shall be removed and replaced, when field splice plates are placed in their final position or shifted laterally with respect to their final position. Keep material clean and properly drained. Install bearing devices and anchorages according to Item 516.

Thoroughly clean bearing surfaces and surfaces to be in permanent contact before the members are assembled in the field.

Before erecting structural steel, completely bolt up field splices and connections that started before steel erection.

During erection, the Engineer will allow drifting to draw the parts into position, but do not enlarge the holes or distort the metal. Install drift pins and bolts according to 513.20. Fill at least three-fourths of the holes with completely tightened bolts in splices and connections subject to construction loads during erection. Complete permanent fastening of steel truss tension chord members before removing falsework. Permanently fasten compression chord members after the span is released sufficiently from the falsework to bring the compression chord joints into full bearing. Properly regulate and maintain elevations of panel points and ends of floor beams until the falsework is removed.

Do not enlarge the holes of splices and connections between segments or elements of main members without approval by the Office of Materials Management.

Adjust structures to the correct alignment and to the marked bearing centerlines before beginning permanent fastening. Do not permanently fasten cross frames and lateral bracing in continuous beam or girder spans until completing main connections in adjacent spans; however, install sufficient bracing to maintain structural stability. For erection bolts used to fasten cross frames, use not less than 5/8-inch (16 mm) diameter, and fully tighten bolts according to 513.20.

Erect end cross frames and end dams in a manner that ensures bearing parts remain in bearing contact.

Permanently fasten all intermediate cross frames before deck placement begins.

The webs of primary members shall be plumb before deck placement begins.

513.27

**513.27 Shop Coating.** For steel surfaces specified to be coated according to Item 514, apply a prime coat in the shop.

**513.28 Cleaning ASTM A 709/A 709M, Grade 50W (345W) Steel.** Before the new steel is shipped, solvent clean, where necessary, all surfaces of ASTM A 709/A 709M, and Grade 50W (345W) steel that are to be left unpainted to remove all traces of asphalt cement, oil, grease, diesel fuel deposits, chalk, paint marks, and other soluble contaminants according to SSPC-SP 1 Solvent Cleaning. QCP #1 and QCP #2 shall apply according to Item 514.

Shop blast unpainted Grade 50W material to SSPC-SP 6, commercial blast. QCP #3 shall apply according to Item 514.

After placing superstructure concrete, clean, where necessary, the exterior surface and bottom flanges of all fascia beams or girders that are to be left unpainted to remove all traces of asphalt cement, oil, grease, diesel fuel or petroleum deposits, concrete, and other contaminants.

Do not use acid for cleaning.

**513.29 Method of Measurement.** The Department will measure Structural Steel Members on a lump sum basis or by the number of pounds (kilograms).

If payment is per pound (kilograms), submit weight computations to the Office of Materials Management based upon the accepted shop drawings. Deduct waste material, removed by burning, cutting, machining, holes, etc., but include groove weld bevels. Include the weight of all permanent fasteners, shop fillet welds, other metals and preformed bearing pads. Exclude the weight of paint or galvanized coatings. Exclude thickness or weight of members exceeding the plan requirements (due to overweight or other cause), unless authorized by the Department. As an option, measure and record the weight of structural members before painting in the presence of the inspector. Use the following unit weights for computations.

	lb/ft <sup>3</sup> (kg/m <sup>3</sup> )
Steel, cast steel, and deposited weld metal	490 (7850)
Cast iron	450 (7210)
Phosphor or leaded bronze	550 (8810)
Lead	710 (11370)
Preformed bearing pads	710 (11370)

The Department will measure Welded Stud Shear Connectors by the number of each installed and accepted.

**513.30 Basis of Payment.** If the fabricator’s proposed methods of assembly with numerically controlled drilling or punching fail to produce specified results and the Office of Materials Management directs the Contractor to perform work, as per 513.19 and 513.24, the Department will not pay for this work.

For steel surfaces specified to be coated according to Item 514, the cost of applying a prime coat in the shop is incidental to the bid for structural steel.

The Department will not pay for repairing or replacing members damaged by improper handling, storing, transportation, or erection.

The Department will pay for the accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
513	Lump Sum	Structural Steel Members, Level UF
513	Lump Sum	Structural Steel Members, Level 1
513	Lump Sum	Structural Steel Members, Level 2
513	Lump Sum	Structural Steel Members, Level 3
513	Lump Sum	Structural Steel Members, Level 4
513	Lump Sum	Structural Steel Members, Level 5
513	Lump Sum	Structural Steel Members, Level 6
513	Pound (Kilogram)	Structural Steel Members, Level UF
513	Pound (Kilogram)	Structural Steel Members, Level 1
513	Pound (Kilogram)	Structural Steel Members, Level 2
513	Pound (Kilogram)	Structural Steel Members, Level 3
513	Pound (Kilogram)	Structural Steel Members, Level 4
513	Pound (Kilogram)	Structural Steel Members, Level 5
513	Pound (Kilogram)	Structural Steel Members, Level 6
513	Each	Welded Stud Shear Connectors

#### **ITEM 514 PAINTING OF STRUCTURAL STEEL**

- 514.01 Description**
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## 514.01

### 514.23 Method of Measurement

### 514.24 Basis of Payment

**514.01 Description.** This work consists of cleaning and painting all steel surfaces.

**514.02 Materials.** On existing steel, apply a three-coat paint system consisting of an organic zinc prime coat, an epoxy intermediate coat, and a urethane finish coat. The coating system shall conform to 708.02.

On new steel, apply a three-coat paint system consisting of an inorganic zinc prime coat, an epoxy intermediate coat, and a urethane finish coat. The prime coat shall conform to 708.01, and the intermediate and finish coats shall conform to 708.02. Supply the intermediate and finish coats from the same manufacturer. The Contractor may supply the prime coat from a manufacturer other than the manufacturer of the intermediate and finish coats.

For caulking, use a single pack moisture cured polyurethane based material, which will not shrink or sag, capable of filling voids greater than 1/8 inch (3mm) and up to 1 inch (25 mm) wide. Only material that is listed on the OMM Qualified Product List website may be used.

**514.03 Superintendent.** In addition to the requirements of 105.06, the Superintendent must successfully complete a Bridge Painting pre-qualification course and training offered by the Department. The course must have been completed within the past four years and an individual course certificate must have been received by the Superintendent. Present certificate to the Engineer prior to commencing work. No work is permitted unless the Superintendent provides a valid course certificate.

**514.04 Quality Control.** Quality control consists of designating quality control specialists to control the quality of work in each phase established by Quality Control Points (QCPs). Control quality by inspection, tests, and cooperation with inspection and testing performed by the Engineer and inspector.

**A. Quality Control Specialist.** Identify the individuals dedicated to performing duties as the painting quality control specialists before starting work in the field. Provide a quality control specialist for each structure, but one quality control specialist must be provided for every three structures for which work is progressing concurrently on this contract.

Each quality control specialist must be either a NACE (National Association of Corrosion Engineers) certified coating inspector or a SSPC (The Society for Protective Coatings, SSPC) protective coating specialist or formally trained or retrained by a NACE certified coating inspector or a SSPC protective coating specialist. The training shall be adequate to ensure that the quality control specialist is able to use all the testing equipment and understands the requirements of this specification. Provide a copy of the NACE or SSPC certification or a copy of the trainer's NACE or SSPC certification and a letter or certificate signed and dated by the trainer to the Office of Construction Administration. Ensure that the NACE or SSPC certification is current or retrain the quality control specialist every five years in accordance with the above requirements.

The quality control specialist must successfully complete a Bridge Painting prequalification course offered by the Department. The training course must have been completed within the past four years and an individual course certificate must have been received by the quality control specialist.

Select only a quality control specialist who is approved by the Department. The Office of Construction Administration will publish a list of approved Quality Control Specialists. Present all required certificates, letters of certification, and valid identification to the Engineer prior to commencing work.

The quality control specialist will be immediately removed from the work and disqualified from future work if any quality control failure occurs. A quality control failure is defined as any of the following:

1. The dry film thickness has been approved by the quality control specialist and it is later found that over 20 percent of the spot measurements of any one member of a structure, such as a cross frame, web, flange, stiffener, or other parts of the structure are either under the minimum or over the maximum spot thickness.

2. The dry film thickness has been approved by the quality control specialist and it is later found that the thicknesses of any area of a structure as described in 514.20 are either under the minimum or over the maximum specification thickness.

3. Two separate occurrences when the surface preparation has been approved by the quality control specialist of any one member type, such as the cross frames, webs, flanges, stiffeners, or other parts of the structure and it is later found that the surfaces of those members were either not properly profiled or not properly cleaned as required by the Contract Documents. Occurrences are determined per structure.

4. Two separate occurrences of the quality control specialist performing production duties not allowed by the Contract Documents. Occurrences are determined per structure.

5. Two separate occurrences when the quality control specialist fails to perform any one of the duties assigned to the quality control specialist in the Contract Documents. Occurrences are determined per structure.

Suspend work if the quality control specialist is not available or has been removed. The Engineer or Inspector will immediately provide written notification to the Office of Construction Administration of any quality control failure identified above. Resume work when a quality control specialist, qualified and approved as provided in 514.04, is available.

For work in the fabrication shop, each fabricator shall identify one or more full-time individuals who shall perform the duties of the painting quality control specialist.

The quality control specialist may not be used to perform production duties including supervision, blasting, painting, waste disposal, mixing, operating or repairing equipment, or other tasks not associated with duties of the quality control

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specialist while the Contractor is performing work toward the completion of a Quality Control Point.

Ensure that each quality control specialist is trained and equipped with Material Safety Data Sheets (MSDS), product data sheets, tools, and equipment necessary to provide quality control on all aspects of the work. Each quality control specialist shall have a thorough understanding of the plans for the work, including any pertinent addenda, change order, or other contract documents, and these Specifications. Duties each quality control specialist shall perform include:

1. Inspect equipment and abrasive at specified intervals.
2. Approve the work and provide documentation that the work has been approved immediately before each QCP.
3. Inspect the work with the Engineer or Inspector at each QCP.
4. Verify the Contractor or fabricator performed work according to the Contract Documents.
5. Cooperate with the inspection and testing performed by the Engineer and inspector.
6. Document test results and compare test results with the Engineer's and inspector's test results.
7. Notify Superintendent of nonconforming work.
8. Stop work when test equipment is not available and when necessary to ensure the work is performed according to the Contract.

The fabricator's quality control specialists shall provide the Engineer with a letter that includes specified information or check point data documenting acceptance of the work and consisting of the following:

1. Checks on the abrasive to ensure that it has not been contaminated with oil.
2. The profile of the blasted surface.
3. The air and steel temperature and dew point before blast cleaning and painting and at 4-hour intervals during the blasting and painting operation.
4. Readings of the actual dry film thickness.
5. The lot and stock number of the paint and the date of manufacture.
6. Documentation that the paint mixer is functioning properly, that each spray operator has demonstrated the ability to paint, and that all spray equipment is used as per the manufacturer's recommendation.

**B. Quality Control Points (QCP).** QCPs are points in time when one phase of the work is complete and approved by the quality control specialist and ready for inspection by the Engineer or the inspector before commencing the next phase of the work. At a QCP, the quality control specialist shall provide quality control tests bearing his signature to the Engineer or Inspector. The Contractor or fabricator shall provide the Engineer and inspectors access to inspect all affected surfaces. If

inspection identifies a deficiency, correct the deficiency according to the Contract Documents before starting the next phase of work. Discovery of defective work or material after a Quality Control Point is past or failure of the final product before final acceptance, shall not, in any way, prevent the Department from rejecting the final product or obligate the Department to final acceptance. **Final acceptance will be determined as per 514.21, Final Inspection.**

Quality Control Points	Purpose	New Steel	Existing Steel
1.Solvent Cleaning	Remove asphalt cement, oil, grease, etc.	Yes	Yes
2.Grinding Flange Edges	Remove sharp corners	Yes	Yes
3.Abrasive Blasting	Blast surfaces to receive paint	Yes	Yes
4.Containment/Waste Disposal	Contain, collect, & dispose of abrasive blasting debris	No	Yes
5.Prime Coat Application	Check surface cleanliness, apply prime coat, check coating thickness	Yes	Yes
6.Remove Fins, Tears, & Slivers	Remove surface defects and slivers	Yes	Yes
7.Washing of Shop Primer	Remove all water soluble materials (salt, dirt, etc.)	Yes	No
8.Intermediate Coat Application	Check surface cleanliness, apply intermediate coat, check coating thickness	Yes	Yes
9.Caulking	Caulk areas not sealed by the intermediate coat	Yes	Yes
10. Finish Coat Application	Check surface cleanliness, apply intermediate coat, check coating thickness	Yes	Yes
11. Final Review	Acceptance and check total system thickness	Yes	Yes

**514.05 Testing Equipment.** For the project duration, provide the Engineer or inspectors with the test equipment listed below for the type of work at each work site with ongoing work. With the exception of the recording thermometer, the fabricator shall provide its quality control specialists with the test equipment listed below. The Contractor and fabricator shall maintain all testing equipment in good working order. When no test equipment is available, no work shall be performed.

A. Film and a camera with the following features:

1. Uses self developing color print film.
2. Lens with auto focus system.
3. Focuses from 2 feet (0.6 m) to infinity.
4. Built-in fill flash.

Or provide a digital camera with the following features:

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1. 5.0 Megapixel or greater resolution.
  2. Minimum 3X Optical zoom lens capability with automatic focus.
  3. Minimum 512M Memory capability.
  4. Built-in flash.
  5. Photograph printer with docking capability compatible with the camera including supplies necessary to print. (i.e. Ink Cartridges, Photograph quality paper, and other consumables required for operation and photograph printing.)
- B. One Spring micrometer and extra-coarse replica tape on the project at all times.
- C. One SSPC-PA2 Type 2 (electronic) non-destructive coating thickness gage and two sets of National Institute of Standards & Technology calibration plates. The first set of calibration plates shall be 1.5 to 8 mils (38 to 200 µm), Model No. 1362b, and the second set shall be 10 to 25 mils (250 to 625 µm) , Model No. 1363b.
- D. One Sling Psychrometer including Psychometric tables.
- E. Two steel surface thermometers accurate within 2 °F (1 °C).
- F. Flashlight 2-D cell.
- G. SSPC Visual Standard for Abrasive Blast Cleaned Steel (SSPC-VIS 1).
- H. One recording thermometer capable of recording the date, time, and temperature over a period of at least 12 hours.

**514.06 Work Limitations.** Apply the prime coat to new structural steel inside permanent buildings at the fabricator’s facility. If inside permanent buildings, the fabricator may perform year-round abrasive blasting and painting. Perform abrasive blasting and painting in the field from April 1 to October 31. The Department will not issue a time extension due to adverse weather during the month of April. The plans or other Contract Documents may require additional work limitations for specific bridges or projects.

**A. Temperature.** Except for inorganic zinc, apply paint when the steel, air, and paint temperature is 50 °F (10 °C) or higher and expected to remain higher than 50 °F (10°C) for the cure times listed below. Apply inorganic zinc when the steel, air, and paint is 40 °F (4 °C) or higher. Cure inorganic zinc according to the minimum curing time and temperatures specified in the paint manufacture’s printed instructions.

	<b>50 °F (10 °C)</b>	<b>60 °F (16 °C)</b>	<b>70 °F (21 °C)</b>
Primer (Organic Zinc)	4 hrs	3 hrs	2 hrs
Intermediate	6 hrs	5 hrs	4 hrs
Finish	8 hrs	6 hrs	4 hrs

Monitor the temperatures listed above for cure times using the recording thermometer. The Contractor may use a heated enclosure or building. Supply heat

continuously and uniformly to maintain the required minimum curing temperature within the enclosure or building until the coating has cured.

If combustion type heating units are used, vent the units away from the enclosure or building and do not allow exhaust fumes to enter the enclosure or building. Do not use open combustion in the enclosure or building.

The fabricator may use radiant heat when painting new structural steel inside permanent shop buildings. Locate radiant heaters at least 10 feet (3 m) above all surfaces to be painted. Vent exhaust fumes to prevent fumes from contacting surfaces to be painted.

**B. Moisture.** Do not apply paint:

1. If the steel surface temperature is less than 5 °F (3 °C) above the dew point.
2. If the steel surface is wet, damp, frosted, or ice-coated.
3. If the relative humidity is greater than 85 percent.
4. During periods of rain, fog, or mist unless the above moisture criteria is met.

If steel was abrasive blasted when the temperature of the steel was less than 5 °F (3 °C) above the dew point, reblast the steel when the steel temperature is at least 5 °F (3 °C) above the dew point.

**514.07 Protection of Persons and Property.** Collect, remove, and dispose of all rubbish, buckets, rags, or other discarded materials and leave the job site in a clean condition.

Except for deck bottoms and backwalls which have not been sealed or are not to have a sealer applied, protect all portions of the structure, that are not to be painted from damage or disfigurement by splashes, spatters, and smirches of paint.

If the Contractor causes any damage or injury to public or private property, the Contractor shall restore the property, to a condition similar or equal to the condition existing before the damage or injury.

**514.08 Pollution Control.** Comply with pollution control laws, rules, or regulations of Federal, State, or local agencies and requirements of this specification.

**514.09 Safety Requirements and Precautions.** Comply with the applicable safety requirements of the Ohio Industrial Commission and OSHA.

Provide Material Safety Data Sheets (MSDS) at the preconstruction meeting for all paints, thinners, and abrasives used on this project. Do not begin work until submitting the MSDS to the Engineer.

**514.10 Inspection Access.** In addition to the requirements of 105.10, furnish, erect, and move scaffolding and other appropriate equipment to allow the inspector and the Engineer the opportunity to closely observe all affected surfaces during all phases of the work and for at least 10 workdays after completely painting each structure to allow for the Final Inspection as per 514.21. Submit to the Engineer

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for information, complete details of the inspection access that complies with the applicable safety requirements of The Ohio Industrial Commission and OSHA. The details shall be reviewed, signed, stamped and dated by an Ohio registered Professional Engineer certifying that they meet these requirements. Maintain the in-place inspection access equipment employed during original painting activities or provide alternate inspection equipment such as platform lifts, bucket trucks, snooper trucks, or equivalent as approved by the Engineer. If scaffolding, or any hanger attached to the scaffolding, is supported by horizontal wire ropes, or if scaffolding is directly under the surface to be painted, comply with the following requirements:

A. If scaffolding is suspended 43 inches (1092 mm) or more below the surface to be painted, place two guardrails on all sides of the scaffolding. Place one guardrail at 42 inches (1067 mm) above the scaffolding and the other guardrail at 20 inches (508 mm) above the scaffolding.

B. If scaffolding is suspended at least 21 inches (533 mm) but less than 43 inches (1092 mm) below the surface to be painted, place one guardrail on all sides of the scaffolding at 20 inches (508 mm) above the scaffolding.

C. If 514.10.A and 514.10.B do not apply, place two guardrails on all sides of scaffolding. Place one guardrail at 42 inches (1067 mm) above the scaffolding and the other guardrail at 20 inches (508 mm) above scaffolding.

D. Provide scaffolding at least 24 inches (610 mm) wide if guardrail is used and 28 inches (711 mm) wide if guardrail is not used and scaffolding is suspended less than 21 inches (533 mm) below the surface to be painted. If using two or more parallel scaffolding to achieve the proper width, rigidly attach the scaffolding together to prevent differential movement.

E. Construct guardrail as a substantial barrier, securely fastened in place and free from protruding objects such as nails, screws, and bolts. Provide a properly located opening in the guardrail to allow the Engineer and inspector access onto the scaffolding.

F. Construct guardrails and uprights of metal pipe, steel angles, or wood. If using pipe railing, provide pipe with a nominal diameter of at least 1 ½ inches (38 mm). If using steel angle railing, provide 2 × 2 × 3/8-inch (50 × 50 × 9 mm) steel angles or other metal shapes of equal or greater strength. If using wood railing, provide 2 × 4-inch (50 × 100 mm) nominal stock. Space uprights no more than 8 feet (2.4 m) on center. If using wood uprights, provide 2 × 4-inch (50 × 100 mm) nominal stock.

G. If the surface to be inspected is more than 15 feet (4.57 m) above the ground or water, and the scaffolding is supported from the structure being painted, provide a safety harness (not a safety belt) and lifeline for the Engineer and inspector. The lifeline shall not allow a fall greater than 6 feet (1.8 m). Provide a method to attach the lifeline to the structure that is independent of the scaffolding, cables, and brackets supporting the scaffolding.

H. If scaffolding is more than 2.5 feet (762 mm) above the ground, provide an access ladder and equipment to attach the ladder onto the scaffolding capable of

supporting 250 pounds (113 kg) with a safety factor of at least four. uniformly space rungs, steps, cleats, and treads no more than 12 inches (305 mm) on center. Extend at least one side rail at least 36 inches (914 mm) above the landing near the top of the ladder.

I. If the distance from the ladder to the access point on the scaffolding exceeds 12 inches (305 mm), provide an additional landing that is capable of supporting a minimum of 1000 pounds (454 kg) and at least 24 inches (610 mm) wide and 24 inches (610 mm) long. Size and shape the landing so that the distance from the landing to the point where the scaffolding is accessed does not exceed 12 inches (305 mm). Firmly attach the landing to the ladder; however, do not use the ladder to support the landing.

J. In addition to the scaffolding requirements above, comply with all Federal, State, and local laws, ordinances, regulations, orders, and decrees.

K. Furnish all necessary traffic control to allow inspection during and after all phases of the project.

**514.11 Job Site Visual Standards.** Before starting abrasive blasting, establish job site visual standards by preparing a test section, subsequent test sections, and by using photographs of approved test sections. Use job site visual standards and SSPC-VIS 1 standard for blasting. The Contractor or fabricator shall prepare an approximately 20 to 30-square foot (2 to 3 m<sup>2</sup>) test section from a representative area on the first structure to be painted. After the Engineer or Inspector and the Contractor or fabricator agree the test area was blast cleaned to the requirements of the Contract Documents, photograph the test section and check the steel surface for the proper profile. After the Engineer or Inspector approves the test section and the job site visual standards are documented by photographs and replica tape, the Contractor or fabricator may start abrasive blasting. The quality control specialists and Engineer or Inspector will use the job site visual standards (photographs), the Plan, Specification and requirements to determine acceptance of blast cleaning procedures. In all cases of dispute, the SSPC-VIS 1 standard shall govern. If the Contractor, Engineer, Inspector, or fabricator believe the initial test section does not establish the proper visual standard for a different structure another test section on the different structure may be performed.

**514.12 Quality Control Point Photographic Verification and Documentation.** The Engineer or Inspector will take a sufficient number of photographs to document the condition of the work at Quality Control Points 3, 4 and 11.

### **514.13 Surface Preparation.**

A. **Solvent Cleaning (QCP #1).** Solvent clean by methods described in SSPC-SP 1, areas containing oil, grease, asphalt cement, diesel fuel deposits, other petroleum products and contaminants.

**B. Grinding Flange Edges (QCP #2).** Before abrasive blasting, round all exposed flange edges of all beams and girders to a radius of  $1/8 \pm 1/16$  inch ( $3 \pm 1.5$  mm). This work has no weather and temperature restrictions.

**C. Abrasive Blasting (QCP #3).** Do not abrasive blast areas that contain asphalt cement, oil, grease, or diesel fuel deposits. Before abrasive blasting, completely remove all dirt, sand, bird nests, bird droppings, and other debris from the scuppers, bulb angles, and pier and abutment seats.

Abrasive blast all steel to be painted according to SSPC-SP 10 and as shown on the pictorial surface preparation standards for painting steel surfaces shown in SSPC-VIS 1. Maintain steel in a blast cleaned condition until it has received a prime coat of paint. The Contractor may commercial blast clean the back side of end cross frame assemblies that are 3 inches (75 mm) or closer to backwalls according to SSPC-SP 6.

Cover and protect galvanized and metalized steel (including corrugated steel bridge flooring), adjacent concrete already or specified to be coated or sealed, and other surfaces not intended to be painted, from damage caused by blasting and painting operations. Repair adjacent coatings damaged during the blasting operation. Backwalls and bottoms of decks not sealed nor specified to be sealed do not need to be covered and protected.

For field blasting, use a recyclable steel grit. For shop blasting, use an abrasive that produces an angular profile. All abrasives shall provide a profile from 1.5 to 3.5 mils (40 to 90  $\mu\text{m}$ ) as determined by replica tape according to ASTM D 4417, Method C. Clean the abrasive of paint, chips, rust, mill scale, and other foreign material after each use and before each reuse. Use equipment specifically designed for cleaning the abrasive.

Check abrasives used at the job site or fabrication shop for oil contamination at the beginning of each shift and at 4-hour intervals. Also check each load of abrasive delivered to the job site or fabrication shop for oil contamination before use. Check for oil by placing a small sample of abrasives and tap water into a jar. Reject the abrasive if an oil film is detected on the water surface.

To ensure that the compressed air is not contaminated, the quality control specialists shall blow air from the nozzle for 30 seconds onto a white cloth or blotter held in a rigid frame. If the cloth or blotter retains oil or other contaminants, suspend abrasive blasting until retests verify the problem was corrected. Perform this test at the start of each shift and at 4-hour intervals.

The Contractor may simultaneously abrasive blast and paint the same bridge provided the abrasive blasting debris and dust does not contact freshly painted surfaces and does not contaminate paint during the curing period. For shop blasting, the fabricator may simultaneously abrasive blast and paint if the two operations are separated by distance or containment that prevents paint contamination.

For surface preparation of new structural steel in the fabricator's shop, the quality control specialist shall take replica tape readings as follows:

1. For an automated blasting process, test the greater of 20 percent of the main members or one member per shift. These tests shall consist of taking five random readings per member.
2. For a manual blasting process, test each main member. The test of a main member consists of taking five readings at random locations.
3. For both an automated and manual blasting process, test 15 percent of all secondary members. The test of a secondary member consists of taking one random reading.

Remove abrasives and residue from all surfaces to be painted. Keep all structural steel that was blast cleaned in the field or the fabricator's shop dust free. Apply a prime coat to steel that was blast cleaned in the field within 12 hours of the beginning of the abrasive blasting operation. Apply a prime coat to structural steel that was blast cleaned in the fabricator's shop within 24 hours of the beginning of the abrasive blasting operation. If a prime coat is not applied within the times stated above, reblast the steel before applying the prime coat. Remove all dust or abrasives from adjacent work and from the finish coat.

Provide the Engineer and Inspector with field wash facilities and an adequate supply of running potable water, soap, and towels for washing face and hands during the surface preparation operation. Properly contain, test, and dispose of the wastewater. Locate a wash facility at each bridge site and in an area that will not be contaminated by the blasting debris.

**D. Containment/Waste Disposal (QCP #4).** Waste material generated by abrasive blasting operations in the field is a solid waste and may be a hazardous waste. Contain, collect, store, evaluate, and properly dispose of the waste material. Comply with all Federal, State, and local environmental protection laws, regulations, and ordinances including, but not limited to, air quality, waste containment, and waste removal. The Contractor is advised that various governmental bodies are involved with solid waste and hazardous waste disposal and the Contractor is responsible for complying with laws enforced by the various governmental bodies.

To prevent contamination of the pavement or soil, park all equipment on ground covers free of cuts, tears, and holes.

Clean equipment of spent abrasives or debris before bringing equipment to the project, moving equipment from one bridge site to another, and removing equipment from the project. Store debris cleaned from equipment with the debris from the structure that generated the debris.

Erect an enclosure to completely surround (around, under and over the top on truss type bridges) the blasting operations. The Contractor may use the ground as the bottom of the enclosure if the ground is completely covered with plastic or tarps.

Construct the enclosure of flexible materials such as tarpaulins (specifically designed for blasting containments), or construct the enclosure of rigid materials such as plywood. Maintain all materials free of tears, cuts, and holes. Overlap all seams a minimum of 6 inches (150 mm) and fasten the seams together at 12-inch

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(300 mm) centers or in a manner that ensures a seal that does not allow openings between the edges of the containment material. Extend the vertical sides of the enclosure completely up to the bottom of the deck on a steel beam bridge and use bulkheads between beams to enclose the blasting area.

Collect all debris from blasting operations, equipment, or filters, and all debris that fell to the ground. Store the debris in steel containers with lids that are locked at the end of each workday. The storage location shall be at the bridge site unless, the Engineer and Contractor agree on an alternate storage location. Test and evaluate the debris for disposal. The location of centralized cleaning stations for recyclable steel shall also be agreed by the Engineer and the Contractor.

Obtain the services of a testing laboratory to obtain directly from the project site and evaluate a composite representative sample of the abrasive blasting debris for each bridge site. The person taking the sample must be an employee of the testing laboratory.

Take composite sample in the presence of the Engineer or Inspector, comply with the requirements of U.S. EPA Publication SW 846 and take individual samples from all containers that are on the site at the time of the sampling. Blend individual samples of equal size together to comprise one composite sample. Take one individual sample from each drum and four randomly spaced individual samples from each container other than drums.

Take individual samples and place into clean glass or plastic containers.

Prepare a chain of custody record (Chain of Custody) for all composite samples. The Chain of Custody must include the name of the person taking the sample, the name of the testing laboratory for which the person works, the date and time the sample was taken, the bridge sampled, the Township and Municipality where the bridge is located, and the signatures and dates of all persons in possession of the sample in the Chain of Custody.

Sample the abrasive blasting debris within the first week of production blasting at each bridge. Cease all blasting and painting operations on the bridge from which waste was generated, if sampling is not performed within the first week of production blasting.

Test composite samples for lead, chromium, cadmium and arsenic according to the U.S. EPA Publication SW 846 Method 1311 (TCLP). Provide the Chain of Custody and test results to the District Regulated Waste Engineer (DRWE) immediately after the test results are available. If the DRWE determines the blasting debris is hazardous, as defined below, provide the Engineer with the names of the hauler and treatment facility. Perform all sampling and testing required by the hauler, treatment facility, or disposal facility.

The existing paint removed from bridges may contain lead, chromium, cadmium or arsenic. The Contractor is responsible for taking the proper safety precautions to ensure workers in this environment are properly protected.

**1. Hazardous Waste.** The blasting debris is hazardous if lead, chromium, cadmium or arsenic exceed any of the regulatory concentration limits shown below:

SW 846 Analyte	Regulatory Concentration Limit
Lead	5.0 mg/l
Chromium	5.0 mg/l
Arsenic	5.0 mg/l
Cadmium	1.0 mg/l

Label all the containers of hazardous blasting debris “HAZARDOUS”. Secure the storage location by surrounding the site with a 5 foot (1.5 m) high chain link fence fabric supported by traffic sign drive posts 10 feet (3 m) apart. Drive the traffic signposts into the ground at least 2 feet (0.6 m) deep. Secure the fencing with padlocks at the end of each day. Post hazardous waste warning signs at obvious locations on the fenced enclosure.

The Office of Construction Administration will obtain a generator number assigned to the State. After the Office of Construction Administration obtains the generator number, arrange for the hauling, treating, and disposing of the hazardous waste. Use a firm licensed by EPA to haul and dispose of the hazardous waste. This firm is also responsible for providing the completed Uniform Hazardous Waste Manifest (EPA Form 8700-22, or current version).

In every case, properly dispose of all hazardous waste within 60 days after it is generated. If hazardous waste is not properly disposed of within 60 days, the Department will consider the Contractor in breach of its Contract and the Department will take the following actions:

- a. Immediately suspend all abrasive blasting and painting of structural steel on the Project until hazardous waste is properly disposed.
- b. Cease processing all pay estimates.
- c. Forward a breach of contract notification to the Contractor’s Surety.

The Contractor is responsible for fines or liens assessed by any governmental agency that has jurisdiction over the disposal of this hazardous waste material.

Decontaminate or dispose of all collection and containment equipment according to EPA guidelines.

The Contractor shall inform the Department when all hazardous waste has been removed from the Project so the EPA Site ID Number (Hazardous Waste Generator Number) can be deactivated.

**2. Non-Hazardous Solid Waste.** For all waste that is determined to be a Non-Hazardous Solid Waste by the DRWE, the Contractor is required to:

- a. Before disposing of any material, provide the Engineer with documentation that the disposal facility is licensed by the EPA to accept non-hazardous solid waste.

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- b. Haul and dispose of the waste to the documented, non-hazardous solid waste facility.
- c. Obtain from the disposal facility and provide the Engineer with a receipt that documents disposal of waste material at the licensed disposal facility.
- d. Properly dispose of all waste within 60 days after it is generated.

**514.14 Washing Shop Primer** (QCP #7). Wash shop primed structural steel after it is erected and the concrete deck is placed and within 30 days of applying the intermediate coat.

Wash the steel with potable water. Use equipment capable of delivering the water at a nozzle pressure of at least 1000 pounds per square inch (7 MPa) and at a rate of not less than 4 gallons (15 L) per minute. The Contractor shall provide the Engineer with equipment specifications that verify both the delivery pressure and rate. Provide gauges on the equipment to verify the pressure during operation. Hold the nozzle a maximum of 12 inches (300 mm) from the surface being washed. The surface is clean when clear rinse water runs off the structure. After rinsing the surface, inspect for remaining dirt and rewash dirty areas until clean.

**514.15 Handling.** Deliver all paint and thinner in original unopened containers with labels intact. The Engineer or Inspector will accept containers with minor damage provided the container is not punctured. Thinner containers shall be a maximum of 5 gallons (19 L). Before use, provide the Engineer with shipping invoices for all painting materials used on the Project.

Supply containers of paint and thinner with labels clearly marked by the manufacturer to show paint identification, component, color, lot number, stock number, date of manufacture, and information and warnings as may be required by Federal and State laws.

Store paint at the temperature recommended by the manufacturer and in a storage facility that prevents theft. Provide thermometers capable of monitoring the maximum high and low temperatures inside the storage facility.

Before opening paint or thinner containers, check the labels to ensure the proper container is opened and the paint has not been stored beyond its shelf life. Do not use paint that exceeded its shelf life. Do not open containers of paint and thinner until required for use and then open the oldest paint of each kind first. Solvent used for cleaning equipment is exempt from the above requirements.

Do not use paint that has livered, gelled, or otherwise deteriorated during storage. Properly dispose of unused paint and paint containers.

**514.16 Mixing and Thinning.** Thoroughly mix all ingredients immediately before use with a high shear mixer (such as a Jiffy Mixer). Do not mix paint using paddle mixers, paint shakers, or an air stream bubbling under the paint surface. After mixing, carefully examine the paint for uniformity and to ensure that no unmixed pigments remain on the bottom of the container. Before use, strain the paint through strainers that remove skins or undesirable matter but not pigment.

Except for primer, mix paint as necessary during application to maintain a uniform composition. Continuously mix primer using an automated agitation system. Do not use hand-held mixers for primer paints.

Do not add thinner to the paint without the Engineer's or Inspector's approval, and only add thinner if necessary for proper application as recommended by the manufacturer's printed instructions. In the Engineer's or Inspector's presence, slowly add the amount of thinner recommended and supplied by the manufacturer to the paint during the mixing process. Do not mix other additives into the paint.

Add catalysts, curing agents, or hardeners that are in separate packages to the base paint only after thoroughly mixing the base paint. With constant agitation, slowly pour the proper volume of catalyst into the required volume of base. Do not pour off liquid that has separated from the pigment before mixing. Use the mixture within the pot life specified by the manufacturer and dispose of unused portions at the end of each workday.

### **514.17 Coating Application.**

**A. General.** Paint all structural steel, scuppers, expansion joints except top surface, steel railing, exposed steel piling, drain troughs, and other areas as shown on the plans. Paint galvanized or metalized surfaces if shown on the plans. Unless otherwise shown on the plans or specified below, apply paint by brush, spray, or a combination of brush and spray methods. If brush and spray are not practical to paint places of difficult access, the Contractor may use daubers, small diameter rollers, or sheepskins.

Use daubers, small diameter rollers, or sheepskins to paint the following areas:

1. Where cross-frame angles are located within 2 inches (50 mm) of the bottom flange.
2. Where end cross frames are within 6 inches (150 mm) of the backwall.
3. Where there is less than 6 inches (150 mm) between the bottom of the bottom flange and the beam seat.

**B. Application Approval.** The Engineer or Inspector may inspect the initial application of the prime, intermediate, and final coats. If the Engineer or Inspector discovers defects, adjust the method of application to eliminate the defects then continue applying the coat.

**C. Additional Information Pertaining to Shop Applied Primer.** Apply a prime coat to all structural steel surfaces including insides of holes, behind stiffener clips and contact surfaces of connection, and splice material that is to be fastened with bolts in the shop or field. Apply a mist coating from 0.5 to 1.5 mils (12.5 to 37.5  $\mu\text{m}$ ) on surfaces that are to be imbedded in concrete and on surfaces within 2 inches (50 mm) of field welds other than those attaching intermediate or end cross frames to beams or girders. Apply one coat of primer to pins, pin holes, and contact surfaces of bearing assemblies, except do not paint those containing self-lubricating bronze inserts. Once the prime coat is dry, apply erection marks, using a thinned paint of a type and color that is completely concealed by, and compatible, with the second coat.

Do not handle or remove structural steel coated with inorganic zinc primers from the shop until the paint has cured as specified by the paint manufacturer's printed instructions.

Reduce the thickness of thick films of inorganic zinc primer by screening, sanding, or sweep blasting. If the primer paint cured longer than 24 hours, apply a re-coating of primer paint according to the paint manufacturer's printed instructions. Abrasive blast and re-apply the primer to the affected area if "mud cracking" occurs. If "checking" occurs, abrasive blast and reapply the primer or remove the "checking" by screening and evaluate the area by adhesion testing.

**D. Surface Cleanliness.** All surfaces to be painted shall be free of dust, dirt, grease, oil, moisture, overspray, and other contaminants. If the surface is degraded or contaminated, restore the surface before applying paint. In order to prevent or minimize degradation or contamination of cleaned surfaces in the field, the prime coat of paint shall be applied within 12 hours of the beginning of the abrasive blasting operation as required in surface preparation above, for steel which is cleaned and painted in the shop, the prime coat of paint shall be applied within 24 hours of the beginning of the blasting operation.

Schedule cleaning and painting when dust or other contaminants will not fall on wet, newly painted surfaces. Protect surfaces that do not receive paint or have already been painted from the effects of cleaning and painting operations. Before applying the next coat, remove overspray and bird droppings with a stiff bristle brush, wire screen, or a water wash with sufficient pressure to remove overspray and bird droppings without damaging the paint. Before applying the next coat, remove all abrasives and residue from painted surfaces with a vacuum system equipped with a brush type cleaning tool.

Remove all visible abrasives on the finish coat that came from adjacent work.

**E. Brush Application.** Apply the paint to produce a smooth coat. Work the paint into all crevices, corners, and around all bolt and rivet heads. Apply additional paint as necessary to produce the required coating thickness.

**F. Spray Application (General).** Apply paint using spray application as follows:

Keep spray equipment clean so that dirt, dried paint, solvents, and other foreign materials are not deposited in the paint film. Remove solvent left in the equipment before using the equipment.

Apply paint in a uniform layer with overlapping at the edges of the spray pattern. Paint the border of the spray pattern first, followed by painting the interior of the spray pattern. Complete painting a spray pattern before moving to the next spray pattern area. Within a spray pattern area, hold the gun perpendicular to the surface and at a distance that will ensure a wet layer of paint is deposited on the surface. Release the trigger of the gun at the end of each stroke. To ensure coverage, spray all bolts and rivet heads from at least two directions or apply the paint to bolts and rivet heads using a brush.

Each spray operator shall demonstrate to the Engineer or inspector the ability to apply the paint as specified before the operator sprays paint.

If mud cracking occurs, the affected area shall be cleaned to bare metal in accordance with surface preparation above and repainted. Fill all gaps and crevices 1/8 inch (3 mm) or less with primer.

Use spray equipment recommended by the paint manufacturer and suitable for use with the specified paint. Provide adequately sized traps or separators to remove oil and condensed water from the air. Periodically drain the traps during operations. To ensure that the traps or separators are working properly, test by blowing air from the spray gun for 30 seconds onto a white cloth or blotter held in a rigid frame. The Engineer or Inspector will verify the test results by inspecting the white cloth or blotter. If the cloth or blotter retains oil, water, or other contaminants, suspend painting until retests verify the problem was corrected. Perform this test at the start of each shift and at 4-hour intervals. This is not required for an airless sprayer.

Do not use spray application unless the operation is totally enclosed as required for abrasive blasting, to prevent overspray damage to the ground, public and private property, vegetation, streams, lakes, and other surfaces not to be painted.

**G. Prime, Intermediate, and Finish Coat Application (QCP #5, #8, and #10).** Apply paint as a continuous film of uniform thickness, free of all defects such as holidays, pin holes, mud cracking, checking, drips, runs, and sags. The Contractor is responsible for applying the manufacturer's paint as necessary to satisfy the above requirement. Repaint all thin spots or areas missed before the next coat of paint is applied.

Ensure that each coat of paint is properly cured before applying the next coat. Comply with the manufacturer's written instructions for the time interval between coats and apply the next coat when an additional coat will not cause detrimental film irregularities, such as lifting, wrinkling, or loss of adhesion of the undercoat. Do not exceed the following time intervals. If the prime coat is organic zinc, the maximum time between the prime and intermediate coats is 30 days. There is no maximum time between the prime and intermediate coats for an inorganic zinc primer. The maximum time interval between intermediate and finish coats is 13 days. These maximum recoat times include adverse weather days and the Engineer will not extend the times. If the next coating is not applied within the times stated above, remove the coatings and re-blast the steel according to SSPC-SP 10.

Stencil the Completion Date (month and year) of the finish coat and the letters of the applied paint system on the steel in 4 inch (100 mm) letters with black urethane paint. The appropriate letters for the paint systems are as follows:

<b>System Comprised of:</b>	<b>Letters</b>
Inorganic zinc prime coat, epoxy intermediate coat, and urethane finish coat	IZEU
Organic zinc prime coat, epoxy intermediate coat, and urethane finish coat	OZEU

Apply the date and paint system at four locations near the end of each outside beam on the outside web visible from the road or as directed by the Engineer.

**514.18 Removing Fins, Tears, or Slivers (QCP #6).** Use a grinder to remove all fins, tears, slivers, or any other burred or sharp edges that become evident after applying the prime coat. Retexture ground surfaces to produce a profile from 1.5 to 3.5 mils (40 to 90  $\mu\text{m}$ ) and reprime ground surfaces before applying the intermediate coat. The Contractor may begin removing fins, tears, and slivers after blasting and before priming. Temperature and weather restrictions do apply to removing fins, tears, and slivers, and to applying the prime coat.

**514.19 Caulking (QCP #9).** After the intermediate coat cures and before applying the finish coat, caulk gaps or crevices greater than 1/8 inch (3 mm).

**514.20 Dry Film Thickness (QCP #5, #8, and #10).** Determine prime coat thickness; prime and intermediate coat thickness; and prime, intermediate, and finish coat thickness using a Type 2 magnetic gage as follows:

Measure paint thickness at separate, evenly spaced, spot measurement locations over each 100-square foot (9  $\text{m}^2$ ) of area of structural steel. Locate five spot measurements on each of the following locations: top flanges; bottom flanges; webs; cross bracing; stiffeners; etc. At each spot location, take three gage readings of either the substrate or the paint. Move the probe 1 to 3 inches (25 to 75 mm) for each new gage reading. Discard an unusually high or low gage reading that is not consistently repeated. The spot thickness measurement is the average of the three gage readings.

The average of five spot measurements for each location in the 100-square foot (9  $\text{m}^2$ ) area shall not be less than the specified thickness. No single spot measurement area shall be less than 80 percent of the specified minimum thickness nor greater than 150 percent of the maximum specified thickness when organic zinc is applied and 120 percent of the maximum specified thickness when inorganic zinc is applied. Any one of three readings which are averaged to produce each spot measurement, may under run or overrun by a greater amount. Take five spot measurements per location for each 100-square foot (9  $\text{m}^2$ ) area as follows:

A. For all shop painted steel, regardless of size, randomly select and then measure one 100-square foot (9  $\text{m}^2$ ) area within each 300 square foot (27  $\text{m}^2$ ) unit of surface area that is painted.

B. For structures not exceeding 300 square feet (27  $\text{m}^2$ ) in area, measure each 100-square foot (9  $\text{m}^2$ ) area.

C. For structures not exceeding 1000 square feet (90  $\text{m}^2$ ) in area, randomly select and then measure three 100-square foot (9  $\text{m}^2$ ) areas.

D. For structures exceeding 1000 square feet (90  $\text{m}^2$ ) in area, measure the first 1000 square feet (90  $\text{m}^2$ ) as stated in section C and for each additional 1000 square feet (90  $\text{m}^2$ ), or increment thereof, randomly select and then measure one 100-square foot (9  $\text{m}^2$ ) area.

E. If the dry film thickness for any 100-square foot (9  $\text{m}^2$ ) area (sections C and D) is not in compliance with the requirements of this subsection, then measure each 100-square foot (9  $\text{m}^2$ ) area.

F. Measure other areas or revise the number of spot measurements as shown on the plans.

Each coat of paint shall have the following thickness measured above the peaks:

	<b>Min. Spec. Thickness</b>	<b>Max. Spec. Thickness</b>	<b>Min. Spot Thickness</b>	<b>Max. Spot Thickness (Inorganic Zn)</b>	<b>Max. Spot Thickness (Organic Zn)</b>
Prime	3.0 mils (75 µm)	5.0 mils (125 µm)	2.4 mils (60 µm)	6.0 mils (150 µm)	7.5 mils (188 µm)
Intermediate	5.0 mils (125 µm)	7.0 mils (175 µm)	4.0 mils (100 µm)	10.5 mils (263 µm)	10.5 mils (263 µm)
Subtotal	8.0 mils (200 µm)	12.0 mils (300 µm)	6.4 mils (160 µm)	16.5 mils (413 µm)	18.0 mils (450 µm)
Finish	2.0 mils (50 µm)	4.0 mils (100 µm)	1.6 mils (40 µm)	6.0 mils (150 µm)	6.0 mils (150 µm)
Total	10.0 mils (250 µm)	16.0 mils (400 µm)	8.0 mils (200 µm)	22.5 mils (563 µm)	24.0 mils (600 µm)

Remove paint with a film thickness greater than the maximum specified thickness unless:

A. The paint does not exhibit defects such as runs, sags, bubbles, or mud cracking, etc.

B. The manufacturer provides a written statement to the Engineer that the excessive thickness is not detrimental.

For any spot or average of five spots at any location of a 100-square foot (9 m<sup>2</sup>) area that exceeds the maximum spot thickness, either remove and replace the coating according to 514.22 or prove to the Office of Construction Administration that the excess thickness will not be detrimental to the coating system. In order to prove to the Office of Construction Administration that the excess thickness will not be detrimental to the coating system, the Contractor must provide the Office of Construction Administration with the following information.

Certified test data proving that the excessive thickness will adequately bond to the steel when subjected to thermal expansion and contraction. The thermal expansion and contraction test shall take place over five cycles of a temperature ranges from -20° to 120 °F (-49° to 49°C). After the thermal contraction and expansion cycles have taken place, the tested system shall be subjected to pull off tests and the results compared to the results of pull off tests that have been performed on a paint system with the proper thicknesses. In addition to the certified test results, the Contractor shall provide the Office of Construction Administration a written statement from the paint manufacturer stating that the excessive thickness is not detrimental.

If the Office of Construction Administration does not approve the excessive coating thicknesses or the Contractor elects not to provide the required written statement from the paint manufacturer and the certified test results when required,

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the Contractor shall remove and replace the coating. The removal and replacement of the coating shall be done as specified in 514.19.

### 514.21 Final Inspection.

A. The Engineer will select locations for coating removal for inspection of surface preparation and dry film thickness. For all structures in which the supporting members are rolled beams or girders, remove a minimum of one location per 150 linear feet (46 m) of beam line for webs and flanges and 5% of all cross frame assemblies and other secondary structural members shall be selected for destructive testing. For all other bridge types with structural steel, remove one location for every 1,200 square feet (108 m<sup>2</sup>) of steel surface for destructive testing. Do not perform destructive testing on areas that have been painted with an inorganic zinc prime coat.

B. At the selected areas, the Engineer will perform total dry film thickness testing using a type 2 magnetic gage. If the dry film thickness for that spot does not meet the requirements of 514.18, additional measurements will be taken to determine the extent of the deficient coatings.

C. At the selected areas, where an organic zinc prime coat has been applied, remove at least 9 square inches (58 cm<sup>2</sup>) of the new coatings by methods that will not damage the surface of the steel. Approved removal methods are scraping, sanding, or the use of solvents. Do not use power tools. Perform removal while in the presence of the Engineer. The Engineer will document and photograph the selected areas after removal of the new coatings. If work is found not to be in conformance with the specifications and pertinent contract documents, additional locations may be selected for testing.

D. Make repairs of areas where the coatings were removed and other areas that were determined to be deficient. Make repairs as per 514.22. If the final destructive testing according to 514.21.C, reveals greater than 15% of the areas inspected are not in complete conformance with the specifications and pertinent contract documents, the Department will require that surface preparation and painting of the structural steel be completely redone to meet the requirements of the Contract Documents at no additional cost to the Department.

E. Final Acceptance shall be based upon the results of the surface preparation observations and dry film thickness measurements obtained from the final inspection. Final Acceptance will also take into consideration acceptable progressive project documentation and progressive field measurements in determining the final acceptability of the Bridge Paint System.

Inspection access to the test locations to perform the required final inspection measurements shall conform to the requirements of 514.10.

**514.22 Repair Procedures.** Remove paint and correct defects or damaged areas, including areas damaged by welding, and in areas that do not comply with the requirements of this specification. Correct defects and damaged areas using the same paint as originally applied except the Engineer may approve using organic zinc to repair inorganic zinc in the field. Retexture the steel to a near white condition and a profile between 1.5 to 3.5 mils (40 to 90 μm). Measure the profile

immediately before applying the prime coat to ensure the profile is not destroyed during the feathering procedure. See 514.13C.

Feather the existing paint to expose a minimum of 1/2 inch (13 mm) of each coat.

During the reapplication of the paint, apply paint as follows:

- A. Apply the prime coat only to the surface of the bare steel and the existing prime coat exposed by feathering. Do not apply the prime coat to the adjacent intermediate coat.
- B. Apply the intermediate coat only to the new prime coat and the existing intermediate coat exposed by feathering. Do not apply the intermediate coat to the adjacent finish coat.
- C. Apply the finish coat only to the new intermediate coat and the existing finish coat that was feathered or lightly sanded. Do not apply the finish coat beyond areas that were feathered or lightly sanded.

At the perimeter of the repair area, apply the prime and intermediate coats using a brush. Apply the finish coat using either brush or spray.

The Contractor may need to apply several applications to obtain the proper thickness for each coat.

During the application of the prime coat, the paint shall be continuously mixed.

Perform all surface preparation and painting according to this specification. Instead of abrasive blasting, the Engineer may allow alternate methods of preparing the surface.

Blend repair areas with the adjacent coating and provide a finished surface in the patched areas that is smooth and has an even profile with the adjacent surface.

Submit, in writing, the method of correcting areas with runs to the Office of Construction Administration for approval.

**514.23 Method of Measurement.** The Department will measure Surface Preparation of Existing Structural Steel and Field Painting of Existing Structural Steel Prime Coat by the number of square feet (square meters) of structural steel painted or on a lump sum basis. The Department will measure Field Painting Structural Steel, Intermediate Coat and Field. Painting Structural Steel, Finish Coat by the number of square feet (square meters) or pounds (kilograms) of structural steel painted, or on a lump sum basis.

The Department will determine the number of pounds (kilograms) of new structural steel painted by the accepted pay weight of the new structural steel.

For steel beam and steel girder bridges, the Department will determine the surface area by taking a nominal measurement of the beams (i.e., two times the beam depth plus three times the flange width). In addition to this nominal measurement, the Department will add a percentage to account for incidentals such as cross frames, bearing assemblies, stiffeners, expansion joints, scuppers, etc. It is not necessary for the Engineer or Inspector to field measure every detail of the bridge to verify quantities. If there is a quantity dispute, exact field measurements

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of all painted surfaces and calculations will govern over the above percentage to account for incidentals.

For extremely complex bridges, such as trusses, the Department will pay for painting on a lump sum basis.

The Department will measure grinding fins, tears, slivers on existing structural steel by the number of man hours expended by the workers actually doing the grinding and will include the time when the workers are performing grinding and repairing prime coat and not limited to only the actual grinding duration (i.e., the Department will include all hours of the workers when assigned to grinding regardless of actual grinding time). The Department will not measure grinding fins, tears, and slivers on new steel but will consider it incidental to unit price for the new steel.

**514.24 Basis of Payment.** The Department will pay for accepted quantities at the Contract prices as follows:

The Department may consider paint as eligible for payment for material on-hand as specified in 109.10, however, only paint that the Contractor can prove to the Engineer will be used during the construction season is eligible for payment. The Contractor shall provide the Engineer calculations indicating the total square feet (square meter) of steel to be painted during the construction season. The Contractor shall also provide calculations showing the total number of gallons (liters) required.

If the Contractor causes damage or injury to public or private property, the Department will not pay for restoring the property to its original condition.

The Department will not pay for repairing adjacent coatings damaged during the blasting operation.

The Department will not pay for removing and replacing an area of coating because a spot or maximum average thickness exceeds the maximum spot thickness.

The Department will not pay for additional testing required by any hauler, treatment facility, disposal facility or landfill.

The Department will pay for caulking under Field Painting Structural Steel, Intermediate Coat.

The Department will pay for final inspection access, test area preparation and test area repair at each selected area under Final Inspection Repair. The Department will not pay for accessing, inspecting, and repairing areas that are not found to be in conformance with the specifications and pertinent contract documents.

All other requirements of this specification are considered incidental to the work.

<b>Item</b>	<b>Unit</b>	<b>Description</b>
514	Square Foot (Square Meter) Lump Sum	Surface Preparation of Existing Structural Steel
514	Square Foot (Square Meter) Lump Sum	Field Painting of Existing Structural Steel, Prime Coat
514	Square Foot (Square Meter) Lump Sum, Pound (Kilogram)	Field Painting Structural Steel, Intermediate Coat
514	Square Foot (Square Meter) Lump Sum, Pound (Kilogram)	Field Painting Structural Steel, Finish Coat
514	Man Hour	Grinding Fins, Tears, Slivers on Existing Structural Steel
514	Each	Final Inspection Repair

## **ITEM 515 PRESTRESSED CONCRETE BRIDGE MEMBERS**

### **515.01 Description**

### **515.02 Fabricator Approval Procedure**

### **515.03 Levels of Fabricator Qualification**

### **515.04 General**

### **515.05 Fabricator Documentation Responsibility**

### **515.06 Shop Drawings**

### **515.07 Pre-Fabrication Meeting**

### **515.08 Materials**

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### **515.11 Weather Conditions During Production**

### **515.12 Equipment**

### **515.13 Inspection Facilities**

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### **515.16 Release of Prestressing Strands**

### **515.17 Fabrication tolerances**

### **515.18 Prestressed Member Acceptance and Repair**

### **515.19 Handling, Storage, Transportation, and Erection**

### **515.20 Safety Requirements**

### **515.21 Method of Measurement**

### **515.22 Basis of Payment**

**515.01 Description.** This work consists of preparing shop drawings and manufacturing, testing, fabricator performed quality control and documentation, and handling, transporting, storing, and erecting prestressed concrete bridge members.

**515.02**

**515.02 Fabricator Approval Procedure.** Select fabricators that are pre-qualified and evaluated by the Office of Materials Management (OMM) according to Supplement 1079 and listed by the Department before the Contract letting Date.

**515.03 Levels of Fabricator Qualification.** There are three levels of fabricator qualification. The Laboratory will classify each fabricator at the highest level of fabrication it is qualified to perform.

Level	Description of Capabilities
1	Straight strand prestressed box beam members
2	Straight strand prestressed I-beam members
3	Draped strand prestressed I-beam members

**515.04 General.** Produce all members according to Item 511, except as otherwise specified herein.

**515.05 Fabricator Documentation Responsibility.** The fabricator shall keep and maintain records for each project bid line number concerning:

- A. Fabricator plant approval.
- B. Shop drawing approval.
- C. Material test reports.
- D. Welding qualifications.
- E. Quality Control Plan (QCP) per Supplement 1079.

The fabricator shall provide access to the above records for audit, inspection, and copying. Provide a copy of the complete records at the completion and final shipment of the work. The Fabricator shall retain all documentation for at least 5 years from the date of final shipment from the fabrication shop.

The fabricator shall document all Quality Control (QC) activities to verify the fabrication conforms to the specification requirements. QC activities include material quality checks, dimensional checks, weld inspections, strand tensioning procedures, release procedures, post-pour inspections, concrete strengths at release of strand and final strength of concrete before shipment, cleaning operations, coating applications, final QC inspections, repairs and all other QC procedures required to provide a prestress concrete member conforming to the specifications.

Supplement 1079 defines the quality control plan evaluation process and quality control plan enhancement process

The Department will perform a quality assurance (QA) evaluation of the fabricator’s quality control performance using forms in Supplement 1079 and will include both validation of the fabricator’s actual records of inspection and Department inspection.

**515.06 Shop Drawings.** Provide shop drawings conforming to 501.04 and the following requirements.

Include all details, dimensions, dimensional tolerances, size of materials, lifting devices, inserts, reinforcing steel supports, fabricator incorporated reinforcing, piece mark diagrams for field connection and erection of any steel and all prestress

members, and all other information necessary for the complete fabrication and erection of the prestressed members. Show all items that will be incorporated into each prestressed member.

Provide the detensioning procedure and pattern conforming to 515.16.

**515.07 Pre-Fabrication Meeting.** At least 7 days after the Department receives shop drawings, conduct a pre-fabrication meeting at the fabricator's facilities, or another location agreed to by all parties.

As part of the pre-fabrication meeting request, provide a initial fabrication schedule for the prestressed beam project including:

- A. Start date for fabrication of the project
- B. Expected phasing of fabrication, if any
- C. Number of workdays for the project and length of work day
- D. Quality control final inspection date

The fabricator's production manager, quality control specialists (QCS) for the project, the Department's inspector, and the Contractor, or its designated representative, shall attend the meeting. The meeting is to review fabrication issues, including information on shop drawings, previous QC/QA inspection issues, QC and Quality Assurance inspection hold points, unique and special fabrication items, and special processes. The QCS will conduct the meeting and record and distribute meeting minutes that document all issues discussed. Begin fabrication when all meeting issues have been resolved.

Office of Material Management may waive the pre-fabrication meeting if accepted by the Fabricator and the Contractor. If Contractor submitted shop drawings do not comply with the requirements of 515.06, no pre-fabrication meeting can be scheduled or waived.

**515.08 Materials.** Furnish materials conforming to:

Reinforcing steel .....	509
Concrete .....	515.15
Portland cement .....	701.01 thru 701.09
Aggregate* .....	703.02
Air-entraining admixture .....	705.10
Chemical admixtures for concrete .....	705.12
Prestressing steel .....	711.27
Transverse tie rods .....	711.01

\* For fine aggregate, use natural sand for members without a separate wearing course. Modify coarse aggregate as follows:

Do not allow more than 0.4 percent deleterious materials.

For gradation, use No. 57, 6, 67, 68, 7, 78, or 8 size coarse aggregate.

**515.09 Materials Approval.** The fabricator shall control, test, and validate material requirements for all materials either incorporated into the prestressed fabricated item or supplied under Item 515 as component parts to the fabricated

## 515.10

items. The fabricator shall provide S 1079 documentation to the inspector at the time of final inspection.

The Department will not sample materials at the fabricator's shop for Department approval. The Department will randomly sample materials to verify the fabricator's performance.

**515.10 Casting Beds.** Use steel or concrete casting beds set above grade to ensure the beds remain above the accumulation of water resulting from production and curing operations. Design beds and abutments capable of safely resisting all forces applied to them without appreciable movement or deflection. These forces include compression and eccentric forces due to end-jacking operations, forces at hold down points when draped strands are used, and downward forces due to the dead weight of the members.

**515.11 Weather Conditions During Production.** Make temperature change adjustments to initial strand tensioning according to PCI Quality Control Manual 116.

**A. Cold Weather.** Conform to the requirements of this subsection if the ambient air temperature is below 50 °F (10 °C). Heat mixing water, aggregates, or both as necessary to produce a concrete temperatures from 50 to 70 °F (10 to 21 °C) when placed. Do not allow water heated above 150 °F (66 °C) to directly contact the cement. Do not place concrete against forms, reinforcing steel, prestressing strand, or other hardware materials with a temperatures below 32 °F (0 °C).

Do not place concrete when the ambient temperature with sustained wind chill factor at the point of concrete placement is below 0 °F (-18 °C).

**B. Hot Weather.** If the ambient temperature is above 90 °F (32 °C) cool the mixing water, aggregates, or both, as necessary to produce a concrete temperature from 70 to 90 °F (21 to 32 °C). Do not place concrete against forms, mild reinforcing steel, prestressing strand, or other hardware materials with a temperature greater than 120 °F (49 °C).

Water fog spray forms, mild reinforcing steel and strand just prior to placing the concrete. Cover beams immediately after casting to prevent surface drying.

Do not place concrete when the ambient temperature at the point of concrete placement is above 100 °F (38 °C).

**C. Inclement Weather.** If a rainfall event begins after placement of concrete in the forms has begun, provide cover and complete only the beam that had concrete in it when the rain began. Provide immediate cover over previously poured concrete, not yet cured. Resumption of concrete placement is permitted after the rainfall stops.

**515.12 Equipment.** Provide hydraulic jacks of sufficient capacity and stroke to tension strands. Use either single or multiple strand tensioning. Provide tensioning jacks equipped with automatic cutoff valves and equipped with 6 inch (150 mm) minimum diameter gages that provide readings at 500-pound (2 kN) increments. Calibrate gages for the jacks with which they are to be used. Have a graph or table showing the calibration available for the inspector. Calibrate jacks

according to a method acceptable to the Laboratory at least every 6 months or as required by the Director. Maintain calibration documentation as part of the project's QC inspection records.

Design the jacking system to ensure uniform stress in all strands. If simultaneously tensioning multiple strands, use approved types of dynamometers to equalize the initial stress on all strands before applying the full tensioning load with the master jack. Provide dynamometers with sufficient capacity to ensure that the desired readings are in the middle to upper range.

**515.13 Inspection Facilities.** The fabricator shall provide the inspector office accommodations conforming to the following requirements:

- A. Minimum floor area of 120 square feet (11 m<sup>2</sup>).
- B. Minimum ceiling height of 7 feet (2.1 m).
- C. Adequate working and storage facilities, work space, lighting, electrical outlets, lockable files or cabinets and ventilation.
- D. Heat capable of maintaining a temperature of not less than 68 °F (20 °C).
- E. Telephone with direct access to an outside trunk line for the inspector's exclusive use.
- F. A set of keys for the lockable files or cabinets in the office.

**515.14 Construction Methods.** Use metal forms capable of producing members within the tolerances shown on the plans. Forms made of material other than metal may be used for bulkheads and voids. Ensure that the surfaces of the forms in contact with the concrete are smooth and the joints between panels are tight. The soffit form shall have a plane surface at right angles to the vertical axis of the members and have the two bottom edges beveled 3/4 inch (19 mm) with a triangular strip built into the forms. Increase the length of the forms for elastic shortening and normal concrete shrinkage, and design the forms to accommodate this movement.

Provide water-resistant formwork for box beam voids constructed of a material that resists breakage and deformation during placement of concrete. Provide form material that does not excessively increase the dead load of the beams.

Prevent the release agent from contacting the prestressing strands or reinforcing steel.

Install and assemble reinforcing steel according to the approved shop drawings. If authorized, weld reinforcing cages using welders qualified to AWS D1.4. Do not weld epoxy coated or galvanized reinforcing steel unless approved by Office of Material Management. Repair all coating areas damaged by welding according to the coating manufacturer's instructions. Reject reinforcing steel with a loss of cross-section of reinforcing caused by welding.

Provide a protective covering for the prestressed steel from the elements until the strand is pulled into the bed. Accurately place strands in the positions shown on the shop drawings. Do not use strands with kinks, bends, nicks, broken wires, scale, loose rust, or other defects. The fabricator may use slightly rusted reinforcing steel provided the rust is not sufficient to cause visible pits. Before

## 515.15

placing the concrete, carefully clean the strands of all dirt, grease, oil, or other foreign matters. Do not splice strands within a member.

Tension strands uniformly to the stress indicated on the shop drawings. If multiple stands are stressed simultaneously, use dynamometers to equalize the initial stress on all strands before applying full tension load with master jack. Measure the required stress in the strands using the calibrated jacking equipment gages, and check the measured stress by the elongation of the strands. If the stress from the gages and the measured elongation are not within a 5 percent tolerance of the design, stop stressing the strands and determine the reason for the differences. The quality control specialist shall keep a record of the jacking forces and elongations of all strands. Secure the strands by suitable anchorage devices capable of developing at least 85 percent of the ultimate strength of the strands. The anchorage shall not allow the strand to slip after the tensioning operation.

If using draped strands, the loss of stress due to friction shall not exceed 5 percent. Tension the strands at both ends. The quality control specialist shall measure the loss due to friction by a procedure approved by the Office of Material Management. Place hold-down points within 3 inches (90 mm) of the locations shown on shop drawings and within 12 inches (0.3 m) of the locations shown on the plans.

**515.15 Concrete.** The fabricator shall provide concrete mix designs to Office of Material Management. The submittal will include:

A. Test data showing the mix achieves the required 28-day strength when cured by methods used for member fabrication.

B. Maximum w/c ratio

C. A design and maximum slump

D. Test data showing the mix design achieves 2000 coulombs or less @ 90 days when tested per AASHTO T277. Use samples for the test that were mixed without corrosion inhibitors and that were cured with the same methods that will be used to produce the prestressed concrete bridge members. Do not apply additional cure to samples that have reached the required design strength.

Changes in proportioning, cement, pozzolans or aggregate will require retesting and resubmittal. Office of Materials Management may waive the retests. Provide the waiver request in writing and include all information for the new mix design and a comparison to the previously tested and approved mix design(s).

Deliver concrete according to Item 499, except that 499.03 and 499.04 does not apply. The plastic air content of the concrete before placement shall be  $6 \pm 2$  percent. If the Department questions the concrete's placed air content, obtain cores from the prestressed member and have hardened air testing performed by an independent testing lab acceptable to the Department. Beams with hardened air contents below 4% will be rejected. Add an approved corrosion inhibiting admixture at the approved dosage and document the dosage that has been incorporated into each batch of concrete.

Maintain the mix design slump during production. Segregation of the mix is not acceptable. Do not exceed the maximum water-cement ratio during concrete

production. When using admixtures to increase the slump, use Type F or G as described in 705.12. Do not use calcium chloride or admixtures containing calcium chloride.

For beams containing up to 20 yards of concrete each, make at least two cylinders from both the first and last loads placed on each casting bed, each day. If producing more than 200 feet (60 m) of beam on the same bed, make at least two additional cylinders for each additional interval of 100 feet (30 m) or part thereof. In general, produce the additional cylinders from a load placed in the middle of the additional member length. The QCS shall determine the exact location for these samples.

For beams containing between 20 and 35 yards of concrete, make at least one set of two cylinders per beam. For beams containing more than 35 yards of concrete, make at least two sets of two cylinders per beam.

Determine strength, for both strand release and final shipping, by testing a group of cylinders, which consists of one cylinder from every sample location. Each group of cylinders shall have an average strength of what is specified in the shop drawings, and no individual cylinder shall have less than 95 percent of the specified strength.

The inspector may require additional cylinders from locations where the concrete does not conform to mix design or placement requirements. Include these additional cylinders in the group of cylinders for determining release and final strength.

The fabricator may place concrete in the bottom flange of a box beam before placing the interior forms and reinforcement for the upper portion of the member, provided continuous concrete placement is not interrupted for more than 45 minutes.

Screed the top surfaces of non-composite members and finish the surface with a burlap drag or other means to provide a uniform surface with a gritty texture suitable for waterproofing.

Screed the top surface of composite members and finish the surface with a wire broom, in a transverse direction and penetrating the finished surface approximately 1/4 inch (6 mm) + 1/16 inch (1.5 mm) – 1/8 inch (3 mm).

Immediately after final concrete placement and surface finishing, protect the concrete surface with a suitable enclosure until application of live steam or radiant heat. Assure the enclosure's ambient temperature is at least 50 °F (10 °C). Assure the plastic concrete's temperature before initial set doesn't rise more than 10 °F (5 °C) per hour. Limit the total rise before initial set to less than 40 °F (22 °C) and the maximum temperature to 100 °F (38 °C). Record the times and concrete temperatures before initial set.

For curing with low-pressure steam, do not apply live steam directly onto the concrete forms if it causes localized high temperatures.

For accelerated curing with radiant heat, apply radiant heat using pipes circulating steam, hot oil, or hot water, or using electric heating elements. Minimize moisture loss by covering all exposed concrete surfaces with plastic

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sheeting, 705.06, or by applying a liquid membrane curing compound, 705.07, to all exposed concrete surfaces. Before bonding field-cast concrete or other materials in the finished structure, remove the curing compound from the shear faces of composite members and other surfaces.

Start initial application of the steam or heat 2 to 4 hours after final concrete placement. If using retarders, start applying the steam or heat 4 to 6 hours after final concrete placement. If determining the time of initial set according to ASTM C 403, these time limits do not apply. Record and report the actual time of concrete placement of the last load, placement of enclosure and initial set time.

Apply live steam or radiant heat so the ambient temperature within the curing enclosure does not gain more than 40 °F (22 °C) per hour until reaching the curing temperature. Do not exceed 160 °F (71 °C). Only use a maximum temperature of 180 °F (82 °C) if the fabricator documents to the Department that delayed ettringite or alkali silica reaction is not at issue. Maintain the maximum curing temperature until the concrete has reached the required release strength. Detension the strands immediately upon completing the accelerated curing. Keep a record of the time the application of heat began, and curing temperatures throughout the entire curing process.

Neatly fill cavities in the exposed surface of beams with nonshrink grout. Clean the concrete, and apply and cure the grout according to the manufacturer's published recommendations. Reject beams with honeycombing that impairs the member's performance.

**515.16 Release of Prestressing Strands.** Do not release prestressed strands until the concrete reaches a minimum strength of 4000 pounds per square inch (28.0 MPa), or plan defined release strength. Determine strength of concrete by testing cylinders produced according to AASHTO T 23 and cured in the same method as the member. Test cylinders in the fabricator's laboratory. Assure all tested cylinders obtain the required strength of 4000 pounds per square inch (28.0 MPa) or the plan defined release strength. Provide the Department the ability to witness the cylinder testing by notifying the inspector before testing.

Before releasing prestressed strands, loosen or remove forms and hold-downs and all other attachments restricting either horizontal or vertical movement of prestressed members. Release the strands immediately upon completing accelerated curing. Heat release and burn the strands simultaneously between each beam and at all exposed points between anchorages, and follow an approved predetermined pattern, to equalize the forces being transferred to the various areas of the cross-section of the member. Submit any alternative strand release plans during the prefabrication meeting to OMM for approval. For heat release, use a low-oxygen flame to uniformly heat at least a 4 inch (100 mm) long section of strand before completely cutting the strand.

**515.17 Fabrication Tolerances.** Construct all members to conform to the following tolerances.

<b>BEAM DIMENSIONAL TOLERANCES</b>		
<b>Description</b>	<b>Box Beam</b>	<b>I Beam</b>
Length of beam	$\pm 1/8''$ per 10 ft (1 mm/m) max $\pm 3/4''$ (19 mm)	$\pm 1/8''$ per 10 ft (1 mm/m) max $\pm 1''$ (25 mm)
Depth of beam	$\pm 1/4''$ (6 mm)	$+1/2''$ (13 mm) – $1/4''$ (6 mm)
Depth of I beam flange including fillets	N/A	$\pm 1/4''$ (6 mm)
Flange Width	$\pm 1/4''$ (6 mm)	$+3/8''$ (10 mm) – $1/4''$ (6 mm)
Flange Thickness excluding fillets		
a) Top	$+ 1/2''$ (13 mm)	$\pm 1/4''$ (6 mm)
b) Bottom	$+ 1/2''$ (13 mm) – $1/8''$ (3 mm)	$\pm 1/4''$ (6 mm)
Width Web	N/A	$+3/8''$ (10 mm) – $1/4''$ (6 mm)
Width beam walls	$+3/8''$ (10 mm) – $1/4''$ (6 mm)	N/A
Width of Void	$\pm 1/2''$ (13 mm)	N/A
Height of Void	$\pm 1/2''$ (13 mm)	N/A
Box Beam Diaphragm spacing	$\pm 2''$ (50 mm)	N/A
Deviation from True Vertical	$\pm 1/8''$ (3 mm)	$1/8''$ per ft (8 mm per m)
Deviation from Skew Angle	$\pm 1/2''$ (13 mm)	$\pm 1/2''$ (13 mm)

<b>BEAM ACCESSORY TOLERANCES</b>		
<b>Description</b>	<b>Box Beam</b>	<b>I Beam</b>
Position of railing anchors	$\pm 1/4''$ (6 mm)	N/A
Position of lifting Devices	$\pm 6''$ (150 mm)	$\pm 6''$ (150 mm)
Positions of anchor dowels and tie rods, inserts	$\pm 1/2''$ (13 mm)	$\pm 1/2''$ (13 mm)
Deviation from Skew Angle	$\pm 1/2''$ (13 mm)	$\pm 1/2''$ (13 mm)

<b>BEAM STRAND TOLERANCES</b>		
<b>Description</b>	<b>Box Beam</b>	<b>I Beam</b>
Strand tendon position	$\pm 1/4''$ (6 mm)	$\pm 1/4''$ (6 mm)
Strand CG position	$\pm 1/4''$ (6 mm)	$\pm 1/4''$ (6 mm)

<b>REINFORCING STEEL TOLERANCES</b>		
<b>Description</b>	<b>Box Beam</b>	<b>I Beam</b>
Clear cover	-0 + $1/4$ (6 mm)	-0 + $1/4$ (6 mm)
Splice lengths	- 1 $1/2''$ (38 mm)	- 1 $1/2''$ (38 mm)
Stirrup spacing In Anchorage Zone	$\pm 1/4''$ (6 mm)	$\pm 1/4''$ (6 mm)
Stirrup spacing outside Anchorage Zone	$\pm 1''$ (25 mm)	$\pm 1''$ (25 mm)
Stirrup extension above top flange	$+1/4''$ (6 mm) – $1/2''$ (13 mm)	$+1/4''$ (6 mm) – $3/4''$ (19 mm)

<b>BEAM SWEEP AND CAMBER TOLERANCES</b>		
<b>Description</b>	<b>Box Beam</b>	<b>I Beam</b>
Horizontal Sweep	±1/8" per 10 ft (1 mm/m) max ±3/4" (19 mm)	±1/8" per 10 ft (1 mm/m) max ±1" (25 mm)
Max Gap between beam	1" (25 mm)	N/A
Camber – Deviation from Design camber (DC)*	±1/8" per 10 ft (1 mm/m) max ±1/2" (13 mm)	For member lengths ≤ 80 ft: ± 1/8" per 10 ft (1 mm/m) max ± 1/2" (13 mm) For member lengths > 80 ft: ± 1/8" per 10 ft (1 mm/m) max ± 1" (25 mm)
Design plan camber at release (0 days)= Dcr Design plan camber at paving (30 days old) = Dcp Design plan long term camber (720 days old)= Dlcr Formulas For DC [0 – 30 days] = [Dcp-Dcr]* [(beam age/30) + Dcr For DC [> 30 days] = [Dlcr -Dcp] * [(beam age -30)/690] + Dcp		
Variation in camber between beams in same span	max 1/2" (13 mm)	N/A

**515.18 Prestressed Member Acceptance and repair.** Throughout the fabrication process reject all prestressed members not meeting specification requirements.

For all rejected members provide the Department with a complete description of the rejection, and unless waived by the Director, an Ohio registered professional engineer’s written evaluation of the criticalness of the rejection and the professional engineer’s proposed repair method that will repair the rejected member to an acceptable condition. The Department will determine the acceptability of the member and the repair procedure. If acceptable, the fabricator will only make repairs witnessed by the Department’s inspector unless waived by Director.

Use the Precast/Prestress Concrete Institute’s Manual for the evaluation and repair of Precast, Prestressed Concrete Bridge Products MNL-137-06 as a general guide.

**515.19 Handling Storage, Transportation, and Erection.**

Handle, store, transport, and erect the members in an upright position. The direction of support reactions during storage and transportation shall be the same as the member will experience in its in-service position. Do not ship prestressed members until the concrete obtains its 28-day design strength and the inspector’s approval.

Provide at least 30 inches (762 mm) horizontally between each beam for inspection. Provide at least 8 inches (200 mm) of vertical clearance from the bottom. Use storage support locations as close as practical to the in-service

support locations. During storage, provide unyielding horizontal supports and bracing capable of maintaining the members in a vertical position.

Transportation support locations shall be the sole responsibility of the fabricator with respect to member stresses and safe delivery to the job site. If it is necessary to transport the members in a position other than vertical, obtain the Director's written approval.

Provide lifting devices capable of withstanding the required loads to lift and erect the members. During erection, accurately place the prestressed beams on their bearings to ensure a uniform load on all bearings. When shifting a member, lift the member up completely off of its bearings. Temporarily brace the first I-beam erected to its substructure support units in the vertical position before releasing the beam from the crane. Tie each subsequent I-beam to the previously braced beam(s). Provide bracing after erection adequate to prevent sliding, tipping, or other movement that may result from high winds, creeping down the grade, or other causes, until placement of the diaphragms. Within any one day erect and brace at least 2 adjacent members in any one span before suspending operations for the day.

Place box beams to ensure a correct fit of the keyways and to ensure proper grouting of the keyways. After placing the beams and installing tie devices, fill the longitudinal keyways using non shrink keyway grouts, 705.22, approved by OMM. Mix, install, and cure the grout according to the manufacturer's published recommendations to obtain a design compressive strength of 5000 pounds per square inch (34.5 MPa).

Do not allow vehicular load on an individual prestressed concrete box beam until the grout in the keyway obtains the specified design strength of 5000 pounds per square inch (34.5 MPa).

If erection of prestressed members requires placing cranes or launching devices on previously erected spans, submit erection procedures for approval according to Item 501.

At the Director's discretion, repair or replace members damaged by improper handling, storage, transportation, or erection.

**515.20 Safety Requirements.** Provide effective safety measures to prevent injuries to personnel due to breakage of strands or failure of anchorage devices during the tensioning operations. Provide adequate protection and assure the OMM inspector can perform inspection of beams and manufacturing processes. The Department inspector will report any inadequate safety precautions to the plant QCS and to OMM if fabricator remedial action is not taken. OMM inspectors will follow safety rules established by the fabricator, at a minimum. Where fabricator safety rules interfere with the inspectors duties, the process should be altered to allow the inspections to be performed while maintaining the required level of safety.

**515.21 Method of Measurement.** The Department will measure Prestressed Concrete Bridge Members by the number of members.

**515.22**

The Department will measure the intermediate diaphragms by the number of each placed.

**515.22 Basis of Payment.** Payment for prestressed concrete beams include all inserts, sleeves, fittings, reinforcing steel fully or partially encased in the members, and all transverse tie rods necessary to complete this work.

The Department will pay for concrete diaphragms, steel diaphragms, and bearing plates or pads, or other expansion materials, as separate items.

The Department will not pay for repaired or replaced members damaged by improper handling, storing, transporting, or erecting.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
515	Each	Prestressed Concrete Non- Composite Box Beam Bridge Members, Level 1
515	Each	Prestressed Concrete Composite Box Beam Bridge Members, Level 1
515	Each	Straight Strand Prestressed Concrete Bridge I-Beam Members, Level 2
515	Each	Draped Strand Prestressed Concrete Bridge I-Beam Members, Level 3
515	Each	Intermediate Diaphragms

**ITEM 516 EXPANSION AND CONTRACTION JOINTS JOINT SEALERS AND BEARING DEVICES**

- 516.01 Description**
- 516.02 Fabrication**
- 516.03 Coating**
- 516.04 Materials**
- 516.05 Expansion and Contraction Joints**
- 516.06 Joint Sealers**
- 516.07 Bearing Devices**
- 516.08 Method of Measurement**
- 516.09 Basis of Payment**

**516.01 Description.** This work consists of fabricating, assembling, constructing, coating, and installing expansion and contraction joints, vertical extension of structural expansion joints, joint sealers, or bearing devices of the type and size specified.

**516.02 Fabrication.** Fabricate metal joint armor and metal bearings according to Items 513. Select a fabricator that is at least pre-qualified at level SF. The Department will base final acceptance of fabricated members on the Engineer’s approval that the fabricated items that can be successfully incorporated into the structures. Submit mill test reports for structural steel, steel castings, bronze, and sheet lead certified according to 501.06.

**516.03 Coating.** Coat exposed steel bearings according to Items 513 and 514 that are to be attached to structural steel. Galvanize bearings according to 711.02 that are to be attached to concrete beams.

Coat metal parts of expansion joints with metalized 100% zinc wire. Prepare the surface to be coated and apply coating as required by The Society of Protective Coatings SSPC-CS-23.00(1). Apply coating to a minimum thickness of 6 mils.

Repair metalized coatings damaged during fabrication by removal of the damaged coating and reapplication as specified above. Repair metalized or galvanized coatings damaged during shipping, construction, or field welding according to 711.02.

**516.04 Materials.** Furnish materials conforming to:

Structural steel .....	513
Bearing bolts and anchor rods.....	711.10
Painting.....	514
Joint sealer, hot applied .....	705.04
Preformed elastomeric compression stager.....	705.11
Steel castings .....	711.07
Sheet copper .....	711.15
Bronze.....	711.16, 711.17, 711.18
Sheet lead.....	711.19
Preformed bearing pads .....	711.21
Elastomeric bearings.....	711.23
Preformed fillers .....	705.03
Swedged anchor bolts or bars* .....	711.10

\* Fabricated by deforming a minimum of 20 percent of the embedded bolt surface with deformations whose radial dimensions are 15 to 20 percent of the bar diameter.

**516.05 Expansion and Contraction Joints.** Ensure that expansion joints are completely open for the dimension specified for their full length. Remove stones, forms, or other materials that interfere with expansion.

Finish the surface adjacent to preformed expansion joints to a smooth, uniform surface. Use methods that do not interfere with the free compression of the joint material to anchor the expansion joint materials. The joint material shall neatly fill the space, and have a uniform thickness for the full extent of the joint.

**516.06 Joint Sealers.** Before applying joint sealer to the surface, clean the concrete of foreign matter, curing compounds, oil, grease, dirt, free water, and laitance and clean steel by sand blasting.

Apply joint sealer with a minimum depth of 1 inch (25 mm) at its thinnest section. Fill joints to within 1/4 inch (6 mm) of the roadway surface.

Separate joint sealer from contact with asphalt concrete using a barrier of foil or other material that is impervious to the joint sealer.

As required to prevent bonding of the joint sealer with a joint surface, place a suitable bond breaker barrier before applying the joint sealer.

## 516.07

Remove joint sealer that did not bond to the joint face as intended within 24 hours after placing. Clean the joint by sandblasting and reseal the joint.

Mix and place joint sealer according to the manufacturer's instructions. Provide the Engineer with a copy of the manufacturer's instructions.

Protect joint sealer with an impervious masking tape during the application of concrete protective coatings containing mineral spirits.

**516.07 Bearing Devices.** For sliding plates, lubricate the sliding surfaces with flake graphite, and superimpose plates on each other with their edges flush.

Accurately set the level and alignment of elastomeric bearings, bearing plates, and bolsters. Set bearing plates and bolsters on 1/8-inch (3 mm) thick sheet lead, conforming to 711.19, or on 1/8-inch (3 mm) thick preformed bearing pads, conforming to 711.21.

Set bearing plates or bolsters on bridge seat areas that are flat and smoothly finished. If the bridge seat area is high or uneven, use a bushhammer or grinder followed by thin film of portland cement mortar or paste to fill the pitted surface to bring the seat area to the proper elevation and provide a level, even surface. If the bridge seat area is low, use steel plate shims of the same bearing area as the bearing plates and bolsters to bring the seat area to the proper elevation.

Set elastomeric bearing pads directly on the concrete surface.

Position rockers, elastomeric bearings, and rollers so that, when the completed bridge is at 60 °F (16 °C), the rockers and elastomeric bearings are vertical and the rollers are centered on the base.

Set anchor bolts for bearing devices that are clear of the beam or girder flanges, in the concrete after erecting the main structural steel, except as specified below for bearing devices at abutments. Place reinforcing steel in the bridge seat to not interfere with the drilling of anchor holes. Accurately set anchor bolts in the holes and embed the anchor bolts in cement mortar. Until the anchors' are installed, prevent water from entering and or freezing in the anchor bolt holes.

If structural steel interferes with the setting of the anchor bolts, set the anchor bolts before erecting the steel. The Contractor may determine the location of the bolts by using a template and form holes or embed the bolts when placing concrete or, drilling holes in the hardened concrete.

Install anchor bolts to project at least ¼ inch (6mm) beyond the nut when tightened. Damage or burr the threads on the projecting end of the bolt after the nut is tightened. The bolt threads shall not extend to the planes of the contact surfaces between the connected parts. Include the length of two additional threads to the specified thread length of the bolt to allow for thread runout. Washers no thicker than ¼ (6mm) are permitted under the nut.

Permanently fasten bearing devices to the abutments, steel beams, or girders after backfilling the abutments to within 2 feet (0.6 m) of the top of the bridge seat.

**516.08 Method of Measurement.** The Department will measure the specified items by the number of each, square feet (square meters), pounds (kilograms), or

feet (meters) horizontally along the joint centerline and between the outer limits of the fabricated joint.

For deck resurfacing, the Department will measure Structural Steel Expansion Joints extending vertically by the actual horizontal length of joint.

**516.09 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
516	Foot or Pound (Meter or Kilogram)	Structural Steel Expansion Joints
516	Foot (Meter)	Structural Expansion Joints Including Elastomeric ___ Seals
516	Foot (Meter)	Elastomeric Compression Seals for Structural Steel Joints, ___ Width
516	Foot (Meter)	Folder Copper Strip ___
516	Foot (Meter)	Vertical Extension of Structural Expansion Joints
516	Square Foot (Square Meter)	___ Preformed Expansion Joint Filler
516	Foot (Meter)	Joint Sealer
516	Each, Foot, Square Foot, Pound (Meter, Square Meter, Kilogram)	Bearing Devices
516	Each, Square Foot (Square Meter)	___ inch (___ mm) Elastomeric Bearing Pad
516	Each	Elastomeric Bearing with Internal Laminates Only
516	Each	___ × ___ × ___ Elastomeric Bearing with Internal Laminates and Load Plate ___ × ___ × ___
516	Square Foot (Square Meter)	1/8-inch (3 mm) Preformed Bearing Pads

## **ITEM 517 RAILINGS**

**517.01 Description**

**517.02 Fabrication**

**517.03 Materials**

**517.04 Construction Methods, General**

**517.05 Steel and Iron Railings**

**517.06 Aluminum Railings**

**517.07 Method of Measurement**

**517.08 Basis of Payment**

**517.01 Description.** This work consists of furnishing, constructing, coating, and erecting the type of railing specified. This work also consists of providing and galvanizing structural posts, anchors, and connections.

**517.03**

**517.02 Fabrication.** Fabricate railing according to Items 513. Select a fabricator that is at least prequalified at level SF. The Department will base final acceptance of fabricated members on the Engineer’s approval that the fabricated items that can be successfully incorporated into the structures. Submit mill test reports for structural steel, steel castings, bronze, and sheet lead certified according to 501.06.

**517.03 Materials.** Furnish materials conforming to:

Concrete, Class S or Class HP.....	499, 511
Reinforcing steel .....	509, 709
Structural steel.....	513
Preformed fillers (sponge rubber or PVC).....	705.03, 711.28
Steel tubing .....	707.10
Paint .....	708
Metal deep beam rail .....	710.06
Ductile iron casings.....	711.13
Aluminum .....	711.20
Timber.....	711.26
Stainless steel fasteners.....	730.10
Pipe .....	748.06

Submit mill test reports for structural steel and aluminum according to 501.06.

**517.04 Construction Methods, General.** Construct railings as shown on the plans. Install posts for metal railings normal to the grade line. Install the tops of railings parallel to the grade line.

Remove or release shoring or falsework supporting the superstructure before placing railing that has no expansion joints or that is on the concrete parapet.

**517.05 Steel and Iron Railings.** Unless specified to paint according to Item 514, galvanize all parts of steel and iron railings.

Erect metal deep beam rail elements according to Item 606.

**517.06 Aluminum Railings.** Use alloy conforming to 711.20 for aluminum railings.

Give the extreme outer surfaces of cast railing posts a 40-grit finish. The Contractor is not required to provide a special finish for other portions of railings. Do not scratch, dent, or cause other damage to railings that may affect the durability or appearance of the railing.

Use galvanized steel anchor bolts and hexagon nuts conforming to 711.02. Coat the entire projecting portion of anchor bolts and fill the space between the bolts and post base with an aluminum-impregnated caulking compound.

Where aluminum contacts concrete or stone masonry, thoroughly coat the contact surfaces with an aluminum-impregnated caulking compound or with a heavy asphalt material paint pigmented with aluminum powder or paste thereby providing an aluminum appearance. Where aluminum or aluminum shims contacts different metal, thoroughly coat the contact surface with an aluminum-

impregnated caulking compound or place a synthetic rubber impregnated fabric gasket between the metals.

Weld only where shown on the plans using inert gas shielded metal-arc or tungsten-arc method without flux, or by other approved methods.

**517.07 Method of Measurement.** The Department will measure Railing by the number of feet (meters) of railing including end posts. If deep beam guardrail is used, the Department will measure the length of railing between the first posts off the bridge excluding the first posts off the bridge. If hand rails or tubular backup rails are used, the Department will not measure any portions extending beyond the first posts off the bridge. If twin steel tube bridge railing is used, the Department will measure the length of the railing between the second post off the bridge including the second post.

**517.08 Basis of Payment.** The cost of hand rails or tubular backup rails extending beyond the measured limits are included for payment in the unit price bid for the measured length.

The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
517	Foot (Meter)	Railing (___)

## ITEM 518 DRAINAGE OF STRUCTURES

### 518.01 Description

### 518.02 Fabrication

### 518.03 Materials

### 518.04 General

### 518.05 Porous Backfill

### 518.06 Pipe

### 518.07 Scuppers

### 518.08 Excavation

### 518.09 Method of Measurement

### 518.10 Basis of Payment

**518.01 Description.** This work consists of constructing drainage systems.

**518.02 Fabrication.** Fabricate scuppers according to Item 513. Select a fabricator that is at least pre-qualified at level SF. The Department will base final acceptance of all fabricated members on the Engineer's approval that the fabricated items can be successfully incorporated into the structures. Submit mill test reports for structural steel, steel castings, bronze, and sheet lead certified according to 501.06.

**518.03 Materials.** Furnish materials conforming to:

Scuppers, structural steel and cast steel .....	513
Metal pipe.....	707
Plastic pipe.....	707.33, 707.45
Other metals.....	711
Filter fabric, Type A .....	712.09

## 518.04

Furnish pipe specials of a grade at least as high as the type of pipe specified.

Furnish porous backfill consisting of gravel, stone, or air-cooled blast furnace slag, with a NO. 57 size gradation as per Table 703.01-1. The sodium sulfate soundness loss shall not exceed 15 percent.

Furnish ACBF slag conforming to Supplement 1027.

**518.04 General.** As shown on the plans, connect all parts to new or existing sewers or other outlets.

When installing to superstructure, take into account the deflection of spans under full dead load.

**518.05 Porous Backfill.** Place porous backfill as shown on the plans. When not shown on the plans place at least 18 inches (0.5 m) thick behind the full length of abutments, wing walls, and retaining walls. Measure the thickness of porous backfill normal to the abutment or wall face. The Contractor may leave undisturbed rock or shale within 18 inches (0.5 m) of the abutment or wall. Place sufficient coarse aggregate or other material adjacent to, but not more than 6 inches (150 mm) below, the bottom of the weep hole to retain the porous backfill. Compact porous backfill according to Item 603.11 D.

**518.06 Pipe.** For drain pipe leading down from the superstructure, use either galvanized steel pipe, 748.06; or plastic pipe, 707.45. Provide specials, elbows, tees, wyes, and other fittings essential for a complete and satisfactory installation of the same material and quality as the pipe. Construct watertight joints of adequate strength. In steel pipe, weld joints or use clamp-type couplings having a ring gasket. In plastic pipe, make joints according to the applicable ASTM standard. Securely fasten the pipe to the structure with hanger or clamp assemblies that are galvanized according to 711.02.

Place subsurface pipe according to Item 603. If the plans require drainage pipe in the porous backfill, provide plastic pipe conforming to 707.33.

For corrugated metal pipe, perforated specials are not required and the Contractor may make bends with adjustable elbows conforming to the thickness requirements of the pipe specifications.

**518.07 Scuppers.** Construct secure and watertight connections, including the connections to adjacent concrete. Provide castings, true to form and dimension. Weld the joints of structural steel scuppers. Galvanize scuppers according to 711.02.

**518.08 Excavation.** Excavate all material encountered to the dimensions necessary to provide ample space at least to install pipe or other drainage facility behind abutments and for outlets.

**518.09 Method of Measurement.** The Department will measure Porous Backfill and Porous Backfill with Filter Fabric by the number of cubic yards (cubic meters) or lump sum. The Department will measure pipe specials by the same method as the pipe. If pipe is by the foot (meter), the Department will measure the pipe along its centerline.

**518.10 Basis of Payment.** The cost to backfill, if not separately itemized in the Contract, and excavation is incidental to the drainage facility that necessitates them.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
518	Cubic Yard (Cubic Meter) or Lump Sum	Porous Backfill
518	Cubic Yard (Cubic Meter) or Lump Sum	Porous Backfill with Filter Fabric
518	Foot (Meter)	___ inch (___ mm) ___ Pipe, Including Specials
518	Each	Scuppers, Including Supports
518	Pound or Foot (Kilogram or Meter)	Trough Horizontal Conductors
518	Pound or Foot (Kilogram or Meter)	Pipe Horizontal Conductors
518	Foot (Meter)	___ inch (___ mm) Pipe Downspout Including Specials

**ITEM 519 PATCHING CONCRETE STRUCTURES**

**519.01 Description**

**519.02 Materials**

**519.03 Removal of Disintegrated Concrete**

**519.04 Preparation of Surface**

**519.05 Placing of Reinforcing Steel**

**519.06 Placing, Finishing, and Curing of Concrete**

**519.07 Method of Measurement**

**519.08 Basis of Payment**

**519.01 Description.** This work consists of removing all loose and disintegrated concrete; preparing the surface; furnishing and placing reinforcing steel including welded steel wire fabric, dowels, and expansion bolts; placing forms; and placing concrete patches, including curing of same.

**519.02 Materials.** Furnish materials conforming to:

Concrete, Class S* .....	499, 511
Dowels .....	709.01, 709.03, or 709.05
Reinforcing steel .....	509
Welded steel wire fabric .....	709.10 or 709.12

\* For aggregate for superstructure, conform to 703.02 and use No. 57 or 8 size.

**519.03 Removal of Disintegrated Concrete.** Remove all loose and disintegrated concrete from the areas to be repaired in such a manner and to such

#### 519.04

an extent as to expose a sound concrete surface. Provide patches at least 4 inches (100 mm) deep, except on top horizontal surfaces, provide patches at least 3 inches (75 mm) deep. Remove sound concrete (beneath the disintegrated concrete) for a depth of not less than 1/4 inch (6 mm) and not more than 1 inch (25 mm), provided that the above minimum depth of patch is maintained. Make square or, preferably, slightly undercut shoulders having a depth of not less than the specified minimum depth of the patch at the edges of all patches.

Only use pneumatic or hand tools that give results satisfactory to the Engineer in the removal of the disintegrated concrete and in preparing and shaping the areas to be patched.

If working around reinforcing steel, avoid damaging or debonding the reinforcing steel, or shattering the concrete, beyond the area to be patched.

Adequately support reinforcement that is loose, and tie it back into place. Replace reinforcement damaged during removing concrete.

**519.04 Preparation of Surface.** After removing all disintegrated and loose concrete, properly shape the area to be patched, and install dowels or expansion bolts as necessary to hold the wire fabric to be used in the patch. Thoroughly clean the surface of the area to be patched and all exposed reinforcing steel of all dirt, dust, or other foreign materials with water, air under pressure, or any other method that produces satisfactory results. Thoroughly drench the surface with clean water. Before placing the concrete, allow the surface to dry to a damp condition.

**519.05 Placing of Reinforcing Steel.** The Department will not require reinforcement for patches on top horizontal surfaces. Reinforce patches on other surfaces with welded steel wire fabric either 2 × 2 inch (50 × 50 mm) using wire size number W 0.9, or 3 × 3 inch (75 × 75 mm) using wire size number W 1.4. Cover the entire area of the patch with the fabric, and place and hold the fabric approximately 1 inch (25 mm) from the completed exposed surface of the patch. Securely fasten the fabric to the reinforcing steel in the original structure exposed in removing the disintegrated concrete. If no reinforcing steel is exposed or it is not practical to fasten the fabric to exposed steel, install dowels or expansion bolts at a distance not to exceed 18-inch (0.5 m) centers in both directions, and fasten the fabric to these dowels or bolts.

**519.06 Placing, Finishing, and Curing of Concrete.** Place and finish Class S concrete according to Items 499 and 511.

Remove the forms within 24 hours after placing the concrete, and finish all exposed surfaces by rubbing to match the surrounding concrete. Apply membrane curing according to 511.17, Method B, immediately after rubbing the surfaces.

After curing and before final acceptance, sound all patched areas. Remove and replace all unsound or visibly cracked areas.

**519.07 Method of Measurement.** The Department will measure Patching Concrete Structures by the number of square feet (square meters) of the exposed surfaces of all completed patches, irrespective of the depth or thickness of the patch. If a patch includes corners or edges of members such as beams, curbs, and

columns, the Department will measure all of the exposed surfaces. If a patch extends completely through a member of a slab, the Department will measure both exposed surfaces.

**519.08 Basis of Payment.** The Department will pay for accepted quantities at the contract price as follows:

The Department will not pay for replacing reinforcement damaged during concrete removal.

The Department will not pay for removing and replacing of patched areas that are unsound or visibly cracked.

<b>Item</b>	<b>Unit</b>	<b>Description</b>
519	Square Foot (Square Meter)	Patching Concrete Structures

## **ITEM 520 PNEUMATICALLY PLACED MORTAR**

- 520.01 Description**
- 520.02 Materials**
- 520.03 Removal of Concrete**
- 520.04 Reinforcement**
- 520.05 Preparation of Repair Area**
- 520.06 Mixing**
- 520.07 Proportions**
- 520.08 Pressures**
- 520.09 Preconstruction Testing**
- 520.10 Placing**
- 520.11 Inspection and Testing**
- 520.12 Method of Measurement**
- 520.13 Basis of Payment**

**520.01 Description.** This work consists of repairing the surface of concrete structures using pneumatically placed mortar where the depth of repair generally is less than 6 inches (150 mm).

**520.02 Materials.** Furnish materials conforming to:

Reinforcing steel .....	509
Portland cement .....	701.01 through 701.05, 701.09
Fine aggregate .....	703.02, 703.03
Welded steel wire fabric. ....	709.10 or 709.12

Use water free from sewage, oil, acid, strong alkalis, vegetable matter, clay, and loam. Potable water is satisfactory for use in mortar.

**520.03 Removal of Concrete.** In areas to be repaired, remove all loose, soft, honeycombed, and disintegrated concrete, plus a 1/4-inch (6 mm) depth of sound concrete. Remove additional concrete as necessary to permit the placement of the minimum specified mortar thickness of not less than 1 1/2 inches (38 mm), except on top horizontal surfaces where it shall not be less than 3/4 inch (19 mm). Perform all work in such a manner as not to damage or shatter the concrete that is

#### 520.04

to remain in place. Make square or, preferably, slightly undercut shoulders at the edge of all repair areas.

Encase reinforcing bars exposed after concrete removal, as required above, with pneumatically placed mortar. If these bars are less than 1 inch (25 mm) from the proposed finished surface of mortar, drive them back, if practical, into recesses cut in the masonry to obtain that coverage. If this is impractical because of large concentrations of reinforcing bars, provide the minimum specified mortar coverage by modifying the finish surface as the Engineer approves.

If the bond between the concrete and a primary reinforcing bar has been destroyed, or if more than one-half of the periphery of a bar has been exposed, remove the adjacent concrete to a depth that will provide a minimum 3/4-inch (19 mm) clearance around the bar, except where other reinforcing bars make this clearance impractical. Adequately support reinforcing that has become loose, and tie it back into place. Replace reinforcement that is damaged during construction operations.

Only use pneumatic or hand tools that give results satisfactory to the Engineer in the removal of concrete and in preparing and shaping the areas to be repaired.

If working around reinforcing steel, avoid loosening the steel, or shattering the concrete around it, beyond the repair area.

**520.04 Reinforcement.** If pneumatically placed mortar is specified to repair areas of unsatisfactory concrete, or for surface coverage of exposed reinforcing steel, place wire fabric in all areas where the thickness of the mortar patch is 1 1/2 inches (38 mm) or more. For areas where the thickness of the mortar patch exceeds 4 inches (100 mm), use a single layer of wire fabric to reinforce each 4-inch (100 mm) thickness of patch or fractional part thereof. Use fabric that is either 2 × 2 inches (50 × 50 mm) using wire size number W 0.9, or 3 × 3 inches (75 × 75 mm) using wire size number W 1.4. Place all fabric parallel to the proposed finished surface. Completely encase each layer of fabric in mortar that has taken its initial set before the succeeding layer of fabric is applied. Ensure that fabric supported adjacent to the prepared masonry surface is no closer than 1/2 inch (13 mm) to that surface. Overlap adjacent sheets of fabric by 6 inches (150 mm), and securely tie them together. Carefully pre-bend fabric before installation to fit around corners and into re-entrant angles. Never spring fabric into place.

Place all steel items, including reinforcing bars and wire fabric, no closer than 1 inch (25 mm) to the proposed finished surface of mortar.

Support wire fabric with anchor bolts except where existing reinforcing steel in the repair area is considered by the Engineer to be satisfactory for this purpose. Construct anchors of 1/4-inch (6 mm) minimum diameter expansion hook bolts, and ensure that each bolt has sufficient engagement in sound masonry. For repairs that are generally 4 inches (100 mm) thick or less, space anchors no more than 12 inches (0.3 m) and 18 inches (0.5 m), center-to-center, on overhead and vertical surfaces, respectively, and 36 inches (1.0 m), center-to-center, on top horizontal surfaces. For repairs that exceed 4 inches (100 mm) in thickness, ensure that the anchor bolts are capable of supporting three times the weight of suspended mortar

and two times the weight of mortar on vertical surfaces. Use at least three anchors for each patch.

If specified, thoroughly clean reinforcing exposed in the original structure, or exposed after removals as required above, and restore any appreciable reduction in steel area as directed.

**520.05 Preparation of Repair Area.** After removing all unsatisfactory concrete, properly shaping the sound concrete surface, placing dowels and expansion hook bolts, and restoring steel area as directed, and within 24 hours before placing the mortar, blast clean all surfaces to which the mortar is to bond, including exposed reinforcing steel, existing concrete, and the work face of any previously placed mortar, to remove all spalls, laitance, and contaminants detrimental to the achievement of an adequate bond. The Contractor may blast clean these surfaces using high-pressure water blasting with or without abrasives in the water, abrasive blasting with containment, or vacuum abrasive blasting. If a bonding compound is not specified, drench the prepared masonry surface with water and keep the prepared surface wet during the 2 hours preceding the placement of the mortar. Ensure that all surfaces are damp, but without free water, while placing mortar. The Engineer will approve the preparation and condition of all surfaces immediately before the application of the mortar.

**520.06 Mixing.** Thoroughly dry mix the materials in a batch mixer. Before placing the mixture in the hopper of the cement gun, remove all materials and lumps over 1/4 inch (6 mm) in size by screening.

Apply the screened sand and cement to the masonry surface within 1 hour after being combined.

**520.07 Proportions.** Ensure that the mixture as placed in the hopper has a ratio of one volume of portland cement to three volumes of sand.

**520.08 Pressures.** Use at least 35 pounds per square inch (240 kPa) pneumatic pressure at the cement gun in placing the mixed material. If more than 100 feet (30 m) of hose or a greater lift than 25 feet (7.5 m) is used, increase the pressure proportionately. Maintain the water at a uniform pressure of not less than 25 pounds per square inch (170 kPa) above the pressure of the air on the gage at the cement gun.

**520.09 Preconstruction Testing.** Before the start of placing any mortar, perform a preconstruction test to verify the operation of the equipment, to confirm the application crew's capability, and to ensure the pneumatically placed mortar will be of acceptable quality.

Fabricate the test panel by gunning mortar onto the plywood bottom of an open box 4-foot (1.2 m) square and 4 inches (100 mm) deep. Install reinforcement in the test panel that matches the largest size and tightest spacing found for the reinforcement in the bridge. Mount the box vertically and apply the mortar using the same personnel, equipment, and procedures that will be used on the project, until the box is full. Adjust the mixing water to provide mortar of the proper consistency, but do not exceed a total water content, including the free moisture in the aggregate and water added at the nozzle, of 4.5 gallons (17 L) per sack of cement (94 pounds = 42.6 kg).

## 520.10

Take three cores from the test panel, and test them for compressive strength at an independent testing laboratory. Ensure that the strength at 28 days is a minimum of 4200 pounds per square inch (29.5 MPa) or at a minimum compressive strength of 3200 pounds per square inch (22.5 MPa) at 7 days.

After taking the cores, break the test panel and allow the Engineer to carefully examine the interior portions. Ensure that they are substantially free of hollow areas and sand pockets, and ensure that the mortar is well bonded to the reinforcement.

Have each crew proposed to perform this work fabricate a satisfactory panel before allowing that crew to apply mortar to the structure.

**520.10 Placing.** Place the premixed dry cement and sand by pneumatic equipment with the proper amount of water applied in the mixing nozzle for the correct placement consistency. Apply the mortar as dry as practical to prevent shrinkage cracking. Use shooting strips to ensure square corners, straight lines, and a plane surface of mortar, except as otherwise permitted by the plans or approved by the Engineer. Place shooting strips so as to keep the trapping of rebound at a minimum. At the end of each day's work, or similar stopping periods requiring construction joints, slope the mortar off to a thin edge. In shooting all surfaces, ensure that the stream of flowing material from the nozzle impinges as nearly as possible at right angles to the surface being covered, and hold the nozzle 2 to 4 feet (0.6 to 1.2 m) from the working surface.

Apply a sufficient number of mortar coats to obtain the required thickness. Finish mortar repairs flush with the original masonry surface, except as noted for areas of exposed reinforcing steel. On vertical and overhead surfaces, do not apply any coat thicker than 1 inch (25 mm), except as the Engineer approves, and place each coat so that it will neither sag nor decrease the bond of the preceding coat. If a successive coat is applied on mortar that has set for more than 2 hours, clean and dampen the mortar surface as required in 520.05 for the prepared masonry surface. Remove deposits of rebound from previous shooting, whether loose or cemented.

After mortar has been placed to the desired thickness, cut off all high spots with a sharp trowel, or screed them to a true plane as determined by shooting strips or by the original masonry surface, or as directed. If using screeds, apply them lightly to all surfaces so as not to disturb the mortar for an appreciable depth, and work them in an upward direction when applied on vertical surfaces. Unless otherwise directed, give the finished mortar surface a flash coat about 1/8 inch (3 mm) thick. Take special care to obtain a slightly appearance on all exposed surfaces.

Cover the pneumatically placed mortar patches with burlap or cotton mats, and keep them wet for 7 days after placing. If it is not practical to use mats, keep the surface wet by sprinkling for the same length of time. If the Engineer determines that the above curing procedures are impractical because of the inaccessibility of isolated repair areas, the Contractor may cure the final mortar surface according to 511.17, Method B. Do not place pneumatically placed mortar when the air temperature is below 50 °F (10 °C) or against a surface in which there remains any frost. Protect all mortar against cold weather according to 511.15.

**520.11 Inspection and Testing.** After curing and before final acceptance, sound all patched areas. Remove and replace all unsound or cracked areas. In addition to sounding all patches, the Department will base acceptance of the pneumatically placed mortar on 4-inch (100 mm) diameter cores taken from patched areas and tested for compressive strength. The Engineer will determine the location of the cores, with one core being taken for each 200 square feet (20 m<sup>2</sup>) of pneumatically placed mortar. Drill the cores completely through the patched area and into the underlying sound concrete at least 1/2 inches. Ensure that the depth of the cores is at least 4 inches. The Engineer will visually inspect the cores at the site for hollow areas, sand pockets, and voids around reinforcing steel. Test the cores at an independent laboratory for compressive strength. The required minimum average compressive strength is 3000 pounds per square inch (21 MPa) at 7 days, with no single core test less than 2600 pounds per square inch (18 Mpa).

The Engineer will waive coring on small quantities or overhead patches if it is determined by sounding and visual inspection that the patches are sound.

Remove, replace, re-inspect, and re-test all defective patches, as determined by sounding, visible cracks, or unacceptable cores.

Fill core holes with concrete as per 519.

**520.12 Method of Measurement.** The Department will measure Pneumatically Placed Mortar by the number of square feet (square meters) as determined under Method A, unless Method B or another method is specified.

**A. Method A.** The Department will measure the actual area of exposed surfaces of all completed, tested, and approved patches, irrespective of depth or thickness of the patch. If a patch includes corners or edges of such members as beams, columns, or curbs, the Department will include all of the exposed surfaces; or if a patch extends completely through a member or a slab, the Department will include both exposed surfaces.

**B. Method B.** For unreinforced mortar repairs, the Department will measure the actual area of exposed surfaces of all completed, tested, and approved patches, irrespective of depth or thickness of patch. If a patch includes corners, or edges of such members as beams, columns, or curbs, the Department will include all of the exposed surfaces. For fabric reinforced mortar repairs, the Department will measure the actual surface area of fabric, complete and in place. The Department will consider fabric laps and layers of fabric closer than 2 1/2 inches (65 mm), center-to-center of layer, as a single layer in area measurements. The Contractor and the Engineer will agree on the measured area of wire fabric before said fabric is encased in mortar, otherwise the Department will obtain the area of the patch for pay purposes as described for unreinforced mortar repairs.

The Contractor is responsible for all test panels, coring repair of core holes, independent laboratory testing of the cores, and replacement of rejected areas and shall include them under Pneumatically Placed Mortar.

**520.13 Basis of Payment.** The Department will not pay for additional reinforcement to replace that damaged by the Contractor's operations.

**522.01**

The Department will not pay for removing, replacing, and re-inspecting of defective patched mortar as determined by sounding, visible cracks, or unacceptable cores.

The Department will pay for accepted quantities at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
520	Square Foot (Square Meter)	Pneumatically Placed Mortar

**ITEM 522 STRUCTURAL PLATE CORRUGATED METAL STRUCTURES ON FOOTINGS**

**522.01 Description**

**522.02 Materials**

**522.03 General**

**522.04 Method of Measurement**

**522.05 Basis of Payment**

**522.01 Description.** This work consists of furnishing structural plate corrugated metal structures of specified dimensions, including metal bearing angles or channels as required, and erecting same on concrete footings.

**522.02 Materials.** Furnish plates and bolts conforming to 707.03 or 707.23. Furnish steel bearing angles or channels conforming to 707.03 or 711.01. Furnish aluminum bearing angles or channels conforming to 707.23.

**522.03 General.** Properly support the metal bearing angle or channel in the position shown on the plans before placing footing concrete.

Erect the plates according to the manufacturer’s assembly instructions. Hold the unsupported edges of all plates in position using temporary props. Progressively install a sufficient number of bolts to hold the plates in position. Do not tighten bolts until tightening will not interfere with the adjustment and matching of additional sections. If using drift pins or pry bars, take care to prevent chipping or injury to the galvanized coating. Tighten the bolts to a final minimum torque of 100 foot-pounds (140 Nm).

Within the limits of backfill, field coat the exterior of the 707.03 conduit above the limits of the bedding. The coating material and application shall conform to AASHTO M 243M. Thoroughly seal around all plate seams and bolts. Allow asphalt mastic material to dry for 48 hours and tar base material to dry for 28 hours before placing the conduit backfill.

Backfill according to the requirements for 603.08, Type A conduit.

**522.04 Method of Measurement.** The Department will measure the actual number of feet (meters) of the corrugated metal structure, installed in place. The Department will determine the length by taking the average of the two side measurements, end to end, at the point of bearing.

Excavation will be paid for under Item 203 or 503 as shown on the plans.

Concrete footings will be paid for as a separate pay item.

**522.05 Basis of Payment.** The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
522	Foot (Meter)	___' ___" (___ mm) Structural Plate Corrugated Metal Structure, ___-inch (___ mm)

## ITEM 523 DYNAMIC LOAD TEST

### 523.01 Description

### 523.02 General

### 523.03 Equipment

### 523.04 Test Report

### 523.05 Basis of Payment

**523.01 Description.** This work consists of establishing a driving criteria for all the piles of a specified shape, cross-section, and ultimate bearing capacity or as specified on the plans to be installed in the structure. This shall be accomplished by applying dynamic loads with a pile hammer during driving of production piles to determine driving requirements. Apply the dynamic load to the piles using a pile hammer that is operating at its normal operating level. Perform restrrike tests when specified in the plans

**523.02 General.** Perform dynamic tests on a minimum of two piles. Perform Case Pile Wave Analysis Program (CAPWAP) analysis on at least one of the two test piles. Perform the test according to ASTM D 4945 to determine driving requirements to achieve the required ultimate bearing values for the piles to be installed in the structure.

Perform restrrike tests after piles have been driven and a minimum time specified in the plans has elapsed. When performing a restrrike, warm the hammer before restriking the pile by applying at least 20 blows to another pile. Each restrrike consists of performing dynamic testing on two piles and performing a CAPWAP analysis on one of the two piles tested.

Use the hammer selected for driving the test piles to drive all piles represented by the test piles. If the Contractor subsequently finds it necessary to use a different hammer or multiple hammers to drive piles represented by dynamic load testing, or if the hammer performance varies subsequent to the dynamic test, complete additional tests at no additional cost to the Department.

**523.03 Equipment.** Supply all required dynamic testing equipment necessary to run the test set forth in ASTM D 4945. Supply personnel with an Advanced, Master, or Expert Level Certification in High Strain Dynamic Pile Testing (HSDPT) from Foundation QC to operate this equipment. Supply the Engineer a copy of the certificate showing that personnel operating dynamic testing equipment are currently certified. Supply all personnel and equipment needed to strike the test piles with the pile hammer.

**523.04**

**523.04 Test Report.** Perform the dynamic test and CAPWAP analysis and immediately provide the Engineer driving criteria for any piles to be driven within the next 48 hours. Within 48 hours after performing the dynamic pile test or restrrike tests, supply the Engineer with a written report confirming driving requirements for piles represented by the test. Include in the report, the required blow count for:

- A. The different strokes of the ram at 6-inch (150 mm) intervals within the expected range of operation as determined by a wave equation analysis (WEAP), when open ended diesel hammers and drop hammers are used.
- B. The selected bounce pressures when closed end diesel hammers are used.
- C. The operating air pressure and stroke when an air operated hammer is used.
- D. The selected output energy or stroke when a hydraulic hammer is used.

Also include in the report a minimum depth of penetration if applicable.

Submit an electronic version of the report and data files from the testing and analysis to the Office of Structural Engineering.

**523.05 Basis of Payment.** The Department will pay for dynamic load testing after being provided the written test at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
523	Each	Dynamic Load Testing
523	Each	Restrike

**ITEM 524 DRILLED SHAFTS**

- 524.01 Description**
- 524.02 Materials**
- 524.03 Contractor’s Installation Plan**
- 524.04 Hole Excavation**
- 524.05 Friction Type Drilled Shafts**
- 524.06 Casings**
- 524.07 Slurry**
- 524.08 Excavation Inspection**
- 524.09 Reinforcing Steel for Drilled Shafts**
- 524.10 Concrete for Drilled Shafts**
- 524.11 Free Fall Concrete Placement**
- 524.12 Tremie**
- 524.13 Pumped Concrete**
- 524.14 Construction Tolerances**
- 524.15 Inspection Records**
- 524.16 Method of Measurement**
- 524.17 Basis of Payment**

**524.01 Description.** This work consists of furnishing and installing drilled shafts. The lengths of the drilled shafts shown on the plans are estimated from available subsurface information. Furnish the proposed drilled shafts according to

plan requirements, with the understanding that the actual length required is based on conditions encountered during construction and may differ from the estimated length shown on the plans.

**524.02 Materials.** Furnish material conforming to:

Concrete, Class S.....	511
Epoxy coated reinforcing steel .....	509

**524.03 Contractor's Installation Plan.** Submit, for the Engineer's acceptance, a written installation plan of procedures to follow when excavating the hole, placing the concrete, and monitoring the concrete placement. Submit the installation plan at least 14 Calendar Days before constructing the drilled shafts. Include the following information:

- A. Details of the sequence proposed for the overall drilled shaft construction operation.
- B. Procedures for maintaining correct horizontal and vertical alignment of the excavation.
- C. If using a casing, method to advance the casing.
- D. If using a temporary casing, details of the methods to extract the temporary casing and to maintain the concrete slump to keep concrete workable by adding admixtures such as retarders or superplasticizers.
- E. If using slurry, details of the methods to mix, circulate, and de-sand the slurry. For polymer slurry, submit the manufacturer's recommendations for use of the slurry.
- F. Details of methods to clean the shaft excavation.
- G. Details of reinforcement placement including support and centralization methods.
- H. Details of concrete placement including proposed operational procedures for free fall, tremie, or pumping methods.
- I. A list of proposed equipment to be used such as cranes, drills, augers, bailing buckets, final cleaning equipment, de-sanding equipment, slurry pumps, tremies, concrete pumps, casings, etc.

Acceptance of the installation plan will not relieve the Contractor of the responsibility for obtaining the required results.

**524.04 Hole Excavation.** Take precautions to prevent damaging existing structures and utilities. Precautions include, but are not limited to, selecting construction methods and procedures that will prevent excessive caving of the shaft excavation, and monitoring and controlling the vibrations from the driving of casing or sheeting or drilling of the shaft.

When encountered, remove objects such as large boulders. Do not blast unless shown on the plans or authorized in writing by the Engineer.

Unless otherwise shown on the plans, where drilled shafts are to be installed in conjunction with embankment placement, construct shafts after the placement of the fill and completion of any specified settlement periods.

Excavate for the shafts to the dimensions and elevations shown on the plans. Use methods and equipment suitable for the intended purpose and materials encountered. Use either the dry method, wet method, temporary casing method, or permanent casing method as necessary to produce sound, durable concrete foundation shafts free of defects. When a particular method of construction is required on the plans, that method shall be used. If no particular method is specified for use, select and use a method based on site conditions.

If the excavation operation is stopped, protect the shaft cavity by installing a safety cover. The Contractor is responsible for the safety of the shaft excavation, surrounding soil, and the stability of the sidewalls. If necessary to ensure such safety and stability, use a temporary casing, slurry, or other methods accepted by the Engineer. Unless cased to the full depth, do not leave excavations unfilled overnight.

Use appropriate means, such as a cleanout bucket or air lift, to clean the bottom of the excavation of all shafts. Promptly notify the Engineer when unexpected obstructions are encountered.

**A. Dry Construction Method.** Use the dry construction method only at sites where the groundwater table and site conditions are suitable to allow construction of the shaft in a relatively dry excavation, and where the sides and bottom of the shaft remain stable without any caving, sloughing, or swelling and may be visually inspected before placing the concrete. The dry method consists of excavating the drilled shaft hole, removing accumulated water, and loose material from the excavation, and placing the shaft concrete in a relatively dry excavation. The rate of flow of water into the hole should not be more than 12 inches (300 mm) within a 1-hour period. Do not place the initial concrete if there is more than 3 inches (75 mm) of water in the bottom of the hole.

**B. Wet Construction Method.** Use the wet construction method at sites where a dry excavation cannot be maintained for placement of the shaft concrete. The wet method consists of using water or slurry to contain seepage and groundwater movement and placing concrete using a tremie or concrete pump. Additionally, use this method to maintain stability of the hole perimeter while advancing the excavation to its final depth, placing the reinforcing cage, and placing the shaft concrete. This method also consists of de-sanding and cleaning the slurry. For drilled shafts that are not socketed into the bedrock and during drilling operations, maintain a water or slurry fluid elevation inside the shaft excavation higher than the static water table. Unless demonstrated to the Engineer's satisfaction that the surface casing is not required, provide temporary surface casings to aid shaft alignment and position and to prevent sloughing of the top of the shaft excavation. Extend surface casings from the ground surface to a point in the shaft excavation where sloughing of the surrounding soil does not occur.

**C. Temporary Casing Construction Method.** Use the temporary casing construction method when the stability of the excavated hole and/or the effects of

groundwater must be controlled. Remove temporary casings while the concrete remains workable. As the casing is being withdrawn, maintain a 5-foot (1.5 m) minimum head of fresh concrete in the casing so that all the fluid trapped behind the casing is displaced upward without contaminating the shaft concrete. As necessary, increase the required minimum concrete head to counteract groundwater head inside the casing. Extract casing at a slow, uniform rate with the pull in line with the shaft axis. Rotate, tap, push down, or vibrate the casing when necessary to extract it. Rotate the casing as little as possible to avoid deforming the reinforcing steel cage.

**D. Permanent Casing Construction Method.** The permanent casing construction method generally consists of driving or drilling a casing to a specified depth before excavation begins. If full penetration of the casing to the specified depth cannot be attained, the Contractor may either excavate material within the embedded portion of the casing or excavate a pilot hole ahead of the casing until the casing reaches the desired penetration. Make the pilot hole no larger than one-half the diameter of the shaft and center the hole in the shaft. Do not over ream to the outside diameter of the casing unless specifically shown on the plans.

Ensure that the casing is continuous between the elevations shown on the plans. Unless otherwise shown on the plans, do not use temporary casing instead of or in addition to the permanent casing.

After installing the casing and excavating the shaft, place the reinforcing steel, then place the shaft concrete. After filling the permanent casing with concrete, pressure grout voids between the shaft excavation and the casing with cement grout. Submit the method of pressure grouting the voids to the Engineer for approval. Pressure grouting is required to ensure contact (bearing) between the casing and any surrounding soil layer that is used for lateral support.

**524.05 Friction Type Drilled Shafts.** Friction type drilled shafts are defined as drilled shafts that do not bear on bedrock and obtain their ability to support load from a combination of end bearing on the soil and adhesion between soil and concrete along the length of the shaft.

For friction type drilled shafts, dry construction method may be used for cohesive soils only. If using a casing for the construction of a friction type drilled shaft, remove the casing completely or partially as shown on the plans. If enough water is entering the hole through the sides and bottom of the hole such that the supporting soils are being eroded, maintain a positive head of fluid in the excavation hole to ensure that water is not continuously flowing into the hole.

If the Engineer determines that the hole sidewall has softened due to excavation methods, swelled due to delays in concreting, or degraded because of slurry cake buildup, over ream the sidewall to sound material. If the concrete is not placed the same day that the excavation is completed, protect the excavation with a temporary casing, and redrill the hole at least 6 inches (150 mm) larger in diameter, clean the excavation, and perform slurry test before concreting.

**524.06 Casings.** Use smooth, watertight, steel casings of sufficient strength to withstand handling and driving stresses and the concrete and surrounding earth pressures. Provide an outside diameter of the steel casing equal to or greater than

524.07

the plan diameter of the shaft. If the plan diameter of the bedrock socket is same as the drilled shaft above the bedrock and a steel casing is used, provide a diameter of the bedrock socket as shown on the plans. Ensure that the diameter of the casing is large enough to allow the excavation of the bedrock socket.

Where drilled shafts are located in open water areas, extend the casing a minimum of 12 inches (300 mm) above the water to protect the shaft concrete from water action during placement and curing of the concrete. Cut off the casing at the plan top of drilled shaft elevation after the concrete has cured. If practical, install the casing in a manner that produces a positive seal at the bottom of the casing to prevent piping of water or entry of other material into the shaft excavation.

If it becomes necessary to remove a casing and substitute a longer or larger diameter casing through caving soils, stabilize the excavation with slurry or backfill before installing the new casing. The Contractor may use other methods accepted by the Engineer to control the stability of the excavation and to protect the integrity of the foundation soils.

**524.07 Slurry.** Slurry used in the drilling process shall be a mineral or polymer slurry. The mineral slurry shall have both a mineral grain size that remains in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. Ensure that the percentage and specific gravity of the material used to make the suspension is sufficient to maintain the stability of the excavation and to allow proper concrete placement. Maintain the level of the slurry at a height sufficient to prevent caving of the hole.

Thoroughly premix the mineral slurry with clean fresh water and allow adequate time for hydration before introduction into the shaft excavation. Agitate, circulate, and adjust the properties of the slurry to prevent the slurry from “setting up” in the shaft excavation.

Perform control tests using suitable apparatus on the mineral slurry to determine density, viscosity, and pH. Conform to the acceptable range of values for these physical properties as shown in Table 524.07-1.

**TABLE 524.07-1 MINERAL SLURRY SPECIFICATIONS  
RANGE OF VALUES AT 68 °F (20 °C)**

<b>Property</b>	<b>Test Method</b>	<b>Time of Slurry Introduction</b>	<b>Time of Concreting in Hole</b>
Density lb/ft <sup>3</sup> (kg/m <sup>3</sup> )	Density Balance	64.3 to 69.1 (1030 to 1107)	64.3 to 75.0 (1030 to 1201)
Viscosity s/qt (s/L)	Marsh Cone	28 to 45 (30 to 48)	28 to 45 (30 to 48)
pH	pH Paper or meter	8 to 11	8 to 11

If de-sanding is required, do not allow the sand content to exceed 4 percent by volume at any point in the shaft excavation as determined by the American Petroleum Institute sand content test.

Determine density, viscosity, and pH values before and during the shaft excavation to establish a consistent working pattern.

Before placing shaft concrete, use an approved slurry-sampling tool to take slurry samples from the bottom and at mid-height of the shaft. Eliminate heavily contaminated slurry that has accumulated at the bottom of the shaft. Ensure that the mineral slurry conforms to the requirements specified immediately before shaft concrete placement.

Only use polymer slurry after demonstrating to the Engineer that the stability of the hole perimeter can be maintained while advancing the excavation to its final depth by excavating a trial hole of the same diameter and depth as that of the production shafts. Use the same polymer slurry in the trial hole as proposed for the production shafts. If using different sizes of the shafts at the project, use the same size trial hole as that of the largest diameter shaft, except the depth of the trial hole need not be more than 40 feet (12 meters). Only one trial hole per project is required. Do not use the trial hole excavation for a production shaft. After completing the trial hole excavation, fill the hole with sand. The acceptance of the polymer slurry does not relieve the Contractor of responsibility to maintain the stability of the excavation. Polymer slurry shall conform to the manufacturer's requirements.

**524.08 Excavation Inspection.** Provide equipment for checking the dimensions and alignment of each shaft excavation. Determine the dimensions and alignment. Measure the final shaft depth after final inspection.

Immediately before placing concrete, ensure that the bottom of the completed drilled shaft excavation is as clean as practical. Remove drilling spoils that adhere to the vertical sides of the bedrock socket.

**524.09 Reinforcing Steel for Drilled Shafts.** Place the reinforcing steel cage as a unit immediately after inspection of the excavation and before placing concrete. If not placing the concrete immediately after installing the cage, the Contractor may have to remove the cage before placing the concrete to verify the integrity of the excavated area and to ensure loose material is removed from the bottom of the hole.

Tie and support the reinforcing steel so it remains within the required tolerances. Securely tie spacers at quarter points around the cage perimeter and space at intervals not to exceed 5 feet (1.5 m) along the length of the cage. If the size of the longitudinal reinforcing steel equals or exceeds 1-inch (25 mm) in diameter, the Contractor may increase the minimum spacing of the spacing devices to 10 feet (3 m). Use spacers of adequate dimensions to ensure a minimum annular space between outside of cage and side of hole or casing of 3 inches (75 mm) for shaft diameters up to 4 feet (1.2 m) and 6 inches (150 mm) for shaft diameters larger than 4 feet (1.2 m). The Contractor may use round plastic spacers.

Maintain the top of the reinforcing steel cage no more than 6 inches (150 mm) above and no more than 3 inches (75 mm) below the required position. If the reinforcing steel cage is not maintained within tolerances, make acceptable

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corrections and do not construct additional shafts until the method of reinforcing steel cage support has been approved.

When approved by the Engineer, the Contractor need not provide the reinforcing steel for the extended length of the drilled shaft if it is determined in the field that the Contractor must drill the shaft deeper than the estimated length.

**524.10 Concrete for Drilled Shafts.** For all drilled shafts, use Class S concrete according to Item 511 except as modified and supplemented as follows. The required slump is  $6 \pm 1$  inch ( $150 \pm 25$  mm). Achieve the additional slump over 4 inches (100 mm) by using chemical admixtures conforming to 705.12, Type F or G. The maximum water-cement ratio shall not exceed 0.44. If placing concrete under water, add 10 percent more cement to the concrete mix. If placing concrete using a tremie, further increase the slump to  $8 \pm 1$  inch ( $200 \pm 25$  mm), by using chemical admixtures.

For wet method construction, place concrete in one continuous operation from bottom to top of the shaft. After the concrete has reached the top of the drilled shaft, continue pumping and remove all contaminated concrete until acceptable quality concrete is evident at the top of the shaft. Do not vibrate concrete with a vibrator. Carefully remove the casing so that the reinforcing steel cage is not deformed by the force of the downward flowing concrete.

Do not place concrete in any drilled shaft excavation without acceptance from the Engineer. Inspect the drilled shaft excavation immediately before placing the concrete. Provide a light powerful enough to thoroughly inspect the reinforcing steel cage, the sides, and the bottom of the drilled shaft. The inspection for the wet construction method consists of only probing and measuring.

If the elevation of the top of the shaft is below ground at the time of concrete placement, use a casing to prevent caving of materials into fresh concrete.

**524.11 Free Fall Concrete Placement.** The Contractor may place the concrete in a dry drilled shaft excavation using the free fall method provided the concrete falls to its final position through air without striking the sides of the hole, the reinforcing steel cage, or any other obstruction. Use a centering drop chute, at least 3 feet (1 m) long with the free fall method. Unless shown on the plans, there is no limit to the height of free fall. If the concrete placement causes the shaft excavation to cave or slough or if the concrete strikes the rebar cage or sidewall, reduce the height of free fall or the rate of concrete flow into the excavation, or both.

If the Engineer determines that dewatering is not practical or placement by free fall method cannot be accomplished, place the concrete using a tremie or a concrete pump.

**524.12 Tremie.** The Contractor may use a gravity tremie to place concrete placement instead of a concrete pump in either wet or dry holes. For uncased wet holes, maintain the drilled shaft excavation full of slurry or water to such a depth that water does not flow into the shaft excavation at any time. To place concrete, use tremies consisting of a tube of sufficient length, weight, and diameter to discharge concrete at the shaft base elevation. If the tremie contains aluminum

parts, do not allow these parts to contact the concrete. Use tremies with an inside diameter of at least 10 inches (250 mm). Ensure that the inside and outside surfaces of the tremie are clean and smooth to allow both flow of concrete and unimpeded withdrawal during concreting. Use tremies with a wall thickness adequate to prevent crimping or sharp bends that restrict concrete placement.

For concrete placement, use water-tight tremies. Do not begin underwater placement until the tremie is placed to the shaft bottom elevation. Use valves, bottom plates, or plugs so concrete discharge can begin within one tremie diameter of the base. Either remove plugs from the excavation or use plugs of an Engineer approved material that does not cause a defect in the shaft if not removed. Construct the discharge end of the tremie to allow the free radial flow of concrete during placement operations. Immerse the tremie discharge end at least 10 feet (3 m) in concrete at all times after starting the flow of concrete.

If the tremie line orifice is removed from the fluid concrete column during the concrete pour, and discharges concrete above the rising concrete level, consider the drilled shaft defective.

**524.13 Pumped Concrete.** Pump concrete into either wet or dry holes. For uncased wet holes, maintain the drilled shaft excavation full of slurry or water to such a depth that water does not flow into the shaft excavation at any time. Use concrete pump pipe at least 4 inches (100 mm) in diameter and constructed with watertight joints. Arrange the concrete pump equipment so no vibrations result that might damage fresh concrete. Arrange pipes carrying concrete from the pump to the shaft with a minimum number of bends. Anchor the pipe used to convey the concrete to the bottom of the drilled shaft excavation to the steel casing or another suitable stationary object to prevent the pipe from undulating during the initial placement of the concrete. Do not begin placing concrete until the pump line orifice is at the shaft base elevation.

Do not use aluminum pipe as a conveyance for the concrete. Pump an adequate quantity of grout, mortar, or concrete without coarse aggregate through the equipment ahead of the specification concrete to provide lubrication to the pumping system. Do not place the concrete used for lubrication in the shaft. The lubrication process will not be repeated as long as the pumping operations are continuous. Operate the pump so a continuous stream of concrete without air pockets is produced. To prevent the contamination of the concrete placed initially at the bottom of the shaft, seal the outlet end of the pumping pipe with a diaphragm or plug that is flushed out when the hydrostatic pressure from the column of concrete exceeds that of the water in the shaft. Control the initial rate of concrete placement so not to lift or displace the cage of reinforcing steel. Use a watertight conveying system, and leave the outlet end well below the top of the freshly placed concrete. The preferred concrete placement procedure is to maintain the outlet end of the pumping system at approximately 10 feet (3 m) below the top of the fresh concrete. When the concrete reaches the top of the drilled shaft column, remove all laitance.

If the concrete pump line orifice is removed from the fluid concrete column during the concrete pour, and discharges concrete above the rising concrete level, the drilled shaft shall be considered defective.

**524.14 Construction Tolerances.** For shafts supporting single columns, position the drilled shaft within 3 inches (75 mm) of the plan location in the horizontal plane at the plan elevation for the top of the shaft. For shafts supporting footings, position the center within 6 inches (150 mm) of the plan location. Do not allow the vertical alignment of the shaft to vary from the required alignment by more than 1/4 inch per foot (21 mm/m) of depth. Construct the supported elements at the plan location. Perform all corrections required to construct the supported elements.

**524.15 Inspection Records.** Provide all necessary equipment and labor needed to obtain measurements for completing the Inspection Records. Obtain measurements before placing concrete.

**524.16 Method of Measurement.** The Department will measure Drilled Shafts by the number of feet (meters), measured along the axis of the drilled shaft from the required bottom elevation of the shaft to the proposed top plan elevation. The Department will not measure the length of reinforcing steel projecting from the drilled shaft into the pier column or the footing supported on Drilled Shafts as shown on the plans. If the drilled shaft extends into the bedrock, The Department will divide the total length of each drilled shaft into two segments. The length of the lower segment is the length of the bedrock socket, and the length of the upper segment is the length of the drilled shaft above the bedrock socket.

If a steel casing extending down to bedrock is used, the Department will measure the bedrock socket from the bottom of the casing to the bottom of the drilled bedrock excavation. If the Engineer is assured that a portion of the metal casing is embedded in solid bedrock, and upon the Engineer’s concurrence, the Department may include the embedded distance as a part of the bedrock socket.

**524.17 Basis of Payment.** Payment is full compensation for performing required excavation; furnishing and placing steel casings; furnishing and placing reinforcing steel and concrete by free fall, pumping, or tremie method; removing casings; casings left in place; supplying equipment and performing slurry testing; supplying and disposing of slurry; and disposing excess excavated material.

The Department will not pay for the cost of performing slurry tests before concreting.

The Department will not make separate payment for the trial holes.

The Department will not pay for corrections required to construct the supported elements.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
524	Foot (Meter)	Drilled Shafts, ___" (___ mm) Diameter, above Bedrock
524	Foot (Meter)	Drilled Shafts, ___" (___ mm) Diameter, into Bedrock
524	Foot (Meter)	Drilled Shafts, ___" (___ mm) Diameter

## ITEM 526 APPROACH SLABS

### 526.01 Description

### 526.02 Materials

### 526.03 Forming and Placing Reinforcing Steel

### 526.04 Placing and Sampling Concrete

### 526.05 Finishing and Curing

### 526.06 Side Curbs

### 526.07 Method of Measurement

### 526.08 Basis of Payment

**526.01 Description.** This work consists of constructing reinforced portland cement concrete approach slabs for bridges on the completed and accepted subgrade or subbase.

**526.02 Materials.** Furnish materials conforming to:

Concrete, Class S, HP 3 or HP 4*.....	499
Epoxy coated reinforcing steel.....	509.02, 709.00
Preformed joint filler .....	705.03
Joint sealer .....	705.04 or 705.11

\* Use the same class of concrete used in the bridges superstructure that the approach slab is attached to unless otherwise shown in the plans. If the super-structure concrete class for the bridge is not identified in the plans use Class S.

**526.03 Forming, Furnishing and Placing Reinforcing Steel.** Furnish true and straight steel or wooden side forms. Securely brace and hold forms to the line and grade shown on the plans. Do not allow forms to vary more than 1/8 inch (3 mm) from a 10-foot (3 m) straightedge. Do not remove forms for a minimum of 36 hours. Clean and oil forms after each use.

Furnish reinforcing steel and place it in the position shown on the standard construction drawing and firmly secure the steel during placing and setting of the concrete. Tie reinforcing bars at all intersections, except tie reinforcing bars at alternate intersections where bar spacing is less than 1 foot (0.3 m) in any direction.

**526.04 Placing and Sampling Concrete.** Immediately before placing concrete according to Item 511.10, thoroughly moisten the subgrade or subbase with water in the amount and manner directed by the Engineer. The Engineer will make at least two test cylinders for each 50 cubic yards (35 cubic meters) of concrete.

**526.05 Finishing and Curing.** If the approach slab is to serve as a base for an asphalt concrete wearing course, finish and texture the approach slab according to Item 305. If the approach slab is to serve as a wearing surface finish and test the surface according to 451.12 and diamond groove the surface according to 511.20. Cure approach slabs according to 511.17.A, deck superstructure concrete.

Open approach slabs to traffic according to Table 511.17-1.

**526.06**

**526.06 Side Curbs.** If concrete curb extends across the approach slab, construct side curbs of the dimensions required, and place the concrete curb at the same time as the approach slab. Finish the curb according to Item 609.

**526.07 Method of Measurement.** The Department will measure Reinforced Concrete Approach Slabs by the number of square yards (square meters) complete in place.

**526.08 Basis of Payment.** The Department will pay for accepted quantities at the contract price as follows which includes all concrete, curbs, reinforcing steel, dowels, joints and other materials:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
526	Square Yard (Square Meter)	Reinforced Concrete Approach Slabs

## 600 INCIDENTALS

### ITEM 601 SLOPE AND CHANNEL PROTECTION

- 601.01 Description**
- 601.02 Materials**
- 601.03 General Construction**
- 601.04 Riprap**
- 601.05 Grouted Riprap or Rock**
- 601.06 Crushed Aggregate Slope Protection**
- 601.07 Concrete Slope Protection**
- 601.08 Dumped Rock Fill**
- 601.09 Rock Channel Protection**
- 601.10 Detention Basin, Infiltration Basin, or Water Quantity Swale Aggregate**
- 601.11 Paved Gutter**
- 601.12 Tied Concrete Block Mat**
- 601.13 Method of Measurement**
- 601.14 Basis of Payment**

**601.01 Description.** This work consists of the excavation for and the construction of gutters, riprap, interlock precast concrete blocks, concrete, grouted items, tied concrete block mats, crushed aggregate, or rock items for protecting slopes and channels.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

**601.02 Materials.** Furnish materials conforming to:

Curing .....	451 or 705.07 Type 1
Concrete, Class C .....	499, 511
Water for grout .....	499.02
Reinforcing steel .....	509.02
Cement for grout .....	701
Structural Backfill Type 3 .....	703.11
Sand for grout .....	703.03
Rock and Aggregate Materials .....	703.19
Brick and blocks .....	704
Preformed expansion joint .....	705.03
Joint sealer .....	705.04
Filter fabric, Type B .....	712.09

Provide steel filter fabric securing pins with washers for securing filter fabric. Use a steel washer having an outside diameter not less than 1 1/2 inches (38 mm). Use securing pins at least 18 inches (0.5 m) long and at least 3/16 inch (5 mm) in diameter that are pointed at one end and fabricated with a head to retain the steel washer.

### 601.03

For tied concrete block mats, the articulating concrete blocks are held together by galvanized steel wire, HDPE mesh, stainless steel wire, or any 75 year mat material. The size of the concrete blocks, the space between the concrete blocks, and the required wire or mesh area shall conform to designs on file with the Office of Structural Engineering.

**601.03 General Construction.** Cure gutters, concrete slope protection, and grouted riprap according to Item 451, except apply all the membrane cures at the rate of not less than 1 gallon per 200 square feet (1 L/5 m<sup>2</sup>) of surface.

Mix and place all concrete according to Item 511. Finish to produce a sandy texture.

**601.04 Riprap.** Construct riprap according to one of the following four alternatives unless specifically itemized in the Contract. The Contractor may elect to use a different alternative at each location on the project.

**A. Provide Flat Stones or Broken Concrete.** Ensure that individual pieces are roughly rectangular in cross-section with a minimum volume of 1/3 cubic foot (0.01 m<sup>3</sup>) and a minimum thickness of 3 inches (75 mm). Place individual pieces by hand in courses and so that the pieces overlap the joints in the course below. Place riprap with the flat surfaces roughly perpendicular to the slope and in contact with the courses immediately below and above. Fill spaces between larger pieces with spalls that are rammed into place to present an even and tight surface, pleasing in appearance and varying not more than 3 inches (75 mm) from that shown on the plans. When required by the plans, fill riprap with grout. Compact the backing as riprap construction progresses. Ensure that the thickness of the riprap, measured perpendicular to the slope, is not flatter than 9 inches (230 mm) and averages not flatter than 12 inches (0.3 m).

Approved manufacturers are on file with the office of Materials Management. For approval, manufacturers will submit product information to the Office of Structural Engineering.

**B. Provide Interlock Precast Concrete Blocks.** Interlock precast concrete blocks are approved by the Office of Structural Engineering. A list of manufacturers is on file with the Laboratory. Place the interlock precast concrete blocks per the manufacturer's recommendations.

**C. Construct Concrete Riprap Using Cloth or Burlap Bags.** After soaking the bags with water, fill them with approximately 2/3 cubic foot (0.02 m<sup>3</sup>) of concrete and place the bags by hand to the limits on the plans. Provide bags with approximate dimensions of 6 × 12 × 16 inches (150 × 300 × 400 mm).

Stack the bags on the slope to ensure a minimum of 1/3 cubic yard (0.3 m<sup>3</sup>) of concrete for each square yard (square meter) of riprap in place as measured along the slope.

Tie the open end of each bag and fold the tie under the bag. Place each tie or fold so that it overlaps the joint in the lower layer. After placing, pierce each bag in the lower layer to allow some concrete to flow out and bond with the top overlying layer.

Stretchers are bags placed with the long length parallel to the streambed flow. Headers are bags placed with the long length perpendicular to the streambed flow. A layer runs horizontally at approximately the same elevation perpendicular to the protected slope grade.

If the slope is 1.5:1 or steeper, make the bottom layer with two bags laid as stretchers. Place the next overlying layer as a header. Place the rest of the overlying upslope layers as stretchers.

If the slope is flatter than 1.5:1, make the bottom layer with two bags as stretchers. Place all remaining layers as headers.

Push or drive No. 4 (No. 13M) reinforcing bars approximately 18 inches (0.5 m) long and spaced approximately 12 inches (0.3 m) apart through the top three layers. When required by the plans, fill voids with grout.

**D. Construct a 6-inch (150 mm) Reinforced Concrete Slab.** Reinforce the slab approximately midway between the top and bottom of the slab with steel bars or fabricated reinforcement equivalent to No. 3 (No. 10M) round bars, spaced at 24-inch (0.6 m) centers in two directions, or wire fabric according to the standard construction drawing for pavement reinforcing. The Contractor may use formed construction joints. Extend reinforcement through all formed construction joints. Include cutoff walls as shown on the plans in the unit price bid for reinforced concrete slab.

**601.05 Grouted Riprap or Rock.** When specified, grout in place riprap cloth bags, riprap burlap bags, flat stones, precast blocks, broken concrete, rock, or tied concrete block mats. Make the grout by mixing one part portland cement, three parts sand, and enough water to allow the grout to flow into the joints and cracks.

Prepare the grout in a mixing machine of an approved design and equipped with an accurate graduated regulating device for controlling the amount of water in each batch. Accurately measure and proportion the quantities for each batch, and ensure that the quantities are exactly sufficient for one or more sacks of cement.

Immediately before applying grout, thoroughly wet all surfaces. Place the grout, filling all the joints or voids. Do not add water to the grout after it has been placed.

**601.06 Crushed Aggregate Slope Protection.** Furnish material conforming to 703.19. Place the material on the filter fabric so that the surface is flush with the embankment slopes. Use a thickness of 12 inches (300 mm) unless a different thickness is specified. Extend the aggregate from the face of the abutments down to the toe of the slope or to normal water elevation, and a minimum of 3 feet (1 m) beyond the outer edges of the superstructures or as shown on the plans.

**601.07 Concrete Slope Protection.** Construct a concrete slab, 6 inches (150 mm) thick, extending over the embankment area under a bridge from the face of the abutment down to the toe of the slope and extending a minimum of 3 feet (1 m) beyond the outer edges of the superstructure or as shown on the plans. Thicken the bottom 3 feet (1 m) of the concrete slab from 6 to 18 inches (150 to 460 mm) to provide resistance to sliding.

## 601.08

Where pier columns extend through the slab, place 1-inch (25 mm) preformed expansion joint material around the columns and for the full thickness of the slab.

Divide the surface into an equally spaced block grid pattern at approximately 4 to 5-foot (1.2 to 1.5 m) intervals. Make the block grid pattern with one direction horizontally at a constant elevation or as directed by the Engineer, and the other direction parallel to the superstructure centerline, skewed, or as directed by the Engineer. Saw or form the block grid pattern to make joints at a depth of not less than one-fourth the thickness of the slab and approximately 1/8 inch (3 mm) wide.

**601.08 Dumped Rock Fill.** Furnish material conforming to 703.19. Dump larger pieces at the outer face and smaller pieces in the inner surface of the protected area. Ensure a reasonably smooth and continuous surface conforming to the slope lines shown on the plans. Avoid concentration of fines and small pieces at any location in the completed dumped rock fill material. When required by the plans fill all voids with grout.

**601.09 Rock Channel Protection.** Furnish material conforming to 703.19. When specified with a filter, provide a filter consisting of filter fabric or a 6-inch (150 mm) bed of aggregate conforming to 703.19. When placing rock, exercise reasonable care to ensure that the finished surface of the protected channel conforms to the channel cross-sections shown on the plans.

If filter fabric is used, prepare the surface to receive the fabric to a relatively smooth surface, free of obstruction and debris. With the long dimension parallel to the flow direction, loosely place the fabric without wrinkles and creases. Where joints are necessary, provide a 12-inch (0.3 m) minimum overlap, with the upstream strip overlapping the downstream strip. Place securing pins with washers at a minimum distance apart of 2 feet (0.6 m) along the joints and at a minimum distance apart of 5 feet (1.5 m) everywhere else. When required by the plans fill all voids with grout.

**601.10 Detention Basin, Infiltration Basin, or Water Quantity Swale Aggregate.** For detention basin or infiltration basin aggregate, furnish material conforming to Structural Backfill Type 3 at 6 inches (150 mm) thick. Furnish material conforming to 703.19.B, Type D for Water Quantity Swale Aggregate. Use a filter consisting of filter fabric. When placing aggregate, exercise reasonable care to ensure that the finished surface of the basin conforms to the details shown in the plans.

**601.11 Paved Gutter.** Mix and place concrete paved gutters according to Items 499 and 511 and to the dimensions and shape shown on the plans or the standard construction drawing.

When gutter constructed under this item is to be tied to an existing concrete base, pavement, or other rigid structure, match the type and location of the joints in the gutter with those in the adjoining pavement.

When gutter constructed under this item is not tied to an existing concrete base, form impressed joints using a device or bar shaped to the gutter cross-section. Make the impression before initial setting of the newly placed concrete. Remove the device or bar as soon as the concrete is in such condition to retain its shape when the bar or device is removed. Form an impressed joint that is 3/8 inch (10

mm) wide at the surface; 1/4 inch (6 mm) wide at the bottom; and a depth equal to one-third the thickness of the concrete. Edge the joints to a radius not greater than 1/4 inch (6 mm). Until the filler is placed, protect the joint from dirt or foreign matter. Fill the impressed joints in such a manner to confine the material to the joint and in no way mar the surface.

Compact the subgrade for all paved gutters according to 204.03. When required by the plans fill all voids with grout.

Approved manufacturers are on file with the Laboratory. For approval, manufacturers will submit product information to the Office of Structural Engineering.

**601.12 Tied Concrete Block Mat.** When specified, use Tied Concrete Block Mat Type \_\_\_ for protection of slopes, channels, and gutters as shown on the plans. Place directly on the filter fabric. Toe in the mat along the top of the slope and along the first or leading edge that is exposed to flow. When Tied Concrete Block Mat for Water Quantity Swales is specified, furnish Tied Concrete Block Mat Type 1. When required by the plans, fill all voids with grout. Tied concrete block mats are approved by the Office of Structural Engineering. Furnish products according to the Departments Qualified Products List (QPL).

Tied Concrete Block Mats may be used instead of Rock Channel Protection, Dumped Rock, or Riprap with the approval of the Office of Structural Engineering.

**601.13 Method of Measurement.** The Department will measure Riprap, Interlock Concrete Blocks, Crushed Aggregate Slope Protection, Concrete Slope Protection, and Tied Concrete Block Mats by the square yard (square meter) of the finished surface completed and accepted in place, with or without grout.

The Department will measure Dumped Rock Fill and Rock Channel Protection (with or without filter), by the cubic yard (cubic meter), completed and accepted in place according to the dimensions shown on the plans, excluding rock filter, with or without grout. The Department may determine quantities by volume in the vehicle or by a job conversion weight of acceptable material delivered.

The Department will measure Paved Gutter by the foot (meter) completed and accepted in place.

**601.14 Basis of Payment.** The Department will specify with grout in the pay item description when required. When the pay item calls out Tied Concrete Block Mat, include filter fabric material and installation in the price.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
601	Square Yard (Square Meter)	Riprap
601	Square Yard (Square Meter)	Crushed Aggregate Slope Protection
601	Cubic Yard	Water Quantity Swale Aggregate

**602.01**

	(Cubic Meter)	
601	Square Yard (Square Meter)	Tied Concrete Block Mat for Water Quantity Swale
601	Square Yard (Square Meter)	Concrete Slope Protection
601	Square Yard (Square Meter)	Tied Concrete Block Mat, Type ____
601	Cubic Yard (Cubic Meter)	Dumped Rock Fill, Type ____
601	Cubic Yard (Cubic Meter)	Rock Channel Protection, Type ____ with Filter
601	Cubic Yard (Cubic Meter)	Rock Channel Protection, Type ____ without Filter
601	Cubic Yard (Cubic Meter)	Rock Channel Protection, Type ____ with Aggregate Filter
601	Cubic Yard (Cubic Meter)	Detention Basin Aggregate
601	Cubic Yard (Cubic Meter)	Infiltration Basin Aggregate
601	Square Yard (Square Meter)	Interlock Concrete Blocks
601	Foot (Meter)	Paved Gutter

**ITEM 602 MASONRY**

**602.01 Description**

**602.02 Materials**

**602.03 Construction Requirements**

**602.04 Method of Measurement**

**602.05 Basis of Payment**

**602.01 Description.** This work consists of constructing headwalls, pipe cradles, collars, and other brick and masonry units of the types and sizes specified.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

**602.02 Materials.** Furnish materials conforming to:

Backfill.....	203
Concrete, Class C.....	499 and 511
Water for grout and mortar.....	499.02
Reinforcing steel .....	509.02
Cement for mortar.....	701.01 through 701.07
Sand for mortar .....	703.03
Granular base .....	Granular material Type B (203.02.R)
Brick and masonry units.....	704.01, 704.02, 704.03
Nonshrink mortar .....	705.22
Lime for mortar.....	712.04

**602.03 Construction Requirements.** Construct the designated items as shown on the plans.

A. Excavate to dimensions that provide ample room for construction. Remove obstructions as necessary to perform this work.

Protect the sides of all excavations from caving by providing suitable sheeting, shoring, and bracing. Use excavation methods that do not disturb the original material below the bottom of footers or below the additional 6 inches (150 mm) required for precast structures.

If the material found at the bottom of the headwall or below the additional 6 inches (150 mm) required for precast structures is not suitable for a foundation, excavate to further depth to provide a suitable foundation. Backfill the void left by the additional excavation with granular base. The Department will pay for this additional work according to 109.05.

Backfilling shall follow completion of the work as closely as the construction will allow. Backfill with granular base or soil. Place backfill in 6-inch (150 mm) loose lifts.

B. Compaction requirements are according to Item 203 except for the following:

Four passes per lift with additional passes as required until 95 percent compaction is reached. Use compaction equipment with a minimum total weight of, or minimum centrifugal force of, 1 ton (0.9 metric ton). Supply the manufacturer's specifications for this equipment to verify these requirements.

C. Cast-in-place structures are headwalls, pipe cradles, collars, and other units. Construct cast-in-place structures according to the corresponding Standard Construction Drawing using methods specified in Items 499, 511, and 509.

D. Pre-cast structures are half height headwalls for conduits up to a maximum of 78 inches (1980 mm). These pre-approved pre-cast structure drawings are on file in the Office Material Management. With the submission of the TE-24 from an approved manufacturer furnish stamped, approved from the Office of Structural Engineering design drawing sheets. Pre-cast half-height headwalls for elliptical and pipe arch conduits may be constructed from templates of the actual conduit being supplied, up to a maximum 78 inch (1980 mm) (round equivalent) to the project to ensure the opening is OD plus one inch. Submit drawings to the Office of Structural Engineering for approval, on a project by project basis, of pre-cast half-height headwalls for elliptical and pipe arch conduit. Non-pre-approved drawings are required to be submitted to the Office of Structural Engineering for approval. Allow 4 weeks for approval. Failure to furnish the stamped, approved design drawing sheets will result in rejection of the pre-cast structure. The drawings will include the following:

1. All manufacturers are pre-approved per Supplement 1073.
2. All reinforcing steel will be epoxy coated.
3. All HW-2.1 SCD require wire insert details.
4. Attachment detail for metal or plastic conduit per SCD HW2.1.

### 602.03

5. Non-corrosive lifting devices.
6. Maximum opening is conduit outside diameter plus 1 inch (25 mm) for each conduit material type.
7. All openings to be filled with nonshrink mortar including all lifting device voids.
8. Changes in pre-approved drawings are the same as non pre-approved drawings.
9. Detail how the 6 inch (150 mm) extension is treated if required.
10. Fill the void between the precast half height headwall and the conduit by using nonshrink mortar.
11. Apply marking, either stamped or painted, to the headwall to ensure each headwall size is matched to the proper conduit size and material type.

E. Pre-cast structures for slab footers, cut off walls, wingwalls, and headwalls for use with Items 706.05, 706.051 and 706.52 that conform to the manufacturers pre-approved design. Approved manufacturers that change their designs are considered non-approved designs. The pre-approved design is on file in the Office of Structural Engineering. With the submission of the TE-24 from an approved manufacturer furnish stamped, approved from the Office of Structural Engineering design drawing sheets. Non-approved designs are required to be submitted to the Office of Structural Engineering for approval. For non-approved designs submit structural design criteria, analysis method and structural details for approval to the Office of Structural Engineering. Allow 4 weeks for approval. Furnish 7 shop drawings to the Office of Structural Engineering for construction project pre-approved pre-cast structure review and approval. Allow 4 weeks for review and approval. Failure to furnish the stamped, approved design drawing sheets will result in rejection of the precast structure. Include the following:

1. All manufacturers are pre-approved per Supplement 1073.
2. All reinforcing steel will be epoxy coated.
3. Furnish PE signed sealed dated.
4. Non-corrosive lifting devices.
5. All openings to be filled with non-shrink mortar including all lifting hook voids.

F. Masonry units structures are headwalls, pipe cradles, collars, and other units. Thoroughly wet masonry units before laying the mortar. Lay masonry units with full mortar joints. Take adequate precautions to prevent the mortar from freezing. Do not set masonry units having a temperature of 40 °F (4 °C) or less with mortar until heated. When required, heat to ensure that a temperature of 50 to 80 °F (10 to 27 °C) is obtained throughout the entire masonry units. Cure the exposed surfaces of the masonry units by covering with wet burlap for 48 hours or by applying curing membrane according to Item 511. Construct the masonry units structures according to the corresponding Standard Construction Drawing. Use one of the following mortars:

1. One part Portland cement to two parts sand by volume. The Contractor may add lime in an amount not to exceed 10 percent of the cement by weight

2. One part masonry cement to two parts sand by volume.

**602.04 Method of Measurement.** The Department will measure Brick Masonry, Block Masonry, and Concrete Masonry by the number of cubic yards (cubic meters) calculated from dimensions shown on the plans.

**602.05 Basis of Payment.** When a precast structure is used, payment is based on the number of cubic yards (cubic meters) required for the cast in place item and is considered full compensation for construction of the precast structure.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
602	Cubic Yard (Cubic Meter)	Brick Masonry
602	Cubic Yard (Cubic Meter)	Block Masonry
602	Cubic Yard (Cubic Meter)	Concrete Masonry

## ITEM 603 PIPE CULVERTS, SEWERS, AND DRAINS

**603.01 Description**

**603.02 Materials**

**603.03 Definitions**

**603.04 Material Provisions**

**603.05 Excavation**

**603.06 Bedding**

**603.07 Laying Conduit**

**603.08 Joining Conduit**

**603.09 Exterior Coatings and Membrane Waterproofing**

**603.10 Backfilling**

**603.11 Placement and Compaction Requirements**

**603.12 Clearing Site and Restoring Damaged Surfaces**

**603.13 Field Paving of New or Existing Pipe**

**603.14 Method of Measurement**

**603.15 Basis of Payment**

**603.01 Description.** This work consists of constructing or reconstructing long span structures, pipe culverts, sewers, and drains (referred to below as Type A, Type B, Type C, Type D, Type E, and Type F conduit).

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

**603.02 Materials.** Furnish materials conforming to:

Soil and granular embankment ..... 203.02.R

Structural backfill, Types 1 and 2..... 703.11

The Engineer will allow Type 3 structural backfill, conforming to 703.11, to be used as bedding below the pipe only when pumping operations do not control severe ground water problems. Place at least 12 inches (300 mm) of Type 1 structural backfill on top of the Type 3 structural backfill to prevent piping.

- Embankment .....203.02.R
- Concrete for collars and encasement,
  - Class C.....499 and 511
- Concrete for field paving using
  - aggregate No. 7, 8, or 78, Class C .....499 and 511
- Reinforcing steel (collars and encasement) ..... 509.02
- Mortar ..... 602
- Non-shrink mortar ..... 705.22
- Bituminous pipe joint filler ..... 706.10
- Resilient and flexible gasket joints for:
  - Concrete sewer and culvert..... 706.11
  - Vitrified clay, B & S..... 706.12
- Preformed butyl rubber joint filler ..... 706.14
- 4x4 - W1.4 x W1.4 galvanized
  - welded wire fabric for field paving..... 709.08
- Type 2 membrane waterproofing ..... 711.25
- Type 3 membrane waterproofing ..... 711.29
- Fabric wrap, Type ..... 712.09
- Joint wrap.....ASTM C 877
- Buried Liner Waterproofing Membrane..... 711.22

Furnish pipe of the size and kind specified in the Proposal and conforming to applicable subsections of 706 and 707. The metric equivalent pipe size may vary with material type for the same English size pipe. The difference in sizes shall not be construed as an exclusion of a material type. The kinds of pipe allowed for each of the designated types of conduit are as follows:

Type A Conduits - Culverts:

- Non-reinforced concrete pipe, Class 3 ..... 706.01
- Reinforced concrete pipe..... 706.02
- Reinforced concrete pipe, epoxy coated..... 706.03
- Reinforced concrete elliptical pipe ..... 706.04
- Precast reinforced concrete box sections..... 706.05
- Precast reinforced concrete 3-sided flat topped culverts ..... 706.051
- Precast reinforced concrete arch sections ..... 706.052
- Vitrified clay pipe
  - (extra strength only) ..... 706.08
- Corrugated steel conduits ..... 707.01 or 707.02
- Structural plate corrugated
  - steel structures ..... 707.03
- Precoated, galvanized steel culverts ..... 707.04
- Bituminous coated corrugated steel pipe and pipe arches with

paved invert.....	707.05 or 707.07
Corrugated aluminum alloy pipe.....	707.21 or 707.22
Aluminum alloy structural plate conduits .....	707.23
Corrugated steel box culverts.....	707.15
Corrugated aluminum box culverts.....	707.25

#### Type B Conduits - Storm sewers or sanitary under pavement:

Non-reinforced concrete pipe, Class 3 .....	706.01
Reinforced concrete pipe .....	706.02
Reinforced concrete elliptical pipe .....	706.04
Precast reinforced concrete box sections .....	706.05
Vitrified clay pipe (extra strength only).....	706.08
Mortar lined corrugated steel pipe .....	707.11
Corrugated steel spiral rib pipe .....	707.12
Bituminous lined corrugated steel pipe .....	707.13 or 707.14
Corrugated aluminum spiral rib pipe .....	707.24
Corrugated polyethylene smooth lined pipe.....	707.33
Polyvinyl chloride plastic pipe (non-perforated) .....	707.41
Polyvinyl chloride corrugated smooth interior pipe .....	707.42
Polyvinyl chloride profile wall pipe.....	707.43
Polyvinyl chloride sanitary pipe .....	707.44
Polyvinyl chloride solid wall pipe .....	707.45
Polyvinyl chloride drain waste and vent pipe .....	707.46
Polyvinyl chloride ABS composite pipe.....	707.47
ABS drain waste and vent pipe.....	707.51
ABS sewer pipe .....	707.52
Ductile iron pipe (sanitary) .....	748.01
Polyvinyl chloride pipe (sanitary).....	748.02

#### Type C Conduits - Storm sewers or sanitary not under pavement:

Non-reinforced concrete pipe .....	706.01
Reinforced concrete pipe .....	706.02
Reinforced concrete elliptical pipe .....	706.04
Precast reinforced concrete box sections.....	706.05
Vitrified clay pipe .....	706.08
Mortar lined corrugated steel pipe .....	707.11
Corrugated steel spiral rib pipe .....	707.12
Bituminous lined corrugated steel pipe .....	707.13 or 707.14
Corrugated aluminum spiral rib pipe .....	707.24
Corrugated polyethylene smooth lined pipe.....	707.33
Polyvinyl chloride plastic pipe (non-perforated) .....	707.41

Polyvinyl chloride corrugated  
 smooth interior pipe..... 707.42  
 Polyvinyl chloride profile wall pipe ..... 707.43  
 Polyvinyl chloride sanitary pipe..... 707.44  
 Polyvinyl chloride solid wall pipe ..... 707.45  
 Polyvinyl chloride drain waste  
 and vent pipe ..... 707.46  
 Polyvinyl chloride ABS composite pipe ..... 707.47  
 ABS drain waste and vent pipe ..... 707.51  
 ABS sewer pipe..... 707.52  
 Ductile iron pipe (sanitary)..... 748.01  
 Polyvinyl chloride pipe (sanitary) ..... 748.02

Type D Conduits - Drive pipes and bikeways:

Non-reinforced concrete pipe, Class 3 ..... 706.01  
 Reinforced concrete pipe..... 706.02  
 Reinforced concrete elliptical pipe ..... 706.04  
 Vitrified clay pipe  
 (extra strength only) ..... 706.08  
 Corrugated steel conduits ..... 707.01 or 707.02  
 Structural plate corrugated  
 steel structures ..... 707.03  
 Corrugated aluminum alloy pipe ..... 707.21 or 707.22  
 Aluminum alloy structural  
 plate conduits..... 707.23  
 Corrugated polyethylene  
 smooth lined pipe ..... 707.33  
 Polyvinyl chloride corrugated  
 smooth interior pipe..... 707.42  
 Polyvinyl chloride profile wall pipe ..... 707.43  
 Polyvinyl chloride sanitary pipe..... 707.44  
 Polyvinyl chloride solid wall pipe ..... 707.45

Type E Conduits - Miscellaneous small drain connections and headers:

Non-reinforced - concrete pipe..... 706.01  
 Reinforced concrete pipe..... 706.02  
 Reinforced concrete elliptical pipe ..... 706.04  
 Concrete drain tile, extra quality ..... 706.07  
 Vitrified clay pipe ..... 706.08  
 Clay drain tile, extra quality ..... 706.09  
 Corrugated steel conduit..... 707.01 or 707.02  
 Corrugated aluminum alloy pipe ..... 707.21 or 707.22  
 Corrugated polyethylene  
 drainage pipe ..... 707.32  
 Corrugated polyethylene  
 smooth lined pipe ..... 707.33  
 Polyvinyl chloride plastic pipe  
 (non-perforated)..... 707.41  
 Polyvinyl chloride corrugated  
 smooth interior pipe..... 707.42  
 Polyvinyl chloride profile wall pipe ..... 707.43

Polyvinyl chloride sanitary pipe .....	707.44
Polyvinyl chloride solid wall pipe .....	707.45
Polyvinyl chloride drain waste and vent pipe .....	707.46
Polyvinyl chloride ABS composite pipe .....	707.47
ABS drain waste and vent pipe .....	707.51
ABS sewer pipe .....	707.52

Type F Conduits - Conduits on steep slopes; underdrain outlets:

Corrugated steel conduits (steep slope conduit), Type C .....	707.05 or 707.07
Corrugated aluminum alloy pipe (steep slope conduit) .....	707.21 or 707.22
Corrugated polyethylene smooth lined pipe (underdrain outlets) .....	707.33
Polyvinyl chloride plastic pipe (non-perforated underdrain outlets) .....	707.41
Polyvinyl chloride corrugated smooth interior pipe (underdrain outlets) .....	707.42
Polyvinyl chloride solid wall pipe (underdrain outlets) .....	707.45

**603.03 Definitions.** For the purposes of this specification, the following definitions are used:

- A. Long span structure includes all of the following material kinds: 706.05, 706.051, 706.052, 707.15, and 707.25.
- B. Plastic pipe includes all of the following materials kinds: 707.31, 707.32, 707.33, 707.41, 707.42, 707.43, 707.44, 707.45, 707.46, 707.47, 707.51, 707.52, and 748.02.
- C. Corrugated metal pipe includes all of the following material kinds: 707.01, 707.02, 707.03, 707.04, 707.05, 707.07, 707.11, 707.12, 707.13, 707.14, 707.21, 707.22, 707.23, and 707.24.
- D. Iron pipe includes the following material kind: 748.01.
- E. Rigid Pipe includes all of the following material kinds: 706.01, 706.02, 706.03, 706.04, 706.08, 706.09, and 748.06.
- F. Conduit includes long span structures, pipe, culverts, sewers, drains, or any other item specified herein.
- G. Backfill is soil, granular embankment, or structural backfill placed above the bedding to the elevation as describe.
- H. A cut situation is an existing field situation when the top of the conduit is below the existing ground where an embankment may be constructed.
- I. A fill situation is an existing field situation when the top of the conduit is above the existing ground where an embankment is to be constructed.
- J. A fill situation, meets the requirements of a cut if the fill is constructed to at least 2 feet (600 mm) above the top of the conduit before placing the conduit.

#### 603.04

- K. The conduit rise is the vertical distance from outside wall to outside wall or outside corrugation measured at the middle of the conduit.
- L. The conduit span is the horizontal distance from outside wall to outside wall or outside corrugation measured at the widest point of the conduit.
- M. The conduit spring line is equal to the rise divided by two.
- N. Trench width is the horizontal distance between the vertical walls of the trench measured in feet.

#### 603.04 Material Provisions.

The Engineer will allow any of the following alternate material provisions:

- A. The Contractor may use Type 1 or 2 structural backfill if granular or soil embankment is required or allowed.
- B. Supply pipe of the required size or one size larger.
- C. If 707.05 or 707.07 conduit is specifically itemized or specified in the Proposal, the Contractor may provide conduit conforming to 707.04 and having a bituminous paved invert. Provide the same corrugation profile and sheet thickness listed in the Proposal.
- D. The Contractor may furnish higher strength concrete or plastic pipe of the same type where lower strength pipe is specified.
- E. The Contractor may furnish a thicker metal pipe of the same corrugation profile and type where a lesser thickness is permitted or specified.
- F. If 706.02 reinforced concrete pipe is specifically shown on the plans as “special design”, the manufacturer shall submit shop drawings and design calculations by a Registered Engineer for review and written approval before manufacture. Submit a minimum of seven copies of the shop drawings and allow a minimum of 4 weeks for approval. Include the following in the shop drawings:
  - 1. All structural design and loading information.
  - 2. All material specifications.
  - 3. All dimensions.

Design reinforced concrete pipe based on *AASHTO LRFD Bridge Design Specifications*, Section 12.

- G. If a 706.05 structure is specifically itemized or specified in the Contract, the Contractor may submit to the Department for approval a request to supply a 706.051 structure placed on precast slab bottom, or a 706.052 structure placed on precast slab bottom, that is hydraulically equivalent and meets all cover requirements. These structures and slab bottoms shall conform to the pre-approved design by a Registered Engineer from approved manufacturers on file with the Department. Manufacturers not approved may submit structural design criteria, analysis method, and structure details for approval. The manufacturer shall submit shop drawings and hydraulic calculations by a Registered Engineer for review and approval before manufacture. The bottom slab may be cast-in-

place with approval from the Department however there will be no increase in time permitted.

H. If 706.051 or 706.052 is specifically itemized or specified in the Contract, on footers, the Contractor may substitute each one for the other upon structure approval for hydraulics and cover. The manufacturer shall submit shop drawings and hydraulic calculations by a Registered Engineer for review and approval before manufacture. If 706.051 or 706.052 is specifically itemized or specified in the Contract, on pedestal walls, the Contractor may substitute each one for the other upon structure approval for hydraulics, cover and pedestal wall design. 706.051 or 706.052 require different pedestal wall designs.

I. All 706.051 or 706.052 shop drawings require a Registered Engineer signature for design and check. The manufacturer shall submit shop drawings and hydraulic calculations to the Department for review and approval before manufacture.

J. For metal pipe 54 inch (1350 mm) diameter or larger and pipe-arch, ensure the manufacturer provides match marked ends and a layout drawing.

**603.05 Excavation.** Measure trench width at the span of the conduit. Center the trench excavation about the centerline of the conduit.

Use Method A for a cut situation, and use Method B for a fill situation.

**A. Method A.** Excavate the trench for the conduit. Provide vertical trench walls.

If long span culvert is used, provide a minimum trench width of the span plus 2 feet (0.6 m) on each side.

If rigid pipe is used, provide a minimum trench width of the span times 1.33.

If plastic or corrugated metal pipe is used, provide a minimum trench width of the span times 1.25 plus 1 foot (0.3 m).

If plastic pipe is used and the ID is 8 inch (200 mm) or less furnish a minimum trench width of the OD.

Increase these minimums to a width that allows the jointing of the conduit, and the placement and compaction of the backfill.

**B. Method B.** Construct the embankment to a height at least equal to half of the rise and to a width on each side of the conduit two times the span of the conduit before excavating for the conduit. Excavate the trench in the constructed embankment to a width conforming to Method A above.

Furnish a firm foundation for the conduit bed for its full length. The Engineer will require the removal of unsuitable material below the conduit bedding or below the bottom of the conduit if bedding is not required for the width of the trench. Replace the unsuitable material with structural backfill. Remove rock or shale in the conduit foundation for at least 6 inches (150 mm) below the bottom of the bedding. Replace the rock or shale with structural backfill. Unless in the contract documents, the Department will pay for this work according to 109.05.

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If the Engineer changes the flow line by more than one foot (0.3m), the Department will pay according to 109.05.

The Contractor may jack or tunnel the pipe with the written permission of the Director.

**603.06 Bedding.** Type 1 bedding consists of structural backfill extending at least 6 inches (150 mm) below the bottom of the conduit for the full width of the trench. Compact the bedding according to 603.11.

Use Type 1 bedding for 706.05, or 706.051 and 706.052 on slab bottoms, or corrugated invert plates.

Type 2 bedding consists of structural backfill extending at least 3 inches (75 mm) for all 706 rigid pipe conduits and 6 inches (150 mm) for all other conduits below the bottom of the conduit for the full width of the trench. Extend the bedding up around the pipe for a depth of not less than 30 percent of the rise of the conduit. Shape the bedding to fit the conduit with recesses shaped to receive the bell of bell-and-spigot pipe. Leave the bedding below the middle one-third of the pipe span uncompacted. Compact the remaining bedding according to 603.11.

Use Type 2 bedding for Types A, B, C, and D conduits except for long span structures and for conduits that require Type 3 bedding.

Type 3 bedding consists of a natural foundation with recesses shaped to receive the bell of bell-and-spigot pipe. Scarify and loosen the middle one-third of the pipe span.

Use Type 3 bedding for Type C and Type D conduits of the following materials: 706.01, 706.02, or 706.03.

Type 4 bedding consists of a natural foundation shaped to fit the conduit with recesses shaped to receive the bell of bell-and-spigot pipe.

Use Type 4 bedding for Types E and F conduits.

**603.07 Laying Conduit.** Lay the conduit in the center of the trench starting at the outlet end with the bell or groove-end laid upgrade. Ensure that the conduit is in contact with the bedding throughout its full length such that line and grade is maintained. Lay metal conduits according to one of the following methods:

A. If the seam is longitudinally either riveted or welded, place the seam or weld at the spring line.

B. If the metal pipe is fabricated helically (having a continuous seam running around the outside of the pipe), arrange the corrugations so the helix angle or twist is rotating downstream in the direction of the flow to increase hydraulic performance.

Maintain flows at all times until the new facilities are completed and in service. Maintain the flows through existing facilities to be replaced unless a temporary bypass conduit is used.

Construct the inlet and outlet ends of all conduit runs with pipe ends as normally fabricated by the manufacturer. If field cutting is necessary, locate the

cut end at an interior joint within the run and provide a cradle, collar, or band to ensure a stable joint.

Construct a concrete collar on the last joint if field cutting is necessary to meet a structure or headwall.

Erect 707.03, 707.15, 707.23, and 707.25 conduits according to 522.03. Where two plate thicknesses are specified, locate the thicker plates at the bottom and corner plates in pipe-arch structures, and the bottom row, if centered, or bottom two rows, if not centered, in round structures.

Set the 706.051 units on the concrete footing shown on the plans. Unless otherwise shown on the plans, provide a 3-inch (75 mm) deep by 14-inch (350 mm) wide keyway in the center of the footing. Place the units in a 1/2-inch (13 mm) bed of mortar. If proper line and grade of the structure cannot be maintained on the bed of mortar, set the units on 5 × 5-inch (125 × 125 mm) masonite or steel shims. Fill the entire keyway joint with mortar.

Set the 706.052 units on the concrete footing shown on the plans. Unless otherwise shown on the plans, provide a 3-inch (75 mm) deep by 14-inch (350 mm) wide keyway in the center of the footing. Place the units on 5 × 5-inch (125 × 125 mm) masonite or steel shims to provide a minimum 1/2-inch (13 mm) gap between the footing and bottom of the unit's bottom leg. Fill the entire keyway joint with mortar.

If reinforced concrete pipe has elliptical reinforcing, the top and bottom of the pipe are clearly marked on the pipe. Handle and place reinforced concrete pipe with elliptical reinforcement and reinforced concrete horizontal elliptical pipe with single cage reinforcement with the reinforcement markings along a vertical plane as marked on the pipe. Handle and place reinforced concrete pipe with auxiliary supports (S-stirrups) with the centerline of the auxiliary support system (S-stirrups) in a vertical plane as marked on the pipe.

For 706.05, 706.051, or 706.052 structures fill the lifting devices with mortar. Cover the exterior of the lifting devices with joint-wrap material if outside the limits of the membrane waterproofing. Use joint-wrap with a minimum width of 9 inches (225 mm). Use only lifting devices that do not require a hole through the structure.

For all 707 conduit, use only lifting devices that do not require a hole through the structure.

Immediately after placing conduit, construct the end treatments at both the outlet and inlet ends. These end treatments include headwalls, concrete riprap, rock channel protection, sod or other erosion control items.

**603.08 Joining Conduit.** Join the conduit sections so that the ends are fully entered and the inner surfaces are flush and even. Furnish sealed, banded, or bolted joints for Types A, B, C, D, and F conduits. Provide open joints for Type E conduits wrapped with 4-inch (100 mm) wide tarred paper or tarred burlap with pack soil placed around this material to hold it in place during backfilling.

The Engineer may allow joint materials other than those listed below, provided the Contractor demonstrates the proposed material makes durable sealed joints.

Furnish joints that do not allow infiltration of backfill material into the conduit or use a fabric wrap on the outside of the conduit.

Install conduit so that match marks align and in accordance with the layout drawings supplied by the manufacturer.

**A. Joints.**

1. Metal Pipe.

If using corrugated metal pipe, provide coupling bands conforming to 707.01 or 707.02. These bands will have the same coating as the pipe being joined and use gasketed coupling bands or fabric wrap the coupling bands when using structural backfill Type 2 for the bedding or backfill. A maximum difference between adjacent pipe sections of 1/2 inch (15 mm) will be allowed before coupling bands are placed. Securely strut the end of each pipe section for pipe diameters 54 inches (1350 mm) or greater that have a wall thickness of less than 0.109 inch (2.77 mm). Install the ties or strapping in the first or second valley of the annular corrugations on each end of each piece of pipe. Install two struts per end such that they are perpendicular to one another and cross at their midpoints. Strut by using wire ties or other approved methods. Remove the strutting after securing the coupling bands.

Bell and spigot joints conforming to 707.12 may be used for corrugated steel spiral rib conduits. Ensure the spigot and bell ends are clean and free from dirt or debris prior to assembly. Place a gasket in the first corrugation of the spigot end and thoroughly lubricate the gasket and the bell end of the receiving conduit prior to assembly. Ensure the spigot is securely driven home into the bell upon final assembly.

2. Rigid Pipe.

a. For 706.01, 706.02, or 706.04, 706.05, or 706.08 that require sealed joints, use any of the following methods:

i. Apply 706.10 to the pipe in sufficient quantity to completely fill the joint once the pipe is placed in its final position at a gap of 1 inch (25.4 mm) or less. After placing the pipe in its final position, point and trowel the 706.10 to form a smooth transition on the inside and a complete seal on the outside.

ii. Apply 706.14 to the pipe in sufficient quantity to seal the joint but not necessarily fill the joint once the pipe is placed in its final position at a gap of 1 inch (25.4 mm) or less. Immediately before installing 706.14, clean the joint free of all debris then prime both sides of the joint with an asphalt based primer according to the 706.14 manufacturer's recommendations.

iii. Provide 706.11 or 706.12 as specified.

b. For 706.03 conduit, use fibrated coal tar joint compound applied according to the manufacturer's recommendations.

c. If resilient and flexible gasket joints conforming to 706.11 or 706.12 are specified on sanitary sewer conduits, test the joints for infiltration or exfiltration according to ASTM C 969. If any section of conduit fails to meet the test requirements, make corrections until the test requirements for the section are met.

**B. Filling Joints.** After placing 706.05, 706.051, or 706.052 in their final position with a maximum joint gap of 1 inch (25.4 mm), clean the joint gap or joint of all debris and perform the following:

1. For 706.05 joints, fill the top exterior joint gap and the bottom and side interior joint gap with mortar. Next, for any exterior joint not covered by membrane waterproofing, cover the exterior joint with a 9-inch (225 mm) wide strip of joint wrap. Center the joint wrap on the joint. Use a continuous length of joint wrap sufficient to extend from the bottom of the vertical face on one side to the bottom vertical face on the other side.

2. For 706.051, fill the top keyway joint with 705.22. The side or leg joints shall also be filled with 705.22 for the key way type joint or filled per 706.05 for a tongue and groove type joint. Clean the joint of all debris immediately before installing the joint filling material. Prepare, place, and cure the 705.22 according to the manufacturer's recommendations. Wet all surfaces of the keyway joint, but do not allow excess water in the joint. Next, for any exterior joint not covered by membrane waterproofing, cover the exterior joint with a 12-inch (300 mm) wide strip of joint wrap. Center the joint wrap on the joint. Use a continuous length of joint wrap sufficient to extend from the bottom of the vertical face on one side to the bottom vertical face on the other side.

3. For 706.052, install a  $7/8 \times 1\ 3/8$ -inch ( $24 \times 34$  mm) 706.14 joint filler along the outside joint chamfer. Use a continuous length of joint filler sufficient to extend from the bottom of the vertical face on one side to the bottom vertical face on the other side. Before installing the joint filler, prime the joint chamfer with a primer according to manufacturer's recommendations. Next, cover the exterior joint with a 9-inch (225 mm) wide strip of Type 3 membrane waterproofing centered on the joint, and then apply all waterproofing as shown on the plans. For any exterior joint not covered by membrane waterproofing, cover the exterior joint with a 12-inch (300 mm) wide strip of joint wrap. Use a continuous length of joint wrap sufficient to extend from the bottom of the vertical face on one side of the structure to the bottom vertical face on the other side.

**C. Sealing Concrete Surfaces.** For 706.05, 706.051, or 706.052, apply an approved epoxy sealer per the plans to all top surfaces not covered by membrane waterproofing. Extend the sealer 1 foot (0.3 m) below the backfill on all sides of the culvert sections including the joint.

The Engineer and Contractor will visually inspect all conduit and joints before any backfill is placed. Rejoin, re-lay, or replace all conduit out of joint tolerance, alignment, settled, or damaged.

**603.09 Exterior Coatings and Membrane Waterproofing.** Apply waterproofing to 707.03, 707.15, 707.23, and 707.25 conduits with less than eight feet of cover by one of the following methods.

## 603.10

A. Coat the exterior of the conduit above the limits of the bedding and within the limits of backfill. Ensure that all plate seams and bolts are thoroughly sealed. The coating material and application shall conform to AASHTO M 243. Allow asphalt mastic material to dry 48 hours and tar base material to dry 28 hours before placing the conduit backfill. Rib stiffeners do not need to be coated.

B. Construct Buried Liner Waterproofing Membrane protection in the fill per the manufacturer's recommendations. The Buried Liner Waterproofing Membrane protection will be a seamless continuous sheet placed over the conduit and extend at least 10 feet (3.3m) outside of the paved shoulder and for the width of the trench.

For 707.03, 707.15, 707.23, and 707.25 conduits, coat the exterior of the conduit above the limits of the bedding and within the limits of backfill. Ensure that all plate seams and bolts are thoroughly sealed. The coating material and application shall conform to AASHTO M 243. Allow asphalt mastic material to dry 48 hours and tar base material to dry 28 hours before placing the conduit backfill. Rib stiffeners do not need to be coated.

**603.10 Backfilling.** Place backfill to the limits described and according to the compaction requirements. Place the backfill in the trench and embankment outside the trench uniformly on both sides of the conduit for all conduit installations.

A. General. The Contractor may operate small compaction equipment with less than a total weight of 1 ton (0.9 metric ton) over the conduit to compact the backfill. Do not use hoe packs on top of the conduit until 2 feet (0.6 m) of backfill is compacted on top of the conduit. The Contractor may operate compaction equipment with less than a total weight of 8 tons (7 metric tons), but more than 1 ton (0.9 metric ton), over the conduit after placing and compacting 2 feet (0.6 m) of backfill. Do not operate equipment with a total weight of 8 tons (7 metric tons) or more, until placing and compacting a cover of 4 feet (1.2 m) over the top of the conduit. The above restrictions apply when working within one span on each side of the conduit, or 6 feet (1.8 m), whichever is less. As shown on the plans, encase conduits with the specified thickness of Class C concrete.

B. Long Span.

1. For long span structures in cut, place and compact structural backfill over the top of the section to a minimum depth 4 feet (1.2 m) or to the subgrade elevation whichever is less and for a width of 2 feet (0.6 m) on each side of the section. Use soil, granular embankment, or structural backfill to construct the adjacent embankment and for the remaining depth to the subgrade. Construct the adjacent material according to Item 203.

2. For long span structures in fill, place and compact structural backfill over the top of the section to a minimum depth of 2 feet (0.6 m) or to the subgrade elevation whichever is less and for a width of 2 feet (0.6 m) on each side of the section. Use soil, granular embankment, or structural backfill to construct the adjacent embankment and for the remaining depth to the subgrade. Construct the adjacent material according to Item 203.

C. Type A and B. Backfill Types A and B conduits except for long span structures as follows

1. In a cut situation, place and compact structural backfill above the bedding for the full depth of the trench. Within the trench and more than 4 feet (1.2 m) above the top of the conduit, if the trench can accommodate compaction equipment, the Contractor may construct Item 203 Embankment. For plastic pipe with an ID 8 inch (200 mm) or less, place and compact structural backfill above the bedding for the full depth of the trench.

2. In a fill situation, place and compact structural backfill above the bedding for the full depth of the trench specified in 603.05.B. Above these limits, uniformly place the lesser of one pipe span or 4 feet (1.2 m) of structural backfill on each side of the conduit and to a depth of 2 feet (0.6 m) above the top of the conduit. Construct the embankment outside the limits of the backfill. For plastic pipe with an ID 8 inch (200 mm) or less, place and compact structural backfill above the bedding for the full depth of the trench.

D. Type C and D. Backfill Type C and D conduits as follows:

1. In a cut situation, for plastic pipe, place and compact structural backfill above the bedding and to 12 inches (300 mm) over the top of the pipe. All other conduit material types place and compact backfill. For plastic pipe with an ID 8 inch (200 mm) or less, place and compact structural backfill above the bedding for the full depth of the trench.

2. In a fill situation, for plastic pipe, place and compact structural backfill above the bedding for the full depth of the trench specified in 603.05.B. Above these limits, uniformly place the lesser of one pipe span or 4 feet (1.2 m) of structural backfill on each side of the conduit and vertically to the top of the conduit. Then place for a depth of 12 inches (300 mm) structural backfill over the top of the pipe equal to the trench width centered on the pipe center line. Construct the embankment outside the limits of the backfill. All other conduit material types place and compact backfill. For plastic pipe with an ID 8 inch (200 mm) or less, place and compact structural backfill above the bedding for the full depth of the trench.

E. Type E. Place and compact backfill above the bedding to a height equal to two-thirds of the conduit rise then place and lightly compact backfill for a depth of 12 inches (0.3 m) above the pipe. Place no stones larger than 4 inches (100 mm) that will be part of the embankment in contact with the pipe.

F. Type F. Place and compact backfill above the bedding. Backfill Type F conduits for underdrain outlets according to 605.03.C.

**603.11 Placement and Compaction Requirements.** Place soil, granular embankment, or Structural Backfill Type 1 or 2 in lifts not to exceed 8 inches (200 mm). The Department will perform all compaction testing according to Supplement 1015. The compaction requirements per material type are as follows:

A. For soil embankment, compact each lift until 96 percent of AASHTO T 99 is achieved.

B. For granular embankment and Structural Backfill, Type 1 or 2, compact each lift of material according to 603.11.E using mechanical devices, hoe packs, jumping jacks, hand devices, vibrating plates, or other equipment that meets the

## 603.12

restrictions in 603.10. Provide compaction equipment that compacts the material under the haunch of the pipe. If the compaction equipment cannot fully compact the material under the haunch, supplement the compaction equipment by using shovel slicing, spud bars, or mechanical spud bars to compact the material under the haunch of the pipe. Use shovel slicing and spud bars in conjunction with the compaction operations to compact the material and to manipulate the material under the haunch of the pipe.

C. For Structural Backfill Type 2, compact each lift of material according to 603.11.E using flood compaction or mechanical devices, hoe packs, jumping jacks, hand devices, vibrating plates, or other equipment that meets the restrictions in 603.10. Provide compaction equipment that compacts the material under the haunch of the pipe. If the compaction equipment cannot fully compact the material under the haunch, supplement the compaction equipment by using shovel slicing, spud bars, or mechanical spud bars to compact the material under the haunch of the pipe. Use shovel slicing and spud bars in conjunction with the compaction operations to compact the material and to manipulate the material under the haunch of the pipe.

D. Place Structural Backfill Type 3 in layers not to exceed 12 inches (300 mm) loose depth. Vibrate, tamp, or compact to approximately 85 percent of the original layer thickness.

E. At the beginning of the work, construct a test section in the conduit trench. The Engineer will use at least 96 percent of the test section maximum dry density for acceptance of the production areas. Use at least the same number of passes or compactive effort used to construct the test section to compact the production areas. Use compaction equipment with a total weight or centrifugal force of at least 1/2 ton (0.5 metric tons). Supply the manufacture's specification for the compaction equipment. Except when using a hoe pack, use at least six passes with the compaction equipment in the production areas.

The Engineer may reduce the minimum passes if the passes are detrimental to compaction.

Construct a new test section if the pipe type, bedding material, backfill material, or trench conditions change.

F. If using trench boxes with either Type A or B conduits, configure the trench box so that the bedding and backfill material is compacted directly against the trench walls.

G. The Engineer may adjust the lift thickness to obtain the required compaction, fill all the voids, achieve the proper seating of the backfill material, and achieve the stability of the backfill material and the pipe. Do not use equipment or methods that compromise the structural integrity of the pipe.

**603.12 Clearing Site and Restoring Damaged Surfaces.** Immediately after completion of the placing and compacting of the backfill remove and dispose of all surplus material according to 603.01 and clear the site and restore all required surfaces

**603.13 Field Paving of New or Existing Pipe.** Field pave the bottom of the conduit with concrete as shown on the plans.

For new pipe installations, do not pave until at least 4 feet (1.2 m) of fill is placed on top of the conduit, or the top of subgrade is reached. If the paving is placed before completion of the entire fill, clean any gaps between the conduit and concrete paving, then fill with heated bituminous material conforming to 705.04.

Reinforce the paving with  $4 \times 4$ -W1.4  $\times$  W1.4 galvanized welded wire fabric (or comparable). Provide a mesh with a width 4 inches (100 mm) less than the finished paving. Securely fasten the mesh to the conduit near each edge and at the center of the mesh at points not more than 4 feet (1.2 m) apart along the flow line of the culvert. Repair any damage to the galvanizing or other coating material caused by placement or by tack welding. Use wire brushing and paint with zinc rich paint to make the repairs.

For aluminum structural plate, securely fasten the mesh to the circumferential seam bolts with galvanized tie wire.

Provide a paving that is 3 inches (75 mm) thick measured from the top of the corrugations of the conduit to a height equal to 1/3 of the rise. Provide galvanized reinforcing steel support chairs beneath the mesh where necessary. Give special care to the mesh during concrete placement. After placing the concrete, strike it off with a template to produce the proper radius, and finish with a float to produce a smooth finish. Cure the concrete according to 451.10.

**603.14 Method of Measurement.** The Department will measure conduit by the number of feet (meters), measured from center-to-center of appurtenant small structures or between open ends inclusive of lengths of pipe bends and branches. The Department will not deduct for catch basins, inlets, or manholes that are 6 feet (2 m) or less across, measured in the direction of flow. Where the location of an appurtenance or an open end is changed with the approval of the Engineer to accommodate full conduit sections, the Department will measure the length placed. Conduits placed on slopes steeper than 3:1 or with beveled or skewed ends will be measured along the invert.

When the pay item calls for concrete encasement, payment for furnishing and placing the concrete encasement, and for any additional excavation required shall be included in the unit bid price for the pertinent conduit. When the pay item calls for a new conduit to be field paved, payment for the field paving, including all work and materials necessary for the item, shall be included in the unit bid price for the pertinent conduit.

The Department will measure field paving of existing pipe by the number of feet (meters).

**603.15 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
603	Foot (Meter)	___" (___ mm) Conduit, Type ___
603	Foot (Meter)	___ $\times$ ___ Conduit, Type ___
603	Foot (Meter)	___" (___ mm) Conduit

**604.01**

603	Foot (Meter)	Reconstructed, Type ___ Type ___ Precast Reinforced Concrete Flat Topped Three-Sided Culvert, ___' (___ mm) Span × ___' (___ mm) Rise
603	Foot (Meter)	Type ___ Precast Reinforced Concrete Arch Sections, ___' (___ mm) Span × ___' (___ mm) Rise
603	Foot (Meter)	___' (___ mm) Rise × ___' (___ mm) Span Conduit, Type A Corrugated Steel Box Culvert, ___' (___ mm) Minimum Cover, ___' (___ mm) Maximum Cover
603	Foot (Meter)	___' (___ mm) Rise × ___' (___ mm) Span Conduit, Type ___ Corrugated Aluminum Box Culvert, ___' (___ mm) Minimum Cover, ___' (___ mm) Maximum Cover
603	Foot (Meter)	___" (___ mm) Conduit, Type ___, with Field Paving of Pipe
603	Foot (Meter)	___" (___ mm) Conduit, Type ___, Field Paving of Existing Pipe
603	Foot (Meter)	Conduit, Type F for underdrain outlets

**ITEM 604 MANHOLES, CATCH BASINS, INLETS, INSPECTION  
WELLS, JUNCTION CHAMBERS, PRECAST REINFORCED  
CONCRETE OUTLETS,  
OR MONUMENTS**

**604.01 Description**

**604.02 Materials**

**604.03 Construction Methods, General**

**604.04 Excavation and Backfill**

**604.05 Brick and Block Masonry**

**604.06 Precast Concrete Modular Construction**

**604.07 Concrete (Cast-In-Place)**

**604.08 Method of Measurement**

**604.09 Basis of Payment**

**604.01 Description.** This work consists of constructing or reconstructing manholes, catch basins, inlets, inspection wells, junction chambers, precast reinforced concrete outlets, or monuments of the type and sizes specified; or adjusting existing castings to grade, as specified.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

**604.02 Materials.** Furnish materials conforming to:

Structure concrete, Class C.....	499, 511
Brick and masonry units .....	704
Precast reinforced concrete manhole, catch basin, and inlet sections .....	706.13
Precast reinforced concrete outlet.....	706.15
Preformed expansion joint fillers.....	705.03
Epoxy coated reinforcing steel.....	509.02, 709.00
Cast frames, grates, and covers. 711.12, 711.13, or 711.14	
Welded frames and grates.....	513.17, 711.01
Steps .....	711.13, 711.30, or 711.31
Structural backfill, Types 1, 2 and 3.....	703.11
Resilient and flexible gasket joints .....	706.11
Curing materials.....	705.05, 705.07
Mortar .....	602
Nonshrink Mortar .....	705.22

**604.03 Construction Methods, General.** Construct the specified structures according to the plans. Place inlets, catch basins, inspection wells, junction chambers, monuments, or precast outlets at the locations and elevations shown in the plans according to the standard construction drawings or as directed by the Engineer. Place manhole castings at the elevation and station with offset to the center of the casting or as directed by the Engineer. Place the manhole base at the elevation and station with offset to agree with the pipe station, offset and pipe invert elevation according to the standard construction drawings or as directed by the Engineer. Use flat slab top manholes as shown on the standard construction drawing. Do not remove the flat slab top manhole lifting devices.

If the Engineer changes the structure elevation by more than 1 foot (0.3 m), the Department will pay according to 109.05.

Thoroughly mortar with a flush mortar joint the underdrain outlet pipe to the precast reinforced concrete outlet. Furnish and place lateral sewer connections including drops and leads except pipe included in Item 603.

Locate or cut conduits as shown on the standard construction drawings so they do not protrude inside the structure walls.

Take adequate precautions to prevent structure concrete or mortar cement from freezing. Preheat the brick, concrete block, or precast concrete structure throughout the entire mass to a temperature between 50 to 80 °F (10 to 27 °C) before placing mortar if the ambient temperature is 40 °F (4 °C) or less.

Set iron frames, tops, and covers of the type shown on the plans in a mortar bed with a flush mortar joint.

Prevent earth or debris resulting from construction operations from entering the manholes, catch basins, junction chamber, inlets, and precast reinforced concrete outlets. Remove any debris.

## 604.04

### A. Reconstruction to grade

1. Carefully remove and clean the existing castings.
2. Remove the existing walls of manholes down to the spring line or below as necessary.
3. Remove existing walls of catch basins and inlets below the window openings, grates, or any points of wall failure.
4. Using the salvaged casting, reconstruct the structure to the new grade, conforming as nearly as practicable to the existing dimension and type of construction.

### B. Adjustment to grade

1. Carefully remove and clean the existing frame, adjust the height of supporting walls, and reset the existing frame in a bed of concrete mortar or structure concrete to the new grade.
2. Carefully remove the existing cover or grate and install a casting or an acceptable adjusting device on file at the Laboratory or an adjusting device approved by the Engineer to the new grade and install per the manufacturer's recommendations.

**604.04 Excavation and Backfill.** Excavate to dimensions that provide ample room for construction.

The Engineer will require the removal of unsuitable material below the structure bedding. Replace unsuitable material with Item 603 Structural Backfill. When the Engineer requires the removal and replacement of unsuitable material below the bedding for precast structures and below the structure for cast-in-place structures, the Department will provide compensation according to the Contract or by Supplemental Agreement.

Ensure that the backfilling follows the completion of the work as closely as the type of construction will permit. Do not disturb the structure while backfilling. Backfill structures located within the pavement area with structural backfill to the subgrade according to Item 603, Type A or B conduit. Backfill structures outside of the pavement area according to Item 603, Type C conduit.

**604.05 Brick and Block Masonry.** Thoroughly wet brick and concrete block masonry units before laying in the mortar, and lay the brick and masonry units with a flush mortar joint.

Take adequate precautions to prevent concrete and mortar from freezing. Do not set brick and masonry units having a temperature of 40 °F (4 °C) or less with mortar until heated. When required, heat to ensure that a temperature of 50 to 80 °F (10 to 27 °C) is obtained throughout the entire mass of the material.

Cure the exposed surfaces of all brick and block masonry by covering with wet burlap for 48 hours or by applying curing membrane according to Item 511.

**604.06 Precast Concrete Modular Construction.** Furnish precast bases on a compacted structural backfill bed having a minimum thickness of 3 inches (75

mm). Ensure that the structural backfill bed is level and uniformly support the entire area of the base.

After placing the pipe, grout all openings between the pipe and structure less than 4 inches (100 mm) with mortar and grout all openings between the pipe and structure greater than 4 inches (100 mm) with nonshrink mortar. Seal all joints between modules with materials specified in Item 603 for Type A, B, C, D, or F conduit.

Cure median inlets with the same materials and methods specified in 622.07.

The manufacturer of precast modular items must be certified according to Supplement 1073.

**604.07 Concrete (Cast-In-Place).** Place and furnish structure concrete as shown on the plans.

**604.08 Method of Measurement.** The Department will measure Manholes, Inlets, Catch Basins, Monument Assemblies, Reference Monuments, Inspection Wells, Junction Chambers, and Precast Reinforced Concrete Outlets, whether new, reconstructed, or adjusted to grade, by the number of each type of structure complete and accepted.

**604.09 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
604	Each	Manholes
604	Each	Inlets
604	Each	Catch Basins
604	Each	Monument Assemblies
604	Each	Reference Monuments
604	Each	Right-of-Way Monuments
604	Each	Inspection Wells
604	Each	Junction Chambers
604	Each	Manhole, Catch Basin or Inlet Reconstructed to Grade
604	Each	Manhole, Catch Basin, Inlet, or Monument Box Adjusted to Grade
604	Each	Precast Reinforced Concrete Outlet

## **ITEM 605 UNDERDRAINS**

**605.01 Description**

**605.02 Materials**

**605.03 Pipe Underdrains Construction**

**605.04 Construction Underdrains**

**605.05 Prefabricated Edge Underdrains**

**605.06 Underdrain Outlets**

**605.07 Aggregate Drains**

**605.08 Method of Measurement**

**605.09 Basis of Payment**

605.01

**605.01 Description.** This work consists of constructing unclassified pipe underdrains, shallow pipe underdrains, deep pipe underdrains, base pipe underdrains, or rock cut underdrains with or without a filter fabric, construction underdrains, prefabricated edge underdrains and aggregate drains.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

**605.02 Materials.**

Concrete, Class C .....	499 and 511
Reinforcing steel .....	509.02
Filter fabric, Type A .....	712.09

Backfill unclassified pipe underdrains, shallow pipe underdrains, deep pipe underdrains, base pipe underdrains, or rock cut underdrains with or without a filter fabric, construction underdrains and aggregate drains with granular material consisting of No. 8, 9, or 89 size air-cooled blast furnace slag, limestone, or gravel. Use granular material with a maximum sodium sulfate soundness loss of 15 percent.

Backfill prefabricated edge underdrains with granular material consisting of No. 8 size air-cooled blast furnace slag, limestone, or gravel. Use granular material with a maximum sodium sulfate soundness loss of 15 percent.

For 605.02.A through 605.02.B, use the pipe of the same size and kind listed in the Proposal. If the kind of pipe is not specifically itemized in the Proposal, use types as listed below.

**A. Pipe for 605 Rock Cut Underdrains.**

Corrugated polyethylene drainage tubing (perforated) .....	707.31
Polyvinyl chloride plastic pipe .....	707.41
Polyvinyl chloride corrugated smooth interior pipe (perforated per 707.31) .....	707.42
Polyvinyl chloride solid wall pipe (perforated per 707.31) .....	707.45

**B. Pipe for 605 Unclassified Pipe Underdrains, Shallow Pipe Underdrains, Deep Pipe Underdrains, Base Pipe Underdrains**

Perforated concrete pipe .....	706.06
Concrete drain tile, extra quality .....	706.07
Perforated vitrified clay pipe .....	706.08
Clay drain tile, extra quality .....	706.09
Corrugated steel underdrains, Type III .....	707.01
Corrugated polyethylene drainage tubing, (perforated) .....	707.31
Polyvinyl chloride plastic pipe .....	707.41
Corrugated aluminum alloy pipe and underdrains, Type III .....	707.21

If the size of the underdrains required is a 6-inch (150 mm) shallow pipe underdrain and the kind of pipe material is not specifically itemized, then 4-inch (100 mm) 707.31 perforated corrugated polyethylene drainage tubing may be used.

**C. Pipe for 605 Construction Underdrains**

6 inch (150 mm) Corrugated polyethylene drainage tubing (perforated) ..... 707.31

**D. Pipe for 605 Prefabricated Edge Underdrains.** Use pipe conforming to 712.10.

**605.03 Pipe Underdrains Construction.** Construct underdrains as follows:

**A. Excavation.** Excavate trenches to such dimensions allowing ample room for construction. Construct the trench width to at least 14 inches (350 mm) for 6-inch (150 mm) diameter underdrains, and to at least 10 inches (250 mm) for 4-inch (100 mm) diameter underdrains. Excavate the trench walls as vertical as possible, and excavate bell holes to allow proper placing of the underdrain. Remove obstructions encountered while excavating for the underdrains.

Excavate trenches measured vertically from the subgrade to the bottom of the trench at a depth of 18 inches (450 mm) for base pipe underdrains, 30 inches (760 mm) for shallow pipe underdrains, and 50 inches (1270 mm) for deep pipe underdrains unless otherwise specified in the plans. Furnish a depth of 30 inches (760 mm) for construction underdrains unless otherwise specified in the plans. Excavate trenches for unclassified pipe underdrains to the depth specified in the plans.

Excavate trenches to a depth of 6 inches (150 mm) below the rock, shale or coal depth required in 204.05 for Rock Cut underdrains unless otherwise specified in the plans.

If underdrains are to be placed within or beneath an embankment, construct the embankment to the elevation of the top of the subgrade before trenching for the underdrain.

If filter fabric is specified, line the underdrain trench with filter fabric. Place the filter fabric to completely surround the granular material. Overlap the filter fabric at the top of the trench. Match the overlap to the trench width. At other seams, overlap filter fabric a minimum of 12 inches (0.3 m).

**B. Laying Underdrain.** Lay the underdrain true to line and grade with close fitting joints. Place the underdrain in the center of the trench. Use locking bands or smooth sleeve type couplers matching the underdrain material type to join 707.01, 707.31, 707.41, and 707.21. When bell and spigot underdrain is used, lay it with the bell end facing up grade. Set the underdrain on a solid bed shaped to fit the underdrain throughout its entire length. Make all necessary connections with branches, wyes, tees, transitions, and bends that match the underdrain material type. Close the upper ends of underdrains with suitable plugs.

#### 605.04

Lay perforated underdrain so that the perforations are in the bottom half of the underdrain.

**C. Backfilling.** Inspect the underdrains before placing any granular material. Place the granular material for the full width of the trench around the underdrain, and extend it to the bottom of the pavement or base as shown on the plans. If underdrains are placed outside of the pavement or base area, extend the granular material to within 4 inches (100 mm) of the finished grade. Fill the remaining depth of the trench with 203 embankment material.

**D. Protection.** Place the pavement over the underdrain trench within 90 days after placing the trench backfill. If the trench remains open for longer than 90 days, remove and replace backfill contaminated by soil.

**605.04 Construction Underdrains.** Construct construction underdrains as follows:

**A. Excavation.** Construct the trench width to at least 10 inches (250 mm) with a minimum of 2 inches (50 mm) on each side of the underdrain. Excavate the bottom of the trench to allow proper placing of the underdrain. Remove obstructions encountered while excavating for the underdrains.

**B. Trench Depth and Backfill.** Construct the trench depth to that shown on the plans or 30 inches (750 mm). Backfill the trench with granular material for the full width of the trench and to the full height of the trench.

**C. Outlet.** Outlet the construction underdrains as possible into the ditch or drainage structures. There is no change in pipe types for the outlet.

**D. Removal.** Construction underdrains are not to be removed at any time. If the construction practice used requires the construction underdrains to be removed then install replacements as soon as possible.

**605.05 Prefabricated Edge Underdrains.** Install the prefabricated edge underdrains against the outside wall of a 4-inch (100 mm) trench, and backfill the trench adjacent to the pavement with granular material. Place the granular material in one or more lifts with a vibratory compactor run over the final lift to compact the granular material before placing the asphalt plug. Place the first layer of the granular material simultaneously with the trenching operation to hold the edge underdrains flush against the trench wall.

Splice the prefabricated edge underdrains as required before placing in the trench, using material furnished by the manufacturer and according to the manufacturer's directions. Require the manufacturer to furnish all material required for the splices, and furnish any equipment required for splicing. Construct splices to prevent separation of adjoining sections of the prefabricated edge underdrain panels.

**605.06 Underdrain Outlets.** Construct pipe outlets concurrently with underdrains. Provide all outlets on the slope with a precast reinforced concrete outlet according to Item 604 and a tied concrete block mat type 1 grouted according to 601.12.

Construct the underdrains outlets according to Item 603 using outlet fittings. Require the manufacturer to supply outlet fittings that transition between the underdrains and the outlet pipe. Provide smooth-lined or corrugated outlet fittings. Have the underdrains and outlets on fractured slab projects, such as crack and seat, rubblized, or break and seat projects, in place and functional before fracturing the existing pavement.

Mark all underdrain outlets with a wooden lath prior to final seeding. Clean all debris from the outlets after final seeding.

**605.07 Aggregate Drains.** Construct the aggregate drains after the completion of granular pavement courses.

**A. Excavation.** Excavate trenches for aggregate drains to a minimum width of 12 inches (0.3 m) and to the depth shown on the plans. Slope the bottom of the trench to drain and keep it free from loose particles of soil. Excavate the trench to furnish a clean exposure of the granular pavement courses.

**B Placing and Backfilling.** Use granular material for the drains. Place the aggregate to a minimum depth of 8 inches (200 mm) above the bottom of the trench. The remaining depth of the trench backfill with suitable embankment material according to Item 203.

**605.08 Method of Measurement.** The Department will measure Unclassified Pipe Underdrains, Shallow Pipe Underdrains, Deep Pipe Underdrains, Base Pipe Underdrains Construction Underdrains, Rock Cut Underdrains, and Prefabricated Edge Underdrains by the number of feet (meters) completed and accepted in place, measured from end to end of each run.

The Department will measure Aggregate Drains by the number of feet (meters) completed and accepted in place, measured along the bottom of the trench.

**605.09 Basis of Payment.** The Department will pay for pipe outlets under 603 Conduit, Type F.

The Department will pay for precast reinforced concrete outlets under 604 Precast Reinforced Concrete Outlet.

The Department will pay for tied concrete block mats type 1 grouted under 601 Tied Concrete Block Mat.

Rock Cut Underdrains are placed in rock and all required trenching in the rock is included under Rock Cut Underdrain.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
605	Foot (Meter)	____ " (____ mm) Unclassified Pipe Underdrains
605	Foot (Meter)	6" (150 mm) Construction Underdrains 707.31
605	Foot (Meter)	____ " (____ mm) Shallow Pipe Underdrains
605	Foot (Meter)	____ " (____ mm) Deep Pipe Underdrains
605	Foot (Meter)	____ " (____ mm) Base Pipe Underdrains

**606.01**

605	Foot (Meter)	Aggregate Drains
605	Foot (Meter)	____ " (____ mm) Rock Cut Underdrains
605	Foot (Meter)	____ " (____ mm) Prefabricated Edge Underdrains

**ITEM 606 GUARDRAIL**

- 606.01 Description**
- 606.02 Materials**
- 606.03 Setting Posts**
- 606.04 Erecting Rail Elements**
- 606.05 Guardrail Rebuilt**
- 606.06 Impact Attenuators**
- 606.07 Method of Measurement**
- 606.08 Basis of Payment**

**606.01 Description.** This work consists of constructing or reconstructing guardrail, guardrail posts, bridge terminal assemblies, end terminals, and impact attenuators, including the furnishing, assembling, and erecting of all component parts and materials.

Guardrail shall be deep beam rail Type 5, 5A, or 8. Appurtenances shall include bridge terminal assemblies, end terminals, and impact attenuators. Construction of the various types of guardrail include the furnishing, assembling, and erecting of all component parts and materials, complete in place, at the location shown on the plans or as directed, and according to the manufacturer’s recommendations where applicable.

**606.02 Materials.** Furnish materials conforming to:

Concrete, Class C, F, or S .....	499 and 511
Reinforcing steel .....	509.02
Deep beam rail and hardware .....	710.06
Pressure treated guardrail posts and blockouts.....	710.14
Steel guardrail posts .....	710.15
Guardrail posts .....	710.16
Galvanizing .....	711.02

Use galvanized steel posts, rails, bolts, fittings, and other accessories.

For guardrail, use deep beam rail Type 5, 5A, or 8.

**606.03 Setting Posts.** Set or drive posts plumb in a manner that prevents battering or distorting of posts. Trim posts that are set or driven more than 1-inch (25 mm) above grade. Treat trimmed posts with a preservative material specified in 712.06. Backfill post holes with acceptable material, placed in layers, and thoroughly compacted.

Space Type 5 guardrail posts 6 feet, 3 inches (1.905 m) on center measured along the centerline of the rail and construct with blockouts. Construct each end of Type 5 guardrail barricades without blockouts and with a flared end section.

Space Type 5A guardrail posts 3 feet, 1 1/2 inches (953 mm) on center measured along the centerline of the rail and construct with blockouts. Construct each end of Type 5A guardrail barricades without blockouts and with a flared end section.

Space Type 8 guardrail posts 6 feet, 3 inches (1.905 m) on center measured along the centerline of the rail and construct with blockouts.

**606.04 Erecting Rail Elements.** Erect standard design (single-faced) guardrail of the type shown on the plans. Erect barrier design (double-faced) guardrail as shown on the plans.

Erect rail elements in a manner resulting in a smooth, continuous installation. Use shop-curved rail on curves with radii from 5 to 70 feet (1.5 to 22.4 m).

Except where otherwise required, such as expansion joint bolts, draw bolts tight. Tighten bolts through expansion joints as tight as possible without preventing the rail elements from sliding past one another longitudinally. Provide bolts long enough to extend at least 1/4 inch (6 mm) beyond the nuts.

Do not use splice bolts that extend more than 1/2 inch (13 mm) beyond the nuts. For double-faced guardrail, provide bolts that extend from 1/4 to 1 inch (6 to 25 mm) beyond the nuts.

Fabricate all metal in the shop. Do not perform burning or welding in the field. The Engineer may approve making holes in the field, but only for special details in exceptional cases. The Engineer may approve field punching, cutting, and drilling if the Contractor demonstrates that its methods do not damage the surrounding metal.

Repair galvanized surfaces that have been abraded such that the base metal is exposed, including threaded portions of all fittings and fasteners, and cut ends of bolts as specified by ASTM A 780.

Erect guardrail so that the bolts at expansion joints are located at the centers of the slotted holes. Splice the rail elements by lapping in the direction of traffic. Ensure that the plates at each splice make contact throughout the area of the splice.

**606.05 Guardrail Rebuilt.** As shown on the plans, rebuild existing guardrails. Unless otherwise shown on the plans, rebuild units of the same type and spacing of members as the existing guardrail.

For re-erecting, obtain the rail element from specified salvage sources. Furnish the following new materials: posts, blockouts, bolts, washers, and incidental hardware as necessary to complete the guardrail, except: (1) existing steel posts and blockouts that are not damaged and have a good galvanized coating may be reused, and (2) reuse guardrail splice bolts that are undamaged and were not removed during salvage may be reused.

**606.06 Impact Attenuators.** Before installing the attenuator, make all corresponding shop drawings from the manufacturer available for the Engineer's inspection. Include installation drawings and instructions with the shop drawings that completely describe the attenuator system.

**606.07**

Grade the top of each foundation at the same elevation as the adjacent travel lane and/or paved shoulder.

Adjust the location of the anchors to avoid pavement joints.

**606.07 Method of Measurement.** The Department will measure Guardrail, new or rebuilt, of the type specified by the number of feet (meters) from center-to-center of end posts, excluding anchor assemblies. If, however, end connections are made to masonry or steel structures, the Department will measure to the center of the normal post bolt slot. If rail element is used across a bridge, the Department will measure to the first post off the bridge.

The Department will measure Anchor Assembly of the type specified by the number each assembly furnished and erected complete.

The Department will measure Bridge Terminal Assembly of the type specified by the number of each assembly furnished and erected complete.

The Department will measure Impact Attenuator of the type specified by the number of each furnished and erected complete.

The Department will measure Guardrail Post of the kind specified by the number of each furnished and erected.

**606.08 Basis of Payment.** The additional costs associated with furnishing and installing extra-length posts instead of standard-length guardrail posts are incidental to Guardrail Post, 8-foot (2.44 m) or Guardrail Post, 9-foot (2.75 m).

For the extra costs associated with furnishing and installing extra-length posts in lieu of standard-length guardrail posts, payment for 9-foot (2.75 m) guardrail posts is considered full compensation.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
606	Foot (Meter)	Guardrail, Type ____
606	Foot (Meter)	Guardrail, Barrier Design, Type ____
606	Foot (Meter)	Guardrail, Rebuilt, Type ____
606	Each	Anchor Assembly, Type ____
606	Each	Anchor Assembly, Type ____, Barrier Design
606	Each	Bridge Terminal Assembly, Type ____
606	Each	Impact Attenuator, Type ____
606	Each	Guardrail Post
606	Each	Guardrail Post, 8-foot (2.44 m)
606	Each	Guardrail Post, 9-foot (2.75 m)

**ITEM 607 FENCE**

**607.01 Description**

**607.02 Materials**

**607.03 Clearing and Grading**

**607.04 Post Assemblies**

**607.05 Horizontal Deflection****607.06 Line Posts****607.07 Fabric****607.08 Barbed Wire****607.09 Method of Measurement****607.10 Basis of Payment**

**607.01 Description.** This work consists of furnishing and erecting fence and gates of the types designated. Construct fence in a manner that provides a rigid, taut fence closely conforming to the surface of the ground.

Fence is designated by the following types:

- A. Type 47 [47-inch (1195 mm)] woven wire fence fabric with steel line posts.
- B. Type 47RA [47-inch (1195 mm)] woven wire fence fabric with wood line posts.
- C. Type CL [60-inch (1525 mm)] chain-link fence fabric with top rail.
- D. Type CLT [60-inch (1525 mm)] chain-link fence fabric with tension wire.

**607.02 Materials.** Furnish materials conforming to:

Concrete, Class C, F, or S.....	499 and 511
Reinforcing steel.....	509.02
Barbed wire.....	710.01
Woven steel wire fence .....	710.02
Chain-link fence.....	710.03
Fence posts, braces, and dimension lumber .....	710.11
Steel line posts and ties, Type 47 fence .....	710.11
Expansion shield anchors, self drilling .....	712.01

**607.03 Clearing and Grading.** Perform clearing and grading as necessary to construct the fence to the required alignment, and provide a reasonably smooth ground profile at the fence line.

**607.04 Post Assemblies.** Securely brace end, corner, gate, and pull or intermediate anchor posts in position during the curing period of the concrete encasement. The Engineer will not require forms for post encasement.

For Type 47 and Type CLT fence, ensure that the maximum spacing between intermediate anchor post assemblies, or between end post assemblies and intermediate anchor post assemblies, are 660 feet (200 m).

**607.05 Horizontal Deflection.** At points of horizontal deflection, construct the fence as follows:

**A. Type 47 Fence.** If the fence changes alignment by more than 1 degree but not more than 4 degrees, install either steel line posts encased in concrete or wood posts without encasement at all horizontal deflection points. If the change in alignment is more than 4 degrees and less than 30 degrees, build an intermediate anchor post assembly at the deflection point. If the change in alignment is 30 degrees or more, build a corner post assembly at the deflection point.

## 607.06

**B. Type CL Fence.** If the fence changes alignment by more than 1 degree but not more than 4 degrees, install line posts encased in concrete at all horizontal deflection points. If the change in alignment exceeds 5 degrees, provide a post brace and truss rod in each fence panel adjacent to the post located at the angle point. If the change in alignment exceeds 5 degrees, construct the footings for all post located at deflection points as specified for end posts.

**607.06 Line Posts.** Set line posts according to the following:

**A. Type 47 Fence.** Space line posts at intervals not to exceed 12 feet (3.6 m). Anchor line posts at the bottom of dips or depressions in the ground surface in concrete. If channels or streams cross the fence line, construct crossings as shown on the plans.

On tangents, place line posts so that the fabric, when installed on the side toward the highway, is 2 feet (0.6 m) from the Right-of-Way line. If adjacent to Right-of-Way lines with less than 5740 feet (1750 m) radius (in excess of 1 degree curvature), construct line posts on chords so that the fabric, when installed on the side toward the highway, is not less than 2 feet (0.6 m) or more than 8 feet (2.4 m) from the Right-of-Way line.

Locate posts at points of horizontal deflection so that the fence fabric will bear against the post.

**B. Type CL Fence.** Protect the tops of driven line posts by drive caps or other method to prevent distortion of the exposed end. Space line posts at not more than 10-foot (3 m) centers, and place them so that, when the wire is fastened on the side toward the highway, it is 1 foot (0.3 m) from the Right-of-Way line.

**607.07 Fabric.** If setting posts in concrete, do not erect the fabric until after 5 days from the time of setting the posts when using regular cement, or until after 3 days when using high early strength cement.

Stretch and securely fasten Type 47 fabric to line posts using galvanized ties. At a minimum, use one tie each for the top and bottom horizontal wires and one tie for each alternate horizontal wire below the top horizontal wire.

Fasten chain-link fabric to the line posts using clips or bands spaced approximately 14 inches (0.4 m) apart, and to the top rail or top tension wire using bands or tie wires at approximately 24-inch (0.6 m) intervals or less. Join successive rolls of fabric by weaving a single picket into the ends of the rolls to form a continuous mesh.

**607.08 Barbed Wire.** If barbed wire is specified, stretch and fasten it in the same manner as woven wire fabric.

**607.09 Method of Measurement.** The Department will measure Fence, Type \_\_\_ by the number of feet (meters), complete in place. The Department will measure along the top of the fence from outside to outside of end posts, exclusive of gates and other openings.

The Department will count Gate, Type \_\_\_ by the number of complete units of the size and type specified.

**607.10 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
607	Foot (Meter)	Fence, Type___
607	Each	Gate, Type___

## ITEM 608 WALKS, CURB RAMPS, AND STEPS

### 608.01 Description

### 608.02 Materials

### 608.03 Concrete Walks

### 608.04 Asphalt Concrete Walks

### 608.05 Crushed Aggregate Walks

### 608.06 Concrete Steps

### 608.07 Curb Ramps

### 608.08 Method of Measurement

### 608.09 Basis of Payment

**608.01 Description.** This work consists of constructing walks, curb ramps, and steps.

**608.02 Materials.** Furnish materials conforming to:

Aggregate Base .....	304.01 and 304.02
Asphalt concrete Type 1 .....	448
Concrete, Class C.....	499 and 511
Reinforcing steel .....	509.02
Crushed aggregate meeting grading requirements of .....	703.10
Expansion joint material .....	705.03

**608.03 Concrete Walks.** Construct concrete walks as follows:

**A. Excavation.** Excavate to the required depth and to a width that allows installation and bracing of forms. Shape and uniformly compact the subgrade to a surface conforming to the plans.

**B. Forms.** Use either fixed forms or slip-form methods. For fixed-form construction, use wooden or metal forms that extend the full depth of the concrete and that do not spring under the concrete pressure. For slip-form construction, perform the work according to 609.04.C.

**C. Placing and Finishing.** Immediately before placing concrete, thoroughly moisten the subgrade. Deposit concrete in a single layer, strike it off with a template, and smooth it with a float to obtain a sandy texture. Do not plaster the concrete. Use a 1/4-inch (6 mm) radius edging tool to edge all outside edges and joints. Divide the surface of the walks into equally spaced rectangular blocks at approximately 5-foot (1.5 m) intervals. Saw or form transverse joints to a depth of not less than one-fourth the thickness of the slab and to a width of approximately 1/8 inch (3 mm). Install 1/2-inch (13 mm) thick expansion joint filler between the walk and any fixed structure that extends the full depth of the walk. Install 1-inch

#### 608.04

(25 mm) thick expansion joint filler between the walk and the back of curb that is on a 250-foot (75 m) or smaller radius, such as at street intersections.

**D. Slope.** Construct the surface of the walk with a transverse slope rate of 0.02 and with the low side adjacent to the roadway.

**E. Curing.** Cure concrete according to Item 451.

**608.04 Asphalt Concrete Walks.** Construct asphalt concrete walks as follows:

**A. Excavation and Forms.** Excavate and construct forms according to 608.03.A and 608.03.B.

**B. Base.** Place and thoroughly compact aggregate base in layers not exceeding 4 inches (100 mm) in depth.

**C. Asphalt Placement and Compaction.** Place asphalt concrete in one or more courses to provide the required depth when compacted using a hand roller or power roller of a type and weight acceptable to the Engineer.

**608.05 Crushed Aggregate Walks.** Construct crushed aggregate walks as follows:

**A. Excavation.** Excavate according to 608.03.A.

**B. Forms.** Construct forms of wood or metal of acceptable rigidity and to the depth of the necessary loose material. Back forms with compacted soil to the height of the completed walk.

**608.06 Concrete Steps.** Construct concrete steps as follows:

**A. Excavation and Forms.** Excavate and construct forms according to 608.03.A and 608.03.B.

**B. Placement and Finishing.** Place and finish concrete according to Item 511, except finish the treads of steps to produce a sandy texture.

**C. Slope.** Slope step treads at a rate of 0.01 and toward the next lower step.

**D. Curing.** Cure steps according to 608.03.E.

**E. Railing.** If specified, install hand railing according to Item 517.

**608.07 Curb Ramps.** Excavate, form, place, finish, and cure according to 608.03.A, 608.03.B, 608.03.C, and 608.03.E. Finish ramps to a rougher final surface texture than the adjacent walk and with striations transverse to the ramp slope using a coarse broom or other method approved by the Engineer.

**608.08 Method of Measurement.** The Department will measure Concrete Walk, Asphalt Concrete Walk, and Aggregate Walk by the number of square feet (square meters) of finished surface, complete in place.

The Department will measure Curb Ramps in new concrete walk by the number of each completed curb ramp. The Department will measure Curb Ramps in existing walk by the number of square feet (square meters) of finished surface completed.

The Department will measure Concrete Steps by the number of feet (meters), along the front edge of each tread. Where steps are constructed with integral walls, the Department will include the thickness of the integral walls with the tread width measurement.

**608.09 Basis of Payment.** Payment for walks, curb ramps, and steps is full compensation for excavation, backfill, base course material, reinforcing steel, hand railing, expansion joint material, and incidentals necessary to complete the specified items.

Payment for curb ramps in new concrete walk includes the cost of any additional materials, grading, forming and finishing not included in the new walk, which is measured through the curb ramp area. Payment for curb ramps in existing concrete walk includes all materials, grading, forming, and finishing of the curb and walk of the ramp.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
608	Square Foot (Square Meter)	Concrete Walk
608	Square Foot (Square Meter)	Asphalt Concrete Walk
608	Square Foot (Square Meter)	Aggregate Walk
608	Each, Square Foot (Square Meter)	Curb Ramps
608	Foot (Meter)	Concrete Steps

## **ITEM 609 CURBING, CONCRETE MEDIANS, AND TRAFFIC ISLANDS**

### **609.01 Description**

### **609.02 Materials**

### **609.03 Stone Curb**

### **609.04 Cast-in-Place Concrete Curb and Combination Curb and Gutter**

### **609.05 Asphalt Concrete Curb**

### **609.06 Concrete Median and Traffic Island**

### **609.07 Method of Measurement**

### **609.08 Basis of Payment**

**609.01 Description.** This work consists of furnishing and constructing curb, combination curb and gutter, medians, and traffic islands. This work also consists of excavating, backfilling, furnishing and installing joint materials, and disposing of surplus excavation and discarded materials according to Item 203.

**609.02 Materials.** Furnish materials conforming to:

Concrete, Class C.....	499
Preformed filler.....	705.03
Tie bar steel, epoxy coated	

609.03

.....709.00, 709.01, 709.03, 709.05  
Coated dowel bars..... 709.13

For 609.03 Stone Curb furnish the best quality of Berea or Amherst gray sandstone, or sandstone of equal quality.

Furnish asphalt concrete curb conforming to a 448 Type 1 intermediate course, designed for medium traffic, using a PG 64-22 Set the fine aggregate content at the maximum allowed under 448 Type 1 intermediate. Provided the Contractor meets the composition requirements, the Contractor may add mineral filler conforming to 703.07. Add the mineral filler using a method approved by the Laboratory.

**609.03 Stone Curb.**

**A. Cutting and Dressing.** Ensure that 95 percent of all straight curb pieces are at least 5 feet (1.5 m) long, with no pieces less than 42 inches (1.1 m). The Contractor may use a piece as short as 30 inches (0.8 m) for closure. For curves with a radius of 50 feet (15 m) or greater, the Contractor may use radially jointed straight curb pieces between 36 and 42 inches (0.9 and 1.1 m) long. For curves and corners with a radius of less than 50 feet (15 m), use pieces a minimum of 36 inches (0.9 m) long, and dress, joint, and set pieces to the radii specified. For all curves and corners, use curb sections that are approximately uniform in length.

Dress all curb to a straight edge on top and on the exposed face and ends to a depth of at least 6 inches (150 mm) below the gutter elevation. Dress the ends at right angles to the face for straight curb and radially for curb on curves. Do not allow slack or hollow joints. Do not leave any projections after dressing the ends of any curb section that exceed 1/8 inch (3 mm) from the plane of the end of that section. Cut the edge next to the gutter to a 3-inch (75 mm) radius and dress the top to a 1/4-inch (6 mm) bevel rising from the exposed face. Use a pitching tool on the edge at the back to hand dress curb to the specified width.

**B. Setting.** Set the curb on a thoroughly compacted subgrade and with a 1 in 20 batter from the vertical backward from the gutter. If the subgrade consists of clay soils or soils of a character that do not allow free drainage, place a minimum 3-inch (75 mm) thick firm bed of porous material as a foundation for the curb. Use a heavy rammer to settle the curb into place. Place and compact a minimum 4-inch (100 mm) wide porous backfill behind the curb to within 6 inches (150 mm) of the top. Bring the balance of the backfill to the level of the top of the curb for a distance of 2 feet (0.6 m) behind the curb with soil or other acceptable material. Thoroughly tamp the backing in layers not exceeding 6 inches (150 mm) in thickness, loose measurement, with an approved tamper or rammer. Perform as much of the backfilling and tamping as is consistent with alignment of the curb at the time the stone is first set. Set circular curb in plastic concrete 6 inches (150 mm) thick as shown on the plans. Extend concrete the width of the curb plus 6 inches (150 mm) behind the curb, and bring concrete up behind the curb to within 4 inches (100 mm) of the top.

**C. Joints.** Set curbs such that below the dressed portions the space between ends of adjacent sections of curbing is not less than 1/8 inch (3 mm) at any point and not more than 4 inches (100 mm). Cushion the joints between the dressed

portions of adjacent sections of curbing with 1/8-inch (3 mm) thick expansion joint material. Trim expansion joint material flush with the curbing on all edges.

If placing sandstone curb after placing pavement, fill remaining joints with dry sand to within 2 inches (50 mm) of the surface of the pavement, and fill to the pavement surface with asphalt concrete. Take care in filling this joint so that no asphalt concrete comes in contact with the exposed surface of the curb.

**D. Reusing Existing as New Curb.** If specifically allowed by the plans, and to the extent available, use acceptable stone curb sections removed under Item 202 instead of furnishing new stone curb. Use salvaged curb at locations designated by the Engineer. Place all salvaged sections of curb continuously without interspersing salvaged and new curb sections. Haul and store salvaged curb as necessary. Cut, dress, set, and install joints in salvaged curbs according to the requirements for new curbs.

#### **609.04 Cast-in-Place Concrete Curb and Combination Curb and Gutter.**

**A. Forms and Joints.** Use approved steel forms for curbs. Securely brace and hold forms to the line and grade shown on the plans. The Contractor may use approved flexible forms of steel or wood to construct the radius of a circular curb 200 feet (60 m) or less. Immediately before placing concrete, clean the inner surface of the forms, and coat this surface with a form release agent.

Where curb and combination curb and gutter is not constructed integral with, or tied to, the base or pavement, construct 1/4-inch (6 mm) wide contraction joints at 10-foot (3 m) intervals using steel separator plates, a grooving tool, or a saw according to Item 451. For combination curb and gutter, construct the joint to an average depth of 2 inches (50 mm) or more. For curb, construct the joint to an average depth of one-fifth or more of the curb height. Where expansion joints occur in the abutting pavement, separate the section being placed with 1-inch (25 mm) 705.03 preformed filler.

Where the curb is integral with, or tied to, the base or pavement, construct the same type of joints as used in the pavement. Space joints identically with the joints in the base or pavement.

Leave curb forms in place until their removal will not crack, shatter, or otherwise injure the concrete. Do not seal transverse joints in cast-in-place concrete curb and combination curb and gutter.

If curbs are to later serve as a support for a finishing machine in the placing of a surface course, align supporting edges so that the distance between the curbs is within 1/2 inch (13 mm) from that specified.

**B. Placing.** Place concrete in forms prepared as described above, and vibrate the concrete to eliminate all voids.

Place concrete for curb that is integral with the concrete base or pavement while the base or pavement concrete is plastic. Where the presence of the finishing equipment on the forms at the end of the day's run prevents completing the curb, install No. 5 (No. 16M) tie bars vertically in the pavement at 1-foot (0.3 m) intervals and in a line 3 inches (75 mm) inside of and parallel to the pavement edge. Install these tie bars to within 1 1/2 inches (38 mm) of the subgrade or

## 609.05

subbase and 2 inches (50 mm) above the concrete base or pavement surface. Water cure this horizontal construction joint between the concrete base or pavement and the curb, or membrane cure the concrete base or pavement and remove the membrane before placing the curb. Immediately before placing the concrete curb, brush mortar (consisting of one part cement to two parts sand with enough water to form a workable mortar) into the surface area of the hardened concrete pavement or base where the curb is to be placed. Do not allow the mortar to dry before placing the curb on top of it.

**C. Slip-Form Placement.** The Contractor may use a self-propelled machine to place concrete curb or curb and gutter. Force the concrete through a mold of the proper cross-section to obtain the proper density and cross-section. If using a track, set and secure the track on which the machine operates to the exact line and grade given by the Engineer. Use concrete of a consistency that provides the desired shape and remains as placed without slumping of the vertical faces.

**D. Finishing.** Without adding extra mortar, float the top of the curb to thoroughly compact the concrete and produce a smooth and even surface. Round the edges of the curb using a tool specially designed for this purpose. Immediately after removing the forms, rub the exposed face of the curb with a float to eliminate unnecessary tool marks. Provide a finished surface free of irregularities and waves, and uniform in texture.

**E. Protection.** Cure concrete according to Item 451.

**609.05 Asphalt Concrete Curb.** Use one of the following methods, or other method approved by the Engineer, to furnish and place an asphalt concrete curb of the required cross-section.

**A. Method A.** After completing the surface course, paint or spray only the area to be occupied by the asphalt concrete curb with asphalt material conforming to 407.02. Apply the asphalt material at the rate of 0.15 gallon per square yard (0.7 L/m<sup>2</sup>). Place the curb with a hand-operated or self-propelled machine consisting of a hopper and power-driven screw, which forces the material through an extrusion tube. Force the material through a die attached to the end of the extrusion tube to obtain the proper density and cross-section.

**B. Method B.** As an independent operation preceding the final rolling of the asphalt concrete surface course that the curb is placed, place loose asphalt concrete of sufficient height and shape by hand methods using suitable templates or by other means to produce the specified cross-section. Compact the loose asphalt concrete using a hand-operated mechanical vibrating tamper equipped with a compacting shoe of such shape that will produce the specified final cross-section dimensions of the curb.

## 609.06 Concrete Median and Traffic Island.

**A. Forms and Joints.** Securely brace and hold approved steel forms to the line and grade shown on the plans. The Contractor may use approved flexible forms of steel or wood to construct a radius of 200 feet (60 m) or less. Immediately before placing concrete, clean the inner surface of the forms, and coat this surface with a form release agent.

Where medians and traffic islands are not anchored to the pavement, construct contraction joints at 10-foot (3 m) intervals using steel separator plates, a grooving tool, or saw according to Item 451. Construct the joint using steel separator plates, a grooving tool, or saw according to Item 451. Construct the joint to a minimum depth of 2 inches (50 mm).

Where, as shown on the plans, the medians or traffic islands are anchored to the pavement, construct the same type of joints in the median or traffic island as used in the pavement. Space the joints identically with the joints in the pavement.

Leave forms in place until their removal will not crack, shatter, or otherwise injure the concrete.

**B. Placing.** Before placing a concrete median or traffic island on subgrade, sprinkle the subgrade with water until thoroughly moistened at times and in a manner directed by the Engineer.

Place the concrete in forms prepared as described above, and vibrate the concrete to eliminate all voids.

**C. Slip-Form Placement.** The Contractor may use a self-propelled machine to place medians and traffic islands. Force the concrete through a mold of the proper cross-section to obtain the proper density and cross-section. If using a track, set and secure the track on which the machine operates to the exact line and grade given by the Engineer. Use concrete of a consistency that provides the desired shape and remains as placed without slumping of the faces.

**D. Finishing.** Without adding extra mortar, finish the top of the median or traffic island to a broom texture. Round the edges using a tool specially designed for this purpose. Immediately after removing the forms, rub the exposed faces with a float to eliminate unnecessary tool marks. Provide a finished surface free of irregularities and waves, and a uniform texture.

**E. Protection.** Cure concrete according to Item 451.

**609.07 Method of Measurement.** The Department will measure Sandstone Curb, Curb, Combination Curb and Gutter, and Asphalt Concrete Curb by the number of feet (meters) complete in place, measured along the front face of the curb section.

The Department will measure Concrete Traffic Island and Concrete Median by the number of square yards (square meters) or the number of cubic yards (cubic meters) complete in place.

**609.08 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
609	Foot (Meter)	Sandstone Curb
609	Foot (Meter)	Curb, Type ____
609	Foot (Meter)	Combination Curb and Gutter, Type ____
609	Foot (Meter)	Asphalt Concrete Curb, Type ____
609	Square Yard or Cubic Yard	Concrete Traffic Island

**610.01**

	(Square Meter or Cubic Meter)	
609	Square Yard Cubic Yard (Square Meter or Cubic Meter)	Concrete Median

**ITEM 610 CELLULAR RETAINING WALLS**

- 610.01 Description**
- 610.02 Approval by Director**
- 610.03 Materials**
- 610.04 Manufactured Units**
- 610.05 Excavation**
- 610.06 Backfill**
- 610.07 Wall Construction**
- 610.08 Method of Measurement**
- 610.09 Basis of Payment**

**610.01 Description.** This work consists of constructing retaining walls composed of a series of cells formed by assembling precast reinforced concrete or galvanized metal units to form stable walls.

Concrete cellular walls consist of a series of rectangular or triangular cells formed by building up tiers of precast reinforced concrete units.

Metal cellular retaining walls consists of pairs of columns, one column in the plane of the front of the wall and the other column in the plane of the rear of the wall. The column pairs are spaced longitudinally with overlapping S-shaped facing and rear members, and transversely with overlapping U-shaped members.

**610.02 Approval by Director.** Submit to the Director for acceptance, 30 days before the work is to begin, drawings of the units to be furnished. Only submit information for walls produced by manufacturers whose type of wall, and design of units comprising same, has been in successful commercial use for a period of at least 3 years.

**610.03 Materials.** Furnish manufactured units conforming to:

**A. Concrete Cellular Wall.** Use concrete conforming to Item 499, Class C. Use reinforcing steel conforming to 509.02.

**B. Metal Cellular Wall.** Provide units made from galvanized metal sheets. Use base metal conforming to AASHTO M 218. Ensure that both sides of the sheets are galvanized by the hot-dip process. Provide an average spelter coating of not less than 2 ounces per square foot (610 g/m<sup>2</sup>) on each side of the sheet and a spelter coating of at least 1.8 ounces per square foot (550 g/m<sup>2</sup>) on any 2 1/4 x 2 1/2-inch (57 x 64 mm) area on each side of double exposed surfaces. Provide finished sheets that are free from injurious defects, such as blisters, flux, and uncoated spots.

Use metal sheets with a minimum thickness of 0.057 inch (1.45 mm), unless otherwise shown on the plans.

Furnish three copies of the manufacturer's "Analysis and Coating Test Certificate" containing the following information covering each project or order on which galvanized metal walls are furnished.

- A. Heat or heats used for units.
- B. Analysis of each heat.
- C. Amount of spelter coating for each heat.
- D. Total units of each size and thickness.
- E. Name of Contractor.
- F. Name of County, Interstate, U.S., or State route number, and section.
- G. Project number or state purchase order number.

Send one copy of the certificate to the Laboratory and two copies to the Engineer. With each copy of the certificate, include a written statement, signed by a person having legal authority to bind the manufacturer, that the information and test results are correct and that the material complies with all contract requirements.

Furnish 5/8-inch (16 mm) diameter bolts, galvanized according to 711.02 and at least 1 1/4 inches (32 mm) long, measured from the underside of the bolt head.

#### **610.04 Manufactured Units.**

**A. Concrete Cellular Wall.** Cast concrete cellular wall units in substantial, unyielding steel forms. Properly assemble, clean, and oil the forms before placing concrete in the forms. During the placing and setting of the concrete, hold the forms rigidly in place on a smooth and level platform.

Secure the reinforcement to ensure that it remains in the required position while placing concrete.

Vibrate the fresh concrete to fill all space in the form with concrete, to densify the concrete, and to surround the reinforcement. Reject units with segregated areas.

Cure the units by covering with burlap, that is kept wet at least 7 days or by applying steam for at least 24 hours.

The Engineer will reject reinforced concrete units for any of the following reasons:

1. Exposure of the reinforcing.
2. Defects that indicate imperfect mixing, placing, or curing.
3. Fractures and cracks.

**B. Metal Cellular Wall.** Fabricate galvanized metal cellular wall units so that units of the same nominal size are fully interchangeable. Do not drill, punch, or

## 610.05

drift holes to correct manufacturing defects. Replace all units with improperly punched holes.

If possible, maintain a minimum forming radius of 1 inch (25 mm). Hot-dip galvanize all units formed with less than 1-inch (25 mm) radius after forming.

**610.05 Excavation.** Excavate according to Item 203. Obtain the Engineer's approval that the bearing for the foundation of the walls is firm and to the proper elevation before erecting the wall.

**610.06 Backfill.** Below the elevation of the proposed ground line at the face of the wall, fill the cells formed by the units with soil as defined in 203.02.R. Above the elevation of the proposed ground line at the face of the wall, fill the cells with material conforming to 203 Granular Material Type B, except that the percent passing the No. 200 (75  $\mu$ m) sieve shall not exceed 5 percent.

Place the material in layers that compact to a depth not to exceed 6 inches (150 mm). Compact the material to the density established by the Engineer using approved tampers or compactors. Add water as directed by the Engineer.

Fill the space behind the wall according to 503.08, except as noted below.

Backfill around the wall and in the interior cells, concurrent with wall erection and as close to the wall elevation as allowed by the type of construction.

Do not use rolling equipment directly over a portion of the wall until placing at least 12 inches (0.3 m) of compacted fill.

**610.07 Wall Construction.** Construct the wall types as follows:

**A. Concrete Cellular Wall.** Place sills to the required grade and alignment, and support the entire sill length on the foundation material. Do not shim the sill.

Place and interlock the headers perpendicular to the sills and stretches. Use templates to ensure that members are placed in the proper position and with the proper face batter.

Before placing sills, spread two layers of asphalt impregnated paper on all points of contact between the sills and the foundation material to ensure a uniform bedding.

After constructing two tiers of the wall, check and, if necessary, adjust the alignment, grade, and batter of the units, and backfill to this height before adding subsequent units. Complete the remainder of the wall.

**B. Metal Cellular Wall.** Use templates to ensure that members are placed in the proper position and with the proper face batter.

After placing the columns and constructing two tiers of the wall, check and, if necessary, adjust the alignment, grade, and batter of the units, and backfill to this height before adding subsequent units. Complete the remainder of the wall.

Carefully handle members, and remove and replace damaged members.

**610.08 Method of Measurement.** The Department will measure Cellular Retaining Wall by the number of square feet (square meters) of facial area complete in place.

**610.09 Basis of Payment.** Payment is full compensation for furnishing all materials, backfilling, including the interior filling, watering, and disposing of surplus materials.

The Department will not pay for replacing any unit with improperly punched holes.

The Department will not pay for removing or replacing members damaged during handling.

The Department will pay for Excavation Not Including Embankment Construction under Item 203.

The Department will pay for accepted quantities at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
610	Square Foot (Square Meter)	Cellular Retaining Wall

**ITEM 613 LOW STRENGTH MORTAR BACKFILL**

- 613.01 Description**
- 613.02 Materials**
- 613.03 Mix Proportioning**
- 613.04 Mix Adjustment**
- 613.05 Alternate Mixes**
- 613.06 Mixing Equipment**
- 613.07 Mixing the Materials**
- 613.08 Placing Mortar**
- 613.09 Method of Measurement**
- 613.10 Basis of Payment**

**613.01 Description.** This work consists of placing a low strength mortar backfill around conduits and at other locations. Perform the work for this item according to Items 603 and 499, except as modified below.

**613.02 Materials.** Furnish materials conforming to:

- Cement.....701.01 or 701.04
- Fly Ash ..... 701.13

Furnish fine aggregate consisting of foundry sand, natural sand, sand manufactured from stone, gravel, or air-cooled blast furnace slag. Conform to the fine aggregate gradation requirements of 703.05. Use fine aggregate that is fine enough to stay in suspension in the mixture to ensure proper flow.

Furnish an air-entraining admixture that is designed for use in low strength mortar mixtures (also called controlled density fill or flowable fill).

**613.03 Mix Proportioning.** Furnish a low strength mortar mixture listed below or provide an alternate mix conforming to 613.05.

**613.04**

	Type 1 <sup>[1]</sup>		Type 2		Type 3	
	lb/yd <sup>3</sup>	kg/m <sup>3</sup>	lb/yd <sup>3</sup>	kg/m <sup>3</sup>	lb/yd <sup>3</sup>	kg/m <sup>3</sup>
Cement	50	30	100	59	0	0
Fly Ash, Class F	250	148	<sup>[2]</sup>	<sup>[2]</sup>	1500	890
Fly Ash, Class C <sup>[4]</sup>	0	0	0	0	297	297
Fine Aggregate <sup>[3]</sup>	2910	1726	2420	1436	0	0
Water (Target)	500	297	210-300	125-178	850	504
<p>[1] The Contractor may add an air-entraining agent specifically designed for the use in the low strength mortar mixture.</p> <p>[2] Entrained air is substituted for fly ash in this mix. (Approximately 25 percent)</p> <p>[3] Saturated Surface Dry</p> <p>[4] Class C Fly Ash may be substituted for Class F Fly ash in Type 1 mixes with an approved mix design meeting the alternate mix design criteria of this specification.</p>						

These mixtures of materials are expected to yield approximately 1 cubic yard (1 m<sup>3</sup>) of material of a flowable consistency. Make small adjustments, as necessary, in the amounts of the materials in a mix to achieve the final product.

**613.04 Mix Adjustment.** Make one or more 1 cubic yard (1 m<sup>3</sup>) trial batches at different water contents to ensure a flowable material. The mixture is too dry if cracks develop in the mixture as it flows into place.

Adjust the proportions to maintain the total absolute volume. For large adjustments, see 613.05.

In order to expedite the settlement of a Type 1 mixture without entrained air, bleed water may appear on the surface immediately after the material is struck off. A delay in bleeding indicates there are too many fines in the mixture. The Contractor may reduce the fly ash quantity in increments of 50 pounds (30 kg) until the mixture is bleeding freely. Add approximately 60 pounds (36 kg) of sand to replace each 50 pounds (30 kg) increment of fly ash to maintain the original yield.

**613.05 Alternate Mixes.** The Contractor may submit alternate mixes for approval. Furnish the mix design and test data from an independent test laboratory 30 days before the intended usage for approval.

Submit an alternate mix design for all mixes that:

- A. Vary more than 300 pounds (178 kg) in fine aggregate, 100 pounds (59 kg) in water, 20 pounds (12 kg) in cement, or 200 pounds (119 kg) in fly ash from the 613.03 mixes. These are considered large adjustments.
- B. Have less than 50 pounds (30 kg) of cement in the Type 1 mixes or less than 100 pounds (59 kg) of cement in the Type 2 mixes.
- C. Use alternate materials.
- D. Contain foundry sand.
- E. Contain fly ash not conforming to 701.13.
- F. Use fine aggregate gradations other than 703.05.

The Contractor may use foundry sand if it meets the requirements of the Division of Surface Water Policy 400.007 "Beneficial Use of Non-Toxic Bottom Ash, Fly Ash and Spent Foundry Sand and Other Exempt Wastes," and all other regulations. Ten days before using a mixture containing foundry sand on the project, submit written permission from the Ohio EPA to the Engineer. The Contractor may elect to have an independent ODOT consultant pre-qualified in remedial design environmental site assessment review the proposed usage. The consultant will provide all documentation utilized to ensure that the proposed usage obeys all Ohio EPA regulations. The consultant shall coordinate all EPA required meetings, documentation, and testing requirements. The consultant shall certify the report or reports to the Department.

Provide alternate mixes with an unconfined compressive strength between 50 and 100 pounds per square inch (345 and 689 kPa) at 28 days when tested according to ASTM D 4832. Ensure that the long term (12-month) unconfined compressive strength is less than 100 pounds per square inch (689 kPa).

Ensure that the final mix has the required strength, fills the voids of the intended usages and sets up within 12 hours (4 hours for Type 3 or Type 3 alternate mixes). The proportioning, yield, consistency, workability, compressive strength, and all other requirements are the sole responsibility of the Contractor.

**613.06 Mixing Equipment.** Provide the mixing capacity and delivery equipment to place the material without interruption as much as practical. Deliver and place Type 1 and 2 mixes or Type 1 and 2 alternate mixes from ready mixed concrete trucks, or deliver them from a batch plant.

Deliver and place Type 3 mix using volumetric mobile mixers. Calibrate volumetric mixers properly and sufficiently mix the materials in the mixer to produce a uniform material.

**613.07 Mixing the Materials.** Discharge the mixture within 2.5 hours after adding water.

**613.08 Placing Mortar.** Unless specifically shown on the plans, do not place the mortar within 3 (1 m) feet of the subgrade elevation. Discharge the flowable material from the mixer by any reasonable means into the space of the plan intended usage. Bring the fill material up uniformly to the fill line shown on the plans. The Contractor may begin placing the other fill material over low strength mortar backfill material as soon as the surface water is gone. The Engineer reserves the right to reject the mix if a flowable mixture is not produced.

Before placing the low strength mortar backfill as backfill for 603 Conduit, secure the conduit to prevent it from floating during placement of the flowable material.

**613.09 Method of Measurement.** The Department will measure Low Strength Mortar Backfill by the number of cubic yards (cubic meters) completed and accepted in place, computed from the plan lines. The Department will not pay additional compensation for over excavated areas or for a change in the material blends.

**613.10**

**613.10 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
613	Cubic Yard (Cubic Meter)	Low Strength Mortar Backfill
613	Cubic Yard (Cubic Meter)	Low Strength Mortar Backfill (Type ___)

**ITEM 614 MAINTAINING TRAFFIC**

- 614.01 Description**
- 614.02 Traffic Facilities**
- 614.03 Traffic Control - General**
- 614.04 Work Zone Marking Signs**
- 614.05 Road Closed**
- 614.055 Surface Condition Signs**
- 614.06 Detour Signing**
- 614.07 Traffic Maintained**
- 614.08 Flaggers**
- 614.09 Law Enforcement Officer**
- 614.10 Work Zone Traffic Signals**
- 614.11 Work Zone Pavement Markings**
- 614.115 Work Zone Raised Pavement Markers**
- 614.12 Pavement Marking Operations**
- 614.13 Asphalt Concrete for Maintaining Traffic**
- 614.14 Performance**
- 614.15 Method of Measurement**
- 614.16 Basis of Payment**

**614.01 Description.** This work consists of maintaining and protecting vehicular and pedestrian traffic according to these provisions. For through traffic, the Special Provisions or the plans will designate whether the highway will be closed with detours, roads and run-arounds provided or whether traffic will be maintained through all or portions of the project.

**614.02 Traffic Facilities.** Construct and maintain facilities for vehicular and pedestrian traffic of the highway, including all walks, roads, bridges, culverts, and traffic control devices. The Department will maintain public highways used as a detour beyond the work limits of the contract.

A. For local traffic, provide and safely maintain drives, roads, run-arounds, walks, structures, and other facilities. Provide safe vehicular and pedestrian ingress and egress for all property adjacent to any improvement. Provide approaches and crossings of intersecting highways and maintain them in a safe condition. Maintenance includes snow and ice removal as needed.

B. When the highway under construction is being used by through traffic, including periods of suspension of the Work, maintain it so that it is smooth, free from holes, ruts, ridges, bumps, and dust. For the portions of highway being used, provide the necessary outlets to allow free drainage. Maintain pipe trenches or other openings left in hard surface pavements with material of comparable quality. Contractor maintenance responsibilities, including pothole patching begins for a section of highway when the Contractor begins the Work in that section and ends with the acceptance of the Work under 109.11 or 109.12. The two directions of a divided highway are considered separate highway sections and the start of Work on one direction does not begin maintenance responsibilities on the other direction.

C. Remove from the Project as necessary, abrasives and salt residues left by Department or local government snow and ice control operations.

D. Ensure positive drainage into structures that have inlet windows without grates during pavement overlay operations when traffic will be maintained on a pavement course lower than the inlet window. Provide a minimum of 2 inch (50 mm) holes spaced at 2 feet (0.6 m) or a minimum of three 4 inch (100 mm) holes spaced at 4 feet (1.2 m) drilled into the vertical wall of the existing drainage structure below the inlet window. Place steel or iron plating of at least ¼ inch (6 mm) thickness that completely covers the drilled holes prior to construction of the finished pavement course.

**614.03 Traffic Control General.** Conform to the requirements of the plan, standard construction drawings shown on the plans, and the OMUTCD, for the installation, maintenance, and operation of all traffic controls and traffic control devices. When the plans or standard construction drawings do not cover a specific traffic control situation, place the necessary traffic control devices according to the OMUTCD and use the procedures required by the OMUTCD.

Use portable changeable message signs pre-qualified according to Supplement 1061.

Use drums, signs, sign supports, barricades, impact attenuators, and other traffic control devices that are certified to meet NCHRP 350 safe-crash standards or as modified by Contract Documents. Do not use heavy non-yielding devices or supports that do not conform to the current standards of NCHRP 350 unless allowed by Contract Documents.

Use Type G, H or J reflective sheeting complying with 730.19, 730.192 and 730.193, respectively, for faces of construction signs, barricades, vertical panels, object markers, and stripes on glare screen panels. In addition, the Contractor may also use Type G sheeting referred to as damage control for these devices, provided it meets 730.19.

Use fluorescent orange reflective sheeting for all orange construction signs, object markers, and stripes on glare screen paddles. Use standard orange or fluorescent orange reflective sheeting for the orange portions of drums, barricades and vertical panels.

Furnish drums with reboundable reflective sheeting complying with the requirements of 730.191. Ensure that owner identification markings on construction drums are no more than 1 inch (25 mm) in character height and are

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located at least 2 inches (50 mm) below the reflectorized bands or on the top or bottom horizontal surfaces of the drum. Ballast the drums according to the manufacturer's recommendations.

Furnish traffic cones consisting of a highly visible orange predominant color. Ensure that the pavement markings for traffic maintenance conform to Item 640.

Furnish warning signs in advance of channelizing devices such as barricades, drums, vertical panels, and cones. Keep retroreflective materials clean and in good condition.

If equipment, vehicles, and material are stored or parked on highway rights-of-way, locate them not less than 6 feet (2 m) behind existing guardrail or not less than 30 feet (9 m) beyond the traveled way unless otherwise permitted by the Engineer. At night if any such material or equipment is stored between the side ditches, or between lines 6 feet (2 m) behind any raised curbs, clearly outline them with dependable lighted devices that are approved by the Engineer.

All temporary traffic control devices shall conform to the Quality Standards for Temporary Traffic Control Devices available at the following address:  
<http://www.dot.state.oh.us/Divisions/HighwayOps/Traffic/publications2/qualityguidelines/Pages/default.aspx>

**614.04 Work Zone Marking Signs.** Furnish, install, maintain, and subsequently remove work zone marking signs and their supports within the work limits according to the following requirements:

A. Erect a NO EDGE LINES sign in advance of any section of roadway lacking OMUTCD standard edge line markings. Ensure these signs are in place before opening the roadway to traffic. Erect these signs on each entrance ramp, at intersections of through roads to warn entering or turning traffic of the conditions, and at least once every 2 miles (3 km) along the roadway. Remove these signs when they no longer apply.

B. Erect a DO NOT PASS sign at the beginning and a PASS WITH CARE sign at the end of each no passing zone lacking OMUTCD standard center line markings.

**614.05 Road Closed.** When the highway is closed to traffic, furnish, erect, maintain, and subsequently remove advanced warning signs and supports, barricades, ROAD CLOSED signs on the barricades, and Type B yellow flashing lights at the following locations:

- A. Work limits of the project.
- B. Work limits on all intersecting roads.
- C. Any other points specified in the Contract.

Throughout construction, furnish, erect, maintain, and subsequently remove all signs, lights, barricades and other traffic control devices required by the OMUTCD, plans, or standard construction drawings for the maintenance of local traffic.

**614.055 Surface Condition Signs.** Erect a GROOVED PAVEMENT sign 250 feet (75 m) in advance of any section of roadway where traffic must travel on a planed surface. Ensure these signs are in place before opening the roadway to traffic. Erect these signs on each entrance ramp and at intersections of through roads to warn entering or turning traffic of the conditions. Payment for these signs to be included in Item 614 Maintaining Traffic.

#### **614.06 Detour Signing.**

**A. Department Detour Signing.** When the Contract Documents do not require the Contractor to furnish the signing for designated detour routes, the Department will furnish, erect, maintain, and subsequently remove the detour routing signs and supports required on the designated detour highways outside the Project.

**B. Contractor Detour Signing.** When the Contract Documents provide a pay item for Detour Signing and the plans provide a detour-signing plan, provide, maintain, and subsequently remove all required detour signing and supports according to the detour signing plan.

**614.07 Traffic Maintained.** Where the highway under construction is being used by through traffic, including periods of suspension of the work, furnish and maintain pavement markings, lights, construction signs, barricades, guardrail, sign supports, and such other traffic control devices. Maintain pre-existing roadside safety hardware at an equivalent or better level than existed prior to project implementation. Also, provide law enforcement officers, watchmen, and flaggers as necessary to maintain safe traffic conditions within the work limits as directed by the Engineer.

The Department will furnish and erect regulatory signs and guide signs, unless otherwise shown on the plans, within the work limits on all traffic maintained projects. The Contractor is responsible for maintenance of these signs. The Engineer will approve the erection and removal of any regulatory signs not shown on the plans.

Keep existing signs and traffic control devices in use within the work limits during the construction period unless otherwise indicated on the plans. If existing signs and other traffic control devices must be relocated or modified as a consequence of the work, provide suitable supports and modify the devices with prior approval of the Engineer and the concurrence of the maintaining agency. Keep existing STOP or YIELD signs functioning at all times. The Contractor may adjust the position of these signs with the Engineer's approval. Relocate existing signs that must be adjusted laterally according to the OMUTCD. Restore relocated or modified signs to the position and condition that existed before construction as directed by the Engineer. When signs are to be covered, provide an opaque covering that covers the entire message, symbol and all of the sign within the border. Do not use fastenings that damage the sign or reflective face; however, the Contractor may use rivets to attach rigid overlay panels. Do not apply adhesive tapes directly to the face of the sign.

When an existing signal operation must be interrupted for a period of time, provide a traffic control method approved by the Engineer.

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Whenever it is necessary to divert the flow of traffic from its normal channel into another channel, clearly mark the channel for such diverted traffic with cones, drums, barricades, vertical panels, pavement markings, or flashing arrow panels. Also use this method of marking where working adjacent to the part of the highway in use by the public.

Obtain the approval of the Engineer before closing a traffic lane or establishing a one-way traffic operation.

**614.08 Flaggers.** Whenever one-way traffic is established, use at least two flaggers unless the Engineer authorizes otherwise, and erect signs, cones, barricades, and other traffic control devices according to the OMUTCD. Reflectorize traffic control devices as previously noted. Maintain positive and quick means of communication between the flaggers at the opposite ends of the restricted area.

Equip flaggers according to the standards for flagging traffic contained in the OMUTCD. During a flagging operation, other than an intersection or a spot location best controlled by a single flagger, ensure that each flagger uses a STOP/SLOW paddle conforming to the OMUTCD. Mount the paddle on top of a 6 1/2-foot (2 m) handle. Ensure that each face of the paddle is made of Type G reflective sheeting meeting the requirements of 730.19. While flagging, do not allow flaggers to perform other work activities. The Contractor may, instead of using flaggers, or supplemental to them, furnish, install, and operate a traffic signal or signals, for the purpose of regulating traffic according to a written agreement approved by the Engineer.

**614.09 Law Enforcement Officer.** When shown on the plans, furnish the services of a law enforcement officer and patrol car equipped with flashing lights.

**614.10 Work Zone Traffic Signals.** If shown on the plans, furnish, erect, maintain, and subsequently remove signal equipment conforming to Items 632 and 732, and signal controller equipment of a proper type and capacity to provide the required operation. Subject to the Engineer's approval, the Contractor may use new equipment that is to be installed later on the project, or may install used equipment in good condition provided such used equipment meets current Department specifications. The performance test in 632.28 and the working drawing requirements of 632.04 are waived. Recondition used equipment as necessary to ensure proper operation. Operate work zone traffic signals conforming to the requirements of the OMUTCD and subject to the approval of the Engineer.

Procure and pay for electric power for work zone traffic signals. Do not alter the operation of an approved work zone traffic signal without the Engineer's approval. Correct any malfunctions or failures without delay. Cover or remove work zone traffic signals not in use.

**614.11 Work Zone Pavement Markings.** Furnish, install, maintain, and, when necessary, remove work zone retroreflective pavement markings on existing, reconstructed, resurfaced or temporary roads within the work limits, according to the following requirements.

**A. Acceptability and Expected Duration.** The Engineer will evaluate the markings according to the three performance parameters contained in Supplement 1047. Repair or replace the markings when the numerical rating is seven or lower for durability, visual effectiveness and night visibility. Repair or replace unsatisfactory markings immediately and at no additional cost to the Department, if the markings were in place for 120 calendar days or less. The Department will compensate under the applicable contract pay item for work zone pavement marking for the ordered replacement of worn markings after 120 calendar days under traffic.

**B. Work Zone Marking Specifications.** Equip traffic paint striping equipment for Class I and Class III markings with a computerized Data Logging System (DLS) conforming to 641.04 when the length of marking exceeds 0.5 miles (0.8 km) of continuous line equivalent. Furnish the Engineer daily, biweekly and final DLS reports as per 641.04.

Unless otherwise shown on the plans, the Contractor may use 740.02 Type 1 paint or 740.06 Type I or Type II preformed material for work zone pavement markings. Furnish painted markings according to Item 642 except that:

1. For Class I or Class II work zone pavement markings, use the specified application rate from Table 614.11-1.

<b>Type of Pavement Marking</b>	<b>Gallons per Mile of Line Width of Line (inches)</b>		
	<b>4</b>	<b>8</b>	<b>12</b>
Solid Line	22	44	66
10-foot Dashed Line	5.5	--	--
4-foot Dashed Line	2.2	--	--
Dotted Line	7.3	--	--
Arrows, Symbols, and Words	1.4 gallons per 100 square feet		
Glass Beads: 740.09, Type A	15 pounds per 100 square feet		

<b>Type of Pavement Marking</b>	<b>Liters per Kilometer of Line Width of Line (mm)</b>		
	<b>100</b>	<b>200</b>	<b>300</b>
Solid Line	52	105	157
3.0 m Dashed Line	13	--	--
1.2 m Dashed Line	5.2	--	--
Dotted Line	17.3	--	--
Arrows, Symbols, and Words	0.6 liters per square meter		
Glass Beads: 740.09, Type A	7.3 kg per square meter		

2. For Class III work zone markings, use the specified application rate from Table 614.11-2.

TABLE 614.11-2			
Type of Pavement Marking	Gallons per Mile of Line Width of Line (inches)		
	4	8	12
Solid Line	12	24	36
10 foot Dashed Line	3	--	--
Dotted Line	4	--	--
Arrows, Symbols, and Words	0.75 gallons per 100 square feet		
Glass Beads: 740.09, Type A	7.5 pounds per 100 square feet		

TABLE 614.11-2M			
Type of Pavement Marking	Liters per Kilometer of Line Width of Line (mm)		
	100	200	300
Solid Line	28	56	84
3.0 m Dashed Line	7	--	--
Dotted Line	9.4	--	--
Arrows, Symbols, and Words	0.3 liters per square meter		
Glass Beads: 740.09, Type A	3.7 kg per square meter		

Ensure that Type I and II preformed material conform to 740.06, except do not place any preformed material containing metal on any surface unless it will be removed later. Remove work zone pavement markings of 740.06 preformed material before placement of 642 or 644 surface course markings at that location. Ensure that preformed material conforms to Item 645.

**C. Work Sequence.** Ensure that work zone markings are complete and in place on all pavement, including ramps, before exposing the pavement to traffic. When work zone markings conflict with the traffic pattern, remove them according to 641.10.

**D. Layout and Premarking.** Layout and Premark all Class I and Class III Markings according to 641.06. Obtain the Engineer’s approval of the layout and premarking lines before marking operations are started.

**E. Tolerances.** Place lines for final surfaces according to the tolerances of 641.07. On surfaces other than final, the Department will allow tolerances twice that in 641.07.

**F. Classes of Work Zone Pavement Markings.**

**1. Class I Markings (Full Pattern, Full Rate).** Use Class I Markings on all surfaces exposed to traffic for more than 14 days prior to application of final markings and to over-winter the project, with the following exception: Do not use Class I Markings on a surface course if thermoplastic or epoxy final markings are to be applied to the surface course. If thermoplastic or epoxy final markings are to be applied to the surface course, use Class III Markings on that course.

Apply Class I work zone markings to the standard dimensions as defined in Item 641.

**2. Class II Markings (Abbreviated, Full Rate).** Use Class II Markings for short-term use when traffic is to be maintained in parallel lanes nominally in the same location as permanent lanes and where tapers or transitions are not required or other features will not likely divert traffic from the intended path. Class II Markings are limited to center lines, lane lines and gore markings defined as follows:

**a. Center Lines.** Class II center lines consist of single, yellow 4-inch (100 mm) wide by a minimum of 4 feet (1.2 m) long dashes spaced at a maximum of 40 feet (12.0 m) intervals. No Passing Zones must be marked with Class I or Class III Markings or final markings within 3 calendar days per 614.11. H. 1. Passing Zones must be marked with Class I or Class III Markings or final markings within 14 calendar days per 614.11. H. 2.

**b. Lane Lines.** Class II lane lines consist of white 4-inch (100 mm) wide by a minimum of 4 feet (1.2 m) long dashes spaced at a maximum of 40 feet (12.0 m) intervals. Class II Lane Line Markings must be marked with Class I or Class III Markings or final markings within 14 calendar days per 614.11. H. 3.

**c. Gore Markings.** Class II gore markings are continuous, white 4-inch (100 mm) wide lines normally 50 to 100 feet in length placed at the theoretical gore of an exit ramp or diverging roadways. Class II Gore Markings must be marked with Class I or Class III Markings or final markings within 14 calendar days per 614.11. H. 3.

Computerized Data Logging Systems (DLS) are not required for Class II Markings.

**3. Class III Markings (Full Pattern, Low Rate)** Use Class III Markings on surface courses that are expected to receive thermoplastic or epoxy final markings within 30 days. Class III Markings use a lower application rate which reduces the surface preparation needed prior to application of thermoplastic or epoxy final markings. If Class III Markings have been applied and weather conditions are expected to prevent thermoplastic or epoxy final markings application for 30 days or more, re-apply Class III Markings if thermoplastic or epoxy final markings application is expected to occur within 30 days or apply Class I Markings as necessary to carry the project through the season or over the winter.

Apply Class III work zone markings to the standard dimensions as defined in Item 641.

**G. Conflicting Markings.** Before placing work zone markings, remove or cover all conflicting existing markings visible to the traveling public.

**1. Removal and Covering of Markings.**

**a. Removal Methods.** Remove the markings so that less than 5% of the line remains visible. Repair damage to the pavement that results in the removal of more than 1/8 inch of pavement thickness. Remove the markings by using methods specified in the below table:

Type of Pavement		Removal Method	
		grinder[1]	sand, shot or water blast
Existing Asphalt	Temporary	Y	Y
	Permanent	N	Y
New Asphalt	Temporary	Y	Y
	Intermediate	Y	Y
	Permanent	N	Y
Existing Concrete	Temporary	Y	Y
	Permanent	N	Y
New Concrete	Temporary	Y	Y
	Permanent	N	Y
Y - method is permitted to be used			
N - method is not permitted to be used			
[1] – when a drum is mounted to a skid steer loader, the drum must be able to accommodate a minimum of 150 teeth			

**b. Covering Conflicting Markings.** With the Engineer’s approval, use removable, non-reflective, preformed blackout tape according to Supplement 1187 to cover conflicting markings. Remove or replace the blackout tape within 15 days of installation. Furnish products according to the Departments Qualified Products List (QPL).

**2. Raised Pavement Markers.** Remove the prismatic retro-reflector within any raised pavement marker that is in conflict with the work zone pavement markings. When the work zone pavement markings are removed and the raised pavement marker is no longer in conflict, thoroughly clean the recessed reflector attachment area of the casting and install a new prismatic retro-reflector of the same kind and color. The cost for this work is incidental to the various pay items.

**H. Allowable Duration of Work Zone Markings.**

**1. No Passing Zones.** When existing permanent no-passing-zone markings are removed or obliterated as the result of a construction operation (pavement grinding, asphalt concrete pavement overlays, etc.) and the section of pavement continues to be used by the traveling public, place Class I Center Line Markings or final center line markings as specified by the plan within 3 Calendar Days unless thermoplastic or epoxy final markings are to be applied on the surface course. If thermoplastic or epoxy final markings are to be applied on the surface course, place Class III Center Line Markings or final center line markings as specified in the plan within 3 Calendar Days.

**a. Subsequent Work in No Passing Zones.** If, after the original markings are removed or obliterated, the Contractor returns to the subject no

passing zone and places a plan-specified pavement course within the 3-Calendar Day limit, or performs work in preparation for a subsequent pavement course, the Contractor shall have temporarily satisfied the conditions of the previous paragraph. In this event, the 3-Calendar Day limit will begin again.

**b. Liquidated Damages.** For each Calendar Day beyond 3 days that this work remains incomplete, the Department will assess liquidated damages in the amount of \$1000 per Calendar Day. The Department will treat the time for the completion of no-passing-zone markings as an interim Completion Date.

**2. Passing Zones.** Sections of pavement where passing is permitted in both directions must be marked with Class I Center Line Markings or final center line markings as specified by the plan within 14 Calendar Days unless thermoplastic or epoxy final markings are to be applied on the surface course. If thermoplastic or epoxy final markings are to be applied on the surface course, place Class III Center Line Markings or final center line markings as specified in the plan within 14 Calendar Days.

**3. Allowable Duration of Class II Lane Lines and Gore Markings and Absence of Edge lines.** Any time existing permanent lane lines, gore markings, or edge lines have been removed or obliterated as the result of a construction operation (pavement grinding, asphalt pavement overlays, pavement widening, etc.) and the section of pavement continues to be used by the traveling public, place Class I Markings or final markings as specified by the plan within 14 Calendar Days unless thermoplastic or epoxy final markings are to be applied on the surface course. If thermoplastic or epoxy final markings are to be applied on the surface course, place Class III Markings or final markings as specified in the plan within 14 Calendar Days.

**a. Subsequent Work.** If, after the original markings are removed or obliterated, the Contractor returns to the subject section of pavement and places a plan-specified pavement course within the 14-Calendar Day limit, or performs specified work that requires a lane closure (except routine maintenance required by 614.02), the Contractor shall have temporarily satisfied the conditions of the previous paragraph. In this event, the 14-Calendar Day limit will begin again.

**b. Liquidated Damages.** For each Calendar Day beyond 14 days that this work remains incomplete, the Department will assess liquidated damages in the amount of \$1000 per Calendar Day. The Department will treat time for the completion of these markings as an interim Completion Date.

**(1) Continuous Project.** If a section of pavement is in a continuous part of the project, then a new 14-day limit for renewed work on a section applies to all sections in that part.

**(2) Project in Sections.** If the project is in parts and the traveling public could not discern the parts as one continuous project, then a new 14-day limit in one part will not apply to the other parts.

**(3) Freeways and Divided Highways.** Treat the two directional sides of a freeway as separate parts. Work on one side of a freeway does not create a new 14-day limit for the other side.

**614.12**

I. Removal of Work Zone Markings. Remove work zone retroreflective pavement markings when necessary. Accomplish removal of work zone pavement marking by using removal methods specified in 614.11G.1.a for removal of existing markings.

**614.115 Work Zone Raised Pavement Markers.** Furnish, install, maintain and subsequently remove work zone raised pavement markers (WZRPMs). Work zone raised pavement markers may serve as a substitute for, or supplement to, work zone pavement markings. They are provided in both yellow and white versions to match the appropriate pavement marking color.

White units provide reflectorization in one direction while yellow units may provide reflectorization in either one direction or two. They are available as units which are readily visible both night and day as a result of retroreflectors and brightly colored (white or yellow) housing (Type A) or visible only at night due to their retroreflectors (Type B).

**A. Materials.** Prequalify work zone raised pavement markers according to Supplement 1056.

Only use adhesives that are recommended by the reflector manufacturer and are not epoxy.

Provide markers of sufficient strength and properly shaped so as not to be dislodged or broken by impacts from vehicle tires, including those of high pressure truck tires loaded to 4500 pounds (2040 kilograms).

Provide reflectors having an area of 0.35 square inches (225 square millimeters) for Type A or 3.0 square inches (1935 square millimeters) for Type B with brightness or specific intensity (when tested at 0.2 degree angle of observation and the following angles of incidence) meet or exceed the following:

<b>WZRPM SPECIFIC INTENSITY</b>			
<b>TYPE</b>	<b>INCIDENCE ANGLE</b>	<b>WHITE</b>	<b>YELLOW</b>
A	0	1.0	0.6
A	20	0.4	0.24
B	0	3.0	1.8
B	20	1.2	0.72
B	45	0.3	0.2

Angle of incidence: Formed by a ray from a light source to the marker and the normal to the leading edge of the marker face (also horizontal entrance angle)

Angle of observation: Formed by a ray from a light source to the marker and the returned ray from the marker to the measuring receptor

Specific intensity: The mean candlepower of the reflected light (at given incidence and divergence angles) for each footcandle (10.7 lux) at the reflector (on a plane perpendicular to the incident light)

Type A markers, when viewed from above, have a visible area of not less than 14 square inches (9030 square millimeters). When viewed from the front, parallel to the pavement, as from approaching traffic, Type A markers have a width of

approximately 4 inches (100 mm) and a visible area of not less than 1.5 square inches (970 square millimeters).

**B. Patterns.** The patterns of WZRPMs required for the various types of pavement markings are shown in Table 614.115-1.

TABLE 614.115-1		
SUPPLEMENTAL DELINEATION (TYPE A OR B)		
TYPE OF LINE	COLOR	SPACING
Edge Line	1-way white or yellow	20' (6.0 m) c/c
Lane Line	1-way white	40'(12.0 m) c/c or at center of gap
Dashed Center Line	2-way yellow	40'(12.0 m) c/c or at center of gap
Double Center Line	2-way yellow	2 units; 20' (6.1 m) c/c
Channelizing Line	1-way white	10'(3.0 m) or 20'(6.0 m) c/c
Exit Gore(Outline)	1-way white	10'(3.0 m) c/c
SIMULATED DELINEATION (TYPE A ONLY)		
TYPE OF LINE	COLOR	SPACING
Edge Line	1-way white or yellow	10'(3.0 m) c/c
Edge Line on 1-Lane, 2-Way	1-way white & 1-way yellow	white & yellow units back-to-back** 10' (3.0 m)
Lane Line	1-way white	3 units at 5'(1.5 m) c/c;30'(9.0 m) gap
Dashed Center Line	2-way yellow	3 units at 5'(1.5 m) c/c;30'(9.0 m) gap
Double Center Line	2-way yellow	2 units*;10' (3.0 m)c/c
Channelizing Line	1-way white	5'(1.5 m)c/c
Exit Gore(Outline)	1-way white	5'(1.5 m)c/c

\*Place units side by side about 4 inches (100 mm) apart.

\*\*Face the proper color and reflector to the oncoming traffic. Place the units back to back about one quarter inch (6.0 mm) apart.

**C. Installation.** Attach work zone raised pavement markers to clean, dry and sound pavement. Remove all loose gravel, sand and dirt from the area of the line. The minimum pavement temperature for installation is 50 °F (10 °C). When markers are being attached to new concrete pavement with curing compound remaining, remove the curing compound membrane by sandblasting or other mechanical cleaning method. Install markers in accordance with the manufacturer's recommendations.

Work zone raised pavement markers are not suitable for use from October 15 to April 1. If the Contractor elects to start or continue work zone pavement markers during this period, and they fail or are subsequently removed or destroyed by snow and ice control activities, immediately, at his expense, provide a substitute traffic guidance system which is effective during day and night and which is acceptable

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to the Engineer. Other than for replacement of failed WZRPMs, new installations of WZRPMs are not permitted from October 1 to April 1.

Place markers accurately to depict straight or uniformly curving lines. The longitudinal location of WZRPMs are described in Table 614.115-1 except that the spacing of an individual WZRPM may be varied by as much as 2 feet (0.6 m) or 10 percent of the nominal spacing in order to avoid poor pavement conditions, but the average spacing remains unchanged. Poor pavement conditions include separated joints, cracks, deteriorated pavement, usually uneven pavement or where pavement marking material will interfere with the bond.

The lateral location of WZRPMs follows:

1. **Edge Lines:** Install the WZRPM 12 inches (300 mm) outside the work zone pavement marking, if any, or the theoretical edge of the lane. This offset may vary +6 inches (150 mm) as necessary to avoid poor pavement conditions.

2. **Lane lines and dashed center lines:** Install the WZRPM in the center of the gap between pavement marking dashes, if any. If a pavement joint exists, locate the marker approximately 2 inches (50 mm) clear from the joint (and to the left of it for lane lines). Otherwise, center the WZRPM on the theoretical edge of the lane.

3. **Double center line:** Install each WZRPM of the pair in line with the appropriate pavement marking stripe, if any. If the edge of lane is demarcated by a crack or joint, the pair of WZRPMs straddle the joint and install each approximately 2 inches (50 mm) clear from the joint. Otherwise center the pair on the theoretical edge of lane.

4. **Channelizing Line:** Install the WZRPM in line with the pavement marking stripe or immediately adjacent to the line, except when used at exit gore outlines where the WZRPM is installed within the painted gore vee and approximately 12 inches (300 mm) from the pavement marking stripe. Do not install WZRPMs directly on a painted line.

**D. Replacement.** Maintain WZRPMs in good condition. A marker will be considered to have failed when the marker is broken, the marker is worn to the extent that daytime visibility is significantly diminished or of an unacceptable color (type B only), the reflector is broken or detached, the marker is detached from the adhesive, the adhesive is detached from the pavement or the marker or reflector is covered by tar or paint.

Individual replacement of each failed marker as it occurs is not recommended due to increased exposure of workers to traffic. However, maintain the following minimum levels of marker effectiveness:

1. For a given line, no more than 20 percent of the WZRPM units failed in any manner;

2. For a segment of any line, the number of failed units does not exceed the maximums permitted in Table 614.115-2.

<b>Line Type</b>	<b>Normal Spacing Feet (Meter)</b>	<b>Segment Length Feet (Meter)</b>	<b>Normal No. Contained In Segment</b>	<b>Maximum No. Permitted To Fail</b>
Edge	10(3.0) 20(6.0)	5(1.5) 100(30.0)	6	3
Center, Double/Solid	20(6.0) 10(3.0)	100(30.0) 50(15.0)	12	6
Lane or Dashed Center	40(12.0) 5(1.5)	200(60.0) 1-Stripe	6	3
Channelizing	20(6.0) 10(3.0) 5(1.5)	100(30.0) 50(15.0) 25(7.5)	6	3

Replace all failed units within any line or segment before conditions deteriorate below the minimums established in Table 614.115-2. Replace all failed units within the line or segment within 24 hours after notification by the Engineer.

**E. Removal.** Accomplish removal of work zone raised pavement markers in such a manner that no adhesive remains on the pavement. Do not cause permanent pavement surfaces to be scarred, broken or significantly roughened.

**614.12 Pavement Marking Operations.** Perform moving marking operations with a truck equipped with necessary flashers and signs, and protect the operations with a similarly equipped vehicle or vehicles separated a sufficient distance to provide adequate advance warning. Use the extreme left or right lane for the marking operation when possible. Where three or more lanes exist in one direction, perform the marking operation so that traffic passes on one side only.

Protect stationary marking operations in intersections, school zones, gores and other areas with traffic control devices such as advance warning signs and cones.

For stationary operations such as loading material and cleaning equipment, make every effort to have all equipment completely off the traveled way. When equipment cannot be removed from the traveled way, operate all traffic control devices on the vehicles and station flaggers and vehicles to protect the worksite and the traveling public while maintaining traffic.

**614.13 Asphalt Concrete for Maintaining Traffic.** The Contractor may use either a Type 1 or Type 2 mix of Item 448 asphalt concrete PG 64-22, or an asphalt concrete surface course the Engineer approves. Place surface course materials as and where the Engineer directs for maintenance of the existing pavement, shoulders, or structures.

Where materials are placed in small quantities or under adverse conditions, the Engineer may waive specification requirements for placing and finishing if, in the judgment of the Engineer, it is determined that the Contractor can obtain satisfactory results in providing a smooth and durable pavement surface.

**614.14 Performance.** If, in the opinion of the Engineer, the Contractor is not furnishing proper maintenance of traffic facilities and proper provisions for traffic control, the Department may take the necessary steps to place them in proper

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condition, and the Department will deduct the cost of such services from any money that may be due or become due the Contractor.

**614.15 Method of Measurement.** The Department will measure Work Zone Marking Signs as the number of sign installations, including the sign, necessary supports, and all attachment hardware. The Department will include all other work zone signs under Maintaining Traffic unless separately itemized.

The Department will measure Work Zone Pavement Markings complete in place, by class and material, in the units designated.

The Department will measure line quantities as the length of the completed stripe, including gaps, intersections, and other sections of pavement not normally marked.

**614.16 Basis of Payment.** The Department will make partial payments according to 109.09 and as modified by the following schedule:

If the project duration from first day of physical work to original completion date is greater than or equal to 45 calendar days,

- A. The Department will pay 30 percent of the lump sum amount bid for Maintaining Traffic with the first estimate, but not sooner than 15 days after the start of work at the project site.
- B. The Department will pay the remaining 70 percent of the lump sum amount bid for Maintaining Traffic according to 109.09

Unless separately itemized, the lump sum price bid for Maintaining Traffic shall include the cost of removal or covering of conflicting pavement markings, layout, application and removal of pavement markings when required, maintaining the existing highway in a safe condition for public use, removing abrasive and salt residue remaining from snow and ice control performed by the Department or local governments, providing flaggers and their equipment, and furnishing, maintaining in an acceptable condition, and subsequently removing the following work zone traffic control items as required by the Contract Documents:

- A. Signs, supports, and warning lights.
- B. Drums, cones, gates, barricades, and vertical panels.
- C. Flashing arrow panels.
- D. Work zone traffic signals.
- E. Lighting for work zone signals and flaggers.

If traffic permanently damages beyond use any of the following items, the Department will compensate the Contractor for the fair market value of the damaged item according to 109.05 provided the Contractor has pursued but failed to obtain compensation from the motorist. Follow the procedures given in 107.15 for compensation for traffic damage to completed permanent items of Work, to obtain compensation from the motorist before requesting compensation from the Department.

- A. Flashing arrow panel.

- B. Work zone signal, pole, or controller.
- C. Lighting unit or pole.
- D. Changeable message sign.
- E. Work Zone Impact Attenuator

The lump sum price bid for Detour Signing includes the cost of the Contractor furnishing, installing, maintaining, and removing the detour signing shown on the plans and their necessary supports.

The Department will pay for the following items under their associated item numbers: 502 Bridges, 615 Roads and Pavement, 622 Portable Concrete Barrier. The Department will pay for aggregate and calcium chloride authorized by the Engineer and used for Maintaining Traffic under Items 410 and 616.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
614	Lump Sum	Maintaining Traffic
614	Lump Sum	Detour Signing
614	Each	Replacement Drum
614	Each	Replacement Sign
614	Each	Object Marker, ___ - Way
614	Each,	Work Zone Pavement
	Mile, Foot	Markings
	(Kilometer,	
	Meter)	
614	Each	Work Zone Raised Pavement Marker
614	Day	Portable Changeable Message Sign
614	Each	Work Zone Speed Limit Sign
614	Each	Work Zone Marking Sign
614	Hour	Law Enforcement Officer with Patrol Car
614	Each	Barrier Reflector
614	Each	Work Zone Crossover Lighting System
614	Each	Work Zone Impact Attenuator
614	Mile (Kilometer)	Work Zone Lane Line, Class ___, ___*
614	Mile (Kilometer)	Work Zone Center Line,
		Class ___, ___*
614	Foot	Work Zone Channelizing
	(Meter)	Line, Class I, ___*
614	Mile (Kilometer)	Work Zone Edgeline, Class I, ___*
614	Foot	Work Zone Gore Marking,
	(Meter)	Class II, ___*
614	Foot	Work Zone Stop Line,
	(Meter)	Class I, ___*
614	Foot	Work Zone Arrow,
	(Meter)	Class I, ___*
614	Foot	Work Zone Crosswalk
	(Meter)	Line, Class I, ___*

**615.01**

614	Foot (Meter)	Work Zone Dotted Line, Class I, ___*
614	Cubic Yard (Cubic Meter)	Asphalt Concrete for Maintaining Traffic

\* Type material (642 paint; 740.06, Type I or Type II; or left blank to allow any of the three.

**ITEM 615 ROADS AND PAVEMENTS FOR MAINTAINING TRAFFIC**

**615.01 Description**

**615.02 Fences**

**615.03 Earthwork**

**615.04 Guardrail**

**615.05 Pavement**

**615.06 Sidewalk**

**615.07 Maintenance**

**615.08 Removal**

**615.09 Method of Measurement**

**615.10 Basis of Payment**

**615.01 Description.** This work consists of providing, maintaining, and subsequently removing roads and pavements for maintaining traffic.

**615.02 Fences.** If necessary, replace permanent fencing with temporary fencing while occupying any temporary Right-of-Way, provide, erect, and maintain comparable temporary fencing during the period of construction. Take ownership of the existing fence. The Contractor may use this material in the erection of the temporary fence.

Before occupancy of the temporary Right-of-Way is terminated and before removal of the temporary fence, the Engineer will notify the property owner to reinstall permanent fencing according to the Right-of-Way settlement.

**615.03 Earthwork.** Excavate and construct embankment necessary for providing and maintaining temporary roads and any associated drainage facilities, as well as subsequent removal of temporary roads and restoration of the areas to their original condition, according to Item 203. Construct adequate side ditches in cut sections, and provide drainage pipe and culverts where necessary. Ensure that the width of the road from out to out of the shoulders is not less than 26 feet (7.8 m) and the side slopes are not steeper than 1.5:1, unless otherwise shown on the plans. If sidewalks are required, increase the width of embankment accordingly.

**615.04 Guardrail.** Where the height of the embankment is 5 feet (1.5 m) or more, measured at the outside edge of the berm, and the side slope is steeper than 4:1, provide guardrail at a distance of at least 1.5 feet (0.5 m) from the edge of the required width of the surface course. Conform to one of the types of guardrail

specified in Item 606, except that the Department will allow the Contractor to re-use material in good condition.

**615.05 Pavement.** Unless otherwise shown on the plans, ensure that the pavement surface is not less than 20 feet (6.0 m) wide and is constructed of the materials and in the manner specified.

Prepare the subgrade in accordance with 204.03 and 204.04

Provide subgrade conforming to Item 204.03. Soft subgrade will be determined and replaced conforming to Item 204.04.

If a traffic-compacted surface course is shown on the plans, construct it according to Item 410. Furnish and apply calcium chloride according to Item 616. The Engineer will specify the amount of original and subsequent applications of aggregate and calcium chloride.

Where Class A or Class B pavement is shown on the plans, provide either rigid pavement or flexible pavement conforming to the following minimum requirements:

MINIMUM COURSE THICKNESS REQUIRED			
Pavement Type	Course Make-Up	Class A	Class B
Rigid	452	9 in (230 mm)	7 in (180 mm)
Flexible	448 Type 1[1]	1-1/4 in (32 mm)	1-1/4 in (32 mm)
	448 Type 2[2]	1-3/4 in (45 mm)	1-1/2 in (38 mm)
	302[3]	7 in (180 mm)	5 in (125 mm)
	304	6 in (100 mm)	6 in (100 mm)
[1] Meet surface course requirements. The Contractor may use Type 2 surface.			
[2] Meet intermediate course requirements.			
[3] The Contractor may use 301 or 448 Type 2 intermediate course.			

For the indicated pavement type and courses, conform to the requirements of the specified items except as modified below.

For rigid pavements, conform to Item 452. Tiebars or hookbolts for longitudinal joints are not required. Use dowels only at transverse expansion and construction joints. Conform to the quality requirements set forth in 499.02 for the materials, except the requirements of 703.13. Use Class C concrete. For any part of the 452 pavement that is to be incorporated into the permanent pavement, the above exclusions do not apply and conformance to Items 452 and 499 is required.

For a 448 course, if the Contractor spreads and finishes the materials by acceptable hand methods, the Department will waive the requirements for smoothness. Use a PG 64-22 asphalt binder, unless part of the temporary pavement is to be incorporated into the permanent pavement.

For a 304 course, if the Contractor spreads the aggregate by approved hand methods, the Department will not require side forms. If the 304 course is to be removed, the Contractor may use reclaimed asphalt concrete or portland cement concrete pavement.

**615.06**

Determine the thickness of the courses by field measurement.

**615.06 Sidewalk.** If temporary walks are required, provide one of the types specified in Item 608.

**615.07 Maintenance.** Maintain all portions of the temporary facilities in good condition with respect to both safety and smoothness for travel as long as it is needed for maintenance of traffic. If the Engineer determines that the Contractor is not properly maintaining the temporary facilities, the Department may put them into proper condition according to 105.15.

**615.08 Removal.** If the temporary facilities are no longer needed, remove them, except such portions of the embankment as are shown on the plans to be a part of the new roadway embankment, and leave the area in a neat condition.

Take ownership of all material removed, unless otherwise shown on the plans. Use removed materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

**615.09 Method of Measurement.** The Department will measure the quantity of Pavement for Maintaining Traffic by the number of square yards (square meters) of pavement surface placed, maintained, and removed as directed, measured complete in place.

The Department will measure areas of soft subgrade, undercut and replaced, according to 204.08.

The Department will measure the quantity of Traffic Compacted Surface under Item 410 and Calcium Chloride under Item 616.

**615.10 Basis of Payment.** Payment for Roads for Maintaining Traffic will not include those specified for Item 410 Traffic Compacted Surface or Item 616 Calcium Chloride.

The Department will pay for areas requiring undercut and replacement conforming to 204.04 according to 204.09

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
615	Square Yard (Square Meter)	Pavement for Maintaining Traffic, Class A
615	Square Yard (Square Meter)	Pavement for Maintaining Traffic, Class B
615	Lump Sum	Roads for Maintaining Traffic

**ITEM 616 DUST CONTROL**

**616.01 Description**

**616.02 Construction Requirements**

**616.03 Method of Measurement**

**616.04 Basis of Payment**

**616.01 Description.** This work consists of applying water or dust palliative for the alleviation or prevention of dust nuisance originating from earthwork construction operations from within the project construction limits.

**616.02 Construction Requirements.** Perform dust control operations at the time and location and in the amount ordered by the Engineer. Maintain control of the application of water or dust palliative at all times to minimize dust but not to create saturated soil conditions. The Engineer will determine whether water or dust palliative is to be used to alleviate or prevent dust nuisance, and the amounts of each material to be used. Do not apply calcium chloride to areas that will be subsequently seeded or sodded.

Furnish and apply water used for dust control by means of tanks equipped with suitable sprinkling devices.

Use dust palliative consisting of 712.02 calcium chloride or a brine solution containing a minimum of 30 percent by weight of calcium chloride. Spread the calcium chloride uniformly over the surface.

**616.03 Method of Measurement.** The Department will measure Water by the M gallons (cubic meters) applied and measured either in tanks, tank wagons, or trucks of predetermined capacity; or by means of meters of a type and furnished and installed by the Contractor at no expense to the Department; or determined by weight conversion.

The Department will measure Calcium Chloride by the number of tons (metric tons) by weight measurement, furnished and applied. When brine is used, the Department will determine the weight of calcium chloride by multiplying the number of gallons (cubic meters) by the factor 0.0024 (0.575).

**616.04 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
616	M Gallons (Cubic Meter)	Water
616	Ton (Metric Ton)	Calcium Chloride

## **ITEM 617 RECONDITIONING SHOULDERS**

**617.01 Description**

**617.02 Materials**

**617.03 Prosecution**

**617.04 Shoulder Preparation**

**617.05 Furnishing and Compacting Additional Aggregate**

**617.06 Method of Measurement**

**617.07 Basis of Payment**

## 617.01

**617.01 Description.** This work consists of preparing the shoulder, and furnishing and compacting additional aggregate on the existing or prepared shoulder.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

**617.02 Materials.** Furnish materials conforming to 703.18.

**617.03 Prosecution.** If reconditioning shoulders in connection with a resurfacing project and where traffic is maintained, place shoulder material along with the paving operations as rapidly as possible. Complete all shoulder reconditioning within 4 days following the placement of the surface course or any course that results in a drop-off of 2.0 inches (50 mm) or greater.

**617.04 Shoulder Preparation.** If shoulder preparation is specified, loosen the existing surface to a depth of 1 to 2 inches (25 to 50 mm). If the surface is an asphalt mix or seal, cut the surface along the edge of the pavement with a blade or disc to give a straight vertical edge. Reduce pieces of loosened material that exceed approximately 1 1/2 inches (38 mm) in size to at least this maximum size or consider these pieces unsuitable material. Remove and dispose of oversized or other unsuitable material that would interfere with placing of aggregate. Reshape the loosened material as necessary to conform to the requirements for placing aggregate.

**617.05 Furnishing and Compacting Additional Aggregate.** Spread aggregate with approved spreaders. Do not dump or store aggregate on the pavement. Remove spilled aggregate from the pavement as spreading progresses.

Perform the initial compaction of the material using crawler-type tractors, tamping rollers, trench rollers, suitable pneumatic tire equipment, or other suitable equipment. Use compaction equipment weighing at least 6 tons (5 metric tons) and use a minimum of four total passes. Perform final compaction of the surface of the shoulder using approved pneumatic tire equipment. Compact the aggregate immediately after the spreading operation to prevent loss of contained moisture and displacement of the material.

Apply water as directed by the Engineer when required to aid compaction and to prevent segregation of the material.

**617.06 Method of Measurement.** The Department will measure Shoulder Preparation by the number of square yards (square meters).

The Department will measure Compacted Aggregate, by the number of cubic yards (cubic meters) in place computed from the profile grade and typical sections.

The Department will measure Water by the number of M gallons (cubic meters) according to 616.03.

If the plans provide for the use of aggregate in a variable width or depth course and the Department cannot readily calculate the quantity from profile grade and typical sections, the Department will measure the cubic yards (cubic meters) by converting from weight using the following conversion factors:

TABLE 617.06-1

Material	Conversion Factor	
Crushed stone	3800 lb/yd <sup>3</sup>	2250 kg/m <sup>3</sup>
Crushed gravel	3900 lb/yd <sup>3</sup>	2310 kg/m <sup>3</sup>
Crushed slag <sup>[1]</sup>		
less than 90 lb/ft <sup>3</sup> (1450 kg/m <sup>3</sup> )	3600 lb/yd <sup>3</sup>	2140 kg/m <sup>3</sup>
90 to 100 lb/ft <sup>3</sup> (1450 to 1600 kg/m <sup>3</sup> )	4000 lb/yd <sup>3</sup>	2375 kg/m <sup>3</sup>
more than 100 lb/ft <sup>3</sup> (1600 kg/m <sup>3</sup> )	4500 lb/yd <sup>3</sup>	2670 kg/m <sup>3</sup>
Recycled Portland Cement Concrete	3400 lb/yd <sup>3</sup>	2020 kg/m <sup>3</sup>
Recycled Asphalt Concrete Pavement	4000 lb/yd <sup>3</sup>	2375 kg/m <sup>3</sup>

[1] Based on average dry rodded weight of standard sizes of slag aggregates on record at the Laboratory. The conversion factors listed are the long gradation weights. These numbers are based on the dry rodded weights of No. 67, 57, or 8 gradation. The Department will determine slag weights based on weights obtained from the original source.

The Department will classify salvaged or mixed materials according to the material that makes up the majority of the mixture.

The moistures of the delivered material will be less than 2 percent above saturated surface dry condition or the payment will be based on the dry densities and dry weights.

Furnish freight bills or certified weigh bills according to Item 109.

**617.07 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
617	Square Yard (Square Meter)	Shoulder Preparation
617	Cubic Yard (Cubic Meter)	Compacted Aggregate
617	M Gallons (Cubic Meter)	Water

## ITEM 618 RUMBLE STRIPS ON SHOULDERS

### 618.01 Description

### 618.02 Construction of Rumble Strips on Shoulders

### 618.03 Method of Measurement

### 618.04 Basis of Payment

**618.01 Description.** This work consists of grinding depressions (rumble strips) in paved shoulders.

Construct rumble strips according to the standard construction drawings.

**618.02 Construction of Rumble Strips on Shoulders.** Furnish equipment to grind the depressions with a rotary cutting head that will produce the required dimensions and a pattern of cutting tips to produce a smooth cut with

**618.03**

approximately 0.06 inches (1.5 mm) between peaks and valleys. Ensure that the cutting head is on its own suspension system, independent from that of the power unit, to allow the head to align itself with the slope of the shoulder or any irregularities in the shoulder surface. Equip the cutting tool with guides or a guidance system, clearly visible to the operator, to provide for consistent alignment. Take effective measures to control dust during the grinding operation. Remove and dispose of all grinding materials deposited on the roadway pavement in a manner approved by the Engineer and before opening the roadway to traffic.

**618.03 Method of Measurement.** The Department will measure Rumble Strips by the number of feet (meters) or mile (kilometer) as the sum of the lengths of the individual segments. The Department will measure lengths along the inside edge of the shoulder, from the center of the first depression in a segment to the center of the last depression in that segment. If Rumble Strips are provided on more than one shoulder, the Department will measure lengths separately for each shoulder segment and add the individual lengths together to obtain the total length.

**618.04 Basis of Payment.** The Department will not pay for repairing surface damage and extraneous marks caused by the Contractor’s operations.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
618	Feet (Meter), Mile (Kilometer)	Rumble Strips, (Asphalt Concrete)
618	Feet (Meter), Mile (Kilometer)	Rumble Strips, (Concrete)

**ITEM 619 FIELD OFFICE**

**619.01 Description**

**619.02 General**

**619.03 Method of Measurement**

**619.04 Basis of Payment**

**619.01 Description.** This work consists of providing, maintaining, and subsequently removing a field office for the exclusive use of the Department for the duration of the Contract at a location approved by the Engineer.

**619.02 General.** Furnish a completely functional field office of the type specified in the Contract by the date directed by the Engineer.

Furnish each field office with a means for maintaining a room temperature between 68 and 80 °F (20 and 27 °C).

Furnish electric service for each field office.

Furnish potable hot and cold water for each field office.

Furnish neat, sanitary, enclosed toilet accommodations for each field office. Furnish associated lavatory and sanitary supplies. Portable facilities may be provided with the approval of the Engineer.

For projects requiring moisture and density control of construction materials, provide the field office with a lockable wood or metal storage box of sufficient size to store a nuclear density gauge and an electrical connection for the gauge.

For the type of field office specified, provide the items indicated in Table 619.02-1

<b>TABLE 619.02-1 FIELD OFFICE</b>			
Item	Type A	Type B	Type C
Minimum ceiling height, ft (m)	7 (2.1)	7 (2.1)	7 (2.1)
Floor space, ft <sup>2</sup> (m <sup>2</sup> )	150 (14)	500 (46)	1000 (93)
Separate enclosed room, ft <sup>2</sup> (m <sup>2</sup> ) (Part of specified floor space)	0 (0)	0 (0)	100 (9)
Telephone service & telephones <sup>[1]</sup>	2	2	2
Internet service connection with a broadband modem capable of bridge mode <sup>[6]</sup>	1	1	1
Facsimile machine	1	1	1
Copying machine with NIC card capable of scanning documents to a computer <sup>[2]</sup>	1, 11x17	1, 11x17	1, 11x17
Base radio & 4-hand held units <sup>[3]</sup>	---	---	1
Calculator with tape	1	2	3
Desk and chair set	1	3	5
Work table, 30 × 72-inch (750 × 1800 mm)	1	2	3
4-drawer, legal size, lockable metal file cabinet	---	1	2
2-drawer, metal file cabinet	1	2	2
Portable fire extinguishers <sup>[4]</sup>	1	1	2
Plan rack <sup>[5]</sup>	1	1	2
All-weather parking spaces	8	16	20
[1] For each telephone specified, provide the telephone itself, all wiring necessary to connect the phone and computers or fax machines to the phone company system, and a working separate phone number for each telephone. Connect one phone to a recorded answering device. For Types B and C, provide one speakerphone.			
[2] Capable of producing multiple copies of documents of the size designated; provide the copier with all necessary maintenance and paper supplies.			
[3] Capable of transmitting and receiving voice communication between office and any area on the project site.			
[4] Type 2-A:10-B:C, 5-pound (2.27 g) size			
[5] Capable of handling the breakdown of 22 × 34-inch (559 × 864 mm) sized plans in to ten sections.			
[6] Provide a broadband internet connection capable of download speeds greater than 1.5 Mbps. If 1.5 Mbps is not available, provide the highest speed available in the area. When multiple broadband services are available the following is the preferred order: DSL, Cable, Cellular, Satellite. Submit internet connection and network details at the Preconstruction Meeting for approval by the Department.			

With the Engineer's written approval, the Contractor may modify the requirements for the field office.

Maintain all utility services (e.g., electric, security, telephone, water) for the duration of the project.

**619.03**

Furnish a concrete cylinder curing box capable of holding at least eight 6 x 12 inch (150 x 300 mm) cylinders at 73 °F (23 °C) +/- 3 degrees no matter what the ambient temperature is when constructing either portland cement concrete pavement over 10,000 square yards (8000 m<sup>2</sup>) or over 50 cubic yards (38 cubic meters) of bridge structure repair or replacement concrete. The box will have a sealed lid.

**619.03 Method of Measurement.** The Department will measure Field Office, Type \_\_\_ by the number of months the office is maintained. A partial month at the end of the project will be paid as a full month.

**619.04 Basis of Payment.** The Department will pay for accepted quantities at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
619	Month	Field Office, Type ___

**ITEM 620 DELINEATORS**

**620.01 Description**

**620.02 Materials**

**620.03 Layout**

**620.04 Removal**

**620.05 Installation**

**620.06 Method of Measurement**

**620.07 Basis of Payment**

**620.01 Description.** This work consists of furnishing and installing delineators or reflectors, removing existing delineators for storage or disposal, and restoring the surface where delineators are removed.

**620.02 Materials.** Furnish materials conforming to:

Concrete, Class C or F.....	499
Reflectors .....	720.01
Posts, flexible .....	720.03
Steel hardware .....	730.08
Brackets.....	730.09
Stainless steel hardware .....	730.10
Aluminum hardware.....	730.17
Reflective sheeting .....	730.19

Delineators consist of reflectors mounted on flexible posts or brackets. Rectangular reflectors are reflective sheeting adhered to either a flexible post or an aluminum plate. If specified, furnish reflectors separately. The colors of reflectors of each type are:

- Type C    Rectangular white
- Type D    Rectangular yellow
- Type E    Rectangular red

**620.03 Layout.** Lay out all delineator locations to ensure their proper placement. The Engineer will approve the layout before installation is started.

**620.04 Removal.** Remove delineators, including reflectors, posts, brackets, and miscellaneous hardware. The delineator becomes the property of the contractor. Remove and dispose of concrete for delineator post embedment.

Restore surfaces where delineator posts or concrete for embedment are removed.

**620.05 Installation.** Install delineators facing traffic, except install red reflectors facing wrong-way traffic. Do not remove the protective paper covering the face of flexible post-mounted reflectors until after installation. Ensure that posts are not more than 1:50 out of plumb. If soil conditions may cause the post to be out of plumb, the Contractor may drive a pilot shaft before installation.

Install flexible posts using methods and equipment that conform to the post manufacturer's recommendations.

**620.06 Method of Measurement.** The Department will measure Delineator by the number, including reflectors, supports and hardware, in place, completed and accepted.

The Department will measure Reflector by the number, including hardware, in place, completed and accepted.

The Department will measure Removal of Delineator, by the number.

**620.07 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
620	Each	Delineator, Post Mounted
620	Each	Delineator, Bracket Mounted
620	Each	Removal of Delineator
620	Each	Reflector

## **ITEM 621 RAISED PAVEMENT MARKERS (RPM)**

**621.01 Description**

**621.02 Materials**

**621.03 Layout**

**621.04 Installation RPM Casting**

**621.05 Installation RPM Retroreflector**

**621.06 Reflector Replacement**

**621.07 Reflector Color**

**621.08 Raised Pavement Markers Removed**

**621.09 Method of Measurement**

**621.10 Basis of Payment**

**621.01 Description.** This work consists of preparing the pavement and furnishing and placing plowable raised pavement marker castings (RPMs) and prismatic retroreflectors, and removing existing RPMs for disposal.

**621.02**

**621.02 Materials.** Furnish materials from the Department’s Qualified Products List (QPL) conforming to the following:

Castings.....	721.01
Prismatic retroreflectors (reflectors).....	721.02
Casting adhesive.....	721.03
Reflector adhesive.....	721.04

Before installation, a sample of the products to be used on the project shall be verified to be on the Qualified Products List (QPL) by the Engineer. After completion of the work, a spot check of the castings and retroreflectors is required to verify products used are on the QPL.

**621.03 Layout.** Before placing RPMs, lay out the location of all RPMs. Locate RPMs within 5 percent of specified spacing. Do not place RPMs under the following conditions:

- A. On pavement surfaces with cracking, spalling, or failure of underlying base material.
- B. Within 1 foot (0.3 m) of active signal detector loop wires. Exercise care to ensure that detector lead-in cables are not cut.
- C. Over pavement markings except with the Engineer’s approval.
- D. Closer than 2 inches (50 mm) to a pavement construction (transverse or longitudinal) joint or within an intersection.
- E. Within 3 feet (1 m) of a bridge expansion joint.

If the initial location of a RPM is determined to violate one of the aforementioned conditions, relocate the affected RPM longitudinally. Relocate the RPM within a distance not exceeding 25 percent of the specified RPM spacing. If necessary to relocate the RPM to a distance greater than 25 percent of the specified RPM spacing, do not install the affected RPM.

RPMs along double yellow centerline are to be placed in line or on line, but no closer than 2” (50 mm) to a pavement construction (transverse or longitudinal) joint. RPMs installed along a channelizing line are to be placed no more than 1 inch (25 mm) from the edge of the painted line and no closer than 2” (50 mm) to a pavement construction (transverse or longitudinal) joint. Place the RPMs installed along a lane line or dashed yellow centerline between and in line with the dashes no closer than 2” (50 mm) to a pavement construction (transverse or longitudinal) joint.

Install replacement RPMs within 3 feet (0.9 m) longitudinally of the damaged or missing RPM.

**621.04 Installation RPM Casting.** Cut parallel slots with 1/16” to 1/8” (1.5 mm to 3 mm) clearance on each side for installing RPM castings.

Pavement cuts should be inspected prior to adding casting adhesive.

When a casting is inserted in the cut without casting adhesive to test proper cut, at least 3 of the 4 leveling lugs/tabs must contact the pavement surface and all four keel-ends of castings must be below the pavement surface.

Each casting must be centered lengthwise and should have 1/16" to 1/8" (1.5 mm to 3 mm) clearance between pavement cut and casting for casting adhesive to bond properly. Only the leveling lugs/tabs should be in contact with the pavement surface after insertion of casting in pavement so that a minimum of 1/16" (1.5 mm) of casting adhesive is the bonding adhesive between the casting and pavement. The casting adhesive must fill all voids.

The pavement cut must be completely dry and free of dust, dirt or any other material that will interfere with the adhesive bond to the casting and the pavement. Casting adhesive on the active reflector face must be removed immediately.

Install the RPM casting within 24 hours after cutting the slots into the pavement. On new pavement surfaces, the Contractor may begin RPM placement as soon as the pavement markings for that section are completed and dry.

Ensure that the RPM casting is free of dirt, dust, oil, grease, rust, moisture, or any foreign matter that impairs adhesion to the pavement.

Place RPMs when the pavement surface temperature and the ambient air temperature are at least 40 °F (5 °C) and the pavement is dry. Heat both parts of the RPM casting adhesive to 100 ± 10 °F (38 ± 5 °C) during installation when either the pavement surface or ambient air temperature is between 40 and 50 °F (5 and 10 °C).

Ambient Air Temperature		Minimum Period Protected from Traffic
°F	(°C)	Minutes
100	(38)	15
90	(32)	20
80	(27)	25
70	(21)	30
60	(16)	35
50	(10)	45
40	(5)	60

Do not allow traffic on the RPMs until the adhesive has cured.

Two component approved casting adhesive is used to fill the pavement cut to within approximately 3/8" (9 mm) of the top of the pavement cut. A minimum of 3 of the 4 leveling lugs/tabs must be in contact with the pavement surface and the casting adhesive should ooze out from under the casting from all sides filling all voids around the casting and be level with the pavement surface.

Mix the casting adhesive according to the manufacturer's recommendations. Complete the mixing operation and placing of the RPMs rapidly. Do not use any mixed batch that becomes so viscous that it cannot be readily extruded from under the RPM with light pressure.

## 621.05

**621.05 Installation RPM Retroreflector** Attach the reflector to the casting before installation or after the adhesive in the pavement slots has cured.

Remove all dirt, dust, oil, grease, rust, moisture, parts of damaged reflectors, or any foreign matter that impairs adhesion of the reflector to the casting.

Peel the release liner from the back of the reflector with butyl pad. Apply a wide bead (approximately 3/8" [9 mm] ) of an ODOT approved reflector adhesive sufficient to squeeze out on all sides when pressure is applied to seat the reflector.

Apply approximately 100 pounds (45 kg) of pressure on the reflector or foot pressure for 1 to 3 seconds. Do not allow adhesive material on the reflective surface of the reflector. Any adhesive on the active reflector must be removed immediately.

Apply the reflector when the pavement surface temperature and the ambient air temperature are at least 35 °F (2 °C) and the casting surface is dry. Do not attach the reflector to the casting when rain over the work site is imminent.

**621.06 Reflector Replacement.** Replace damaged, non-retroreflective, or missing reflectors within the existing marker installations where the casting remains intact with the appropriate reflector type. The Engineer will determine the location of replacement reflectors.

Perform the cleaning and attachment procedure for replacing reflectors within existing RPM installations according to 621.05.

**621.07 Reflector Color.** Use the appropriate reflector color for the following applications:

- A. Channelizing Lines.** White/red two-way reflectors with white facing traffic.
- B. Lane Lines.** White one-way or white/red two-way reflectors as specified, with white facing traffic.
- C. Edge Lines.** One-way reflectors facing traffic matching the edge line color or two-way reflectors with the edge line color facing traffic and red in the opposite direction.
- D. Center Lines.** Yellow two-way reflectors.

**621.08 Raised Pavement Markers Removed** As designated, remove existing raised pavement markers. Fill all depressions caused by removing the castings with asphalt concrete by the end of the next workday. Remove all standing water from the hole before filling. Compact the asphalt concrete flush with the pavement. Removed raised pavement markers become the property of the Contractor.

**621.09 Method of Measurement.** The Department will measure RPMs by the number of each furnished, complete with reflectors, in place, and accepted.

The Department will measure RPM, Reflectors by the number of each, complete in place, for use on existing RPM castings in the pavement, and accepted.

The Department will measure Raised Pavement Markers Removed by the number. Payment will include the cost of asphalt concrete to fill depressions caused by removal of the castings.

**621.10 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
621	Each	RPM
621	Each	RPM Reflector
621	Each	Raised Pavement Marker Removed

## ITEM 622 CONCRETE BARRIER

### 622.01 Description

### 622.02 Materials

### 622.03 Placing Concrete

### 622.04 Portable Concrete Barrier

### 622.05 Joints

### 622.06 Finish

### 622.07 Curing

### 622.08 Method of Measurement

### 622.09 Basis of Payment

**622.01 Description.** This work consists of furnishing and placing portland cement concrete barrier on the accepted and prepared subgrade, subbase course, or existing pavement. This item also consists of furnishing, placing, maintaining, and removing portable concrete barrier.

**622.02 Materials.** Furnish materials conforming to:

Concrete, Class C.....	499
Reinforcing steel and wire fabric .....	509.02
Forms .....	515.14
Preformed filler .....	705.03
Curing materials.....	705.05, 705.06,
.....	or 705.07 Type 2
Precast concrete .....	706.13
Dowel bars.....	709.01 thru 709.05
Steel.....	711.01

**622.03 Placing Concrete.** Construct concrete barrier by cast-in-place, precast, or slip-form methods. For slip-form construction, conform to 609.04.C.

**622.04 Portable Concrete Barrier.** Furnish individual sections not less than 10 feet (3 m) long. If intending to use the barrier at one location on the project, the Contractor may slip-form barriers in place without joints, or with grooved or sawed joints to facilitate removal. As directed by the Engineer, repair or replace barrier sections damaged during handling or by traffic, for the life of the project.

**622.05 Joints.** Construct joints for cast-in-place or slip-formed barrier of the type and dimensions and at the locations specified.

## 622.06

**A. Contraction Joints.** The Contractor may construct unsealed contraction joints by either sawing, using metal inserts inside the forms, using a grooving tool, or using full-width 3/4-inch (19 mm) thick preformed joint filler conforming to 705.03. Make joints that are sawed, tooled, or formed by inserts a minimum of 1/8 inch (3 mm) wide and 3 inches (75 mm) deep. Saw joints as soon as curing allows sawing to the required depth with minimal spalling of the concrete surface.

**B. Expansion Joints.** Use 3/4-inch (19 mm) preformed joint filler conforming to 705.03 to construct expansion joints at the centerline of and around each bridge pier column and on either side of each sign support foundation.

**C. Horizontal Construction Joints.** If and as shown on the plans, the Contractor may place horizontal construction joints.

**622.06 Finish.** Immediately following removal of fixed forms or slip-form construction, check the surface of the barrier with a straightedge and correct all irregularities of more than 1/4 inch in 10 feet (6 mm in 3 m). Finish and make corrections to the barrier surface according to 511.18.

**622.07 Curing.** Cure concrete according to 511.17, Method B and the following additional requirements. Apply the curing compound using an approved mechanical sprayer equipped with a shield to protect the spray from wind. For small areas, the Engineer will allow the use of other acceptable methods.

Do not apply any load or conduct any work that will damage newly placed concrete. Allow a minimum of 36 hours of cure time to elapse on any concrete placed first at a horizontal construction joint. The Contractor may cure precast sections according to 515.15. With the Engineer's approval, the Contractor may also use radiant heated forms for curing.

The Contractor may use 511.17, Method A for curing of short sections of barrier (leave-outs); however, before the curing is completed for any leave-outs, apply material conforming to 705.07, Type 2 at the normal rate specified in 511.17, Method B.

The Contractor may cure horizontal construction joints between the foundation and the upper portion of the barrier, and between portions of the upper barrier placed separately according to 511.17, Method A or B. Do not remove the membrane before placing the next portion of the concrete barrier.

**622.08 Method of Measurement.** The Department will measure Concrete Barrier by the number of feet (meters) along the centerline of the top of the barrier, including all transitions, end terminals, and bridge pier sections as specified, complete in place.

The Department will measure Portable Concrete Barrier and Portable Concrete Barrier, Bridge Mounted by the number of feet (meters) for each application of the barrier placed according to the plans. The Department will measure each re-use of barrier sections at a different location required by the plans separately.

The Department will not measure repaired or replacement barrier sections damaged during handling or by traffic.

**622.09 Basis of Payment.** The cost of all inserts, sleeves, fittings, connectors, reinforcement, dowels, preformed filler, excavation, and backfill is incidental to these items.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
622	Foot (Meter)	Concrete Barrier, Type ____
622	Foot (Meter)	Portable Concrete Barrier, ____" (____ mm)
622	Foot (Meter)	Portable Concrete Barrier, ____" (____ mm) Bridge Mounted

## ITEM 623 CONSTRUCTION LAYOUT STAKES

### 623.01 Description

### 623.02 General

### 623.03 Basis of Payment

**623.01 Description.** This work consists of furnishing, placing, and maintaining construction layout stakes necessary for the proper prosecution of the work under the contract and removing all stakes at the completion of the project.

**623.02 General.** The Department will locate and reference to either strategically placed Project Control Monuments and Project Geometric Layout Coordinate data or Centerline of Construction points with 3 point reference ties as shown in the plans. The Department will establish benchmarks along the line of the improvement outside construction limits. The Department will establish one benchmark for use at each structure with a span greater than 20 feet (6.1 m). The Department will not locate the centerline of short street intersection returns. Locating and referencing the centerline consists of locating and referencing control points such as point of curve, point of tangent, and sufficient points on tangent to provide a line of sight. Establish reference points outside the construction limits in such a manner that they will be available to reestablish the control points at any time during the course of the work. The Engineer will identify to the Contractor control points set by the Department and will keep the field notes in the field office.

Furnish field forces and set all additional stakes for the project, including interchanges, that are needed to establish offset stakes, reference points, slope stakes, pavement and curb line and grade, stakes for bridges, culverts, sewers and drainage structures, paved gutters, walls, monuments, fence, Right-of-Way lines, and any other horizontal or vertical controls, including supplementary benchmarks, necessary to secure a correct layout of the work. Determine the location of slope stakes for grading work by a calculation method, and make a copy of these calculations available to the Engineer for the project records. Set stakes for the line and grade of pavement and curb at sufficient station intervals but not exceeding 50 feet (20 m) to ensure conformance to plan line and grade. Staking of Right-of-Way lines consists of placing tall stakes, properly identified and readily discernible, at points of change in width or direction of the Right-of-Way line and

**623.03**

at points along the line so that at least two of the stakes can be seen distinctly from any point on the line. Before beginning construction, stake Right-of-Way lines at locations where construction is to be performed. The Engineer will not require the Contractor to set additional stakes to locate a utility line that is not included as a pay item in the Contract, or to determine the property line between the properties.

The Contractor may elect to perform portions of this work by electronic methods. Submit a plan of action to the Engineer detailing the means and methods to produce the desired results. After the plan of action is approved, layout the first 1000 feet (300 m) of the project by conventional methods. The Department will evaluate the first 1000 feet (300 m) using electronic methods to verify the accuracy of the equipment. Ensure that the accuracy of the electronic methods are within 2 percent of the conventional methods.

Once the accuracy of the electronic methods is established, use the conventional methods to set every 1000 feet (300 m) of the project measured along the centerline. A ground control point is required for every structure, and a print out of the work is required for every 200 feet (60 m) of the project.

If the electronic methods are found to be out of the above tolerance, submit a plan of action to correct the problem. If the problem persists, return to conventional methods.

The Contractor is responsible for having the finished Work conform to the lines, grades, elevations, and dimensions shown on the plans. Any inspection or checking of the Contractor’s layout by the Engineer and the acceptance of all or any part of it does not relieve the Contractor of the responsibility to secure the proper dimensions, grades, and elevations of the several parts of the work. Exercise care in the preservation of stakes and benchmarks, and reset them at no additional cost to the Department when any are damaged, lost, displaced, or removed. Use competent personnel and suitable equipment for the layout work required and that a Registered Engineer or a Registered Surveyor supervises the operation. Do not engage the services of any person or persons employed by the Department for the performance of any of the work covered by this specification.

Verify survey information shown on the plans, except for the centerline of the project, which may be use to lay out the Work.

The removal of layout stakes at the completion of the Work is a final cleanup item that is required as a condition of full payment of 624 Mobilization.

**623.03 Basis of Payment.** The Department will pay for accepted quantities at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
623	Lump Sum	Construction Layout Stakes

**ITEM 624 MOBILIZATION**

**624.01 Description**

**624.02 Limitation**

**624.03 Method of Measurement****624.04 Basis of Payment**

**624.01 Description.** This work consists of the preparatory work and operations including, but not limited to, those necessary for the movement of personnel, equipment, supplies, and incidentals to the project site; for the establishment of all field offices, buildings, and other facilities necessary for work on the project; for all other work and operations that must be performed or costs incurred before beginning the Work on the other contract items; and for demobilization.

If Mobilization is not included as a pay item in the Contract, the Department will not pay for this work separately but will consider it incidental to the other Contract Items.

**624.02 Limitation.** The Department will limit the sum of the partial payments specified in 624.04.A and 624.04.B to the amounts shown in Table 624.02-1 under "Maximum Total of Partial Payments". The Department will pay the balance of the lump sum amount bid, as specified in 624.04.C.

<b>Total Contract Amount</b>		<b>Maximum Total of Partial Payments</b>
<b>More than</b>	<b>Up to, inclusive</b>	
(\$)	(\$)	(\$)
0	50,000	0
50,000	100,000	2,000
100,000	200,000	4,000
200,000	500,000	10,000
500,000	1,000,000	20,000
1,000,000	2,000,000	40,000
2,000,000	5,000,000	100,000
5,000,000	10,000,000	200,000
10,000,000	20,000,000	400,000
20,000,000	40,000,000	800,000
40,000,000	60,000,000	1,200,000
60,000,000	80,000,000	1,600,000
80,000,000	--	2,000,000

If the lump sum amount bid for Mobilization exceeds the total shown in Table 624.02-1 for partial payments, the Department will pay the excess upon completion of the project.

**624.03 Method of Measurement.** The Department will measure Mobilization as a unit, acceptably performed.

**624.04 Basis of Payment.** The Department will make partial payments according to 109.09 and as modified by the following schedule:

A. The Department will release 50 percent of the lump sum amount bid for Mobilization or 50 percent of the amount shown in 624.02, whichever is less, to

**624.04**

the Contractor with the first estimate payable, but not sooner than 15 days after the start of work at the project site.

B. The Department will release an additional 40 percent of the lump sum amount bid for Mobilization or 40 percent of the amount shown in 624.02, whichever is less, with the first regular estimate after 10 percent of the original total contract amount, including payments for delivered materials but excluding Mobilization, is earned.

C. Upon completion of all work on the project, including final cleanup, the Department will release payment of the remaining 10 percent of the lump sum amount bid for Mobilization and any amount of the lump sum price bid for Mobilization, in excess of the total amount shown in 624.02 for partial payment. Final cleanup includes but is not limited to the removal of layout stakes installed under Item 623 and as Directed by the Engineer, sediment and erosion control items installed under Item 207.

The Department will pay for accepted quantities at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
624	Lump Sum	Mobilization

**ITEM 625 HIGHWAY LIGHTING**

- 625.01 Description**
- 625.02 Definitions**
- 625.03 Codes**
- 625.04 Permits**
- 625.05 Materials**
- 625.06 Working Plans**
- 625.07 Incidentals**
- 625.08 Luminaires**
- 625.09 Luminaire Supports**
- 625.10 Foundations**
- 625.11 Junction Boxes (Handholes) & Pull Boxes (Manholes)**
- 625.12 Raceways and Conduits**
- 625.13 Trenching**
- 625.14 Jacking or Boring**
- 625.15 Power Service(Control Equipment)**
- 625.16 Grounding**
- 625.17 Wiring and Cabling**
- 625.18 Connections**
- 625.19 Testing of Installations**
- 625.20 Plastic Caution Tape**
- 625.21 Removal of Lighting Equipment**
- 625.22 Method of Measurement**
- 625.23 Basis of Payment**

**625.01 Description.** This work consists of furnishing and installing highway lighting equipment complete and ready for service. This work shall also include necessary excavation and backfill, disposal of discarded materials, restoration of disturbed facilities and surfaces, and testing as specified.

**625.02 Definitions.** Lighting terminology herein is defined in the American National Standard Practice for Roadway Lighting.

**625.03 Codes.** Follow the National Electrical Code, The National Electrical Safety Code and local codes where applicable.

**625.04 Permits.** Obtain all permits required as an incidental to the construction of the lighting installation.

**625.05 Materials.** Furnish materials conforming to:

Concrete .....	499, 511
Reinforcing steel .....	509.02
Sand .....	703.06
Cable .....	725.02
Unit type duct-cable systems .....	725.03
Conduit .....	725.04, 725.051, 725.052
Pull boxes.....	725.06, 725.07, 725.08, 725.12
Junction boxes.....	725.10
Luminaires .....	725.11
Lamps .....	725.11
Cable connectors and connector kits.....	725.15
Cable splicing kits.....	725.15
Ground rods .....	725.16
Power service components.....	725.19
Wood service poles .....	725.19
Multiple cell conduit.....	725.20
Anchor bolts and nuts .....	725.21
Light poles .....	725.21
Light towers .....	725.21
Portable power units.....	725.21
Plastic caution tape.....	725.22

**625.06 Working Drawings.** Submit, to the Engineer prior to incorporation, two copies of the shop drawings and catalog cuts which identify and describe each manufactured item which is being incorporated into the construction. Certify in writing that each manufactured item is in conformance with all contract requirements for that item. Ensure that the documents describing each item indicate the project number (including the construction year) and the bid reference number under which the item is being installed and that the documentation contains all of the information needed to allow the Engineer to determine that the item to be supplied meets all applicable requirements along with all of the information needed by the maintaining agency to obtain an identical replacement unit from the manufacturer. When a given item is to be incorporated into the construction under multiple bid item reference numbers, furnish a separate and complete documentation package for each bid item reference number under which

## 625.07

the item is to be installed. When multiple items are to be incorporated under a single bid reference number, submit the documentation for all such items together.

**625.07 Incidentals.** Furnish and install all incidentals necessary to provide a complete and practical working unit or system.

**625.08 Luminaires.** A luminaire consists of a housing with a lamp, a lamp socket, the optical components to direct the output from that lamp, and the electrical components needed to operate the lamp.

Ensure that luminaires of the same type (i.e. high mast, low mast, conventional, underpass, post top, etc) in a given installation (i.e. interchange, rest area, weigh station, etc.) are of the same brand.

Align each luminaire vertically and horizontally to the roadway as specified. Where the profile grade exceeds 4 percent and the luminaire is mounted less than 60 feet (18 m) above the roadway, adjust the luminaire to be perpendicular to the roadway rather than gravimetric level.

At the locations designated in the plans or as directed by the Engineer, furnish and install glare shields obtained from the manufacturer of the luminaire

After all other work has been completed, clean the reflector, refractor and other components of the optical assembly just prior to leaving the job.

**625.09 Luminaire Supports.** Luminaire supports fall into three categories: bracket, light pole, light tower.

A bracket is the attaching hardware used to mount a luminaire onto the face of a wall or pier cap, or hang a luminaire from the bottom of a deck or beam or other similar installation. A bracket is often supplied for the luminaire by the luminaire manufacturer to facilitate the installation of the luminaire. A more complex situation will require extensive work to fabricate a bracket for the situation.

A light pole is the pole with one or more fixed brackets or arms for supporting luminaires above the roadway to be lighted. A light pole also includes a lower portion of the pole which is embedded or a mounting plate, any base for housing components or wiring, and when specified a breakaway device such as a frangible base, frangible couplings or slip plates.

A light tower is a shaft with a base plate, head frame, ring or similar structure on which one or more luminaires are mounted with a mechanism for lowering the mounting ring and luminaires for servicing and a lightning protection system.

Ensure that luminaire supports of the same type (i.e. high mast, low mast, conventional, underpass, post top, etc) in a given installation (i.e. interchange, rest area, weigh station, etc.) are of the same brand.

Plumb each light pole and each light tower. When shims are used, use only shims of an approved design and installed in an approved manner. Do not install more than the minimum number needed to plumb the pole and neither exceed the maximum allowed total thickness of the shim pack nor the maximum number of shims permitted. When leveling nuts are used, ensure that such nuts are installed in approved locations and that both the anchor and the leveling nuts are properly tightened.

Ensure that the grounding connections for each light pole or light tower have been made and that the resultant ground is within the earth resistance limit specified

Apply a suitable lubricant to prevent seizing to each cover fastener and install all such fasteners.

After erection, the Engineer shall inspect each pole for defects in the surfaces and determine for each defect discovered whether the defect is minor enough that the Contractor may be allowed to field repair the finish or major enough that the Contractor must replace the pole. Make finish repairs and provide and install replacement poles as directed by the Engineer for no additional charge to the project.

Label each light pole and light tower with the alpha numeric identifier. Place the identifier on the quadrant of the surface of the pole that faces oncoming traffic at approximately 7 feet (2 meters) above the roadway surface. Apply the identifier letters and numerals when the ambient air temperature, the temperature of the labeling material and the temperature of the surface to which the labels are applied are all above 40° F (4° C). Identification of the light poles or light towers and the removal of any previous such identifier in the case of light poles or light towers being reassigned shall be considered as incidental work.

**625.10 Foundations.** Excavate for each foundation to the dimensions given.

If a cave in should occur during excavation, excavating using casing, sleeving or other methods may continue with the approval of the Engineer.

Where, in the opinion of the Engineer, the excavation for a foundation has revealed an unstable condition at the bottom of the excavation, drill the foundation shaft deeper, enlarge the diameter of the drilled shaft, or make other modification to the foundation as directed by the Engineer who shall initiate the appropriate arrangements to compensate the Contractor for the addition work required.

When rock is encountered, continue excavation to a minimum of 3 feet (1 meter) into rock. The Engineer may then decrease the total depth of the foundation to not less than 6 feet (2 meters) for a light pole or 10 feet (3 meters) for a light tower.

Reinforce each foundation with steel as specified and such steel reinforcing shall be placed in accordance with 509.

Install the anchor bolts for the light pole or light tower in each foundation using anchor bolt setting templates.

Place Class C concrete for the foundation in accordance with 511 except that forms will not be required for portions of foundations extending more than 6 inches (150 mm) below the ground line, unless the soil does not have sufficient stability to stay in place during the placing of the concrete.

Finish the top of each foundation smooth and level.

After forms have been removed, backfill the excavated spaces around each foundation with suitable material placed and tamped in thin layers as directed by the Engineer.

### 625.11 Junctions Boxes (Handholes) & Pull Boxes (Manholes).

Furnish and install a junction box of the size and type specified. Furnish each junction box embedded in concrete with a drain. Lubricate each cover screw with a compound to prevent the screw from seizing and install all cover screws.

Furnish and install a pull box of the size and type specified. Excavate for each pull box as nearly as practicable to the outside dimensions of the pull box. Install a 6 inch (150 mm) gravel base with a 4 inch (100 mm) underdrain to a suitable outlet below each pull box. After setting the pull box to proper grade, backfill the excavated spaces around the pull box with suitable material placed and thoroughly tamped in thin layers.

When a pull box is to be installed in a paved area, remove an adequate area of the paving by saw cutting the sides of the area to be removed, or by removal of the paving back to an expansion joint as instructed by the Engineer. After setting the pull box to proper grade, backfill the excavated spaces around the pull box with suitable material placed and thoroughly tamped in thin layers, and restore the pavement base and paving to match the surround.

Metal pull box lids shall be bonded by attachment of the equipment grounding conductor to the frame diagonal.

**625.12 Raceways and Conduits.** Furnish and install conduit of the sizes and types specified. When the location, type or size of a conduit has not been indicated, submit to the Engineer working drawings showing the location and size and type of each such conduit along with the number and size of wires contained in each such conduit and secure the approval of the Engineer prior to installing the conduit.

When not otherwise specified, all conduit and fittings on an individual run of conduit shall be of the same material except for approved manufactured transition fittings required at end of the run when the item into which the conduit terminates is not of the same material as the conduit.

Install each conduit with a minimum amount of bending and ensure that the total bending between adjacent access points (junction boxes, pull boxes, light poles, control equipment enclosures, etc.) does not exceed 270 degrees. Do not bend any conduit to a bend radius of less than 12 times the internal diameter of the conduit. Bend each conduit in such a manner as to avoid damage to the conduit and any protective coating and such that the internal diameter of the conduit will not be reduced.

Remove the rough edges from the cut end of each conduit. In addition, ream the cut end of each metallic conduit. Bush each end of each conduit to further protect the wire insulation and cable jackets from damage.

Where threads have been cut onto ferrous metallic conduit after galvanizing, paint the threaded area with an electrical conductive paint in such a manner that there will be no unprotected surfaces.

Make each conduit joint tight to provide structural integrity in all conduits and to electrically bond the jointed sections of metallic conduit. Provide an equipment

grounding conductor that is not in a jacketed cable assembly in metallic conduits when not otherwise available and bond the conduit to this grounding conductor.

Securely fasten onto or build into the structure each conduit.

Install the appropriate expansion or deflection joint in each conduit at all locations where movement must be accommodated (such as expansion joints on structures) and install suitable bonding to assure electrical continuity of the grounding system.

Bond all metallic items enclosing electrical conductors together and to good earth ground.

Furnish each enclosure, junction box, pull box and conduit with a drain. When the low point of a conduit does not occur at a drained access point, install a T coupling at the low point of the run and route the side outlet to drain.

Where underground conduits are to be encased in concrete, use Class C concrete and furnish a minimum of 3 inches (75 mm) of concrete on all sides using spacers.

After installation of the conduit and prior to installing the cables, run a mandrel whose diameter is at least 90% of the interior diameter of the conduit through the conduit.

If a conduit is to remain empty upon completion of the project, leave a 10 AWG copper clad, aluminum clad or galvanized pull wire in the conduit and cap the ends in an approved manner.

Temporarily seal the ends of a conduit immediately after placement of conduit when the conductors or cable cannot be installed promptly.

After installing the wire or cable, seal the end of a conduit entering the base of a signal pole, sign support, light pole, a light tower or a pad mounted equipment enclosure through the foundation.

**625.13 Trenching.** Follow the routing shown on the plan. Keep the trench within 6 inches (150 mm) of the designated line where the trench is adjacent to and parallel with a curb or pavement.

In unpaved areas, a plow may be used in lieu of trenching with the approval of the Engineer. Use a machine that can install the duct uniformly at the specified depth without stretching or abrading the duct and which leaves a narrow self closing slit which presents no significant hazard during the self closing period.

In unpaved areas, make the trench a minimum of 2 feet (0.6 m) deep and not more than 12 inches (300 mm) in width. Backfill the trench in layers not more than 4 inches (100 mm) in loose depth and compact each layer with a mechanical tamper or other approved method as directed by the Engineer. Use suitable soil to backfill a trench in earth. Use granular material to backfill a trench in an aggregate. Ensure that the backfill material around and in the first 4 inches (100 mm) above the top of unit type duct cable not encased in concrete is sand or earth with no stones larger than 1/2 inch (13 mm).

## 625.14

In paved areas, either make a slit or T type trench. Cut the pavement along existing joints or grooves where possible. Mark the pavement with cut lines and secure the Engineer's approval of the location of the cut before cutting the pavement.

**625.14 Jacking and Boring.** In addition to the requirements of 625.12 to furnish and install conduit, use jacking or horizontal boring when the plan calls for such methods to be used. Use these methods in lieu of trenching only with the approval of the Engineer.

Jack only rigid galvanized steel conduit. Use only a machine designed for jacking conduit not the bucket or blade of a machine designed for earthwork.

Horizontal boring may be used to install any conduit or duct which has the adequate strength, flexibility and joints to withstand the process. Make the diameter of the bore no more than 5 percent larger than the outside diameter of the conduit or duct being installed.

**625.15 Power Service.** Furnish and install all equipment necessary to provide a complete electrical service to the roadway lighting facilities.

The power service equipment includes, but is not necessarily limited to: poles or other support structure for the mounting of the equipment, hardware for dead ending an overhead service drop or trench and conduit for receiving an underground service line, lightning arrestor when required, meter base, customer service disconnect, magnetically held lighting contactor, photoelectric cell and Hand-Off-Automatic switch for control of contactor, over current protection devices for each individual lighting circuit, enclosures, conduits, fittings, cables and connectors.

If the power service has multiple enclosures, mark each enclosure in white letters engraved on a black plastic placard with the function of the equipment contained therein such as "SERVICE DISCONNECT", "LIGHTING CONTACTOR", "LIGHTING PANEL", or other appropriate designation.

When an apparatus enclosure contains circuits above the 600 volt class, mark the enclosure in white letters on a red plastic placard with the warning "DANGER-HIGH VOLTAGE" on each enclosure door.

Install each photoelectric cell facing North unless the Engineer directs that a specific cell face otherwise to reduce interference from surround lighting.

Bond all metallic portions of the supporting structure, equipment housings and conduits properly and to an adequate earth ground.

Install a wood or plastic wire moldings from grade to 3 feet (1 meter) above grade over any grounding cables installed on a wood pole.

Coordinate and cooperate with the power company in the making of the connections to establish electrical service. Charges made by the power company for establishing of the account, extension of company facilities, connection of customer equipment to the power company facilities and energy will be borne by the maintaining agency.

**625.16 Grounding.** Connect each light pole or light tower to a local earth ground.

Connect each power service to a local earth ground.

Provide continuity of grounding by bonding the metallic portions of fixtures, apparatus enclosures, supports, conduits, raceways, junction boxes and pull boxes together and connecting to earth ground. At a light pole or a light tower, install a bonding cable between the grounding bushing on each metal conduit and the ground lug or bolt in the pole base. At a junction box or a pull box, install a grounding bushing on each metallic conduit not bonded to the box through the conduit connector, and install a bonding cable between the grounding bushings on the conduits and the ground lug or bolt in the box.

For a light pole, light tower, power service or other such item mounted independently, install one or more grounding electrodes.

For a luminaire, light pole, light tower, switch enclosure, or other such item mounted in or on major highway structures (i.e. bridges), connect the item to the structure grounding system.

For a lighting contactor, lighting circuit panel or other such item mounted in a building (i.e. motorists services building, weigh station scale house, etc.), connect the item to the grounding system provided for the building.

For each bridge, wall, or other structure having electrical elements contained therein or attached thereto, furnish all materials necessary including grounding electrodes and install a complete structure grounding system to bond all exposed metallic portions of the structure (i.e. beams, railings, etc.) electrically together and connect those items to good earth ground. In the case where structures are separate but adjacent, connect the multiple structures together to avoid any difference in earth potential between the structures.

Make the permanent connection between the each ground rod and the grounding conductor by exothermic welding.

If the earth resistance measurement exceeds 10 ohms for a ground for a traffic signal controller or a light tower or 25 ohms for any other ground, install a second ground rod at least 20 feet (3 meters) from the first and temporarily connect the second rod to the first. If the earth resistance still exceeds the above specified values, permanently connect the first two rods using the same type of cable used for the grounding conductor and continue to add rods one at a time as directed by the Engineer.

Where rock does not permit the driving of ground rods, develop an earth connection by constructing a grid from the partially driven rods supplemented by buried bare cable as directed by the Engineer.

**625.17 Wiring and Cabling.** Furnish and install electrical wires and cables of the types and sizes required with no in-line splices between terminations at devices unless specifically called for by the plan or directed by the Engineer.

Install wire mesh cable grips on vertical runs of wire or cable in poles and attach said grips to the "J" hook at the tops of the poles in such a manner as to

## 625.18

prevent the weight of the vertical run from abrading the wire insulation or cable jacket where the wire or cable passes into or from the pole.

Identify all wires and cables, except bare ground bonding cables, as to circuit and function with tags or bands in the base of each light pole or light tower, each junction box or pull box, each apparatus cabinet, and other similar locations.

Pay out each wire, cable and duct cable by “unwinding” it from the shipping reel, spool or coils and not allow the wire cable or duct-cable to “spiral” from off the side of the spool reel or coil. In addition when wire cable or duct cable is being placed in trench, move the reel spool or coil along the side of the trench to allow the wire or cable to pay out into the trench as directly as practical. Seal the ends of each run of duct cable in the same manner as conduit as each run is installed.

Do not install duct cable when the temperature of the duct-cable cannot be kept above 32° F (0° C) except with the permission of the Engineer.

If the end of a wire or cable or duct must stand exposed to the elements or construction activities, protect said exposed end by enclosing it in a plastic bag or wrapping it with tape until the termination or connection can be made.

**625.18 Connections.** Make each wire and cable connection above grade (i.e. bases of light poles or light towers, junction boxes on structure or in concrete barrier medians, etc.) with an approved cable connector kit. Use quick disconnect type kits in the base of each light pole with a fused type in each line or phase conductor. Plug unused line side wire opening in each connector kit installed in the base of the light pole at the outer end of a circuit.

Make each cable connection below grade (i.e. pull boxes, junction boxes in retaining walls, etc.) with a cable splicing kit.

Protect partially assembled connections from damage and the elements.

**625.19 Testing of Installations.** Furnish equipment and personnel to perform each test as an incidental to the construction of the lighting installation. The Engineer shall witness each test and judge the results.

**A. Equipment Calibration.** Submit to the Engineer the types, styles, or catalog numbers of all testing equipment to be used for such tests. Include a current Certificate of Calibration for each instrument showing that the instrument is in current calibration using standards traceable to The National Institute of Standards in accordance with the manufacturer's recommended process by a service center authorized by the manufacturer to calibrate the instrument. Certify and demonstrate to the satisfaction of the Engineer that the instrument has remained sealed since the calibration, and that the manufacturer's recommended process for ensuring that the instrument is in working order and producing valid results has been followed in conducting the test.

**B. Grounding Electrodes and Grounding Systems.** Furnish two certified copies of the completed test records to the Engineer on test reporting forms supplied to the Contractor by the Engineer or on alternate forms approved by the Engineer.

Measure the earth resistance in ohms of each ground immediately after it is installed and before the ground is attached to the item being grounded.

When the ground connection is by driven ground rods, measure each rod separately. In the event that a ground rod has a high resistance and additional rods are being added, measure the earth resistance of the combined group.

Measure a structure grounding system at each point where an exposed metallic item is to be connected to the system. Where driven ground rods are used as the electrodes of the structure grounding system, measure each ground rod separately prior to measuring the system.

Measure each ground grid at the each point where equipment is to be connected to the grid.

**C. Circuit Continuity.** Upon completion of each lighting circuit but prior to energizing the circuit, verify the continuity of each conductor of the lighting circuit from the power service to the load side socket in the line side of the quick disconnect connector kit in the base of each light pole and the line side of each disconnect switch at each light tower, lighted sign and underpass lighting system shall be verified. Demonstrate that there is no cross connection between the conductor being tested and any other conductor (including conductors for other circuits) or earth ground. Conduct this test by applying a low test voltage between the conductor under test and one of the companion conductors for the same circuit and demonstrating that the test voltage is available between only those two conductors at the power service; the load side socket in the line side of the quick disconnect connector kit in base of each light pole; and the line side of each disconnect switch for a light tower, a lighted sign or an underpass lighting system and repeating the process until all possible pairs have been so checked. Throughout this test, ensure that each disconnect switch is in the open position and that the load side of each connector kit is unplugged. Temporarily disconnect the grounded neutral conductor from earth ground and check all pairings involving the neutral after which again connect the neutral to earth ground and check all pairings, both those involving the neutral and those that do not.

**D. Cable Insulation.** After the continuity of a conductor has been verified, test the insulation of that conductor and its connections. Ensure that each disconnect switch is in the open position and that the load side of each quick disconnect connector kit is unplugged during this test. Temporarily disconnect a grounded neutral conductor from earth ground when it is being tested. In addition, when a grounded neutral is under test and the circuit utilizes local equipment earthing rather than a continuous equipment grounding back to the power service, temporarily connect one of the companion line conductors to provide the equivalent of the continuous equipment grounding cable.

When the circuit conductor is comprised of both new wire or cable and wire or cable installed prior to the current project, test the insulation by the megohmmeter method and the resistance of the conductor under test to earth ground or any other conductor shall exceed 10 megohms.

When the circuit conductor is comprised of entirely new wire or cable, test the insulation by the high potential method in accordance with Supplement 1003.

**E. Lowering Device Operation.** Demonstrate to the Engineer that lowering devices on any luminaire supports so equipped operate properly by lowering and raising the luminaire assembly through the full range of motion of the device for each device on two separate occasions at least 10 days apart. The Engineer shall record the dates of operation for each device and in case of failure the details of both the failure and the date and details of the correction. The Engineer will consider a particular unit satisfactory when the device has operated twice in succession on separate occasions without malfunction.

**F. System Performance.** Prior to acceptance and after all other tests are done, the completed lighting system shall be operated on electrical energy from the power company through the permanent customer service connection in its intended normal manner for ninety consecutive days. Notify the Engineer at least 3 days prior to the commencement of this performance test. In addition to the beginning and ending dates of the test period, the Engineer shall record the date and details of each failure and the date and details of the repair. The Engineer will consider the performance satisfactory when the lighting installation has operated for ninety consecutive days without a failure due to the workmanship of the Contractor.

**625.20 Plastic Caution Tape.** Install tape approximately 6 to 10 inches (150 to 250 mm) below the final finished grade. Place with the printed side up and parallel with the finished surface. Insure that the tape is not pulled, distorted or otherwise misplaced in completing the trench backfill.

#### **625.21 Removal of Lighting Equipment.**

**A. Luminaire Removal.** Remove the luminaire from its support taking care not to damage the luminaire, support or wiring connections. If the luminaire is to be reused within the same project, carefully store the luminaire on the project site. If the luminaire is to be reused, but not within the same project, carefully store the luminaire on the project site for pick up by the owner. If the luminaire is not to be reused, properly dispose of the luminaire off the project site.

**B. Luminaire Support Removal.** Remove the luminaire support taking care not to damage the luminaire support, foundation or structure to which it is attached or wiring connections. If the luminaire support is to be reused within the same project, carefully store the luminaire support on the project site. If the luminaire support is to be reused, but not within the same project, carefully store the luminaire support on the project site for pick up by the owner. If the luminaire support is not to be reused, properly dispose of the luminaire support off the project site.

**C. Luminaire Support Foundation Removal.** Remove the luminaire support foundation a minimum of one foot (0.3 m) below finished grade or clear of proposed construction, backfill the resultant depression with compacted soil and restore the disturbed area.

**D. Pull Box Removal.** Remove the pull box, properly dispose of it off the project site, backfill the resultant depression and restore the disturbed area.

**E. Disconnect Existing Circuit.** Disconnect the portion of the lighting circuit to be removed or abandoned from the portion of the circuit to remain in service at the

designated node point. Remove the cable from the link no longer to remain in service from the node point enclosure. Remove the conduit or duct for the link no longer in service from the node point enclosure and properly close the resultant openings in the enclosure unless the conduit or duct is to be left in place to allow another circuit link to enter the node enclosure.

**F. Power Service Removal.** Remove the existing power service equipment and properly dispose of the equipment off the project site. Equipment to be removed includes the wood pole or other supporting structure, foundation work pads, equipment enclosures, photoelectric cell and associated conduits, wiring, overhead or underground service lateral and all other appurtenances. Cut the cable enclosed in conduit which runs into the ground at the lower end of the bend to horizontal approximately 2 feet (0.6 m) below grade. Backfill the resultant depression and restore the disturbed area.

Coordinate with the power company to insure that the company disconnects the service and that items which belong to the power company that are removed, such as the meter base, are returned to the power company.

**625.22 Method of Measurement.** Bracket arms will be included with the light pole, light tower or combination support on which they are mounted for payment. However, when a bracket arm is to be mounted onto an existing support or a support provided by another aspect of the project, it may be a separate item for the purpose of payment in which case payment will be made for each bracket arm.

Transformer bases will be included with the light pole, light tower or combination support on which they are mounted for payment. However, when a transformer base is to be fitted to an existing light pole, it may be a separate item for the purpose of payment in which case payment will be made for each transformer base.

Light pole anchor bolts will be furnished with the light pole and the setting of the anchor bolts included with the foundation. However, in the case of a light pole mounted onto structures such as bridges and retaining walls where the bolts normally furnished with the light pole are not of the proper length and shape and/or the setting of the bolts must be done when the structure is constructed rather than being at the time of construction of the light pole foundation, the bolts shall be a separate item for payment in which case payment will be for each bolt with the count being the number of bolt ends projecting for the anchoring of the light pole. Separate payment shall also be made when the bolts are being set in a normal light pole or light tower foundation but the light pole or light tower is not being furnished by the Contractor or by others to the Contractor.

Foundations for light poles or light towers include excavation, reinforcing steel and, for light poles or light towers mounted on median barrier or retaining walls, the junction box at the point where the stub conduit to the light pole or tower joins the main lighting circuit raceway and the stub conduit from the junction box to the light pole or light tower. Anchor bolts, conduit ells and surface restoration not included elsewhere are also included with the foundation.

Junction boxes include the drain.

Pull boxes include the aggregate for base.

Power service includes the control equipment, the support and foundations on which the equipment is mounted, the pull boxes with underdrain for gathering the lighting circuits into the control equipment at the power service location, ground rods and incidentals required for a completed power service. Also included are any poles, conduits, wire and cable to be provided by the owner to receive the incoming power from the power company.

Structure grounding system includes any ground rods or ground grids required as part of the system.

Ground grids include any ground rods required as part of the grid and includes the associated grounding conductor and connections from the resultant grid to the first point (or points) of connection. Ground grids that result from the addition of ground rods as a result of earth ground resistance measurements will be the sum of each ground rod installed such sum will also include all connecting cable and trenching.

A ground rod includes the associated grounding conductor and connections from the rod to the first point of connection.

Trench will be measured to the center of a light pole foundation, the center of a light tower foundation, the center of a pull box, the center of the pole of an embedded pole mounted power service, the center of the foundation for a power service with a foundation, or the wall of the building when the power service for the lighting in, on or within the building with no allowance for elevation change. The payment for trench includes all excavation, granular and other backfill material, compaction, disposal of surplus materials and restoration to match surrounding surface including any seeding, sodding or other plantings which were disturbed and the replacement of any minor items such as guardrail or fence panels, and return to former position and mounting of items such as trash containers, planter boxes or parking meters and small signs which were temporarily moved to facilitate the trenching. The payment for trench in paved areas includes the aforementioned and in addition sawing and removal of pavement, along with the repaving over the trench. Trench in paved areas shall be separated for payment into Type A for pavements or sidewalks less than 6 inches (150 mm) thick and Type B for pavements 6 inches (150 mm) or greater.

Conduit will be measured to the center of a light pole foundation, the center of a light tower foundation, the center of a pull box, the center of the pole of an embedded pole mounted power service, the center of the foundation for a power service with a foundation, or the wall of the building when the power service for the lighting in, on or within the building with no allowance for elevation change. The payment for conduit includes couplings (plain, expansion, and alignment), bends, hubs, bushings, condulets and other such appurtenances but not junction boxes and pull boxes. Conduit to be encased in concrete or installed by jacking or boring will be paid separately from conduit to be traditionally installed. Concrete and other materials for encasement or the jacking or boring are included with such conduit where specified.

Distribution cable will be measured to the center of foundation, pull box, junction box or power service, plus an allowance of 5 feet (1.5 meters) on each end

except for a power service where the allowance will be 10 feet (3 meters) to allow for slack and connections with the sum multiplied by the number of conductors required.

Pole and bracket cable will be measured as the light pole support height plus the designated arm length with the sum multiplied by the number of conductors required. For twin arm poles the sum shall be increased by the length of the second arm plus the length of the first arm.

Duct cable will be measured to the center of foundation, pull box, junction box or power service, plus an allowance of 5 feet (1.5 meters) on each end except for a power service where the allowance will be 10 feet (3 meters) to allow for slack and connections with no multiplier for the number of conductors. Duct-cable includes the cable(s) and being a factory assembly is differentiated by the number and size of the conductors in each assembly.

Plastic caution tape will be measured to the center of a light pole foundation, the center of a light tower foundation, the center of a pull box, the center of the pole of an embedded pole mounted power service, the center of the foundation for a power service with a foundation, or the wall of the building when the power service for the lighting in, on or within the building with no allowance for elevation change.

**625.23 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
625	Each	Luminaire, (Functional Type), (Housing Size if Conventional), (Light Distribution), (Lamp Wattage), (Light Source), (Voltage)
625	Each	Glare Shield
625	Each	Light Pole, (Pole Style),(Design Number)
625	Each	Light Tower,(Design Number)
625	Each	Light Pole Anchor Bolts
625	Each	Light Pole Foundation
625	Each	Light Tower Foundation
625	Each	Junction Box,(Length X Height X Depth)
625	Each	Pull Box, (Material Type),(Length X Height X Depth)
625	Foot (Meter)	Conduit, (Material Type), (Nominal Diameter)
625	Foot (Meter)	Trench
625	Foot (Meter)	Trench in Paved Area,(Type)
625	Foot (Meter)	Conduit Jacked or Drilled,(Material Type), (Nominal Diameter)
625	Each	Power Service
625	Each	Ground Rod
625	Each	Ground Grid
625	Each	Structure Grounding System
625	Foot (Meter)	Pole and Bracket Cable,(Size of Conductors in AWG), (Voltage Rating)
625	Foot (Meter)	Distribution Cable,(Size of Conductors in AWG), (Voltage Rating)
625	Foot (Meter)	Duct Cable, (Duct Diameter) with

626.01

		(Number of Conductors), (Size of Conductors in AWG), (Voltage Rating) Conductors
625	Each	Connection
625	Each	Service to Underpass Lighting
625	Each	Portable Winch Drive Power Unit
625	Each	Luminaire Removed
625	Each	Luminaire Support Removed
625	Each	Luminaire Support Foundation Removed
625	Each	Pull Box Removed
625	Each	Disconnect Circuit
625	Each	Power Service Removed
625	Foot (Meter)	Plastic Caution Tape

**ITEM 626 BARRIER REFLECTORS**

**626.01 Description**

**626.02 Materials**

**626.03 Layout**

**626.04 Installation**

**626.05 Method of Measurement**

**626.06 Basis of Payment**

**626.01 Description.** This work consists of furnishing and installing barrier reflectors on guardrail blockouts, concrete barrier, retaining wall, and bridge parapets.

**626.02 Materials.** Furnish materials from the Department’s Qualified Products List (QPL) conforming to the following:

Barrier Reflectors ..... 720.04

Conform to the manufacturer’s recommendations for corrosion resistant fasteners, brackets, or adhesives.

Use barrier reflectors that are mountable on guardrail blockouts, concrete barriers, retaining walls, and bridge parapets. For wall or parapet mount, the barrier reflector may not extend further than 5 inches (125 mm) in a horizontal direction towards the traffic lanes.

**626.03 Layout.** Lay out all locations to ensure proper placement. The Engineer will approve the layout before installation of the reflectors.

Furnish reflectors at the beginning and the end of all barrier runs and at least one additional point evenly spaced between the termini. Space the reflectors at 100 feet (30 m) on tangents and on curves of less than 5 degrees (more than 350 m radius). Space the reflectors at 50 feet (15 m) for curves of greater than 5 degrees (350 m radius or less).

The Contractor may vary the spacing on tangents and curves of less than 5 degrees (more than 350 m radius) from 65 feet to 125 feet (20 m to 40 m) in the final 250 feet (80 m) to achieve even spacing of the reflectors.

If using a buffer end section or similar device on the end of the guardrail, place the first reflector so that it is visible to approaching traffic.

If tying guardrails, barriers, retaining walls, or bridge parapets together in a continuous run, use the total length of the run for determining the number and location of reflectors.

If installing a run of rail or barrier that is at varying distances from the edge of pavement, place a reflector where the run first approaches closest to the pavement. If this results in spacing greater than 125 feet (40 m), or 65 feet (20 m) in cases where 50-foot (15 m) standard spacing is required, install an additional reflector. If a non-reflectORIZED impact attenuator is in place, place an additional reflector on the face of the attenuator nearest to, and directed toward, approaching traffic.

**626.04 Installation.** Attach the reflector with a suitable corrosion resistant fastener or adhesive conforming to the manufacturer's recommendations.

On concrete barriers, retaining walls, and bridge parapets, place the top of the reflector so its height is 26 inches (650 mm) above the near edge of pavement, except that the top of the reflector is at least 3 inches (75 mm) below the top of the concrete barrier.

Install guardrail blockout reflectors on the side of the blockout away from traffic. Install guardrail blockout reflectors on the side of the blockout nearest the edge of pavement. Install the guardrail blockout reflector so that the reflective surface is above the guardrail.

Remove loose concrete, rust, dirt, and other loose material from the surface of the concrete barrier using a wire brush. Remove dust created by wire brushing before applying adhesive. Apply adhesive to clean and moisture-free surfaces according to the manufacturer's recommendations.

Ensure that the reflector face is clean and free of dust, dirt, adhesive, or any foreign material after installation.

Except if mounted on a guardrail blockout, rotate the reflective face of one-way reflectors upward from the vertical (or plumb) position 2 to 3 degrees to facilitate "rain washing" of the reflector face.

When replacing reflectors on a concrete surface, locate the new reflector approximately 3 inches (75 mm) horizontally in either direction from the old location.

If specified, use bi-directional reflectors (white/white) on the outside of curves on two-lane highways.

Use barrier reflectors that are the same color as the adjacent edge line.

The Department will classify the reflectors as follows:

<b>Mounting Location</b>	<b>One-Way</b>	<b>Bi-Directional</b>
Guardrail	Type A	Type A2
Concrete barrier, retaining walls, or bridge parapets	Type B	Type B2

**626.05 Method of Measurement.** The Department will measure Barrier Reflector by the number of each in place, completed and accepted.

If a bi-directional reflector consists of two one-way reflectors mounted back-to-back, the Department will measure it as one bi-directional reflector.

**626.06 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
626	Each	Barrier Reflector

**ITEM 630 TRAFFIC SIGNS AND SIGN SUPPORTS**

- 630.01 Description**
- 630.02 Materials**
- 630.03 Certified Drawings**
- 630.04 Sign Fabrication**
- 630.05 Foundations**
- 630.06 Sign Supports**
- 630.07 Sign Erection**
- 630.08 Sign Shipment and Storage**
- 630.09 Specific Service and Tourist-Oriented Directional Signs**
- 630.10 Covering of Signs**
- 630.12 Removal and Storage, Reerection, or Disposal of Signs and Supports**
- 630.13 Inspection**
- 630.14 Method of Measurement**
- 630.15 Basis of Payment**

**630.01 Description.** This work consists of furnishing and installing traffic signs, sign supports, and foundations complete and ready for service. This work also includes necessary excavation and backfill, disposal of discarded materials, and restoration of disturbed facilities and surfaces to a condition equal to that existing before this work started.

**630.02 Materials.** The acceptance of materials and products is based on Certified Test Data, furnished in triplicate, or on test results of samples according to 106.02, as required by the Laboratory.

Transfer manufacturers’ guarantees or warranties on all traffic sign material to the Department or other maintaining agency upon completion and acceptance of the project.

Furnish materials conforming to:

Concrete, Class C.....	499, 511
Steel:	
Structural steel .....	711.01
Reinforcing steel .....	509.02
U-channel posts.....	730.015
Square posts .....	730.016
Wooden Box Beam.....	730.017
Tube and pipe.....	730.01
Anchor bolts and nuts .....	730.02
Poles and arms .....	730.03
Base and arm plates.....	730.04
Handhole covers.....	730.05
Pole caps .....	730.06
Arm caps .....	730.07
Hardware.....	730.08
Stainless steel .....	730.09
Stainless steel hardware .....	730.10
Messenger wire .....	732.18
Aluminum:	
Sheet and plate .....	730.11
Extrusions .....	730.12
Tube and pipe.....	730.13
Castings.....	730.14
Forgings .....	730.15
Welding rods.....	730.16
Hardware.....	730.17
Other materials:	
Decals .....	725.21
Reflective sheeting, Type F.....	730.18
Reflective sheeting, Type G.....	730.19
Reflective sheeting, Type H.....	730.192
Reflective sheeting, Type J .....	730.193
Nonreflective sheeting .....	730.20
Silk screen inks .....	730.22
Transparent electronic cuttable films .....	730.23

**630.03 Certified Drawings.** Furnish certified drawings according to 625.06. Submit sign support certified drawings that cover all design types such as ground mounted, rigid overhead, span wire mounted, and overpass structure mounted supports. On the drawings, show overall height, sign clearance above foundation, span length, sign locations, sign overall heights and widths, and glare shield height and location, if applicable.

Submit sign design certified drawings that show the overall extrusheet size dimensions including glare shield, panel type and length, temporary overlay sign dimensions and location on the covered sign, the type and quantity of assembly and mounting hardware, and guide sign legend details. Furnish guide sign legend details that include sheeting type, copy type, character size and spacing, and reference or code numbers. Indicate the guide sign background and legend colors. For the sign layout, conform to standards maintained by the Department. It is not

## 630.04

necessary to submit drawings of standard warning, regulatory, or route marker signs.

**630.04 Sign Fabrication.** Sign types include flat sheet, double faced, extrusheet, and temporary overlay. Flat sheet signs consist of one-piece units made of aluminum. Double faced signs consist of flat sheet aluminum or extruded aluminum blanks with legend on both sides. Extrusheet signs consist of a number of horizontal panels assembled to form a complete sign. Temporary overlay signs consist of an aluminum sheet covering portions or entire surfaces of extrusheet signs.

Prior to reflective sheeting application, clean aluminum sign surfaces either by total immersion in a tank containing an alkaline solution of the manufacturer's specification or by steam cleaning with an alkaline solution of the manufacturer's specification, followed by a thorough rinsing with running water. After cleaning, etch the surface with an acid solution, and dry. Do not allow cleaned and etched surfaces to become contaminated by contact with oil or grease. Drill or punch bolt holes to finish size.

Use sign legends according to the OMUTCD and the Sign Design Manual. Use Clearview font for positive contrast legends on freeway and expressway guide signs and on all other guide signs when permitted in the Sign Design Manual. Use capital legends and upper/lower case legends in accordance with the Sign Design Manual. When either is permitted in the Sign Design Manual, use upper/lower case legends.

For flat sheet, double faced mile marker, double faced street name and ground mounted extrusheet signs, use Type G, H or J reflective sheeting for background and reflective legends. For overhead extrusheet signs, use Type G, H or J reflective sheeting for the background, and use Type H or J reflective sheeting for reflective legends, shields and symbols (including hazardous cargo plate, airport symbol, arrows and borders). Apply reflective sheeting to the surface according to the manufacturer's recommendations, with no blisters, wrinkles, tears, or blemishes. Do not use reboundable or damage control sheeting for permanent signs.

For reflective legends on flat sheet, double faced mile marker and double faced street name signs, use reverse silk screen transparent ink, electronic cuttable film, or direct applied reflective sheeting copy. When using direct applied reflective sheeting copy, apply all legend on a sign with the same rotation angle orientation. For nonreflective legends, use direct silk screen black ink or direct applied nonreflective black sheeting copy. For double faced mile marker signs, use flat sheet aluminum and apply reflective sheeting and legend to both sides. For double faced street name signs, use extruded aluminum blanks with a minimum thickness of 0.063 inch (1.6 mm) and thicker, stiffened edges, and apply reflective sheeting and legend to both sides.

Extrusheet panels consist of flat sheet aluminum reinforced with aluminum extrusions attached by spot welding. Panels extruded in a single operation may be used in lieu of extrusheet panels. Do not use extruded panels and extrusheet panels in the same sign. Bolt together the minimum number of full length, sheeted

panels to achieve the sign height, using aluminum bolts, washers, lock washers and nuts. For reflective legends, shields and symbols (including hazardous cargo plate, airport symbol, arrows and borders) use direct applied reflective sheeting. Apply all reflective legend on a sign with the same rotation angle orientation. For nonreflective legends, use direct applied nonreflective black sheeting copy.

For temporary overlay signs, use 0.080-inch (2.0 mm) thick flat sheet aluminum, with a maximum panel size of 8 × 4 feet (2.4 × 1.2 m). Apply sheeting and legend as described above for extrusheet signs. Attach temporary overlays to extrusheet signs in the shop or field using aluminum blind rivets at a maximum spacing of 18 inches (0.5 m) on the peripheries of the temporary overlays and 24 inches (0.6 m) within the interior.

Use fluorescent yellow green reflective sheeting for the following signs: SCHOOL (S4-3), School Crossing (S1-1), yellow portions of school speed limit (S5-H3, S5-H4, S5-H5), SCHOOL ENTRANCE (S3-H3), SCHOOL BUS STOP AHEAD (S3-1), SCHOOL BUS TURN AHEAD (S3-H2), Bicycle Crossing (W11-1), Pedestrian Crossing (W11-2), Handicap Crossing (W11-9), SAFETY ZONE (W11-H15), and Playground (W15-1). Fabricate supplemental signs [such as SHARE THE ROAD (W16-1), Advisory Speed Plate (W13-1), Distance Plates (W16-2, W16-2a, W16-3, W16-3a), Supplemental Arrows (W16-5p, W16-6p, W16-7p and AHEAD Plate (W16-9p)] from fluorescent yellow green sheeting when used with a sign above.

Use fluorescent yellow reflective sheeting for all yellow signs, yellow portions of multi-colored signs, and yellow sign post reflectors, except for signs and portions of signs required to be fabricated with fluorescent yellow green reflective sheeting.

For lighted signs, cover glare shield and rectangular luminaire support tube with nonreflective sheeting matching the predominant sign color.

Furnish 4 × 2.5 inch (100 × 62 mm) sign identification stickers of Type F reflective sheeting as shown in Figure 1. For signs fabricated in English based sizes, use white stickers with red ink legend. For signs fabricated in hard metric based sizes, regardless of the sign message units contained on the sign face, use yellow stickers with red ink legend. Place the stickers on the back side of the sign in the lower right corner of rectangular signs, or in an equivalent location for other sign shapes, approximately 3 inches (75 mm) from side and bottom sign edges (for smaller signs, these dimensions may be reduced). Position the sticker so it can be read horizontally and is clearly visible, not near bolt holes or rivets, and not obstructed by the sign support when erected.

Silk screen the fabrication data onto the face of the sticker, and include the sheeting manufacturer identification code and year of fabrication. Alternatively, the numbers 0-1-2-3-4-5-6-7 and 10-11-12-13-14 may be silk screened onto the sticker with the correct sheeting manufacturer identification code and fabrication year punched out, respectively. At the time of sign erection, indicate the erection data by scratching out the appropriate month and year.

**FIGURE 1**

Sticker design:

PROPERTY OF THE STATE OF OHIO												
UP TO \$2500 FINE AND 5 YEARS IMPRISONMENT FOR DAMAGING OR REMOVING THIS SIGN OHIO REV. CODE SEC. 4511.17												
MANU ID *							FAB. **					
EREC	1	2	3	4	5	6	7	8	9	10	11	12
10	11	12	13	14	15	16	17					

\*ID No.

\*\*Year of Manufacture

Alternate design:

PROPERTY OF THE STATE OF OHIO												
UP TO \$2500 FINE AND 5 YEARS IMPRISONMENT FOR DAMAGING OR REMOVING THIS SIGN OHIO REV. CODE SEC. 4511.17												
0	1	2	3	4	5	6	7	08	09	10	11	12
EREC	1	2	3	4	5	6	7	8	9	10	11	12
10	11	12	13	14	15	16	17					

Fabricate sign post reflectors with flat sheet aluminum and Type G, H or J reflective sheeting. Install red sign post reflectors on each post with the following post-mounted signs: Stop (R1-1), Yield (R1-2), Do Not Enter (R5-1), and Wrong Way (R5-1a). Install yellow sign post reflectors on each post with the following post-mounted signs: One-Direction Large Arrow (W1-6), Two-Direction Large Arrow (W1-7), Chevron Alignment (W1-8), and Stop Ahead (W3-1, W3-1a).

**630.05 Foundations.** Locate sign support foundations so the plane of the sign surface is at a right angle to the roadway lanes served (except for signs not intended for this orientation). Install foundations in accordance with 632.14. Furnish and install a ground rod at each rigid overhead and span wire sign support foundation, in accordance with 625.16.

Before placing foundation concrete for embedded supports, brace the supports in a vertical position. 7 days after concrete placement, remove bracing for embedded supports and erect signs.

**630.06 Sign Supports.** Sign supports consist of ground mounted, rigid overhead, span wire, and overpass structure mounted types. Fabricate sign supports according to the applicable requirements of Item 513, and weld according to 513.21. The approval of fabricators according to 501.03 will not apply. Hot-dip

galvanize steel structural members according to 711.02. Galvanize steel hardware according to 730.08.

Tighten threaded fasteners, except anchor bolt nuts, by the “turn of the nut” method according to 513.20.

Furnish anchor bolts with a leveling nut, plain washer, and anchor nut conforming to 730.02. Use anchor nuts with a plain washer against the base plate upper surface.

Tighten anchor bolt nuts according to 513.20, except that under Table 513.20-3, use the “nut rotation from snug tight condition” from 1/12 to 1/6 turn instead of 1/3 turn.

Apply anaerobic adhesive complying with Federal Standard MIL S 46163, Type II, Grade N to anchor bolts and other threaded connections 1/2-inch (13 mm) diameter or larger, according to the manufacturer’s recommendations. Do not use anaerobic adhesive with torque-limiting nuts.

Submit alternate designs or materials for sign supports for acceptance at least 21 days in advance of a bid opening date. The Director will give notification of the acceptance or rejection of the alternate design to the bidder at least 7 days in advance of a bid opening date.

**A. Ground Mounted Supports.** Ground mounted supports consist of structural sections of the material and weights required. Drive the ground mounted supports into the earth or embed them in concrete, as specified. Install supports in exposed locations in accordance with the performance requirements of NCHRP 350. The support lengths shown on the plans are approximate. Determine the exact length of supports before fabrication.

**1. Post Supports.** Mark each driven post with a line of paint 6 inches (150 mm) above the specified driving depth. Drive posts to the specified depth without bending, distortion, or end mutilation. Do not splice posts. Do not place posts in drainage ditches. If unable to install the post at the specified location, relocate the post with the Engineer’s approval.

Install posts located in paved areas through a hole provided by sleeving or core drilling. After the post is in position, patch the hole with asphalt concrete or an approved asphalt material.

For groupings of flat sheet signs in multiple arrangements mounted on posts, provide sign backing assemblies.

For one-way and street name sign supports, use square posts for mounting signs at right angles to other signs on the post.

For temporary sign supports and their placement, conform to the OMUTCD.

**2. Structural Beam Supports.** Furnish ground mounted structural beam supports from rolled steel sections. Furnish slip base connections when specified. Bolt the pieces of each beam together, and preload the assembly bolts before delivery to the project. Carefully handle assembled breakaway beams during

transportation and erection. Upon erection, perform the final specified torquing on all threaded fasteners.

At least 4 weeks after erecting signs on breakaway beams, inspect the breakaway feature for evidence of shifting or loose fasteners. Re-torque all loose fasteners to specified values. Loosen and re-torque slip base plate fasteners even if no shifting or looseness is detected. However, if the base plate connection was made with torque limiting nuts, re-torque only if looseness is detected. Apply anaerobic adhesive to the re-torqued conventional nuts, or, as an alternate, use new torque limiting nuts with the proper range.

**3. Pipe Supports.** Furnish ground mounted pipe supports from structural steel pipe and tubing. Furnish bolt down anchor installations in existing concrete. Furnish triangular slip base connection when specified.

**4. Wooden Box Beam Supports.** Furnish wooden box beam supports from laminated veneers pressure treated with wood preservative. Install breakaway feature after installation when specified.

**B. Rigid Overhead Supports.** Rigid overhead supports consist of single poles with cantilevered arms, or span types supported between end frames. Furnish supports that include brackets for attaching disconnect switch, and pipe couplings for sign wiring. Furnish anchor bolts and conduit ells [at least one 2-inch (50 mm) minimum diameter] for installation in the foundation. Upon erection, set support poles and end frames on their foundations, and plumb using the leveling nuts followed by secure tightening of the nuts on the anchor bolts. Plumb poles supporting cantilevered signs following erection of signs as required. Ensure that a minimum of one full thread remains on each anchor bolt above the top of the anchor nut after final tightening. Do not use concrete grouting in the space between the foundation surface and support base.

Do not provide cover bases or individual anchor bolt covers on support anchor bases regardless of support location.

Furnish overhead sign supports with sign attachment assemblies for attaching extrusheet signs and/or sign hanger assemblies for mounting flat sheet signs to the support chords. Furnish luminaire support assemblies for lighted signs.

When specified, furnish sign support identification stickers of Type F reflective sheeting listing the support type, design number, span/arm length, county, route, and section number (example: TC-7.65, design 6, 80 ft span, CUY-90-17.58). Apply stickers only when the ambient temperature is above 40 °F (4 °C). Locate the sticker approximately 8 feet (2.4 m) above groundline on the quadrant of the sign support facing approaching traffic. Identify sign supports spanning opposing directions of traffic with two stickers, each on a support member facing traffic.

Rigid span supports consist of a box truss supported by single plane truss end frames. Fabricate box trusses from aluminum or steel tubular members with built-in camber, and mark each section "TOP". Do not erect box trusses unless at least one sign or damping device approved by the Engineer is installed within 8 hours.

Provide for the attachment of a luminaire bracket arm on combination overhead sign supports.

**C. Span Wire Supports.** Furnish span wire sign supports with sign hanger and messenger wire assemblies. Furnish anchor bolts and conduit ells [at least one 2-inch (50 mm) minimum diameter] for installation in the foundation.

Achieve a span wire sag under load of 4 to 5 percent of the span. Adjust poles to be essentially vertical after span wire tensioning. Ensure that a minimum of one full thread remains on each anchor bolt above the top of the anchor nut after final tightening.

Do not provide cover bases or individual anchor base covers on support anchor bases regardless of support location.

When specified, furnish sign support identification stickers as described in 630.06.B.

**D. Overpass Structure Mounted Supports.** Mount the supports on the overpass structure so the bottom of the signs are in a level position, regardless of bridge slope.

**E. Sign Attachments.** Use sign attachment assemblies to attach extrusheet signs to rigid overhead supports. Use sign hanger assemblies to attach flat sheet signs to span wire or rigid overhead supports. Use sign support assemblies to attach flat sheet or extrusheet signs to poles or bridge parapets. Use sign backing assemblies for groups of signs attached to a sign post, and to attach exit number or supplemental panels to an extrusheet sign.

**630.07 Sign Erection.** Erect signs on ground mounted or overhead supports according to the schematic signing layout. Do not remove an existing sign until the replacement sign is either erected or available for immediate erection. Do not erect a replacement sign on a new support more than 24 hours before the removal of the existing sign.

**A. Flat Sheet Sign Erection.**

Use steel bolts, wide washers, lock washers and nuts. Use bearing plates between the sign and U-channel post at each bolt. Field drill signs mounted on messenger wire or mast arms to match holes in brackets.

**B. Extrusheet Sign Erection.**

Use self-aligning aluminum mounting clips, aluminum or stainless steel rectangular head bolts, aluminum or stainless steel washers, and stainless steel elastic stop nuts, to attach extrusheet signs to beam or U-channel post supports, and for U-channel post sections used to attach exit number and supplemental panels to extrusheet signs. Use aluminum bolts, washers, lock washers, and nuts to assemble extrusheet signs shipped in two pieces.

**630.08 Sign Shipment and Storage.** Package and ship finished flat sheet signs to assure adequate protection of the sign face, using methods and materials as recommended by the reflective sheeting manufacturer.

## 630.09

Ship extrusheet signs up to 8 feet (2.4 m) high completely assembled. Extrusheet signs over 8 feet (2.4 m) high may be shipped in two pieces for field assembly. Keep extrusheet signs rigid by back bracing or crating.

Store signs, whether provided by the Contractor or furnished by the Department, off the ground in a vertical position with adequate covering or shelter to prevent packing material from getting wet. Immediately remove packing material that does become wet from contact with sign faces to prevent damage to the reflective sheeting.

Identify extrusheet signs on a detachable form on the sign back giving the project number and year, sign reference number, sign legend sketch, and station location. Identify the underlying sign for signs shipped with an attached temporary overlay sign.

**630.09 Specific Service and Tourist-Oriented Directional Signs.** Specific Service (logo) signs and Tourist-Oriented Directional Signs (TODS) and the supports for these signs, are installed and maintained by a private company operating under a contractual arrangement with ODOT. These signs and supports are not to be removed or relocated unless so indicated in the plans, or if their removal or relocation becomes necessary during the course of construction.

For TODS and/or logo signs and associated supports needing to be removed or relocated, provide written notification to the private company operating under contractual arrangement with ODOT at least 60 days prior to the date the signs and/or supports need to be removed or relocated. The private company is responsible for removing the signs and supports within 60 days of notification.

The Engineer will coordinate the removal and/or relocation of the TODS and logo signs and supports.

**630.10 Covering of Signs.** Install temporary covers, and subsequently remove and dispose of them as shown on the plans or as directed by the Engineer. For the covering material, use a sturdy opaque material and obtain the Engineer's approval of the proposed method of covering and attachment.

**630.12 Removal and Storage, Reerection, or Disposal of Signs and Supports.** Carefully dismantle signs and sign supports indicated for removal. Either store on the project, re-erect, or dispose of removed signs and sign supports. To ensure maintenance of adequate traffic control at all times, remove signs only with the Engineer's approval.

Remove sign supports in a manner to avoid damage. Remove sign service to the support by disconnecting and removing cables at the service pull-box. Ensure that connection of remaining cables conforms to 625.18. Remove support foundations to at least 1 foot (0.3 m) below subgrade or finished groundline. Backfill and restore surfaces to a condition equal to that existing before the work started and dispose of surplus material according to 603.12 at no cost to the Department.

Furnish mounting hardware for signs to be re-erected. Field drill as necessary. Furnish anchor bolts and conduit ells for installation in the foundation for overhead sign supports to be re-erected.

Remove temporary overlay signs so as not to damage the underlying sign.

**630.13 Inspection.** After erection, the Engineer will inspect signs under both day and night conditions. Correct deficiencies in lateral position or visibility to the Engineer's satisfaction.

**630.14 Method of Measurement.** The Department will measure Ground Mounted Post Support by the number of feet (meters), and will include driving, hardware for anchor base installation, and furnishing and placing of patching materials for excavations in paved areas.

The Department will measure Foundations for ground mounted pipe supports, ground mounted structural beam supports, rigid overhead sign supports and span wire sign supports by the number of each for one pipe, structural beam, pole, end frame or strain pole, and will include excavation, reinforcing steel, concrete, backfilling, and when required the 10 foot (3m) foundation section of concrete barrier, and the disposal of surplus excavation.

The Department will measure Ground Mounted Structural Beam Support by the number of feet (meters) measured from the bottom of the foundation to the top of the sign, and will include furnishing and placing of patching materials for excavations in paved areas.

The Department will measure Ground Mounted Pipe Support by the number of feet (meters) measured from the bottom of the foundation to the top of the sign and will include u-bracket, tubing, posts and hardware for sign attachment, bolt-down anchor and furnishing and placing of patching materials for excavations in paved areas.

The Department will measure Ground Mounted Wooden Box Beam Support by the number of feet (meters), and will include excavation, backfilling, disposal of surplus material, and installation of breakaway feature.

The Department will measure One Way Support and Street Name Sign Support by the number of feet (meters), and will include driving, hardware for anchor base installation, and furnishing and placing of patching materials for excavations in paved areas.

The Department will measure Temporary Sign Support by the number of feet (meters) or the number of each furnished, erected, maintained, and removed.

The Department will measure Breakaway Structural Beam Connection by the number of each set of connection parts with necessary welding and drilling of holes as required for the breakaway function in one beam, and will include base plates, fuse plate, hinge plate, bolt retainer plate, and bolts assembled to specified torques.

The Department will measure Triangular Slip Base Connection by the number of each set of connection parts with the necessary welding and drilling of holes as required for the breakaway function in one pipe and will include slip plate, slip base casting, locking collar, bolt retainer plate, coiled pin and bolts assembled to specified torques.

## 630.14

The Department will measure Overhead Sign Support by the number of each, and will include anchor bolts and conduit ells furnished for the foundation, sign attachment assemblies, sign hanger assemblies, luminaire support assemblies when required, and identification stickers when specified.

The Department will measure Combination Overhead Sign Support with light pole extension by the number of each, and will include anchor bolts and conduit ells furnished for the foundation, sign attachment assemblies, sign hanger assemblies, luminaire support assemblies when required, and identification stickers when specified. Bracket arms and roadway lighting luminaires are not included.

The Department will measure Sign Attachment Assembly by the number of separately itemized assemblies, and will include one overhead sign bracket, U-bolts, clamps, and miscellaneous hardware.

The Department will measure Luminaire Support Assembly by the number of separately itemized assemblies, and will include one support arm, other necessary structural members, and miscellaneous hardware.

The Department will measure Span Wire Sign Support by the number of each support, and will include two strain poles with span wire clamps and anchor shackles, anchor bolts and conduit ells furnished for foundations, messenger wire, clamps, thimbles, and sign hanger assemblies with hangers, braces, lengths of post, and miscellaneous hardware.

The Department will measure Overpass Structure Mounted Sign Support by the number of each support, and will include attachment work and hardware, to attach one individual sign.

The Department will measure Sign Hanger Assembly by the number of each, and will include all parts necessary to attach one individual sign.

For pole mounted sign supports, the Department will measure Sign Support Assembly by the number of each, and will include brackets, hardware, and posts sufficient to attach each sign or set of signs to an individual pole.

For bridge mounted sign supports, the Department will measure Sign Support Assembly by the number of each, and will include post, hardware, and attachment work.

The Department will measure Sign by the number of square feet (square meters) of signs, and will include the furnishing of identification stickers, sign backing assemblies, mounting bolts, washers, nuts, bearing plates, clips, and rivets. For square, rectangular, circular, or irregular shaped signs, the Department will determine measurement by multiplying the largest dimensions of width and height. For triangular shaped signs, the Department will determine measurement by multiplying the largest dimension of width and one-half the largest dimension of height. The Department will include the area of the glare shields for lighted signs as an integral part of the sign.

The Department will measure Sign Post Reflector by the number of each, and will include the furnishing of mounting bolts, washers and nuts.

The Department will measure Sign, Double-Faced by the number of each, and will include mounting fittings and hardware.

The Department will measure Sign Erected by the number of square feet (square meters) of signs erected, and will include mounting hardware, the assembly of signs that are in more than one piece and the installation of required sign backing assemblies. The Department will exclude the furnishing of signs. For square, rectangular, circular, or irregular shaped signs, the Department will determine measurement by multiplying the largest dimensions of width and height. For triangular shaped signs, the Department will determine measurement by multiplying the largest dimension of width and one-half the largest dimension of height. The Department will include the area of the glare shields for lighted signs as an integral part of the sign.

The Department will measure Sign Backing Assembly by the number of separately itemized assemblies, and will include back bracing for each group of flat sheet signs attached to a post or posts, or a single assembly for backing posts used to attach an exit or supplemental panel to a guide sign.

The Department will measure Covering of Sign by the number of square feet (square meters) of sign face covered, and will include the subsequent removal and disposal of the covering.

The Department will measure Removal and Storage, Reerection, or Disposal of Sign by the number of each sign removed and stored, re-erected or disposed of. Major signs are defined for measurement as being 40 square feet (3.7 m<sup>2</sup>) or larger.

The Department will measure Removal and Storage, Reerection, or Disposal of Support by the number of each support removed and stored, re-erected or disposed of, and will include removal of foundations and restoration of surfaces. With reerection, the Department will include furnishing of anchor bolts, conduit ells, necessary field drilling, and hardware.

**630.15 Basis of Payment.** The Department will not pay for relocating posts from their planned location without prior approval by the engineer.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
630	Each	Ground Mounted Structural Beam Support Foundation
630	Each	Ground Mounted Pipe Support Foundation
630	Each	Rigid Overhead Sign Support Foundation
630	Each	Span Wire Sign Support Foundation
630	Foot (Meter)	Ground Mounted Support, ___ Post
630	Foot (Meter)	Ground Mounted Structural Beam Support, ___
Beam		
630	Foot (Meter)	Ground Mounted Support, Pipe
630	Foot (Meter)	Ground Mounted Wooden Box Beam Support, ___ Beam
630	Foot (Meter)	One-Way Support, ___ Post
630	Foot (Meter)	Street Name Sign Support, ___ Post

**630.15**

630	Foot (Meter) or Each	Temporary Sign Support, ___ Post
630	Each	Breakaway Structural Beam Connection
630	Each	Triangular Slip Base Connection
630	Each	Overhead Sign Support, Type TC-___, Design___
630	Each	Combination Overhead Sign Support, Type TC-___, Design___
630	Each	Sign Attachment Assembly
630	Each	Luminaire Support Assembly
630	Each	Span Wire Sign Support, Type TC-17.10, Design___
630	Each	Overpass Structure Mounted Sign Support, Type TC-___, Design___
630	Each	Sign Hanger Assembly, (Span Wire, Mast Arm)
630	Each	Sign Support Assembly, (Pole or Bridge Mounted)
630	Square Foot (Square Meter)	Sign, (Flat Sheet, Ground Mounted Extrusheet, Overhead Extrusheet, Temporary Overlay)
630	Each	Sign, Double-Faced, (Street Name, Mile Marker)
630	Square Foot (Square Meter)	Sign Erected, (Flat Sheet, Extrusheet, Temporary Overlay)
630	Each	Sign Backing Assembly
630	Each	Sign Post Reflector
630	Square Foot (Square Meter)	Covering of Sign
630	Each	Removal of Ground Mounted(Major) Sign and (Storage, Reerection, or Disposal)
630	Each	Removal of Ground Mounted(Structural Beam, Post, Pipe, Wooden Box Beam) Support and(Storage or Disposal)
630	Each	Removal of Overhead Mounted Sign and (Storage, Reerection, or Disposal)
630	Each	Removal of Overhead Sign Support and (Storage, Reerection, or Disposal), Type TC-___
630	Each	Removal of Overlay Sign

**ITEM 631 SIGN LIGHTING AND ELECTRICAL SIGNS****631.01 Description****631.02 General****631.03 Materials and Equipment****631.04 Sign Service****631.05 Signs Wired****631.06 Disconnect Switch****631.07 Luminaire**

**631.08 Controls****631.09 Electrical Signs****631.10 Removal and Storage or Reerection****631.11 Inspection and Testing****631.12 Method of Measurement****631.13 Basis of Payment**

**631.01 Description.** This work consists of furnishing and installing sign lighting or electrical sign equipment, complete, tested, and ready for service.

**631.02 General.** Perform installations according to the National Electrical Safety Code, the National Electrical Code and local codes for the area of installation. Furnish overhead sign lighting and integrate electric power with roadway lighting circuits.

Furnish certified drawings according to 625.06.

Conform to the requirements of Supplement 1063 for the installation or testing of electrical items installed under 631.08 and 631.09.

Protect wire and cable by installing entirely within support structure interiors, enclosures, junction boxes, and rigid or flexible conduit. Ensure that the methods, materials, and locations of splicing and the methods of connecting and identifying wire and cable conform to Item 625, Item 725, and the plans. Furnish grounding systems according to 625.16.

Power service is furnished under Item 625.

**631.03 Materials and Equipment.** Furnish materials and equipment that are new, of first quality, of current design, and free from defects.

Use electrical parts, wire, switches, and other elements of the installations that are of ample capacity to carry the required current without excessive heating or drop of potential.

Ensure that each item of equipment bears a nameplate, indelible marking, or brand that identifies the type, model, catalog number, and manufacturer.

Furnish materials conforming to the following:

Ground rod.....	625.16
Sealing, conduit .....	625.12
Cable and wire, 600-volt.....	725.02
Conduit, rigid.....	725.04
Mercury vapor ballast .....	725.11
Power service.....	725.19
Disconnect Switch .....	725.19
Switch Enclosure .....	725.19
Changeable message sign, electric type .....	731.03
Internally illuminated fixed message sign.....	731.05
Sign flasher assembly .....	731.06
School speed limit sign assembly .....	731.07
Conduit, flexible .....	731.08
Timer with enclosure .....	731.10

## 631.04

**631.04 Sign Service.** Sign service consists of all cable and other equipment to provide a complete electrical service from either an underground or overhead source to the disconnect switch.

Route sign service cable from a pull box to the switch enclosure for overhead supported signs by means of underground conduit, foundation conduit ell, and the interior of the structural member supporting the enclosure.

Route sign service for overpass structure mounted signs through underground and structure attached conduit terminating at a switch enclosure. Attach the conduit by 0.02-inch (0.5 mm) thick by 3/4-inch (19 mm) wide passivated stainless steel straps spaced at intervals of not more than 5 feet (1.5 m).

Route sign service cable from a distribution system direct drop to the switch enclosure by means of a conduit riser with weatherhead. Form a drip loop into the cable. Use either a cast aluminum or galvanized ferrous metal weatherhead of a threaded design. Attach the conduit by straps as described in the previous paragraph.

For sign service, use single conductor stranded copper. When the connection is to highway lighting distribution and circuit cable, use the same cable for sign service. In other applications, use sign service cable rated at 600 volts minimum and not smaller than 4 AWG.

**631.05 Signs Wired.** Ensure that signs wired complete the electrical system from the disconnect switch to the luminaires.

Furnish continuous wiring from the disconnect switch to a junction box mounted on the sign support or overpass structure. Install junction box in a manner that allows sign removal as a unit by the disconnection of the wires and the removal of sign attachment hardware. Install a junction box for each sign.

Furnish continuous wiring from the junction box to the first luminaire and between additional luminaires.

Use wire rated at 600 volts, single conductor and not smaller than 10 AWG.

Route wire on overhead sign supports from the disconnect switch enclosure through structural member interiors. Support wire hanging within the interior of steel vertical members by looping over the J-hook provided. After wiring in the disconnect switch enclosure, seal the nipple in the enclosure back with self-fusing high-dielectric insulating compound.

Assemble flexible or rigid conduit on the sign structure or lighting support arms with condulets, and attach them to the structure by clamps located within 6 inches (150 mm) of each conduit end and separated by not more than 24 inches (0.6 m).

**631.06 Disconnect Switch.** Install lighted signs with a disconnect switch within a lockable, weatherproof enclosure. For the switch, use a two-pole (minimum), single-throw, fused safety disconnect type, rated at 600 volts, 30 amperes with the fuse size as specified. Furnish a solid neutral bar.

For the enclosure, use stainless steel NEMA 250, Type 4. Furnish space for a chase nipple in the enclosure back. Field drill a hole through the enclosure and

install the nipple. Ensure that enclosures also have a 1/4-inch (6 mm) diameter weep hole located in the bottom surface.

Furnish each enclosure with at least one padlock. Use padlocks with a bronze or brass lock body and a corrosion protected steel shackle. Key all padlocks for a project alike, and obtain the appropriate master key number from the maintaining agency.

When specified, furnish and install bracket assemblies on existing overhead sign supports or on concrete structures. Use bracket assemblies made of steel, galvanized according to 711.02, or aluminum.

**631.07 Luminaire.** Include a lamp of the wattage specified.

Locate ballasts integral with the luminaire. Furnish weatherproof ballast housings made from corrosion resistant materials.

**631.08 Controls.** When specified, furnish photoelectric controls when sign lighting is fed by uncontrolled circuits.

When specified, furnish and install the timer with enclosure to provide automatic school speed limit sign operation.

**631.09 Electrical Signs.** Furnish changeable message signs that conform to the Contract Documents. The pay item will specify if the display capabilities are limited message or unlimited message. The Contractor may use line units of these types as inserts in a panel sign, singly or grouped to provide a multiline sign. Hardware and software shall be complete to operate and maintain the sign.

Furnish internally illuminated signs consisting of the single or double face type. The sign support is furnished under another pay item. Furnish suspended signs that hang plumb, are properly oriented, and locked in place.

Furnish sign flasher assemblies consisting of a pair of flashing beacons. The sign, support, and foundation are furnished under other pay items.

Furnish school speed limit sign assemblies that conform to the Contract Documents. School speed limit sign assemblies consist of a reflectorized SCHOOL SPEED LIMIT 20 DURING RESTRICTED HOURS (S5-H3) sign fitted with a pair of flashing beacons arranged above and below the sign.

**631.10 Removal and Storage or Reerection.** Carefully remove sign lighting equipment (such as luminaires, disconnect switches, or ballasts) and electrical signs, and either store on the project for salvage by the Department or re-erect elsewhere on the project. Clean and restore luminaires to be re-erected to an operating condition, fitted with new lamp boots, relamped with the proper type and size lamp, and provided with new hardware.

**631.11 Inspection and Testing.** Ensure that the sign lighting systems and electrical signs meet all requirements of the ground, cable insulation, and performance tests specified in 625.19. Correct lamps, ballasts, and transformers that failed during the performance test by replacing the faulty component; the entire test period will not require restarting.

During the performance test, make final adjustments to sign lateral position and aiming angles of luminaires to eliminate excessive brightness and glare, and to

## 631.12

obtain optimum sign face reflected brightness, uniformity of illumination, visibility, and legibility, to the satisfaction of the Engineer.

**631.12 Method of Measurement.** All of the following methods of measurement include all hardware necessary to securely mount the associated item including angles, plates, tubes and channels.

The Department will measure Sign Service by the number of complete units for each support, and will include conduit, conduit riser, weatherhead, fittings, cables, trenching, and backfilling.

The Department will measure Sign Wired and Sign Wired, Overpass Structure by the number of complete units of wiring for each individual sign, and will include junction boxes, rigid or flexible conduit, condulets, clamps, wires, and connectors.

The Department will measure Disconnect Switch with Enclosure by the number of each, and will include field drilling and padlocks.

The Department will measure Switch Enclosure Mounting Bracket Assembly by the number of each, and will include two brackets and field drilling.

The Department will measure Ballast and Photoelectric Control by the number of each separate item.

The Department will measure Luminaire by the number of each, and will include lamps and luminaire attachment hardware.

The Department will measure Changeable Message Sign by the number of each, and will include cabinet, external enclosures, conduit, electrical, electronic and auxiliary components, and remote control units to provide a fully functional unit.

The Department will measure Internally Illuminated Fixed Message Sign by the number of each, and will include lamps and ballasts.

The Department will measure Sign Flasher Assembly by the number of each, and will include beacons, flasher control unit with enclosure, and lamps.

The Department will measure School Speed Limit Sign Assembly by the number of each, and will include sign, beacons, flasher control unit with enclosure, and lamps.

The Department will measure Timer with Enclosure by the number of each, and will include field drilling and padlocks.

The Department will measure Removal and Storage or Removal and Reerection of sign lighting equipment or electrical signs by the number of each like items removed and stored or re-erected.

**631.13 Basis of Payment.** The Department will pay for grounding systems under Item 625.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
631	Each	Sign Service
631	Each	Sign Wired
631	Each	Sign Wired, Overpass Structure
631	Each	Disconnect Switch with Enclosure, Type ____
631	Each	Switch Enclosure Mounting Bracket Assembly
631	Each	Ballast, Type ____
631	Each	Photoelectric Control
631	Each	Luminaire, Type ____, with ____-watt Lamp
631	Each	Changeable Message Sign, (Limited, Unlimited) Message
631	Each	Internally Illuminated Fixed Message Sign, Type ____
631	Each	Sign Flasher Assembly
631	Each	School Speed Limit Sign Assembly, ____ inches × ____ inches (____ mm × ____ mm)
631	Each	Timer with Enclosure
631	Each	Removal of (Luminaire, Disconnect Switch, Ballast, etc.) and (Storage or Reerection)

## ITEM 632 TRAFFIC SIGNAL EQUIPMENT

- 632.01 Description**
- 632.02 Contractor Personnel Requirements**
- 632.03 Materials and Equipment**
- 632.04 Certified Drawings**
- 632.05 General**
- 632.06 Vehicular Signal Head, Conventional**
- 632.07 Vehicular Signal Head, Optically Programmed**
- 632.08 Pedestrian Signal Head**
- 632.09 Pedestrian Pushbutton**
- 632.10 Loop Detector Unit**
- 632.11 Detector Loop**
- 632.14 Foundations**
- 632.15 Signal Support**
- 632.16 Strain Pole**
- 632.17 Wood Pole**
- 632.18 Down Guy Assembly**
- 632.19 Pedestal**
- 632.20 Conduit Riser**
- 632.21 Cable Support Assembly**
- 632.22 Messenger Wire**
- 632.23 Cable and Wire**
- 632.24 Power Service**
- 632.25 Covering of Vehicular and Pedestrian Signal Heads**
- 632.26 Removal of Traffic Signal Installation**
- 632.27 Reuse of Traffic Signal Equipment**
- 632.28 Testing**
- 632.29 Method of Measurement**
- 632.30 Basis of Payment**

**632.01 Description.** This work consists of furnishing and installing traffic signal equipment, complete and ready for service. This work also includes necessary excavation and backfill, disposal of discarded materials, restoration of disturbed facilities, and surfaces to a condition equal to that existing before the Work started, and electrical testing as specified.

Pull boxes, conduits, ground rods, and cable splicing kits required for traffic signal equipment installations are specified in Item 625.

**632.02 Contractor Personnel Requirements.** Conform to the requirements of Supplement 1063 for the installation or testing of traffic signal equipment.

**632.03 Materials and Equipment.** Furnish new materials and equipment of first quality, of current design, and free from defects.

Use electrical parts, wire, switches, and other elements of the installations capable of carrying the required current without excessive heating or drop of potential.

Ensure that major items or assemblies of equipment bear a nameplate, indelible marking, or brand that identifies the type, model, catalog number, and manufacturer.

Furnish materials and equipment conforming to:

Concrete, Class C.....	499, 511
Steel*:	
Poles, supports, arms, appurtenances and anchor bases .....	730.02, 730.03, 730.04, 730.05, 730.06, 730.07, 732.12, 732.11
Pedestals.....	732.15
Backplates.....	732.22
Hardware.....	730.08
Stainless steel hardware .....	730.10
Other Items:	
Conduit, rigid.....	725.04, 725.051, 725.052
Ground rod.....	725.16
Pull boxes.....	725.06, 725.07, 725.08, 725.12
Identifying tags or bands.....	725.02
Signal heads .....	732.01, 732.02, 732.03, 732.05
Lamps .....	732.04
Pushbuttons.....	732.06
Detectors .....	732.07, 732.08
Wood poles .....	732.13
Down guys .....	732.14
Conduit risers .....	732.16
Cable supports.....	732.17
Messenger wire .....	732.18
Cable and wire .....	732.19
Power service .....	732.20
Disconnect Switch with enclosure .....	732.21
Backplates.....	732.22
Tether Wire .....	732.185

\* Acceptance of materials and products is based on certified test data, furnished in triplicate, or on test results of samples according 106.04, as required by the Laboratory.

**632.04 Certified Drawings.** Furnish certified drawings according to 625.06.

**632.05 General.** Ensure that major items of traffic signal equipment used in combination are compatible, interchangeable, and, whenever feasible, provided by the same manufacturer or supplier. Furnish electrical materials, equipment, and installations according to the National Electrical Code and the National Electrical Safety Code, and conform to local laws and codes.

Ensure that the traffic control equipment installed in controller cabinets are shop prewired according to a wiring diagram that conforms to plan and specification requirements of the specific project and intersection, and show all wire harness and field connections required, with abbreviations according to Table 632.05-1. Furnish a neat and legibly drawn wiring diagram, reproduced on durable paper,

**632.05**

and place two copies in a plastic envelope fastened to the inside of the controller cabinet.

Identify cable and wire by tags or bands at pull boxes and controller cabinets, with size, material, and method of marking that conform to 725.02, except ensure that the identification on the tags or bands conforms to the wiring diagram with abbreviations according to Table 632.05-1. The Contractor may identify field wiring using an indelible pen on a plastic tag instead of embossed letters.

Use spade terminals for wiring connected at signal heads and the wiring connected at terminal blocks within controller cabinets. However, for incoming power wiring, use either spade terminals or bared conductor wire connected to terminal points utilizing screw or spring applied clamping surfaces compatible with both cooper and aluminum wire and providing a positive grip. Neatly lash and fasten completed wiring to interiors with clamps and/or ties.

**TABLE 632.05-1 TABLE AND WIRE IDENTIFICATION**

<b>Cable</b>	<b>Tag</b>
Ground	GND
Power (2 wire) 1Ø 120 volt	AC +AC- or ACN
Power (3 wire) 1Ø 120/240 volt Neutral wire	AC + 1, AC + 2 AC- or ACN
Phase A Phase 1 Phase 1 northbound left turn lanes	Ø A Ø 1 Ø 1 NBLT
Phase A, pedestrian signal	Ø A PD
Overlap, phase A + C Overlap, phase 1 + 6	Ø A + C Ø 1 + 6
Detector lead-in, phase A Detector lead-in, phase 1 Detector lead-in, phase 1 northbound left turn lanes	DET A DET 1 DET 1 NBLT
Detector lead-in, phase A (call type) Detector lead-in, phase 1 (call type) northbound thru lanes	DET A CALL DET 1 CALL NB-THRU
Detector harness <sup>[1]</sup>	DET A
Interconnect	IC
Pre-emption, fire	PE FIRE
Pre-emption, railroad	PE RR
[1] Place the tag next to the MS plug at the detector amplifier.	

When constructing the traffic control system, cooperate with the agency supplying the electric service. Supply 120/240 volt, single-phase, three-wire (grounded neutral) power to the disconnect switch.

After completion of the 10-day performance test in compliance with 632.28 and until acceptance, the Contractor is responsible for the care and maintenance of traffic control equipment installed or reused as part of the Contract.

Upon acceptance of the project, transfer to the Department all manufacturers' guarantees or warranties covering installed electrical or mechanical equipment. Furnish two copies of wiring diagrams, service manuals, and instructions on installation and maintenance for each different type, model, or system of equipment used on the project.

**632.06 Vehicular Signal Head, Conventional.** Furnish heads in arrangements such that from one to a maximum of five sections assembled with the specified lens size, color, and circular or arrow configuration form a specific signal face. Mount signal faces alone as a one-way head, or combined with additional faces to form a two-way, three-way, or a maximum of a four-way head.

Furnish multi-way heads with top and bottom brackets for mounting purposes. Fit faces of lesser height in multi-way heads with pipe spacers. Close openings unused for mounting purposes with weatherproof caps.

Install signals in a plumb condition, using a balance adjuster only if necessary. Fit heads mounted on mast arms, except those intended to be rigidly mounted, with a universal hanger allowing the head to swing in both longitudinal and transverse directions. Use drop pipes of suitable length only when necessary to bring the bottom of the signal heads to a proper roadway clearance. Use disconnect hangers for suspended heads when specified.

Orient each signal face to its traffic approach, and lock faces in place by the serrated or other type device incorporated in signal housing and support hardware.

Install LED lamps in each section.

When specified, furnish backplates.

**632.07 Vehicular Signal Head, Optically Programmed.** Furnish heads of this type consisting totally of optically programmed sections unless an intermix of optically programmed and conventional sections is specified. Install lamps in each optically programmed section.

Program each signal section according to the plan requirements. For 8-inch (200 mm) sections, use an extender tool as recommended by the manufacturer to program each section. Upon completion of the project, deliver one extender tool per project to the maintaining agency.

When specified, furnish backplates.

**632.08 Pedestrian Signal Head.** Furnish heads with the type of light source and symbol height specified. Orient each signal head to its crosswalk, and lock heads in place by the serrated or other type device incorporated in signal housing and support hardware. Close openings unused for mounting purposes with weatherproof caps.

**632.09 Pedestrian Pushbutton.** Properly orient and install pushbuttons on poles or pedestals. Service pushbuttons mounted on steel poles by wiring inside the poles. Furnish 3/4-inch (19 mm) diameter holes through the back of the housing and the pole wall, install a rubber grommet, and route wiring through until no external wiring is visible. Plug any unused conduit attachment holes. Attach the housing by machine or self-tapping screws in the housing back wall. Service

## 632.10

pushbutton mounted on wooden poles through conduit. Furnish pedestrian pushbutton signs of the legend and size required.

**632.10 Loop Detector Unit.** Install and tune detector units to their loops with the sensitivity set for optimum operation and any interference or cross talk eliminated between other detector units in the cabinet. Perform a field check to ensure that no extraneous detections are occurring by observing each detector unit's operation to determine that a signal occurs only when a vehicle enters its associated loop. If actuations are observed when there is no vehicle in the loop, eliminate the extraneous detections.

**632.11 Detector Loop.** Saw slots in the pavement for installation of vehicle detector loop wire in the configuration, dimensions, and combinations required. Cut an extension from the loop to the pavement edge to allow wire routing to an adjacent pull box.

Furnish slots 1/16 to 1/8-inch (1.6 to 3 mm) wider than the outside diameter of the loop wire or tubing. Ensure that the slot depth provides a covering of not less than 3/4-inch (19 mm) above the uppermost detector wire tubing after the loop installation is completed. Before installing loop detector wire, brush and blow all slots clean of loose material and completely dry. Install loop detector wire according to 632.23.

Fill the slots completely with a flexible embedding sealant, prequalified according to Supplement 1048. Do not disturb slots until sealant has cured. Cured sealant shall be level with or higher than the pavement surface.

For loop detector wire installations in new asphalt, the Contractor may saw slots and embed sealant in a subsurface course with subsequent covering by the surface course, subject to the Engineer's approval.

**632.14 Foundations.** Locate support foundations, and stake with the proper elevation. If underground or overhead obstacles are encountered during stakeout, or to correct slope and subsurface difficulties, change foundation location and orientation with the approval of the Engineer. Ensure that the approved location provides a safe clearance from overhead power lines for construction operations, in compliance with the National Electric Safety Code. The Contractor is responsible for the correct location, elevation, and orientation for all poles and pedestals installed on the foundations.

Excavate for foundations using an earth auger to specified dimensions according to 503.04. Exercise caution when excavating in areas of underground installations to avoid their disturbance or damage. When a cave-in occurs, excavate using casing, sleeving, or other methods, with the Engineer's approval. If subsurface obstructions are encountered, remove the obstructions, or replace the excavated material and relocate the foundation, with the Engineer's approval. If bedrock is encountered, the Contractor may reduce that portion of the specified foundation depth within the bedrock up to 50 percent. Perform all necessary dewatering of the excavation.

Perform foundation concrete work according to Item 511, except that the loading restrictions in 511.17 are modified by this subsection. Place the concrete

against undisturbed soil or compacted embankment. Form the top of the foundations to a nominal depth of 6 inches (150 mm) below the groundline. Place the concrete foundation, including formed top, in one continuous concrete pour.

For foundations for anchor base type supports, provide the required reinforcing rods, and have anchor bolts and conduit ells accurately held by a template.

Remove forms and templates once the concrete has hardened sufficiently so as not to be susceptible to damage. After 14 days, erect and load supports on anchor base foundations. The Contractor may erect and load supports after 7 days if the tests of two beam specimens of concrete yield an average modulus of rupture of not less than 650 pounds per square inch (4.5 MPa).

**632.15 Signal Support.** Furnish supports with mast arms with the required pole and arm length, anchor bolt circle diameter, and anchor bolt size.

Ensure that the combination signal supports with light pole extension provide for the attachment of a luminaire bracket arm.

For support designs not specifically shown on the plans, demonstrate, to the Director's satisfaction, that supports are structurally equivalent to the specified design.

Do not use concrete grouting in the space between the foundation surface and support base.

Conform to the requirements of 630.06 for threaded fasteners, anchor bolts, anchor bolt nuts, and anaerobic adhesive.

**632.16 Strain Pole.** Furnish strain poles for the attachment of messenger wire with the required pole length. Use anchor base type strain poles. Adjust anchor base type poles with the initial rake so that when loaded the poles assume an essentially vertical position.

Ensure that the combination strain poles with light pole extension provide for the attachment of a luminaire bracket arm.

Conform to the requirements of 630.06 for threaded fasteners, anchor bolts, anchor bolt nuts, and anaerobic adhesive.

Do not erect signal supports unless at least one signal, sign or dampening device approved by the Engineer is installed within 24 hours.

**632.17 Wood Pole.** Set wood poles in holes excavated by an earth auger to a minimum depth of 6 feet (1.8 m). Use an auger with a diameter approximately 4 inches (100 mm) greater than the pole butt. Hold poles with initial rake, up to a maximum of 12 inches (0.3 m), while tamping backfill into place, so that under messenger wire tensioning conforming to 632.22, the poles assume an essentially vertical position. Furnish backfill material no greater than 1 inch (25 mm) in size, and thoroughly tamp material in lifts not exceeding 6 inches (150 mm), to the satisfaction of the Engineer. If concrete embedment is specified, brace the poles until the concrete has set.

Liberalily coat field holes bored for the attachment of messenger or guy wire with approved creosote base paint and fitted with 5/8-inch (16 mm) thimble-eye

## 632.18

through-bolts and 3-inch (75 mm) washers. Securely attach and protect ground wire furnished as part of another work item with a wood or plastic molding for a minimum distance of 10 feet (3 m) above groundline.

**632.18 Down Guy Assembly.** Install and tension guy assemblies before erecting signals such that they will resist the major portion of the horizontal loading caused by loading of the messenger wire.

**632.19 Pedestal.** Furnish pedestals for the support of traffic control equipment with a cast or plate steel base, unless a transformer type base is specified.

**632.20 Conduit Riser.** Attach risers to poles to provide a wiring raceway and include a weatherhead, conduit, necessary fittings, and pole attached clamps. Attach risers to poles by clamps spaced at intervals not exceeding 5 feet (1.5 m). Paint conduit risers mounted on painted poles to match the poles.

**632.21 Cable Support Assembly.** Use cable support assemblies to eliminate strain on cables, or groups of cables up to a maximum of four, entering the interior of poles through a weatherhead or mast arm. If required, include a length of messenger wire forming a sling with ends formed of lapped wire, thimbles, and clamps as part of the assembly.

**632.22 Messenger Wire.** Arrange messenger wire with accessories between two or more poles to provide support and attachment for traffic control equipment. Accessories used with messenger wire include bullrings, thimbles, preformed guy grip dead ends, and three bolt clamps. Furnish bullrings at messenger wire network corners. Use thimbles to attach messenger wire to the shackles of strain pole clamps and bullrings.

Adjust the length of the messenger wire under the load of traffic control equipment so the sag at the lowest point is not greater than 5 percent or less than 3 percent of the span. Attach signal cable to messenger wire with lengths of preformed helical lashing rod that are of a proper internal diameter to tightly secure the cable to the messenger wire. Attach interconnect cable with preformed lashing rod or spinning wire.

**632.225 Tether Wire.** Arrange tether wire with accessories to stabilize signal heads and prevent excessive swinging. Accessories included with tether wire include anchor shackles, S-hooks yielding element, thimbles, turnbuckles, guy grips, wire rope clips, lock wire, safety tie wire, lead sheet, and signal head tether anchors and extenders.

Adjust the tether span to be horizontal on simple spans. On complex spans, the tether span shall be essentially parallel to the overlying messenger span. Bull Rings will be used at all internal corners of the tether span. Safety ties shall be installed at all yielding (S-hook) locations to prevent the span end from dropping into the roadway if the S-hook opens. No electrical or communication cables of any kind shall be attached to the tether wire. No signs or other devices shall be suspended from or attached to the tether wire.

**632.23 Cable and Wire.** Fashion cable at traffic signal equipment weatherhead entrance fittings into a drip loop that extends at least 6 inches (150 mm) below the entrance. Do not allow the cable to chafe on the equipment.

Support cables installed in strain poles and signal supports with cable support assemblies according to 632.21.

Do not use splices in any cable or wire, except at the following locations:

- A. At the junction of detector wire and lead-in cable.
- B. At the junction of power cable and the power supply source or service cable.
- C. On long lengths of interconnect or service cable.

For splices allowed in aerial installations, accomplish splicing in weather tight splice enclosures. For splices allowed in underground installations, accomplish splicing in pull boxes or poles where the splice is encapsulated with poured waterproof epoxy insulation according to 725.15.

Install signal cable between signal heads and controller cabinets, and install interconnect cable between controller cabinets of different intersections. Route signal and interconnect cable by aerial installation supported by messenger wire or within underground conduit. If specified, use aerial self-supporting integral messenger type interconnect cable with a figure "8" cross-section and include pole clamps and splice enclosures. Ground the supporting messenger wire of interconnect cable.

Provide loop detector wire consisting of detector wire inserted into flexible plastic tubing. Ensure that the tubing encases the wire continuously from the splice at the lead-in cable, through the entire loop turns, and back to the splice. Install loop detector wire in sawn roadway slots forming loops according to 632.11. Furnish the required number of turns of wire installed for each loop, and push the wire carefully into the slots with a blunt tool to avoid damaging the tubing. Run the wire continuously around the loop perimeter and through a slot leading to the pavement edge and by underground conduit to a roadside pull box or pole with 5 feet (1.5 m) at each end for slack and splice. Uniformly twist wires and tubing installed in the conduit to the splice with lead-in cable at 3 to 5 turns per foot (10 to 16 turns per meter). Splice the loop ends to lead-in cable, which is connected to the controller cabinet. Join the wires by a mutually twisted in-line splice, rosin core soldered, and wrapped in vinyl or equivalent electrical tape, and encapsulate wires with an approved poured waterproof epoxy insulated splice according to 725.15. Extend and seal the tubing ends into the poured epoxy splice. Also, solder crimped terminals to the conductors and the shield for connections inside the cabinet.

For magnetometer sensor probe installations, splice the leads from the probes to the specified lead-in cable by the same method. Route lead-in cable within underground conduit or by aerial installation supported by messenger wire.

Install power cable from the power supply source to the controller cabinet. If multi-conductor power cable is specified, the Contractor may substitute multiple single conductors.

Install service cable aerially from a remote power source to the vicinity of the controller cabinet with the support cable functioning as the electrical neutral. Furnish connections used with aluminum power or service cable of an approved

type for aluminum to aluminum or aluminum to copper connections, and insulate connections with an approved vinyl mastic pad.

**632.24 Power Service.** Furnish and install all equipment necessary to provide complete electrical service to each signal installation as shown on the plans. Make all necessary arrangements with the local electrical power company for connections to establish electrical service. Charges made by the power company for establishing of the account, extension of company facilities, connection of customer equipment to the power company facilities and energy will be borne by the maintaining agency.

Power service consists of equipment to provide a pole attached wiring raceway and disconnect switch for use with power cable routed from the service entrance to the controller cabinet. The power service installation includes a weatherhead, conduit and fittings, a disconnect switch with enclosure, meter base and attachment clamps.

Bend the conduit away from the pole at the top and bottom of the riser to allow the conduit to enter straight into the enclosure or meter base hub, and to provide space for the weatherhead when the riser is pulled tight against the pole. Furnish watertight conduit connections between the meter base and enclosure by using conduit hubs listed on the enclosure UL label.

Paint conduit risers mounted on painted poles to match the poles.

**632.25 Covering of Vehicular and Pedestrian Signal Heads.** Cover vehicular signal heads if erected at intersections where traffic is maintained before energizing the signals. Cover pedestrian signal heads when specified in the plans. Use a sturdy opaque covering material and method of covering and cover attachment as approved by the Engineer. Maintain covers, and remove and dispose of them when directed by the Engineer.

**632.26 Removal of Traffic Signal Installation.** Remove signal heads, cable, messenger wire, strain poles, cabinet, controller, or other incidental items required by the Engineer. Remove support foundations to at least 1-foot (0.3 m) below subgrade or finished groundline. Backfill, restore surfaces, and dispose of surplus material according to 603.12. Store removed items on the project for salvage by the maintaining agency, or reuse removed items as part of a new installation on the project under another item of work. Dispose of all items not designated for salvage or reuse. As specified in 614.03, do not remove signals until a new signal system or a temporary traffic control method approved by the Engineer is in operation. Suitably protect stored equipment.

**632.27 Reuse of Traffic Signal Equipment.** Reinstall or re-erect specified traffic equipment, removed from existing signal installations within the project. Clean and restore reused equipment to an operating condition, and relamp signals with the proper type and size lamp. Furnish all additional hardware and incidentals necessary to allow reuse of the equipment.

**632.28 Testing.**

**A. General.** Furnish all personnel and equipment required to successfully perform the following tests, and furnish to the Engineer six certified copies of

complete test records, test reporting forms supplied by the Engineer, or alternate certification approved by the Engineer.

**B. Ground Test.** Measure each ground rod for earth resistance according to 625.19, except that measurements are not necessary immediately after installation.

**C. Short-Circuit Test.** Before performing any cable insulation tests or performance test, perform a short-circuit test with a volt-ohmmeter or other approved instrument. Conduct short-circuit tests with electrical loads, power sources, equipment grounds, and earth grounds disconnected. Test signal cable routed to signal heads with connections made to lamp sockets without lamps installed. Measure each conductor against every other conductor and ground to ensure that no short-circuits, cross-circuits, or other improper connections exist. Ensure that continuity does not exist between any conductor and another conductor including ground.

**D. Circuit Continuity Test.** Temporarily jumper each circuit branch at its termination and the temporarily looped circuit measured for continuity to ensure that no open circuits exist, that the circuit branch is according to plan, that no high resistance connections exist, and that each circuit is properly identified. Test the lead-in cable for loop detector wire before and after splicing the cable to the loop wire. As an alternative, perform the circuit continuity testing of signal head cable by applying 120 volts to each outgoing circuit and observing that only the proper lamps are lighted.

**E. Cable Insulation Test.** Ensure that the insulation resistance measured to ground is not less than 10 megohms for each conductor of cable or wire terminating at the controller cabinet. Perform insulation testing with all conductors disconnected from their points on the terminal blocks. Measure insulation resistance for the wire of roadway loops after the embedding of the wire with sealant in slots. Include a list of the resistance readings for each conductor in the test results. After completing the cable insulation test, connect all cabinet wiring according to the wiring diagram. Demonstrate to the satisfaction of the Engineer that all circuits are continuous and operating correctly with freedom from shorts, crosses, and unintentional grounds.

**F. Functional Test.** Before the 10-day performance test begins, make the following checks and demonstrate to the Engineer that the system is ready for the performance test. Ensure that the incoming AC voltage is a nominal 120 volts. If the supplied voltage under load is less than 100 or more than 130 VAC, contact the power company to arrange correction. Ensure that the cabinet ventilating fan, fan thermostat, and convenience outlet with lamp is operational. Correct timing settings on the controller as shown on the plans. Check all cabinet switches including the power on/off switch and flash switch. Check all controller functions to verify correct operation. Check the detector units to determine which pavement loop is associated with which detector unit. Check the visual indication of detector units to determine that each vehicle class (truck, car, or motorcycle) entering sensor areas is detected on the associated detector unit and that no extraneous calls occur when the sensor area is vacant. Check the flash switch to verify transfer of signal operation to flash and return to stop-and-go. Check the conflict monitor to verify that it is not activated by normal signal operations or by the manipulation of

cabinet switches. If the monitor is activated, determine the cause of the problem and make appropriate changes and adjustments before beginning the performance test. Test the conflict monitor by artificially causing a number of different conflicting indications, and verify that at each test the monitor causes the signals to begin flashing and places the controller in a “stop timing” mode. Obtain artificial causation either by touching a jumper wire between two conflicting load switch outputs or by other methods approved by the Engineer. Ensure that the signal flashes when the monitor is disconnected.

**G. Performance Test.** At least 7 days before the performance test begins, notify the Engineer of the starting date. The Engineer will notify the maintaining agency. Before acceptance, operate the traffic control system continuously for 10 consecutive days without major malfunction or failure. Immediately replace or repair minor failures (such as lamps, a single detector unit, or an individual signal head, etc.) that do not cause restart of the test. Major malfunctions or failures (such as a master or local controller, interconnect equipment, etc.) will cause termination of the test and, after replacement or repair, the beginning of a new 10-day test. Monitor items that have been repaired or that are replacements for a 10-day period to provide assurance of their reliability. Record, for inclusion in the test result, the method and date of correction of each fault, and the beginning and end of the test.

**632.29 Method of Measurement.** The Department will measure Vehicular Signal Head and Pedestrian Signal Head by the number of complete units, and will include all support or mounting hardware, disconnect hangers, closure caps, dimmers, and lamps as required. Optically programmed heads shall include programming. For programming purposes, 8-inch (200 mm) programmed heads shall include one extender tool per project.

The Department will measure Pedestrian Pushbutton by the number of individual units, and will include pedestrian pushbutton signs.

The Department will measure Loop Detector Unit by the number of individual units, adjusted and tuned, and will include a wiring harness. If multi-channel detector units are used, the Department will consider each channel as an individual detector unit up to the number of units specified.

The Department will measure tether wire by the number of feet (meters) in place, and will include all necessary accessories such as anchor shackles, S-hooks yielding element, thimbles, turnbuckles, guy grips, wire rope clips, lock wire, safety tie wire, lead sheet, and signal head tether anchors and extenders. The Department will measure from pole center to pole center, or pole center to bullring, or bullring to bullring. The Department will not measure any length of tether wire for attachment to poles or bullrings by bending, lapping or wrapping.

The Department will measure Detector Loop by the number of complete detector loops installed in the pavement, and will include pavement cutting, loop detector wire with tubing in place, application of sealant, conduit, trenching, backfilling, and surface restoration from the edge of pavement to the pull box.

The Department will measure Strain Pole Foundation, Signal Support Foundation, and Pedestal Foundation by the number of complete units, and will

include excavation, dewatering, sleeving, casing, reinforcing steel, concrete, backfilling, disposal of surplus excavation, and installation only of anchor bolts and conduit ells.

The Department will measure Signal Support, Combination Signal Support, Strain Pole, Combination Strain Pole, Wood Pole, and Pedestal by the number of complete units of each, and will include pole arms, weather-heads and blind half couplings, anchor bolts and conduit ells furnished for foundations.

The Department will measure Down Guy by the number of individual units, and will include messenger wire, pole clamp or thru-bolt, washer, clamps, guy grips, insulator, guy guard, and anchor.

The Department will measure Conduit Riser by the number of complete units, and will include weatherhead, conduit, fittings, clamps, and hardware.

The Department will measure Messenger Wire by the number of feet (meters) in place, and will include all necessary accessories such as, grips, thimbles, clamps, bullrings, and lashing rod. The Department will measure from pole center to pole center, or pole center to bullring, or bullring to bullring. The Department will not measure any length of messenger wire for attachment to poles, or bullrings by bending, lapping, or wrapping.

The Department will measure Signal Cable, Interconnect Cable, Loop Detector Lead-In Cable, Power Cable, and Service Cable by the number of feet (meters) in place. Cable inside of poles shall include cable support assemblies. Aerial cable shall include pole attachment hardware, splices, splice enclosures, and ground connection. Lead-in cable shall include poured epoxy insulated splices. The Department will measure: (1) horizontally from center-to-center of pull boxes, poles, cabinets, power sources, and signal heads with an additional allowance of 5 feet (1.5 m) at each pull box and terminating points for slack and connections; and (2) vertically between pole or conduit outlets. If single-conductor power cable is substituted for multi-conductor cable, the Department will measure required length of multi-conductor cable.

The Department will measure Power Service by the number of complete units, and will include weatherhead, conduit, fittings, clamps and other necessary hardware, installation of meter base, ground wire connection, and disconnect switch with enclosure.

The Department will measure Covering of Vehicular Signal Head and Covering of Pedestrian Signal Head by the number of individual signal heads covered, and will include materials and labor to erect, maintain, and remove the covering.

The Department will measure Removal of Traffic Signal Installation by the number of installations removed, and will include storage when required.

The Department will measure Removal of (*Item*) and (*Storage or Reerection*) by the number of specific traffic signal installation parts (such as a signal head, controller unit, or pole) removed, and will include storage when required.

The Department will measure Reuse of (*Item*) by the number of traffic signal equipment items reused, and will include cleaning, restoring, and relamping.

**632.30**

**632.30 Basis of Payment.** The costs to arrange service by the supply agency are included under Power Cable.

The costs of personnel, materials, equipment, electrical energy, and incidentals required to conduct performance tests are included under the contract unit price for the respective items tested.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
632	Each	Vehicular Signal Head, ( <i>LED</i> ), (Yellow or Black), ___-Section ___ inch (___ mm) Lens ___-Way (with Backplate)
632	Each	Vehicular Signal Head, Optically Programmed, (Yellow or Black) ___-Section, ___ inch (___ mm) Lens, ___-Way (with Backplate)
632	Each	Pedestrian Signal Head, ( <i>LED</i> ), (Countdown), Type ___
632	Each	Pedestrian Pushbutton
632	Each	Loop Detector Unit
632	Each	Detector Loop
632	Each	Strain Pole Foundation
632	Each	Signal Support Foundation
632	Each	Pedestal Foundation
632	Each	Signal Support, Type TC-___, Design ___
632	Each	Combination Signal Support, Type TC-___, Design ___
632	Each	Strain Pole, Type TC-___, Design ___
632	Each	Combination Strain Pole, Type TC-___, Design ___
632	Each	Wood Pole, Class ___, ( <i>Length</i> )___ feet (___ m)
632	Each	Down Guy
632	Each	Pedestal, ( <i>Length</i> ) ___ feet (___ m)
632	Each	Pedestal, ( <i>Length</i> ) ___ feet (___ m),Transformer Base
632	Each	Conduit Riser, ___ inch (___ mm) Dia.
632	Foot (Meter)	Messenger Wire, ( <i>No.</i> ) Strand ___ inch (___ mm) Dia., with Accessories
632	Foot (Meter)	Signal Cable, ___- Conductor, ___ AWG
632	Foot (Meter)	Interconnect Cable, ___- Conductor, ___ AWG
632	Foot (Meter)	Interconnect Cable, Integral Messenger Wire Type, ___-Conductor, ___ AWG
632	Foot (Meter)	Loop Detector Lead-In Cable
632	Foot (Meter)	Power Cable, ___- Conductor, ___ AWG
632	Foot (Meter)	Service Cable, ___- Conductor, ___ AWG

632	Each	Power Service
632	Each	Covering of Vehicular Signal Head
632	Each	Covering of Pedestrian Signal Head
632	Each	Removal of Traffic Signal Installation
632	Each	Removal of <i>(Item)</i> and <i>(Storage Or Reerection)</i>
632	Each	Reuse of <i>(Item)</i>
632	Foot (Meter)	Tether Wire, with Accessories

## ITEM 633 TRAFFIC SIGNAL CONTROLLERS

### 633.01 Description

### 633.02 Contractor Personnel Requirements

### 633.03 Materials and Equipment

### 633.04 Certified Drawings

### 633.05 General

### 633.06 Testing and Prequalification

### 633.07 Controllers

### 633.08 Cabinets

### 633.09 Cabinet Riser

### 633.10 Foundations

### 633.11 Controller Work Pad

### 633.12 Flasher Controller

### 633.13 Controller, Master, Traffic Responsive

### 633.14 Remote Monitoring Station

### 633.15 Telephone Service

### 633.16 Training

### 633.17 System Analysis

### 633.18 Uninterruptible Power Supply

### 633.19 Method of Measurement

### 633.20 Basis of Payment

**633.01 Description.** This work consists of furnishing and installing traffic signal control equipment, including controllers, cabinets, auxiliary equipment, and specified accessories, completely wired, at the locations shown on the plans and ready for service.

**633.02 Contractor Personnel Requirements.** Conform to the requirements of Supplement 1063 for the installation or testing of traffic signal equipment.

**633.03 Materials and Equipment.** Furnish new materials and equipment of first quality, of current design, and free from defects.

Use electrical parts, wire, switches, and other elements of the installation capable of carrying the required current without excessive heating or drop of potential.

**633.04**

Ensure that each item of equipment bears a nameplate, indelible marking, or brand that identifies the type, model, catalog number, and manufacturer. Use equipment conforming to the types, models, and systems specified.

Furnish material and equipment conforming to:

Concrete	
(cabinet foundations and work pads).....	499, 511
Conduit.....	725.04, 725.051, 725.052
Controller unit.....	733.02
Cabinet and auxiliary equipment.....	733.03
Cabinet riser.....	733.04
Flasher controller.....	733.05
Controller, master, traffic responsive.....	733.06
Remote monitoring station.....	733.07
Telephone service.....	733.08
Uninterruptible Power Supply.....	733.09

**633.04 Certified Drawings.** Furnish certified drawings according to 625.06.

**633.05 General.** Ensure that major items of traffic signal control equipment used in combination are compatible, interchangeable, and, whenever feasible, provided by the same manufacturer or supplier.

Ensure that controller cabinets are shop prewired according to 632.05.

Before starting installation, furnish to the Engineer, two copies of each cabinet wiring diagram, service manuals, and installation and maintenance instructions for each installation, including all components and interconnections. Supply one additional copy of the cabinet wiring diagrams in a clear plastic pouch fastened to the inside of the controller door. Before beginning the 10-day performance test, replace or modify these documents as necessary to reflect current conditions. Upon completion of the work and before its acceptance, replace or modify the documents as necessary.

Transfer manufacturers' guarantees or warranties on all installed traffic signal control equipment to the maintaining agency upon completion and acceptance of the project.

If required by the plans to install equipment furnished by others, store and care of the equipment upon receipt.

**633.06 Testing and Prequalification.** For all traffic control equipment, perform functional tests and a 10-day performance test according to 632.28. Do not clear conflict monitor logs during the 10-day test. Ensure that logs note power-up to start the test and all events until the test is complete. Restart the test upon correcting a noted event. Notify the Engineer at least 3 days before beginning the 10-day performance test. The Engineer will notify the maintaining agency of the beginning of the test. Ensure that the following testing and prequalification requirements are met:

A. For traffic control equipment required by this specification to meet NEMA Standards Publication TS-1 or TS-2, conform to the following:

1. Furnish a certified test report indicating compliance to all requirements of NEMA Standards Publication TS-1 or TS-2 as applicable.

2. Furnish the name and location of the laboratory testing facility as well as the identification of the principal personnel who conducted the equipment testing and a summary of their qualifications.

3. Ensure that the laboratory provides Department representatives access to those parts of the laboratory where the testing was done.

4. Upon request, furnish a copy of the actual test data results for review and analysis.

B. For traffic control equipment required by this specification to meet CalTrans specifications, use a product or manufacturer as stated in this specification that is listed on the CalTrans Qualified Products List.

C. For Type 170/2070 controllers, use conflict monitors listed on the Department's prequalified list as specified in Supplement 1076.

**633.07 Controllers.** Install controller units, consisting of the timing unit, software, and signal timing, into the specified type of prewired cabinet.

Program controller units as shown on the plans unless otherwise directed by the Engineer. If the plan timing data or the supplemental timing data supplied by the Engineer does not exactly fulfill the timing requirements of the installed equipment, notify, in writing, the Engineer of the problem and identify the discrepancies. The Engineer will consult with the maintaining agency and notify the Contractor within 2 weeks. After programming, briefly operate controllers, with the signals turned off by means of the signal shutdown switch, to ensure that operation is reasonable and conforms to the plans.

If the plans show two or more intersection controllers operated in a progressive signal system, coordinate signals by relating the various controller cycle start times to a zero time base, or other cycle start time at an adjacent signalized intersection. Ensure that the controller unit software provides coordination capability to allow associated controllers to be operated within the progressive traffic system. Coordination equipment shall supervise the operation of its associated controller by causing the end of certain phases and the beginning of the following phases to occur at set points. Program coordination timing according to the coordination timing data shown on the plans or provided by the Engineer.

**633.08 Cabinets.** Mount cabinets by attaching to pedestal or pole or by installing on a concrete foundation. Arrange foundation mounted cabinets so that control equipment, terminal blocks, or shelves are no closer than 6 inches (150 mm) to the top of the foundation. Attach pole or pedestal mounted controller cabinets at a height that allows convenient access to all controller components by service personnel.

Make field connections for the conductors of signal cable, power cable, interconnect cable, and detector lead-in cable. Neatly arrange and route all field wiring to the appropriate terminal blocks. Identify field wiring according to 725.02 except mark with either indelible pen or embossed letters.

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Except for power wiring, fit field wiring entering the cabinet with spade terminals to ensure a good connection. For incoming power wiring, either use spade terminals or connect the bare conductor wire to terminal points utilizing screw or spring applied clamping surfaces compatible with either copper or aluminum wire and providing a positive grip. After completing field wiring, seal the conduit entering the cabinet in an approved manner with a removable sealing compound (no foam sealants), or a molded plastic or rubber device that is compatible with the cable jacket, the insulation, and the conduit material.

For foundation mounted cabinets, seal the joint between the controller cabinet and the foundation with a quality, clear silicone caulk.

When future phasing configurations are shown on the plans, furnish the cabinet and hardware to accommodate the future operation through only the future addition of load switches and detector units.

**633.09 Cabinet Riser.** Cabinet risers provide an extension of the cabinet between the ground mounted cabinet and the foundation. Bolt the riser to the foundation, and bolt the cabinet to the riser.

Use a type (size and shape) of cabinet riser compatible with the type of controller cabinets specified for the project.

Seal the joints between the controller cabinet and cabinet riser, and between the cabinet riser and foundation with a quality, clear silicone caulk.

**633.10 Foundations.** Construct foundations for controller cabinets according to 632.14, except that excavation by earth auger is not required and the foundation does not require reinforcing steel. Hold anchor bolts, conduit ells, and similar appurtenances in the proper position until the concrete has set. Pour foundations separately from controller work pad.

**633.11 Controller Work Pad.** Construct controller work pad according to 608.03, except that transverse joints are not required. Provide the top of the pad nominally 1 inch (25 mm) above ground line. If the controller cabinet has both front and back doors, the work pad shall encompass three sides of the cabinet foundation to include the non-hinged cabinet door side of the foundation. Pour controller work pad separately from foundations.

**633.12 Flasher Controller.** Furnish and install a flasher controller with cabinet and mounting hardware when indicated. The flasher controller is for the operation of flashing beacons.

**633.13 Controller, Master, Traffic Responsive.** The traffic responsive master controller supervises and controls the operation of an interconnected system of local controllers. Ensure that the master controller is able to communicate with a remote monitoring station. Locate this master controller in a local intersection controller cabinet unless otherwise shown on plans. If the local controller cabinet size is not sufficient to accommodate the master controller and its associated wiring, furnish the proper size cabinet for the local intersection controller to house the local controller, master controller, modem, and all auxiliary devices.

**633.14 Remote Monitoring Station.** Install, test, and operate the remote monitoring station, consisting of computer equipment, communications equipment,

and software, in one or more locations in the maintaining agency's facilities as shown on the plans. The maintaining agency shall furnish telephone service at these stations.

**633.15 Telephone Service.** Make arrangements with the local telephone company to have telephone service furnished to intersection cabinet locations shown on the plans. Maintain the telephone account until the signal system has been tested and accepted by the Engineer. After acceptance of the signal system, transfer the telephone account to the maintaining agency.

Furnish and install a minimum size 1-inch (25 mm) conduit, twisted pair, shielded telephone cable, and conduit risers necessary to bring the telephone line from the telephone company service location into the controller cabinet. Furnish and install the modem and the lightning protection for the telephone lines in the controller cabinet.

**633.16 Training.** Furnish training for the traffic signal control equipment installed as part of the Contract. Furnish all handouts, manuals, and product information. For the training, use the same models of equipment furnished for the project. The maintaining agency shall furnish the facilities in which the training will take place. Furnish all media and test equipment needed to present the training. Unless otherwise shown on the plans, the minimum training requirements are as follows:

- A. Sixteen hours on how to operate the system, analyze system performance, and revise critical operating parameters.
- B. Eight hours of field trouble-shooting and maintenance procedures.
- C. Eight hours of follow-up training after the maintaining agency has operated the system for a minimum period of 30 days.
- D. Four hours for preemption device training if emergency vehicle preemption is shown on the plans.

**633.17 System Analysis.**

**A. General.** Prepare signal timing and traffic progression programs, load the programs into the signal system, evaluate the performance of the system, and refine the programs as necessary to optimize traffic flow and operation. Collect and evaluate traffic data, analyze traffic signal progression and timing, develop traffic adjusted pattern selection parameters, perform the system evaluation and refine the system operation, and prepare and submit a summary report for review and approval by the Engineer.

If a project contains individual sub-systems that are connected to the remote monitoring station, perform all work as outlined in this subsection for each sub-system. If required, analyze signal "sub-systems" together and coordinate traffic progression programs to optimize the overall traffic flow between the various sub-systems.

Optimize only the cycle lengths, phase splits, permissives, and offsets without changing the actual controller phasing provided in the plan.

**B. Systems Engineer or Technician.** Employ a systems engineer or technician to perform the work required by this subsection and submit to the Engineer for approval three copies of a resume documenting the following qualifications:

1. A minimum of 5 years experience in traffic engineering or traffic engineering technology.
2. The systems engineer or technician's education including training in traffic engineering technology and signal system design.
3. The systems engineer or technician's familiarity with the closed loop system installed and experience in setting up and fine tuning a system of that type. Furnish a list of other closed loop systems that the systems engineer or technician has programmed into the traffic responsive mode for documentation purposes.

Also, submit to the Engineer for approval a brief description of proposed methodology of data collection and analysis of:

- a. System parameter usage in system evaluation.
- b. Frequency and measurement of travel time and delay.
- c. Comparison of actual versus system measurements of delays (level of service).

The systems engineer or technician, under authority of the Contractor, is responsible for the operation of the system from the completion of the signal system acceptance until completion and acceptance of the final summary report by the Engineer. The systems engineer or technician shall provide a 24-hour emergency phone number and shall respond to system related problems as deemed necessary by the Engineer 24 hours a day, 7 days a week. If there is a guarantee period, the Engineer reserves the right to request a systems analysis throughout the entire duration of this period, if new or continuing problems occur with the operation of the traffic responsive system.

The Engineer reserves the right to request that the Contractor furnish a new systems engineer or technician if the current systems engineer or technician fails to perform the required duties in a timely and professional manner or fails to have a firm understanding of the operation and programming of the closed loop system constructed.

**C. Traffic Programs.** The systems engineer or technician shall develop signal progression and timing programs from count and occupancy data obtained from the local intersection and system loop detectors, supplemented by field counts and measurements as required. The systems engineer or technician shall develop the following signal progression programs and parameters:

1. Three inbound preferential (a.m. peak).
2. Three outbound preferential (p.m. peak).
3. Three average (off peak). The three average programs should utilize varying cycle lengths based on traffic volume, density, and occupancy to minimize overall intersection approach delay time.
4. Two special programs for either high congestion or queue backup.

5. A minimum of three timing plans for a back up time base coordinated system. The systems engineer or technician shall program the timing plans into the system, to supplement the timing plans shown on the plans.

6. Define system parameters that enable the system to automatically transfer into a “free operation” mode during light traffic volume periods and to automatically transfer to a computer selected coordinated mode during heavy traffic volume periods. The systems engineer or technician shall establish the following system parameters:

- a. Volume, occupancy and directionality thresholds.
- b. Transition smoothing factors.
- c. System detector assignment.
- d. System detector weighting.

The systems engineer or technician may use the software provided with the remote monitoring station to help assist in the analysis of the operation of the closed loop system.

**D. System Travel Time Studies.** The systems engineer or technician shall conduct a series of travel time studies for each system or sub-system artery constructed as part of the project, to measure the time it takes to travel from 0.25 mile (0.4 km) in advance of the beginning of each system or sub-system to 0.25 mile (0.4 km) after the end of that system or sub-system, in each direction. Ensure that the travel time study parameters are based on the posted speed limit; however, be aware that during peak periods it may not be possible to obtain the posted speed due to larger traffic volumes.

The systems engineer or technician shall conduct four separate sets of travel time studies for each of the following field conditions:

1. Before beginning construction, with the existing signal system in operation (no lane closures shall be in effect during this analysis).
2. Before implementing the traffic responsive mode, while the new traffic signal system is operating under the “time of day” mode (as is shown on the plans).
3. After placing the system(s) in the traffic responsive mode.
4. After the system operation meeting and making final system adjustments.

Each set of travel time studies shall include a minimum of five runs through the system per direction. The systems engineer or technician shall conduct travel time studies during good weather conditions (i.e., no snow, rain, or fog). The Engineer may omit the pre-construction travel time studies if the project includes substantial changes to the roadway geometrics (i.e., roadway widening, reconfiguring of pavement markings, etc.) that would affect the results of a comparison of the level of improvement over preexisting conditions.

The four separate sets of travel time studies shall include the following:

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1. Conduct the first set of travel time studies between the hours of 7:00 a.m. and 9:00 a.m. on weekdays.
2. Conduct the second set of travel time studies between the hours of 11:30 a.m. and 1:00 p.m. weekdays.
3. Conduct the third set of travel time studies between the hours of 4:00 p.m. and 6:00 p.m. weekdays.
4. Conduct the fourth set of travel time studies during any of the following non-peak hour periods:
  - a. 9:00 a.m. to 11:00 a.m. Monday through Saturday.
  - b. 7:00 p.m. to 10:00 p.m. Monday through Saturday.
  - c. 7:00 a.m. to 10:00 p.m. Sunday.

The systems engineer or technician shall furnish a written report documenting, at a minimum, the date of travel time study, day of week, time of day, total time of travel, and total time the vehicle was stopped for each trip.

The systems engineer or technician shall use the reports furnished from each of the four field conditions for which system travel time studies are prepared as one means of measuring the efficiency of the new system.

**E. Draft System Summary Report.** The systems engineer or technician shall prepare a draft system summary report after travel time studies for the first three field conditions are performed. Submit two copies each to the Engineer and the maintaining agency(s) of the signal system for the evaluation and review of the system programming, operation, and efficiency.

The report shall summarize the signal progression and timing programs that were entered into the system. The report shall also include a copy of the systems log after operating in the traffic responsive mode to verify the number of programs used throughout the day as well as the frequency of program changes. The systems engineer or technician shall provide a minimum of at least 4 days of systems logs. The systems engineer or technician shall limit three of the four logs to the weekdays of Monday through Friday; the fourth log shall be on a Sunday. The systems engineer or technician shall include copies of all data and analysis calculations for the system timing in the report. The draft system summary report shall include an evaluation of the system operation, efficiency, and performance and copies of all travel time study data.

**F. System Operation Meeting and Final System Summary Report.** After the draft system summary report has been submitted, the Engineer will schedule a meeting that includes the systems engineer or technician, the Contractor, the Engineer, and representative(s) from the maintaining agency(s) to discuss the operation of the traffic responsive closed loop signal system. This meeting shall occur within 4 weeks after the draft system summary report has been submitted to the Engineer and maintaining agency(s).

The purpose of this meeting is to discuss the operation of the traffic responsive closed loop signal system and to receive comments and recommendations from the Engineer and/or the maintaining agency(s) regarding

potential modifications to the operation of the system. The systems engineer or technician shall answer questions regarding the system summary report as well as the operation of the closed loop system.

The systems engineer or technician shall make final adjustments to the system as directed by the Engineer to address any concerns discussed at this meeting. The systems engineer or technician shall perform the final travel time study before submitting the final report. The systems engineer or technician shall submit one copy of a final system summary report to the Engineer and one additional copy for each maintaining agency for review and approval. The final report shall include any revisions to the draft report that are required as a result of the system operation meeting.

**633.18 Uninterruptible Power Supply (UPS).** Furnish and install a Battery Backup UPS system to provide uninterruptible, reliable, emergency power to a traffic signal intersection in the event of a power failure or interruption. The transfer from utility power to battery power shall not interfere with the normal operations of the traffic controller, conflict monitor or any other peripheral devices within the traffic control system. The system shall be self-contained including all UPS hardware, the required number of batteries and its own separate ventilated enclosure.

**633.19 Method of Measurement.** The Department will measure Controller Unit, Type \_\_\_\_, with Cabinet, Type \_\_\_\_ by the number of each complete unit, and will include controller unit with software, all required auxiliary equipment, loop detector units, and a prewired cabinet, with all items completely wired and tested. Ground mounted cabinets will include anchor bolts and conduit ells for installation in the foundation. Pole mounted cabinets will include pole mounting hardware.

The Department will measure Controller Unit, Type \_\_\_\_ by the number of each controller timing unit with software, and will include any signal timing programming or installation. The Department will measure Controller Unit, Type \_\_\_\_, Furnish Only by the number of each controller timing unit with software, and will exclude any signal timing programming or installation.

The Department will measure Cabinet, Type \_\_\_\_ by the number of each complete prewired cabinet installed, and will include all required auxiliary equipment and loop detector units (excluding controller unit), with all items completely wired and tested. Ground mounted cabinets will include anchor bolts and conduit ells for installation in the foundation. Pole mounted cabinets will include pole mounting hardware. The Department will measure Cabinet, Type \_\_\_\_, Furnish Only by the number of each complete prewired cabinet, and will include pole mounting hardware and anchor bolts, but will exclude installation, controller unit, and detector units.

The Department will measure Cabinet Riser by the number of each unit, and will include materials, mounting hardware, and installation.

The Department will measure Cabinet Foundation and Controller Work Pad by the number of each complete unit, in place, complete and accepted, and will include excavation, concrete, backfilling, and disposal of surplus excavation. Cabinet foundation will include preformed joint filler between the foundation and

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adjacent paved areas. One complete Controller Work Pad unit may encompass several sides of a controller cabinet installation.

The Department will measure Flasher Controller by the number of each complete flasher assembly with cabinet installed and tested.

The Department will measure Controller, Master, Traffic Responsive by the number of each unit, and will include installation, signal system software, programming, and any increase in cabinet size to house the master controller in the local intersection cabinet. The Department will measure Controller, Master, Traffic Responsive, Furnish Only by the number of each unit, and will include software, but exclude any programming or installation.

The Department will measure Remote Monitoring Station by the number of each location shown on the plans, and will include all equipment, testing, and software.

The Department will measure Telephone Service by the number of each location shown on the plans for furnishing telephone service to an intersection controller, and will include the modem, conduit, trenching, and wiring.

The Department will measure Training on a lump sum basis, and will include providing the instruction materials, instructor travel expenses, and test or media equipment for presenting the training material.

The Department will measure System Analysis on a lump sum basis, and will include providing all materials, labor, software, printing reports, and incidentals to analyze all traffic responsive sub-systems included in the project.

The Department will measure Uninterruptible Power Supply by the number of each and will include all equipment, testing and certifications.

**633.20 Basis of Payment.** If a project contains individual sub-systems that are connected to the remote monitoring station, the cost for performing work, as specified in 633.17 is incidental to the bid item price for System Analysis.

The costs to obtain and maintain telephone service by the supply agency are included under Telephone Service.

The Department will pay for accepted quantities at the contract unit prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
633	Each	Controller Unit, Type ____, with Cabinet, Type __
633	Each	Controller Unit, Type __
633	Each	Controller Unit, Type ____, Furnish Only
633	Each	Cabinet, Type __
633	Each	Cabinet, Type ____, Furnish Only
633	Each	Cabinet Riser
633	Each	Cabinet Foundation
633	Each	Controller Work Pad
633	Each	Flasher Controller
633	Each	Controller, Master, Traffic Responsive

633	Each	Controller, Master, Traffic Responsive, Furnish Only
633	Each	Remote Monitoring Station
633	Each	Telephone Service
633	Lump	Training
633	Lump	System Analysis
633	Each	Uninterruptible Power Supply

## ITEM 638 WATER MAINS AND SERVICE BRANCHES

### 638.01 Description

### 638.02 Materials

### 638.03 Notification

### 638.04 Excavation

### 638.05 Pipe Bedding

### 638.06 Pipe Laying

### 638.07 Pipe Joints

### 638.08 Backfilling

### 638.09 Hydrostatic Tests

### 638.10 Disinfection of Completed Water Work

### 638.11 Steel Pipe Encasement

### 638.12 Polyethylene Encasement

### 638.13 Valves and Equipment

### 638.14 Fire Hydrant

### 638.15 Fire Hydrant Adjusted

### 638.16 Service Branches

### 638.17 Meter and Chamber Removed and Reset

### 638.18 Valve Box and Service Box Adjusted to Grade

### 638.19 Method of Measurement

### 638.20 Basis of Payment

**638.01 Description.** This work consists of constructing water mains and service branches, including fire hydrants, water meters, corporation stops, service boxes, service stops, valves, fittings, and valve boxes, and includes:

- A. Excavation for items and preparation of the foundations, necessary for placing water mains and service branches, including fire hydrants, water meters, corporation stops, service boxes, service stops, valves, fittings, and valve boxes.
- B. Furnishing and placing bedding and backfill.
- C. Constructing and subsequently removing all necessary cofferdams, bracing, cribs and sheeting.
- D. Pumping and dewatering.
- E. Providing all joints as shown on the plans.
- F. Furnishing and installing all necessary bends and branches.
- G. Furnishing and installing all necessary tracer tape.

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H. Joining to existing and proposed appurtenances as required in the project plans.

I. Performing all necessary test (leakage test, disinfections, hydrostatic).

J. Restoration of disturbed underground facilities.

K. Constructing all required blocking and wedging and/or thrust blocking.

L. Furnishing and installing all necessary restraining of joints and fittings.

M. Cutting and plugging as required existing water mains to be abandoned.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

**638.02 Materials.** Furnish materials conforming to:

Pipe, joints, and fittings.

Ductile iron pipe, joints, and fittings .....	748.01
Polyvinyl chloride (PVC) pipe, joints, and fittings .....	748.02
Polyethylene (PE) service branches and fittings.....	748.03
Copper service branches and fittings.....	748.05
Steel pipe encasement .....	748.06
Polyethylene encasement .....	748.07

Valves and equipment.

Gate valve and valve box .....	748.08
Inserting valve and valve box.....	748.09
Cutting-in sleeve, valve and valve box.....	748.10
Tapping sleeve, valve and valve box.....	748.11
Tapping saddle and corporation stop.....	748.12
Service stop and service box .....	748.13
Meter, setting, stop and chamber.....	748.14
Fire hydrant .....	748.15

Miscellaneous.

Granular Material .....	605.02
Disinfectant .....	AWWA
Pipe bedding .....	603.02
Concrete, Class C.....	499 and 511
Soil and granular embankment.....	203.02
Structural backfill, Types 1, 2, and 3.....	703.11
Mortar .....	602

The Engineer will allow Type 3 structural backfill, conforming to 703.11, to be used as bedding below the pipe only when pumping operations do not control severe ground water problems. Place at least 12 inches (300 mm) of Type 1 structural backfill on top of the Type 3 structural backfill to prevent piping.

The metric equivalent pipe size may vary with material type for the same English size pipe.

**638.03 Notification.** Notify the Engineer and maintaining agency of the following:

- A. The dates scheduled for testing and for disinfections of mains and branches.
- B. Any clearances less than 1 foot (0.3 m) between new mains and existing pipes, sewers, and structures.

**638.04 Excavation.** Excavate according to Item 603 with the following additions:

- A. Excavate the trench a suitable distance in advance of pipe laying to ensure proper clearance between the waterline and any utility crossing or underground structure. Suitably brace and support utilities and structures.
- B. Excavate the trench walls vertically up to the top of the pipe. Ensure that the clearance on either side of a pipe is a minimum of 6 inches (150 mm) and a maximum of 12 inches (300 mm). In paved areas, neatly line cut the pavement at the surface a distance of at least 12 inches (300 mm) beyond the trench side and remove paving material.
- C. Furnish cover over pipes of 5 feet (1.5 m) unless otherwise shown on the plans.
- D. Pile excavated material in a manner that will not endanger the work or obstruct sidewalks and driveways. Keep gutters clear or make other satisfactory provisions for drainage. Do not obstruct natural water-courses.
- E. Furnish holes for pipe bells at each joint, but make them no longer than necessary for joint assembly and assurance that the pipe barrel will be flat on the trench bottom.
- F. Furnish, place, and maintain such sheeting and bracing as may be required. Immediately backfill and compact voids appearing outside of sheeting. Notify the maintaining agency of sheeting and bracing left in place. Do not remove sheeting and bracing until sufficient backfill has been placed to provide ample support to the sides of the excavation. When sheeting is left in place, cut it off at least 2 feet (0.6 m) below the proposed finished surface or subgrade in paved areas. The Department will pay for sheeting and bracing it orders to be left in place as a separate item of the work.

**638.05 Pipe Bedding.** Where specified, provide structural backfill for bedding according to Item 603 except the bedding is 4 inches (100 mm) thick.

**638.06 Pipe Laying.**

- A. **Inspection.** Inspect water mains and auxiliary equipment upon delivery in the field to ensure proper working order before installation.
- B. **Trench Dewatering.** Where water is encountered in the trench, remove it during pipe-laying operations and maintain the trench water free until the ends of the pipe are sealed and provisions are made to prevent floating of the pipe. Do not allow trench water or other deleterious materials to enter the pipe at any time.

**C. Pipe Clearance.** Lay pipe at least 12 inches (300 mm) from any structure or underground utility, and maintain a minimum 10-foot (3 m) horizontal separation from sanitary sewers.

**D. Existing Systems.** Do not operate any valve or other control on the existing system. The maintaining agency will operate all valves, hydrants, air valves, and service stops.

**E. Pipe Handling.** Handle pipe in a manner that will prevent damage to the pipe, pipe lining, or coating. Load, unload, and place pipe and fittings using hoists and slings in a manner that will avoid shock or damage. Do not drop, skid, or roll pipe or fittings against other pipe.

**F. Pipe Cutting.** Whenever it becomes necessary to cut a length of pipe, make the pipe ends square with the longitudinal axis of the pipe and otherwise smooth so that good connections can be made. Cut pipe using cutters recommended by the manufacturer. Do not cut ductile iron pipe with an oxyacetylene torch. File or grind field-cut pipe lengths to obtain a chamfer on the outside of the pipe, according to the manufacturer's recommendations. Remove rough or sharp edges from the cut end.

**G. Pipe Laying.** Ensure that pipe and fittings are clean when laid. Take precautions to prevent floating. Place the pipe on the trench bottom or bedding. After the pipe has been aligned and jointed, and thrust blocking has been placed, secure the pipe in place with approved backfill material. At times when pipe laying is not in progress, close the open ends of the pipe with a watertight plug.

**H. Pipe Laying on Curves.** If the pipe is shown curved on the plans, construct the curves by special fittings or by deflecting the joints according to the manufacturer's recommendations. Do not make joint deflections at valves.

When rubber-gasketed pipe is laid on a curve, joint the pipe in a straight alignment and then deflect it to the curved alignment. Make trenches wider on curves for this purpose.

**I. Pipe Laying Where Earth Grading is Necessary.** Where a pipe is to be placed within an embankment or the top of the pipe is above the existing ground, construct the embankment to at least 6 inches (150 mm) above the top of the pipe before trenching for the pipe. Excavate the trench to the minimum width necessary for the proper placing and backfilling of the pipe.

**J. Tracer Tape.** Install tracer tape over copper and non-metallic water lines, including service lines. Place the tracer tape approximately 1 foot (0.3 m) above the top of the line and extend the tape for the line's full length. Use tracer tape that is a detectable type and is marked "WATER."

**K. Blocking and Wedging.** Lay fire hydrants, valves, and fittings on hardwood blocks and hold them in position by hardwood wedges. Bed blocks firmly in the bottom of the trench with uniform bearing and with the long dimension of the block perpendicular to the pipe barrel. Ensure that the blocks are level across the trench and that the proper number of blocks are placed one upon the other to bring the fittings to the required grade for jointing.

**L. Thrust Blocking.** Furnish plugs, caps, tees, hydrants, and elbows or bends having a deflection of 11 1/4 degrees or greater with concrete thrust blocking, unless suitably restrained joints are provided. Construct the thrust blocking by placing concrete Class C between firm original undisturbed earth and the fitting to be anchored. Place and shape the thrust blocking in a manner satisfactory to the Engineer with the thrust force contained by the blocking. Place the hardwood blocks between the plugs, caps, and hydrants, and the thrust blocking. Place the thrust blocking so that it allows for pipe and joint accessibility or repair.

**M. Restrained Joints and Fittings.** Where conditions at an elbow, tee, or bulkhead are not conducive to the use of thrust blocking, restrain push-on or mechanical joints and fittings by bent or straight tie-rods, straps, clamps, or other devices, with required hardware. Protect the devices against corrosion by the application of an asphalt coating. Restrain mechanical joints by a wedge action type joint restraint with twist-off nuts. If polyethylene encasement is specified, ensure that the encasement covers the entire assembly. The Contractor may use restraining devices instead of thrust blocking when approved by the Engineer.

**638.07 Pipe Joints.** Furnish ductile iron pipe and cast iron or ductile iron fittings with push-on joints, mechanical joints, boltless-restrained joints, or ball-and-socket joints. Furnish joints with all accessories and install them according to the manufacturer's recommendations. During any construction where the outside temperature is below 40 °F (4 °C), keep rubber gaskets and lubricants in a heated area to at least 40 °F (4 °C) until used. Maintain gaskets in a flexible condition until placed in the bell or on the spigot of the pipe.

**638.08 Backfilling.** Complete backfill from the pipe grade to the finished grade, or to the subgrade surface in paved areas. Furnish and compact backfill material for water mains and appurtenances under pavements in the same manner as for 603 non-plastic Type B conduits. Furnish and compact backfill material for water mains and appurtenances not under pavements in the same manner as for 603 non-plastic Type C conduits.

If hydrostatic testing is performed before the backfilling operation is completed, complete the portion of the backfill from pipe grade to the centerline of the pipe, fittings, or appurtenances and place sufficient backfill material over the pipe barrel between joints to prevent movement.

Place sand cushions at least 12 inches (0.3 m) thick between the pipe and existing pipelines or other conduits when encountered during construction and as directed by the Engineer.

Immediately after completion of the backfilling, restore the site according to Item 603.10.

**638.09 Hydrostatic Tests.** Apply a hydrostatic test to the whole system or to all individual valved-off sections of the mains where work has been performed. Perform the hydrostatic tests according to of AWWA, except make the test pressure greater than 150 pounds per square inch (1000 kPa). Ensure that the quantity of water lost from the main does not exceed the number of gallons (liters) per hour as determined by in AWWA or by the following formula:

$$L = \frac{ND\sqrt{P}}{7400} \quad \left( L = \frac{ND\sqrt{P}}{130000} \right)$$

where:

$L$  = allowable leakage, in gallons (L) per hour

$N$  = number of joints in the length of pipe tested.

$D$  = nominal diameter of the pipe, in inches (mm)

$P$  = average test pressure during the leakage test, in pounds per square inch (kPa)

**638.10 Disinfection of Completed Water Work.** After passing the hydrostatic testing, disinfect the completed water work according to AWWA.

Make all necessary taps and furnish all equipment and labor required for the disinfections. Obtain the Engineer's approval of the time and the section of line to be disinfected.

**638.11 Steel Pipe Encasement.** Furnish and install a steel casing of the diameter and wall thickness shown in the plans.

Make any necessary excavation to install the steel casing. Obtain the Engineer's approval for the method of any boring or jacking operation. If placing the steel casing in an open cut trench, place it according to 638.05 and 638.08.

Join the casing pipe together with a full-circumference weld conforming to 513.21.

Ensure that the inside diameter of the casing allows the water main to be removed without disturbing the casing or roadbed. Ensure that the inside diameter of the casing is at least 2 inches (50 mm) greater than the largest outside diameter of the water main joints or couplings for carrier pipe that is less than 6 inches (150 mm). Ensure that the inside diameter is at least 4 inches (100 mm) greater than the largest outside diameter for carrier pipe 6 inches (150 mm) in diameter and over.

Install the main in the casing on hardwood blocking or stainless steel chocks designed to remain fixed in position. The Contractor may install polyvinyl chloride water main using casing insulators. Close both ends of the casing with mortared 4-inch (100 mm) bricks or a concrete bulkhead.

**638.12 Polyethylene Encasement.** Lay ductile iron pipe with a polyethylene encasement as shown on the plans. Install pipe and polyethylene encasement according to ANSI/AWWA. Any increased girth of wrapping over valves, tees, and any other irregular shaped items are included in this item without any additional payment.

**638.13 Valves and Equipment.** Upon delivery at the work site, open valves to prevent the collection of water in the valve. Clean the interiors of valves of all foreign matter, and inspect them in both the open and closed position before installation.

Set valves plumb and joint them to the pipe according to 638.07 and the ANSI/AWWA standards for the joint type used.

Install valve boxes on all buried valves. Center the valve box and set it in a vertical position directly over the valve nut in such a manner that the box does not transmit shock or stress to the valve. Set the base of the valve box first, and support it with a minimum backfill, hardwood blocks, or a Styrofoam collar at least 2 inches (50 mm) in thickness. Do not allow the base to rest directly on the valve or main. Use valve boxes that are two or three piece boxes with covers. When necessary, furnish extension sections. Carefully tamp backfill around the valve box to a distance of 3 feet (1 m) on all sides or to the undisturbed face of the trench if closer. Set the valve box cover flush with the ground line or finished paved surface.

Installation methods for valves and equipment include the following.

**A. Gate Valve and Valve Box.** Install gate valves directly in new mains or by means of a cutting-in sleeve in existing mains where maintenance of a continuous supply of water is not mandatory. Where it is mandatory not to interrupt the water supply, the Contractor may provide a branch to an existing main with a gate valve installed by means of a tapping sleeve.

**B. Inserting Valve and Valve Box.** Install inserting valves in existing water mains where it is mandatory not to interrupt the water supply.

Assemble the sleeve around the existing main through which water is flowing under pressure. Bolt the equipment to the sleeve, drill a hole through the existing main walls, and insert the valve, according to the manufacturer's recommendations.

**C. Cutting-In Sleeve, Valve, and Valve Box.** Use cutting-in sleeves to install a gate valve in an existing main, without breaking pipe joints, where it is permissible to interrupt the flow for a short period of time. Install the valve by cutting an exact length of pipe from the existing main according to the manufacturer's recommendation.

Assemble the cutting-in sleeve, its glands and gaskets, and the cutting-in valve over the cut ends of the existing pipe according to the manufacturer's recommendations.

**D. Tapping Sleeve, Valve, and Valve Box.** Where it is mandatory not to interrupt the water supply in an existing main and the branch is 4-inch (100 mm) or larger provide tapping sleeves.

Bolt the tapping sleeve around the existing main, assemble the tapping valve, and drill a hole through the main wall, according to the manufacturer's recommendations.

**E. Tapping Saddle and Corporation Stop.** Use corporation stops to provide individual service connections to mains. Ensure that the stops permit a shut-off of the service flow. Either assemble the stops directly to mains by means of a tap tool providing a tapped hole, or use a tapping saddle. Fasten the saddle around the main and drill a hole into the main by an attached drilling machine, then remove the machine and screw the stop into the saddle. Do not use corporation stops larger than 2 inches (51 mm) in size and locate them approximately 60 degrees from the top of the main.

## 638.14

**F. Service Stop and Service Box.** Install service stops in service lines to allow the shutting-off of individual services. Locate the stop beyond the pavement and provide it with a service box centered vertically over the stop operating nut such that the box provides maximum protection for the stop.

When 2-inch (51 mm) service stops are used, provide service boxes with an enlarged base. When necessary, provide extension sections for the service box to bring the box cover to finished grade.

**G. Meter, Setting, Stop, and Chamber.** This pay item is for meters that are to be installed in frost-proof chambers. Set the chamber on hardwood blocks. The maintaining agency shall furnish meters unless otherwise indicated by the plans. Do not transmit shock or stress to the meter body.

**638.14 Fire Hydrant.** The item includes excavation and furnishing and installing a new fire hydrant complete with proper jointing, blocking, and backfilling as outlined below and all other incidental work necessary to complete this item of work. The Department will pay for all hydrant branches, gate valves, and valve boxes required to perform the work separately.

**A. Excavation and Drainage Pits.** Excavate according to 638.04. Excavate a drainage pit 2 feet (0.6 m) in diameter and 3 feet (1 m) deep below the hydrant and fill it with granular material.

**B. Setting Fire Hydrants.** Provide a 3-foot (1 m) minimum radius unobstructed area around all hydrants. Set the sidewalk flange 2 inches (50 mm) above finished grade. Set hydrants on hardwood blocks according to 638.06.K. Provide thrust blocking according to 638.06.L.

Cover any hydrant not in service with a burlap or sturdy opaque plastic bag.

**C. Fire Hydrant Connections.** Construct hydrant branches using a section of ductile iron pipe from the main to the hydrant, and include a gate valve and valve box set vertically and placed in the line as indicated. Locate the valve a minimum of 3 feet (1 m) from the hydrant streamer connection.

**D. Gate Valve and Valve Box.** Provide gate valve and valve boxes for hydrant branches conforming to 638.13.

**638.15 Fire Hydrant Adjusted.** This item includes installing fire hydrants as described below complete with proper jointing, blocking, backfilling as outlined and all other incidental work necessary to complete this item of work. The Department will pay for all hydrant branches, gate valves, and valve boxes required to perform the work separately.

**A. Fire Hydrant Extended or Adjusted to Grade.** Where existing hydrants are to be adjusted to conform to new street alignment and grade, relocate the hydrant without disturbing the location of the hydrant lateral tee at the main.

Before excavating, close valves on hydrant branches to be cut. Where the distance of the center of the existing hydrant to the center of the gate valve on the hydrant branch is less than 4 feet (1.2 m), extend the trench to the hydrant branch valve to permit removal of the pipe. Adequately support the hydrant before being disconnected. Extend the hydrant branch with new pipe of the same size as the existing pipe. Thoroughly clean the removed hydrant of dirt, reset it, and connect

it to the extended branch. Provide drainage pits and thrust blocking according to 638.14.A, and 638.06.L.

After hydrants have been reset, open branch and hydrant valves until water flow expels all air and dirt.

**B. Fire Hydrant Removed and Reset.** Where existing hydrants are indicated for removal, provide adequate support for the hydrant before disconnecting it and resetting it in the new location. Cap the existing branch line, and install adequate thrust blocking to brace the cap according to 638.06.L, unless the line is to be abandoned. Construct a new main tee, a new pipe branch, a new gate valve with valve box, with thrust blocking, and a drainage pit for the reset hydrant items. Adjust the valve box to the finished surface at the new location by raising or lowering the top portion and furnishing an extension section if needed.

**C. Fire Hydrant and Gate Valve Removed and Reset.** Conform to 638.15.B, except remove and reinstall the gate valve and valve box. Furnish a new tee and new pipe branch using the existing valve and box.

**D. Fire Hydrant Removed and Disposed Of.** Remove and dispose of fire hydrants designated for removal. Cap the existing line and place thrust blocking according to 638.06.L, unless the line is to be abandoned.

**638.16 Service Branches.** Furnish and install service branches, either pipe or tubing and fittings, as necessary, or as shown on the plans including the removal of the existing service branches or service boxes, as required according to the following situations. Tapping saddles, corporation stops, service stops, and service boxes, if required, are separate from this item:

A. Where a service branch is disturbed for lowering, raising, or relocation between the water main at the corporation stop and the service stop, replace it with new materials within these limits unless the connections can be made outside the limits of the proposed pavement, paved shoulder, or curb.

B. Where a service branch is disturbed for lowering, raising, extending, or shortening on the property side of the service stop, replace it with new materials from the existing service stop to the proposed service stop. However, if the existing service branch encountered is found to be lead or galvanized pipe, replace it from the corporation stop to the service stop with new material.

**638.17 Meter and Chamber Removed and Reset.** Remove and reset existing water meters and chambers as specified in 638.13.G. Remove existing chambers. Disconnect existing meters, and replace them with suitable connections if necessary. Reconnect the meters at new locations.

**638.18 Valve Box and Service Box Adjusted to Grade.** Raise or lower existing valve boxes and service boxes to grade or the reuse of existing service boxes.

The Contractor may reuse existing service boxes if they are in good condition, as determined by the Engineer then payment is per service box adjusted to grade.

Excavate around the valve box or service box to permit the raising or lowering of the valve box or service box. The Contractor may adjust any screw-type boxes

**638.19**

without the use of extensions provided that ample thread remains on the box to provide adequate rigidity to the box. Provide extension sections for boxes that are not of the screw-type and boxes not having ample thread for rigidity to adjust the top to grade. The Engineer will allow inserts or adapters. Adequately secure new sections of box stem to the existing stems. Backfill the hole after the box has been adjusted to grade.

**638.19 Method of Measurement.** The Department will measure Water Main, Ductile Iron Pipe and Water Main, Polyvinyl Chloride Pipe and Fittings by the number of feet (meters) of each constructed.

The Department will measure Copper Service Branch, Polyethylene Service Branch, and Polybutylene Service Branch by the number of feet (meters) of each constructed.

The Department will measure Polyethylene Encasement by the number of feet (meters) of covered pipe.

The Department will measure Steel Pipe Encasement by the number of feet (meters) constructed, including the open cut or boring or jacking operation, encasement pipe, bedding and backfill, blocking to support the internal main, and end bulkheads.

The Department will measure Gate Valve and Valve Box; Inserting Valve and Valve Box; Cutting-In Sleeve, Valve and Valve Box; Tapping Sleeve, Valve and Valve Box; and Meter, Setting, Stop and Chamber separately as a complete item by the number of each.

The Department will measure Fire Hydrant, Fire Hydrant Extended and Adjusted to Grade, Fire Hydrant Adjusted to Grade, Fire Hydrant Removed and Reset, Fire Hydrant and Gate Valve Removed and Reset, and Fire Hydrant Removed and Disposed Of separately by the number of each.

The Department will measure Valve Box Adjusted to Grade and Service Box Adjusted to Grade separately by the number of each, including any extension sections of valve or service boxes required.

The Department will measure Meter and Chamber Removed and Reset by the number of each.

The Department will measure Sheeting and Bracing Ordered Left In Place in thousands of board feet, MBF (cubic meters).

**638.20 Basis of Payment.** The Department will pay for accepted quantities at the contract unit prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
638	Foot (Meter)	___ inch (___ mm) Water Main, Ductile Iron Pipe, ANSI Class___, (push-on, mechanical, boltless- restrained, ball-and-socket) Joints and Fittings
638	Foot (Meter)	___ inch (___ mm) Water Main, Polyvinyl Chloride Pipe and Fittings, ASTM SAR ___ or AWWA Class ___

638	Foot (Meter)	___ inch (___ mm) Copper Service Branch
638	Foot (Meter)	___ inch (___ mm) Polyethylene Service Branch
638	Foot (Meter)	___ inch (___ mm) Polybutylene Service Branch
638	Foot (Meter)	Polyethylene Encasement
638	Foot (Meter)	___ inch (___ mm) Steel Pipe Encasement, (open cut, bored or jacked)
638	Each	___ inch (___ mm) Gate Valve and Valve Box
638	Each	___ inch (mm) Inserting Valve and Valve Box
638	Each	___ inch (mm) Cutting-In Sleeve, Valve and Valve Box
638	Each	___ inch × ___ inch (___ mm × ___ mm) Tapping Sleeve, Valve and Valve Box
638	Each	Meter, Setting, Stop and Chamber
638	Each	___ inch (___ mm) Fire Hydrant
638	Each	Fire Hydrant Extended and Adjusted to Grade
638	Each	Fire Hydrant Adjusted to Grade
638	Each	Fire Hydrant Removed and Reset
638	Each	Fire Hydrant and Gate Valve Removed and Reset
638	Each	Fire Hydrant Removed and Disposed Of
638	Each	Valve Box Adjusted to Grade
638	Each	Service Box Adjusted to Grade
638	Each	Meter and Chamber Removed and Reset
638	MBF (Cubic Meter)	Sheeting and Bracing Ordered Left In Place

## 640 PAVEMENT MARKING

### ITEM 641 PAVEMENT MARKING—GENERAL

- 641.01 Description**
- 641.02 Materials**
- 641.03 General**
- 641.04 Equipment**
- 641.05 Pavement Preparation**
- 641.06 Layout and Premarking**
- 641.07 Line Placement Tolerance**
- 641.08 Marking Types**
- 641.09 Two-Way Radio Communications**
- 641.10 Removal of Pavement Markings**
- 641.11 Deduction for Deficiency**
- 641.12 Method of Measurement**
- 641.13 Basis of Payment**

**641.01 Description.** This specification gives general requirements for various kinds of retroreflective pavement markings. Deviations from these general requirements are covered in the specific requirements for each marking type.

Place all pavement markings according to the OMUTCD.

**641.02 Materials.** Use marking materials that are a formulation, identified by a manufacturer's code number, prequalified by the Laboratory and that have the same composition as the prequalified marking material.

The Laboratory will require that the materials pass a service test according to Supplement 1047 before prequalifying them. Furnish prequalified materials conforming to Supplement 1047 and supplied by manufacturers conforming to Supplement 1089.

Minimum material performance requirements and chemical and physical properties are stated in Item 740 and the Invitation for Samples for the service test performed according to Supplement 1047.

Materials and manufacturers will be listed on the Laboratory's Approved List.

Any materials delivered without a TE-24 and applied without laboratory approval shall be removed. Laboratory tested materials not meeting specifications shall be removed from the project site.

Furnish a material safety data sheet (MSDS) for each material, including resin, catalyst, primer, adhesive, activator, glass beads, and cleaning solvent, to be used on the project to the Engineer before material delivery. Inform workers of the location of all MSDS and allow workers an opportunity to review them.

Furnish the Engineer, prior to application, the paint manufacturer's printed application equipment requirements and application instructions.

**641.03 General.** Apply lines as solid, broken, or dotted lines, either singly or in combination, as shown on the plans. Apply broken lines in a 40-foot (12.0 m) cycle consisting of a 10-foot (3.0 m) dash and a 30-foot (9.0 m) gap between broken lines, unless otherwise shown on the plans. Use an accurate striping mechanism that is capable of being easily adjusted to retrace existing broken markings or to apply new materials at the correct spacing. Begin broken lines that are to be applied over plainly visible existing broken lines within 6 inches (150 mm) of the beginning of the existing broken line, unless otherwise directed by the Engineer. Apply dotted lines in an 8-foot (2.4 m) cycle consisting of a 2-foot (0.6 m) dot and a 6-foot (1.8 m) gap between dots for line extensions and in a 12-foot (3.6 m) cycle consisting of a 3-foot (0.9 m) line segment and a 9-foot (2.7 m) gap for lane drop/add markings.

Fill gaps that were not marked as a result of template use for spray-applied auxiliary markings with marking material after the template is removed. If applying extruded thermoplastic, the Contractor may leave small gaps in arrows or letters resulting from template use unfilled.

Ensure that pavement markings are free of uneven edges, overspray, or other readily visible defects that detract from the appearance or function of the pavement markings.

Ensure that lines are sharp, well defined, and uniformly retroreflective. Apply the lines to the width specified  $\pm 1/4$  inch (6 mm). Fuzzy lines, excessive overspray, or non-uniform application are unacceptable. The Engineer will inspect lines at night to verify proper retroreflectivity. Correct pavement markings that are improperly applied, located, or reflectorized. Reapply lines applied with insufficient material quantities according to 641.11 or 644.04. Remove improperly located lines according to 641.10, and apply new lines in the correct locations.

Reapply any lines applied with non-specification materials.

Obtain the Engineer's approval for methods and equipment used for pavement preparation, marking, and marking removal. Keep glass beads dry during storage and before use.

Furnish to the Engineer at least 3 days in advance of installation current copies of the manufacturer's instructions and recommendations for application of any marking material, including primer, activator, catalyst, and adhesive, shown on the plans. Schedule and perform other construction work, such as shoulder paving, seeding, and mulching in a manner to avoid damage to applied pavement markings.

Do not apply pavement marking materials to the reflector of a plowable raised pavement marker. Interrupt the application of the pavement marking line at each raised pavement marker where marking material would otherwise be applied to the marker's prismatic reflector. Provide a maximum gap in the marked line of 18 inches (0.5 m) at each marker. Remove pavement marking material applied to a prismatic reflector surface, or replace the reflector that same workday. If material must be removed from the reflector, restore the reflector's brightness to its prior condition.

## 641.04

**641.04 Equipment.** Equip long line pavement marking equipment for traffic paint, polyester, epoxy and work zone marking Item 642 with a computerized Data Logging System (DLS), including a cab mounted display which shows the actual material application rate and film thickness. For center line, lane line and edge line markings, when the length of marking exceeds 0.5 miles (0.8 km) of continuous line equivalent, document the following with the DLS:

1. Measure and record application vehicle speed to nearest 0.1 MPH (0.16 km/h),
2. Measure and record weight and/or volume amount of material used by color,
3. Measure and record weight of glass beads,
4. Measure and record pavement surface temperature,
5. Measure and record air temperature,
6. Measure and record dew point,
7. Measure and record humidity,
8. Calculate and record average material application rate and film thickness over the section painted.

Record as a separate DLS report line entry the above information for each route section painted, when the length of center line, lane line and edge line marking exceeds 0.5 miles (0.8 km) of continuous line equivalent. A route section is defined as one direction of a contiguous section of highway (without breaks) with the same route number designation. DLS documentation is not required for center line, lane line and edge line markings of 0.5 miles (0.8 km) or less, and for channelizing lines of any length.

If the DLS equipment fails, finish that day's work only and resume when the DLS equipment is working.

The Department will provide a standard DLS spreadsheet, which prescribes the correct DLS report format and content prior to beginning of work.

On the first working day following application of markings requiring documentation with the DLS or upon demand, furnish the Engineer a copy of the DLS report in ODOT standard DLS report format. The DLS report can be provided in one of the following methods, which should be agreed upon at the preconstruction meeting:

1. hand delivery of paper report
2. fax delivery of paper report
3. e-mail of Excel spreadsheet file
4. disk or flash drive transfer of Excel spreadsheet file

Within two weeks of the date of application of markings requiring documentation with the DLS, furnish the Engineer the Excel spreadsheet file of the DLS report in ODOT standard DLS report format by e-mail at the e-mail address provided at the preconstruction meeting.

At the end of the project, furnish the Engineer all Excel spreadsheet files in ODOT standard DLS report format.

Each DLS shall have an annual calibration of all mechanical and electrical components and its software function and output confirmed by the DLS manufacturer or their designated representative. Evidence of the annual calibration shall be carried by a signed and dated stamp or seal affixed to the inside of the driver's door of each striper.

**641.05 Pavement Preparation.** Clean all visible loose or foreign material from the surface to be marked. Equip the pavement marking equipment with an air jet to remove all debris from the pavement in advance of the applicator gun. Operate the air jet when marking material is being applied, and synchronize it with marking material application. Power-broom clean all surfaces where gore markings or edge lines are to be applied. If required by the Engineer, also power-broom clean other surfaces. Do not apply marking to portland cement concrete until the concrete in the areas to be marked is clean of membrane curing material and is dry.

**641.06 Layout and Premarking.** Lay out the locations of all lines, words, and other symbols to ensure their proper placement. Do not start marking operations until the Engineer or the Engineer's representative has approved the layout and premarking lines. If applying longitudinal or transverse lines, use existing lines, construction joints, or premarking to guide this marking equipment.

On projects where resurfacing or other operations will result in obliteration of the existing pavement markings, establish reference points to ensure proper placement of restored markings. If existing markings are to be retraced, verify any adjustment in the location with the Engineer.

Establish "T" marking of no-passing zones according to the plans or a no-passing zone log provided by the Engineer.

Locate premarking from survey data or reference points, and offset it so as to parallel the theoretical edge of the marking lines at a maximum distance of 1 inch (25 mm). Use templates for the layout of arrows, words, and other symbols. Place premarking for longitudinal lines at 40-foot (12 m) intervals, and do not exceed 2 inches (50 mm) in width or 12 inches (300 mm) in length. Locate premarking for auxiliary markings from the plans or schematic forms provided by the Engineer.

**641.07 Line Placement Tolerance.** Ensure that pavement marking lines are straight or smoothly curved, true to the alignment of the pavement, and do not deviate laterally from the proper location at a rate of more than 2 inches in 100 feet (50 mm in 30 m). The Engineer will not allow any deviation greater than 3 inches (75 mm). Remove improperly located lines according to 641.10 and apply new lines in the correct locations.

**641.08 Marking Types.** Apply marking materials at the rate or thickness specified in 642.04, 643.04, 644.04, 645.03, 646.05, or 647.04 and, except for parking lot stall markings, ensure that they are uniformly retroreflective. However, ensure that portions of parking stalls that are adjacent to street traffic are retroreflective. Pavement markings consist of the following types:

**A. Edge Lines.** Place edge lines as continuous 4-inch (100 mm) wide stripes. Locate the center of the stripe 6 inches (150 mm) from the edge of the pavement.

**B. Lane Lines.** Place lane lines as 4-inch (100 mm) wide, white stripes between contiguous lanes of pavement carrying traffic in the same direction. Place them as broken lines unless specified solid. Offset lane lines to the left of the longitudinal joint, if present, or the theoretical line lying between contiguous lanes, if a joint is not present. Ensure that the nearer edge of the stripe is 2 inches (50 mm) to the left of the joint or line. Do not place lane lines through intersections.

**C. Center Lines.** Place center lines as single or double yellow stripes between contiguous lanes of pavement carrying traffic in opposite directions. Center line marking includes two-way left-turn lane striping and the outline of left-turn islands. Make each stripe 4 inches (100 mm) wide, solid or broken as specified.

**D. Channelizing Lines.** Place channelizing lines as continuous 8-inch (200 mm) wide white stripes.

**E. Stop and Crosswalk Lines.** Place stop lines as solid 24-inch (600 mm) wide white stripes. Place crosswalk lines as solid 12-inch (300 mm) wide white stripes.

**F. Transverse/Diagonal Lines.** Place transverse/diagonal lines as solid 24-inch (600 mm) wide stripes, of the color specified, and at an angle to the direction of travel.

**G. Curb and Island Marking.** Prepare exposed surfaces and curbs and paved islands according to 641.05. In addition, remove and dispose of all visible loose or foreign material, including vegetation, on and immediately contiguous to surfaces to be marked.

**H. Symbol Markings.** Place all railroad, school, and handicap symbol markings using white markings. A railroad marking includes the 16-inch (400 mm) crossbuck, two 72-inch (1.8 m) "R"s, two 24-inch (600 mm) transverse lines, and a stop line. A school marking includes the word "SCHOOL" and two 16-inch (400 mm) transverse lines.

**I. Parking Lot Stall Marking.** Place parking lot stall marking lines as continuous 4-inch (100 mm) wide white stripes.

**J. Lane Arrows.** Place lane arrows using white markings.

**K. Words on Pavement.** Place words on pavement using white markings.

**L. Dotted Lines.** Place dotted lines using the width and color specified.

The term long lines, when used in sections 642 through 647 includes edge lines, lane lines, center lines, and channelizing lines over 200 feet (60 m) long. The term auxiliary markings, when used in Items 642 through 647 includes channelizing lines 200 feet (60 m) or shorter, stop lines, crosswalk lines, transverse lines, diagonal lines, curb markings, island markings, symbol markings, parking lot stall markings, lane arrows, and dotted lines.

**641.09 Two-Way Radio Communications.** If two-way radio equipment is required, furnish and maintain radio equipment necessary for the voice

communication between the striper and the inspector's vehicle at all times during the pavement marking operation. Use equipment capable of transmitting and receiving normal voice communications to at least 4 miles (6 km).

**641.10 Removal of Pavement Markings.** If specified as a pay item, remove pavement markings as described in 614.11.G. Take care during marking removal not to scar, discolor, or otherwise damage the pavement surface. Do not overpaint or use other methods of covering markings instead of removal.

**641.11 Deduction for Deficiency.** For traffic paint, polyester and epoxy, the Engineer will compute each day the amount of marking material (including all components) and glass beads applied for each route section on the DLS report for determining unsatisfactory sections. The Department will reduce the contract price for each route section in direct proportion to the percent of deficiency of marking material or glass beads as specified in 642.04, 643.04 and 646.05, up to 20 percent for each material deficiency. The Department will only use the greater deficiency of marking material or glass beads to compute the deduction.

If the deficiency of marking material or glass beads is 20 percent or more, the Department will consider the work unsatisfactory. In addition, the Engineer will consider as unsatisfactory materials applied outside the temperature or application requirements in Items 642, 643 and 646 without written approval of the Engineer. Replace pavement markings and glass beads in all sections determined to be unsatisfactory by retracing over the unsatisfactory markings at the full thickness specified in Items 642, 643 and 646.

**641.12 Method of Measurement.** The Department will measure pavement markings complete in place in the units designated. The Department will measure line quantities as the length of completed marking, including the gaps, intersections, and other sections of pavement not normally marked. The Department will measure the removal of pavement markings using the same method of measurement as completed markings in the units designated.

**641.13 Basis of Payment.** The Department will pay for accepted quantities of work performed under Items 642, 643, 644, 645, 646, and 647.

The Department will not pay for costs associated with correcting improperly located lines, replacing reflectors coated with pavement marking material, or replacing unsatisfactory pavement markings.

The Department will not pay for lines placed using non-specification materials.

The Department will not pay for non-specification lines determined through field measurement.

The Department will pay for Two-Way Radio Equipment at the lump sum bid price.

### ITEM 642 TRAFFIC PAINT

**642.01 Description**

**642.02 Materials**

**642.03 Equipment**

**642.04 Application**

**642.05 Basis of Payment**

**642.01 Description.** This work consists of furnishing and applying fast dry water-based traffic paint or fast dry water-based traffic paint for cold weather applications according to Item 641, 740.01, 740.02, 740.09, and the additional requirements specified below.

**642.02 Materials.** Furnish materials from the Department’s Approved List conforming to:

Traffic Paint .....	740.02
Glass Beads, Type A .....	740.09

The Engineer may obtain random samples from the application equipment. Furnish the manufacturer’s identification information for the sampled liquid materials. The Department will test the quality assurance sample for conformance to the manufacturer’s production ranges. Samples not meeting the manufacturer’s production ranges will require the Contactor to re-apply, at his expense, any markings using that sample. All other untested batches will become not approved and will either require testing or re-application.

Do not apply paints that have exceeded the manufacturer’s shelf life. Do not use glass beads that are wet.

**642.03 Equipment.** Use equipment capable of applying the traffic paint as recommended by the manufacturer and applying glass beads at the time of line placement. Furnish a calibrated measuring device acceptable to the Engineer to measure the traffic paint in the striper tanks.

Equip all striping equipment for center line, lane line and edge line markings with a computerized Data Logging System (DLS) conforming to 641.04 when the length of marking exceeds 0.5 miles (0.8 km) of continuous line equivalent.

Furnish written documentation to the Engineer for the equipment’s operational capabilities from the equipment manufacturer.

**642.04 Application.** Apply pavement markings only when the surface is clean and dry in accordance with the paint manufacturer’s written application instructions.

If application is required when air and pavement temperatures are between 35 °F (2 °C) and 50 °F (10 °C) obtain approval from the Engineer and apply only pre-qualified Type 1A cold weather traffic paint materials. Apply traffic paint per manufacturer’s recommendations and protect line from tracking.

Keep the paint thoroughly mixed during application.

Apply 20 mil (0.51 mm) thick traffic paint Type 1 at the following rates:

20 Mil Thickness	Line Width (inch)				
	4	6	8	12	24
	Gallon per Mile of Line				
Solid Line	22	33	44	66	132
Broken Line	5.5	8.25	11	16.5	33
Dotted Line	5.5	8.25	11	16.5	33
Areas, Symbols, Words	1.25 gallon per 100 square feet				

0.51 mm Thickness	Line Width (mm)				
	100	150	200	300	600
	Liter per Kilometer of Line				
Solid Line	50	75	100	150	300
Broken Line	12.5	19	25	38	75
Dotted Line	12.5	19	25	38	75
Areas, Symbols, Words	0.51 L/m <sup>2</sup>				

Apply 15 mil (0.38 mm) thick traffic paint Type 1A at the following rates:

15 Mil Thickness	Line Width (inch)				
	4	6	8	12	24
	Gallon per Mile of Line				
Solid Line	16	24	32	48	96
Broken Line	4	6	8	12	24
Dotted Line	4	6	8	12	24
Areas, Symbols, Words	0.94 gallon per 100 square feet				

0.38 mm Thickness	Line Width (mm)				
	100	150	200	300	600
	Liter per Kilometer of Line				
Solid Line	37	56	74	111	222
Broken Line	9.3	14	18.6	28	56
Dotted Line	9.3	14	18.6	28	56
Areas, Symbols, Words	0.38 L/m <sup>2</sup>				

Do not dilute the paint. However, the Contractor may add spent traffic paint solvents, generated during performance of this work, to virgin traffic paint. If adding spent solvents, add them in a maximum ratio of 1:50 of spent solvents to virgin paint. Ensure that the maximum concentration of spent solvents in the striping equipment tanks is maximum 2 percent. Add spent solvents during the loading of the striping equipment.

Apply glass beads to the wet paint so that the beads are embedded and retained in the paint and provide uniform retroreflectivity in the paint surface. Apply glass beads at a minimum rate of 15 pounds per 100 square feet (7.3 kg

**642.04**

per 10 m<sup>2</sup>) for Type 1 traffic paint. Apply glass beads at a minimum rate of 8.0 pounds per 100 square feet (3.9 kg per 10 m<sup>2</sup>) for Type 1A traffic paint.

Ensure temperature of the paint at the discharge point is within the range recommended by paint manufacturer.

Replace unsatisfactory markings as per 641.11.

Furnish the Engineer daily, biweekly and final DLS reports as per 641.04.

Perform traffic control operations for all 642 pavement markings according to 614.12 and MT-99.20M, but provide for center line, edge line, lane line and channelizing line traffic control equipment according to MT-99.20M equipment requirements for center line, longer than 2 minute dry.

Payment for this work shall be included in the 642 price per mile for Center Line, Edge Line and Lane Line and the 642 price per foot for channelizing Line.

**642.05 Basis of Payment.** The Department will pay for accepted quantities at the contract prices, or prices adjusted according to 641.11, measured according to 641.12, with the provisions specified in 641.13, and as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
642	Mile (Kilometer)	Edge Line, Type ____
642	Mile (Kilometer)	Lane Line, Type ____
642	Mile (Kilometer)	Center Line, Type ____
642	Foot (Meter)	Channelizing Line, Type ____
642	Foot (Meter)	Stop Line, Type ____
642	Foot (Meter)	Crosswalk Line, Type ____
642	Foot (Meter)	Transverse/Diagonal Line, Type ____
642	Foot (Meter)	Curb Marking, Type ____
642	Square Foot (Square Meter)	Island Marking, Type ____
642	Each	Handicap Symbol Marking, Type ____
642	Each	Railroad Symbol Marking, Type ____
642	Each	School Symbol Marking, ____ inch (____ mm), Type ____
642	Foot (Meter)	Parking Lot Stall Marking, Type ____
642	Each	Lane Arrow, Type ____
642	Each	Word on Pavement, ____ inch (____ mm), Type ____
642	Foot (Meter)	Dotted Line, ____ inch (____mm), Type ____
642	Foot or Square Foot (Meter or Square Meter), or Each	Removal of Pavement Marking
642	Lump Sum	Two-Way Radio Equipment

## ITEM 643 POLYESTER PAVEMENT MARKING

- 643.01 Description**
- 643.02 Materials**
- 643.03 Equipment**
- 643.04 Application**
- 643.05 Basis of Payment**

**643.01 Description.** This work consists of furnishing and applying polyester pavement markings according to Item 641, 740.01, 740.03, 740.09, and the additional requirements specified below.

**643.02 Materials.** Furnish materials from the Department's Approved List conforming to:

Polyester Pavement Marking .....	740.03
Glass Beads, Type B .....	740.09

The Engineer may obtain random samples from the application equipment. Furnish the manufacturer's identification information for the sampled liquid materials. The Department will test the quality assurance sample for conformance to the manufacturer's production ranges. Samples not meeting the manufacturer's production ranges will require the Contractor to re-apply, at his expense, any markings using that sample. All other untested batches will become not approved materials and will either require testing or re-application.

Do not apply material that have exceeded the manufacturer's shelf life. Do not use glass beads that are wet.

**643.03 Equipment.** Use application equipment capable of mixing the polyester components in proportions recommended by the manufacturer and applying glass beads at the time of marking placement. Use equipment (striper) capable of applying polyester long-lines at the thickness specified for solid and broken lines while moving on the highway at a speed of not less than 7 miles per hour (11 km/h). Furnish a calibrated measuring device acceptable to the Engineer to measure the polyester resin in the striper tanks.

Equip all striping equipment for center line, lane line and edge line markings with a computerized Data Logging System (DLS) conforming to 641.04 when the length of marking exceeds 0.5 miles (0.8 km) of continuous line equivalent. The DLS shall measure the polyester resin material component and glass beads only. Catalyst will be calculated as 2 percent of the resin used.

Furnish written documentation to the Engineer for the equipment's operational capabilities from the equipment manufacturer.

Furnish written documentation for the equipment's operational capabilities from the equipment manufacturer.

**643.04**

**643.04 Application.** Apply polyester only when the pavement surface is clean and dry and the pavement and air temperature are above 50 °F (10 °C).

If project safety requirements require marking application below 50°F (10°C), obtain approval from the Engineer and apply cold weather traffic paint, Type 1A, as per Item 642 instead of the polyester.

After sampling of resin is completed, transfer the entire contents of each material container to the stripers tanks. Ensure that the polyester is thoroughly mixed at all times during application. Apply polyester (catalyst plus resin) uniformly to the pavement at the following rates:

15 Mil Thickness	Line Width (inch)				
	4	6	8	12	24
	Gallon per Mile of Line				
Solid Line	16	24	32	48	96
Broken Line	4	6	8	12	24
Dotted Line	4	6	8	12	24
Areas, Symbols, Words	0.94 gallon per 100 square feet				

0.38 mm Thickness	Line Width (mm)				
	100	150	200	300	600
	Liter per Kilometer of Line				
Solid Line	37	56	74	111	222
Broken Line	9.3	14	18.6	28	56
Dotted Line	9.3	14	18.6	28	56
Areas, Symbols, Words	0.38 L/m <sup>2</sup>				

Do not dilute the material.

Apply glass beads to the uncured polyester in sufficient quantity so that the beads completely fill the polyester film from the film-pavement interface to the top surface of the film to the extent that there are loose beads on the surface of the uncured line. Apply glass beads at a minimum rate of 16.5 pounds per 100 square feet (8 kg per 10 m<sup>2</sup>) of polyester applied in a manner that provides uniformly retroreflective lines.

If the applied polyester becomes tacky and causes marking discoloration and darkening, cease marking application until the Inspector agrees that the problem is corrected.

If any marking is in a tracking condition 45 minutes after application, cease marking application until the Inspector agrees that the problem is corrected.

Do not apply polyester pavement markings to new asphalt concrete until at least 2 weeks after the pavement is placed. Assure curing compound is removed from portland cement concrete pavements.

Replace unsatisfactory markings as per 641.11.

Furnish the Engineer daily, biweekly and final DLS reports as per 641.04.

**643.05 Basis of Payment.** The Department will pay for accepted quantities at the contract prices, or prices adjusted according to 641.11, measured according to 641.12, with the provisions specified in 641.13, and as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
643	Mile (Kilometer)	Edge Line
643	Mile (Kilometer)	Lane Line
643	Mile (Kilometer)	Center Line
643	Foot (Meter)	Channelizing Line
643	Foot (Meter)	Stop Line
643	Foot (Meter)	Crosswalk Line
643	Foot (Meter)	Transverse/Diagonal Line
643	Foot (Meter)	Curb Marking
643	Square Foot	Island Marking (Square Meter)
643	Each	Handicap Symbol Marking
643	Each	Railroad Symbol Marking
643	Each	School Symbol Marking, ___ inch (___ mm)
643	Foot (Meter)	Parking Lot Stall Marking
643	Each	Lane Arrow
643	Each	Word on Pavement, ___ inch (___ mm)
643	Foot (Meter)	Dotted Line, ___ inch (___ mm)
643	Foot or Square Foot	Removal of Pavement Marking (Meter or Square Meter), or Each
643	Lump Sum	Two-Way Radio Equipment

## **ITEM 644 THERMOPLASTIC PAVEMENT MARKING**

### **644.01 Description**

### **644.02 Materials**

### **644.03 Equipment**

### **644.04 Application**

### **644.05 Layout and Premarking**

### **644.06 Basis of Payment**

**644.01 Description.** This work consists of furnishing and applying screed extruded thermoplastic pavement markings according to Item 641, 740.01, 740.04, 740.09, and the additional requirements specified below.

**644.02 Materials.** Furnish materials from the Department's Approved List conforming to:

Thermoplastic pavement marking.....	740.04
Glass beads, Type C .....	740.09

The Engineer may obtain random samples from the application equipment. Furnish the manufacturer's identification information for the sampled liquid materials. The Department will test the quality assurance sample for conformance to the manufacturer's production ranges. Samples not meeting the manufacturer's production ranges will require the Contractor to re-apply, at his expense, any

### 644.03

markings using that sample. All other untested batches will become not approved materials and will either require testing or re-application.

Do not apply material that has exceeded the manufacturer's shelf life. Do not use glass beads that are wet.

**644.03 Equipment.** Equip all thermoplastic pavement marking trucks for center line, lane line and edge line markings with a computerized Data Logging System (DLS), including a cab mounted display which shows the actual bead application rate. A DLS is not required for markings applied with hand carts. For center line, lane line and edge line markings applied with truck-mounted equipment, when the length of marking exceeds 0.5 miles (0.8 km) of continuous line equivalent, document the following with the DLS:

1. Measure and record application vehicle speed to the nearest 0.1 MPH (0.16 km/h).
2. Measure and record pavement surface temperature.
3. Measure and record air temperature.
4. Measure and record thermoplastic temperature in the kettle and at the point of application.

Record as a separate DLS report line entry the above information for each route section painted, when the length of marking exceeds 0.5 miles (0.8 km) of continuous line equivalent. A route section is defined as one direction of a contiguous section of highway (without breaks) with the same route number designation.

If the DLS equipment fails, finish that day's work only and resume when the DLS equipment is working.

The Department will provide a standard DLS spreadsheet, which prescribes the correct DLS report format and content prior to beginning of work.

Each DLS shall have an annual calibration of all mechanical and electrical components and its software function and output confirmed by the DLS manufacturer or their designated representative. Evidence of the annual calibration shall be carried by a signed and dated stamp or seal affixed to the inside of the driver's door of each striper.

Use application equipment that includes a kettle for melting the thermoplastic and maintaining it at the proper temperature. Equip the kettle with a thermostat to control the temperature of the melted thermoplastic and to prevent overheating. Use equipment that continuously mixes and agitates the molten thermoplastic. Ensure that the parts of the equipment that convey the thermoplastic from the kettle to the application point maintains it at the required temperature.

Attach an automatic bead dispenser to the equipment so that the beads are immediately and uniformly dispensed over the marking surface. Equip the bead dispenser with an automatic cut-off control synchronized with the cut-off of the thermoplastic material.

Ensure that the applicator portion of the equipment has a shoe that rides on the pavement and extrudes the thermoplastic. Ensure that the application equipment applies lines with a square end and can apply broken lines. Furnish application equipment for applying screed extruded markings (no ribbon application) that consists of dies of varying widths to produce different widths of lines. Do not use pans, aprons, or similar devices that the die overruns.

Use equipment that ensures uniformity in the thickness and width of lines. Use equipment that forms lines 12 inches (300 mm) wide or less by one application pass, and lines wider than 12 inches (300 mm) by no more than two passes. Do not allow individual passes to overlap or to be separated by a gap greater than 1/4 inch (6 mm).

**644.04 Application.** If applying thermoplastic to pavements that are less than six months old, ensure that both the pavement surface and the ambient air temperature at the time of application are not less than 50 °F (10 °C) and rising. However, if applying thermoplastic to pavements that are older than a year, ensure that both the pavement surface and the ambient air temperature at the time of application are not less than 70 °F (21 °C) and rising. Ensure that the temperature of thermoplastic at the point of application is at least 400 °F (204 °C) and not more than 440 °F (227 °C).

Apply thermoplastic at a thickness of 125 mils (3.2 mm). Thermoplastic for small quantities or auxiliary markings up to 100 feet (30 m) in length can be exchanged as equal in function and price with 125 mil (3.2 mm) thick heat-fused preformed thermoplastic (Item 647).

Apply thermoplastic at the following rates:

125 Mil Thickness	Line Width (inch)			
	4	8	12	24
	Pounds per Mile of Line			
Solid Line	2340	4680	7020	14040
Broken Line	585	1170	1755	3510
Dotted Line	585	1170	1755	3510
Areas, Symbols, Words	133 pounds per 100 square feet			

3.2 mm Thickness	Line Width (mm)			
	100	200	300	600
	Kilograms per Kilometer of Line			
Solid Line	650	1300	1950	3900
Broken Line	165	325	490	975
Dotted Line	165	325	490	975
Areas, Symbols, Words	6.5 kg/m <sup>2</sup>			

Mechanically apply glass beads to the wet thermoplastic surface so that the beads are embedded and retained and provide uniform retroreflectivity in the surface. Do not place beads by hand, except to symbols and words, and to complete the ends of lines. Apply beads at a minimum rate of 12 pounds per 100 square feet (6 kg per 10 m<sup>2</sup>) of thermoplastic surface area. The Contractor may leave small gaps unfilled in symbols and letters resulting from template use.

**644.05**

If required, furnish primer, and apply it according to the manufacturer’s recommendations. Use primer except on new asphalt pavement.

Do not apply thermoplastic by spraying.

For each route section on the DLS report, the Engineer will compute the amount of thermoplastic marking material and glass beads applied. The Department will reduce the contract price in direct proportion to the percent of deficiency of thermoplastic marking material or glass beads as specified in 644.04, up to 20 percent for each material deficiency. The Department will only use the greater deficiency of marking material or glass beads to compute the deduction.

If the deficiency of thermoplastic marking material or glass beads is 20 percent or more, the Department will consider the work unsatisfactory. In addition, the Engineer will consider as unsatisfactory materials applied outside the temperature or application requirements in 644.04 without written approval of the Engineer. Replace thermoplastic markings and glass beads in all sections determined to be unsatisfactory by entirely removing the unsatisfactory thermoplastic material by grinding as per 641.10 and then reapplying at the full thickness specified in 644.04. Do not apply a layer of sprayed thermoplastic to sections determined to be unsatisfactory to achieve the required thickness.

Furnish the Engineer daily, biweekly and final DLS reports conforming to 644.03, and additional reports indicating material type and quantities in pounds (kilograms) of thermoplastic materials used, as per 641.04.

**644.05 Layout and Premarking.** In addition to the requirements specified in 641.06, only place auxiliary markings on new pavement. The Contractor may place initial thermoplastic markings over work zone traffic paint markings.

**644.06 Basis of Payment.** The Department will not pay for any thermoplastic lines that do not meet the required thickness. The Department will pay for accepted quantities at the contract prices, or prices adjusted according to 644.04, measured according to 641.12, with the provisions specified in 641.13, and as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
644	Mile (Kilometer)	Edge Line
644	Mile (Kilometer)	Lane Line
644	Mile (Kilometer)	Center Line
644	Foot (Meter)	Channelizing Line
644	Foot (Meter)	Stop Line
644	Foot (Meter)	Crosswalk Line
644	Foot (Meter)	Transverse/Diagonal Line
644	Each	Handicap Symbol Marking
644	Each	Railroad Symbol Marking, __ inch (__ mm)
644	Each	School Symbol Marking, __ inch (__ mm)
644	Foot (Meter)	Parking Lot Stall Marking
644	Each	Lane Arrow
644	Each	Word on Pavement, __ inch (__ mm)
644	Foot (Meter)	Dotted Line, __ inch (__ mm)

644	Foot or Square Foot (Meter or Square Meter), or Each	Removal of Pavement Marking
644	Lump Sum	Two-Way Radio Equipment

## ITEM 645 PREFORMED PAVEMENT MARKING

### 645.01 Description

### 645.02 Materials

### 645.03 Application

### 645.04 Layout and Premarking

### 645.05 Basis of Payment

**645.01 Description.** This work consists of furnishing and applying preformed pavement marking material according to Item 641, 740.01, 740.05, 740.06, and the additional requirements specified below.

**645.02 Materials.** Furnish materials from the Department's Approved List conforming to the following:

Type A (permanent markings),	
Type A1, A2, or A3 .....	740.05
Type B (work zone markings),	
Type II (non-removable) .....	740.06
Type C (work zone markings),	
Type I (removable).....	740.06

Do not apply materials that has exceeded the manufacturer's shelf life.

**645.03 Application.** Only apply on clean dry pavement surfaces. If there is oil, salt or dust; power wash the pavement and allow the pavement to dry.

Furnish the Engineer with the manufacturer's application instructions. Record the surface temperature and date of application. Furnish documentation to the Engineer. Apply preformed markings to the pavement by means of a precast adhesive on the back, or by an adhesive or activator furnished with the markings and used according to the manufacturer's recommendations. Form lines 12 inches (300 mm) wide or less by one piece; form lines wider than 12 inches (300 mm) by no more than two pieces. Do not overlap individual pieces. Do not allow a gap greater than 1/4 inch (6 mm) between pieces.

Do not use preformed markings that are subject to premature adhesion or contamination before placement.

Apply preformed markings according to the appropriate type of application as follows:

**A. Type A Marking Application.** Apply the preformed markings while the pavement surface temperature is at the manufacturer's application recommendations. Before any application, test and record the pavement surface temperature, air temperature and dew point. Retest and record every 4 hours of operation. Demonstrate to the Engineer the testing devices are accurate and

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operational. Initially position the marking under light pressure, or use a hand operated light roller or mechanical applicator. Once correctly located, hold the marking in position without delay by rolling.

If Type A preformed markings are specified to be inlaid on newly placed asphalt concrete, press the markings into the warm surface using a mechanical roller. Proper application of inlaid markings requires that the asphalt concrete pavement surface have a temperature below the maximum temperature recommended for the preformed material or its adhesive backing.

**B. Type B and Type C Marking Application.** Apply the preformed markings according to the manufacturer’s recommendations.

**645.04 Layout and Premarking.** In addition to the requirements specified in 641.06, place preformed auxiliary markings only on new pavement.

**645.05 Basis of Payment.** The Department will not pay for under thickness lines or non-specification materials. The Department will pay for accepted quantities at the contract prices, or prices adjusted according to 641.11, measured according to 641.12, with the provisions specified in 641.13, and as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
645	Mile (Kilometer)	Edge Line, Type ____
645	Mile (Kilometer)	Lane Line, Type ____
645	Mile (Kilometer)	Center Line, Type ____
645	Foot (Meter)	Channelizing Line, Type ____
645	Foot (Meter)	Stop Line, Type ____
645	Foot (Meter)	Crosswalk Line, Type ____
645	Foot (Meter)	Transverse/Diagonal Line, Type ____
645	Each	Handicap Symbol Marking, Type ____
645	Each	Railroad Symbol Marking, Type ____
645	Each	School Symbol Marking, ____ inch (____ mm), Type ____
645	Foot (Meter)	Parking Lot Stall Marking, Type ____
645	Each	Lane Arrow, Type ____
645	Each	Word on Pavement, ____ inch (____ mm), Type ____
645	Foot (Meter)	Dotted Line, ____ inch (____ mm), Type ____
645	Foot, Square Foot (Meter, Square Meter), or Each	Removal of Pavement Marking
645	Lump Sum	Two-Way Radio Equipment

**ITEM 646 EPOXY PAVEMENT MARKING**

- 646.01 Description**
- 646.02 Materials**
- 646.03 Equipment**
- 646.04 Cleaning and Surface Preparation**
- 646.05 Application**

## 646.07 Basis of Payment

**646.01 Description.** This work consists of furnishing and applying epoxy pavement markings according to Item 641, 740.01, 740.07, 740.09, and the additional requirements specified below.

Store and handle epoxy material according to all the applicable EPA and local environmental regulations and the manufacturer's recommendations.

**646.02 Materials.** Furnish materials from the Department's Approved List conforming to:

Epoxy pavement markings.....	740.07
Glass beads, Type D .....	740.09

The Engineer may obtain random samples from the application equipment.

Furnish the manufacturer's identification information for the sampled liquid materials. The Department will test the quality assurance sample for conformance to the manufacturer's production ranges. Samples not meeting the manufacturer's production ranges will require the Contractor to re-apply, at his expense, any markings using that sample. All other untested batches will become not approved materials and will either require testing or re-application.

Do not apply material that has exceeded the manufacturer's shelf life. Do not use glass beads that are wet.

## 646.03 Equipment.

**A. General.** Equip all striping equipment for center line, lane line and edge line markings with a computerized Data Logging System (DLS) conforming to 641.04 when the length of marking exceeds 0.5 miles (0.8 km) of continuous line equivalent.

Furnish written documentation to the Engineer for the equipment's operational capabilities from the equipment manufacturer.

Use equipment to apply epoxy pavement markings that has the following capabilities and features:

1. Capable of mixing the epoxy components in proportions recommended by the manufacturer and applying glass beads simultaneously with line placement.
2. Capable of applying epoxy at the specified thickness, width, and pattern.
3. Individual material reservoirs, or space, for the storage of Part A and Part B of the epoxy.
4. Heating equipment of sufficient capacity to maintain the epoxy components at the manufacturer's recommended temperature, and to produce the required amount of heat at the mixing head and gun tip and maintain those temperatures with the tolerances recommended by the epoxy manufacturer for the spray application.

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5. Adequate individual tanks for the storage and dispensing of Size I and Size II glass beads.

6. Individual dispensers for the simultaneous application of Size I and Size II glass beads at specified rates.

7. Individual metering devices on the proportioning pumps (one indicator per pump) and stroke counters to monitor gallon (liter) usage. Ensure that these devices are clearly visible.

8. All the necessary spray equipment mixers, compressors, and other appurtenances to allow for the placement of reflectorized pavement marking systems in a simultaneous sequence of operations.

9. A minimum 24-inch (600 mm) long static mixer unit or an equivalent system that produces properly mixed material.

10. A completely enclosed flush and purge system to clean the lines and the guns without expelling any of the solution into the environment.

**B. Long Line Equipment.** Furnish a striper to apply long line epoxy markings that is:

1. Truck-mounted and self-contained.

2. Designed to spray the epoxy and glass beads in continuous and skip line.

3. Maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

**C. Auxiliary Marking Equipment.** Furnish application equipment for auxiliary markings by either of the following two methods:

1. Equip the striper with accessories for applying auxiliary markings.

2. Use a portable applicator approved by the Engineer.

**D. Documentation Requirements** Furnish the Engineer documentation from the manufacturer that the equipment meets all requirements of 646.03. Demonstrate the equipment has the capability to obtain the manufacturer's required temperature for the mixed components and the required temperature at the lines and gun.

#### 646.04 Cleaning and Surface Preparation.

**A. General.** Before applying epoxy, clean and prepare the pavement surface in the following sequence:

1. Remove all debris, oil, and any other contaminants that may hinder the adhesion of the epoxy to the pavement.

2. Use a power-broom to clean the pavement.

3. Remove residue and debris with blasts of compressed air.

4. Follow any additional manufacturer's recommendations for surface preparation.

Perform operations in such a manner that the finished pavement surface is not damaged or unnecessarily scarred or left in a pattern that will mislead or misdirect the motorist and that minimizes airborne dust. Avoid damage to transverse and longitudinal joint sealers.

**B. Asphalt Concrete Pavements.** In addition to the requirements of 646.04.A, the following apply.

Wait 48 hours after the placement of polymer modified asphalt-concrete pavement before preparing it for epoxy pavement markings.

For any other type of modified asphalt or for open graded friction course asphalts, contact the manufacturer for surface preparation recommendations. Furnish the Engineer copies of the manufacturer's recommendations.

Lightly abrade any new asphalt concrete pavement containing SBS, SBR latex or SMA latex polymer modifiers without scarring the area between the broken lines to the manufacturer's recommendations to remove polymer surface film to assure proper bonding. In no case shall the removal of the polymer surface film be less than that required for the epoxy to properly bond and adhere.

**C. Portland Cement Concrete Pavements.** On new portland cement concrete pavements, do not begin cleaning operations until a minimum of 30 days after the placement of concrete, unless otherwise directed by the Engineer. In addition to the requirements of 646.04.A, the following apply.

Remove all curing compound and laitance on the concrete surface and in any textured pavement valleys.

Round the profiles of the peaks of textured pavement and remove sharp edges and irregularities.

Acceptable removal methods are:

1. Sand blasting with containment.
2. Lightly abrading the surface without scarring the surrounding surface. This must be demonstrated before the application and approved by the Engineer.
3. Blast track cleaning.
4. High-pressure water blasting (greater than 5000 psi [34 450 kPa]) with or without abrasives and with sufficient time to allow the pavement to dry before applying epoxy markings.
5. Other methods approved by the Engineer.

Contain and dispose of all the removal debris.

**D. Removal of Existing Markings.** When placing epoxy markings in the same place as existing pavement markings, remove at least 95 percent of the existing pavement markings. Use a removal method that results in little or no color and texture changes in the surrounding pavement.

**E. Preparation Area.**

**1. Lines.** Prepare an area that is the width of the new pavement marking, or existing line, plus 1-inch (25 mm) on each side and the length of broken lines plus 12 inches (300 mm) on each end.

**2. Arrows, Letters, and Symbols.** When cleaning for letters and symbols, prepare an area that is sufficiently large to accommodate the new marking, or to remove the existing marking.

**646.05 Application.** Apply epoxy only when the surface is clean and dry and when the pavement and air temperature are above 50 °F (10 °C). Transfer the entire contents of each material container to the striper tanks. Keep the epoxy thoroughly mixed at all times during application. Before any application, test and record the pavement surface temperature, air temperature. Retest and record every 4 hours of operation. Demonstrate to the Engineer the testing devices including DLS are accurate and operational.

Apply epoxy uniformly to the surface to be marked at a rate specified below. To achieve the rate, ensure that the thickness of the applied epoxy is 20 mils (0.51 mm).

20 Mil Thickness	Line Width (inch)				
	4	6	8	12	24
	Gallon per Mile of Line				
Solid Line	22	33	44	66	132
Broken Line	5.5	8.25	11	16.5	33
Dotted Line	5.5	8.25	11	16.5	33
Areas, Symbols, Words	1.25 gallon per 100 square feet				

0.51 mm Thickness	Line Width (mm)				
	100	150	200	300	600
	Liter per Kilometer of Line				
Solid Line	50	75	100	150	300
Broken Line	12.5	19	25	38	75
Dotted Line	12.5	19	25	38	75
Areas, Symbols, Words	0.51 L/m <sup>2</sup>				

Do not dilute the epoxy.

Apply enough glass beads to the uncured epoxy so that the beads completely fill the epoxy film from the film-pavement interface to the top surface of the film to the extent that there are loose beads on the surface of the uncured line. Apply glass beads at a minimum rate of 31 pounds per 100 square feet (15 kg per 10 m<sup>2</sup>) of epoxy to achieve uniform retroreflectivity. Drop glass beads onto the epoxy in a double-drop system with the large gradation (Size I) first and the regular gradation (Size II) second in the same pass of the equipment. Apply the beads in equal amounts by weight.

Cease operations when any of the following conditions are observed:

- A. The marking does not consistently dry to a no-track condition.

B. The marking has cyclical soft spots.

Resume marking operations when the Inspector is satisfied the problem is corrected.

Replace unsatisfactory markings as per 641.11.

Furnish the Engineer daily, biweekly and final DLS reports as per 641.04.

**646.07 Basis of Payment.** The cost of cleaning and surface preparation according to 646.04 is included in the unit bid cost for the various pavement markings.

The Department will make payment for accepted quantities at the contract prices, or prices adjusted according to 641.11, measured according to 641.12, with the provisions specified in 641.13, and as follows:

Item	Unit	Description
646	Mile (Kilometer)	Edge Line
646	Mile (Kilometer)	Lane Line
646	Mile (Kilometer)	Center Line
646	Foot (Meter)	Channelizing Line
646	Foot (Meter)	Stop Line
646	Foot (Meter)	Crosswalk Line
646	Foot (Meter)	Transverse/Diagonal Line
646	Foot (Meter)	Curb Marking
646	Square Foot (Square Meter)	Island Marking
646	Each	Handicap Symbol Marking
646	Each	Railroad Symbol Marking
646	Each	School Symbol Marking, ___ inch (___ mm)
646	Foot (Meter)	Parking Lot Stall Marking
646	Each	Lane Arrow
646	Each	Word on Pavement, ___ inch (___ mm)
646	Foot	Dotted Line
646	Each, Foot, (Meter) Square Foot (Square Meter)	Removal of Pavement Marking
646	Lump Sum	Two-Way Radio Equipment

**ITEM 647 HEAT-FUSED PREFORMED THERMOPLASTIC  
PAVEMENT MARKING**

**647.01 Description**

**647.02 Materials**

**647.03 Equipment**

**647.04 Application**

**647.05 Basis of Payment**

**647.01 Description.** This work consists of furnishing and applying heat-fused preformed thermoplastic for use as auxiliary pavement markings according to Item 641, 740.01, 740.08 and the additional requirements specified below.

**647.02 Materials.** Furnish materials from the Department’s Approved List conforming to:

Heat fused preformed thermoplastic  
pavement marking material ..... 740.08

**647.03 Equipment.** Use manufacturer recommended equipment to apply the heat-fused preformed thermoplastic pavement marking material according to the appropriate type, as follows:

**A. Type A90 or Type A125 Material.**

1. Propane torch to heat the pavement and material according to 647.04.B.
2. Infrared thermometer to assure that both the pavement and the material are properly heated and do not exceed the manufacturer’s specified application temperature.

**B. Type B90 or Type B125 Material.**

1. Propane torch for ensuring no moisture is present on the pavement and heating the material according to 647.04.C.
2. A thermometer is not required.

**647.04 Application.**

**A. General.** Apply the heat-fused preformed thermoplastic pavement marking material to clean, dry pavement surfaces according to the appropriate type unless otherwise directed by the manufacturer's recommendation. Apply primer sealer on portland cement concrete pavements for proper adhesion only if the manufacturer requires its use.

Form lines 12 inches (300 mm) wide or less by one piece; form lines wider than 12 inches (300 mm) by no more than two pieces. Do not overlap individual pieces. Do not allow a gap greater than 1/4-inch (6 mm) between pieces.

**B. Type A90 and Type A125 Material Application on Asphalt Concrete and Portland Cement Concrete Pavements.** Uniformly pre-heat the pavement to 300 °F (149 °C) with a propane torch. Place the material on the warm surface as soon as practical, then uniformly post-heat to 400 °F (204 °C). Begin the post-heating

process of material application as quickly as possible. The Contractor may have to extend post-heating on concrete having a high moisture content. Allow the material to cool naturally and solidify before exposing it to traffic.

Type A90 and A125 materials shall contain intermix beads throughout. Drop-on glass beads are not required unless using a non-surface beaded marking (i.e., for turn or combination arrows).

**C. Type B90 and Type B125 Material Application on Asphalt Concrete and Portland Cement Concrete Pavements.** Heat the pavement only to ensure no moisture is present. Place the material on the dry surface and then uniformly heat the material until it bubbles and changes color to off-white. Material must be able to be applied with no preheating of the pavement to a specified temperature and without the use of a thermometer. Allow the material to cool naturally and solidify before exposing it to traffic.

Type B90 and B125 material shall contain intermix glass beads throughout. Drop-on glass beads are not required unless using a non-surface beaded marking (i.e., for turn or combination arrows).

**647.05 Basis of Payment.** The Department will pay for accepted quantities at the contract prices, or prices adjusted according to 641.11, measured according to 641.12, with the provisions specified in 641.13, and as follows:

Item	Unit	Description
647	Foot (Meter)	Channelizing Line, Type ____
647	Foot (Meter)	Stop Line, Type ____
647	Foot (Meter)	Crosswalk Line, Type ____
647	Foot (Meter)	Transverse/Diagonal Line, Type ____
647	Each	Handicap Symbol Marking, Type ____
647	Each	Railroad Symbol Marking, Type ____
647	Each	School Symbol Marking, ____ inch (____ mm), Type ____
647	Foot (Meter)	Parking Lot Stall Marking, Type ____
647	Each	Lane Arrow, Type ____
647	Each	Word on a Pavement, ____ inch (____ mm), Type ____
647	Foot (Meter)	Dotted Line, ____ inch (____ mm), Type ____
647	Each, Foot, Square Foot (Meter, Square Meter)	Removal of Pavement Marking

## 650 ROADSIDES

### ITEM 651 TOPSOIL STOCKPILED

**651.01 Description**

**651.02 Construction Requirements**

**651.03 Method of Measurement**

**651.04 Basis of Payment**

**651.01 Description.** This work consists of stripping topsoil from areas shown on the plans or from within the Right-of-Way limits, transporting, and stockpiling topsoil at locations shown on the plans or at locations elected by the Contractor with project approval.

**651.02 Construction Requirements.** Remove all heavy grass, weeds, or other vegetation over the areas before stripping. Keep the topsoil separate from other excavated materials. Remove topsoil before beginning the regular excavation or embankment work in the area. The depth of stripping will be per the plans or per the Project Engineer.

**651.03 Method of Measurement.** The Department will measure Topsoil Stockpiled by the number of cubic yards (cubic meters) completed and accepted, measured from the removal areas.

**651.04 Basis of Payment.** The Department will not pay for any removal of topsoil beyond the directed depth.

The Department will pay for accepted quantities at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
651	Cubic Yard (Cubic Meter)	Topsoil Stockpiled

### ITEM 652 PLACING STOCKPILED TOPSOIL

**652.01 Description**

**652.02 Construction Requirements**

**652.03 Method of Measurement**

**652.04 Basis of Payment**

**652.01 Description.** This work consists of hauling and spreading topsoil from stockpiles and preparing the surface.

**652.02 Construction Requirements.** Prepare the surface according to 653.03. Place and spread the topsoil according to 653.03.

**652.03 Method of Measurement.** The Department will measure Placing Stockpiled Topsoil by the number of cubic yards (cubic meters) completed and accepted in place.

**652.04 Basis of Payment.** The Department will pay for accepted quantities at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
652	Cubic Yard (Cubic Meter)	Placing Stockpiled Topsoil

## **ITEM 653 TOPSOIL FURNISHED AND PLACED**

### **653.01 Description**

### **653.02 Materials**

### **653.03 Construction Requirements**

### **653.04 Method of Measurement**

### **653.05 Basis of Payment**

**653.01 Description.** This work consists of furnishing and spreading topsoil and preparing the subgrade.

**653.02 Materials.** Furnish topsoil consisting of loose, friable, loamy material without admixture of subsoil or refuse. For topsoil to be considered loamy, ensure that the fraction passing the No. 10 (2.00 mm) sieve does not contain more than 40 percent clay. Furnish topsoil consisting of not less than 4 percent and not more than 20 percent organic matter as determined by loss on ignition of samples oven dried to constant weight at 212 °F (100 °C). Furnish topsoil that is free of grass, brush, and, roots.

**653.03 Construction Requirements.** Before placing any topsoil, prepare all areas to be covered with topsoil according to 659.10. Place the topsoil according to 659.11. When seeding is specified, open the topsoil up to receive the seed.

**653.04 Method of Measurement.** The Department will measure compacted Topsoil Furnished and Placed by the number of cubic yards (cubic meters) of after compaction furnished.

**653.05 Basis of Payment.** The Department will pay for accepted quantities at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
653	Cubic Yard (Cubic Meter)	Topsoil Furnished and Placed

**ITEM 654 RENOVATING EXISTING SOIL**

**654.01 Description**

**654.02 Materials**

**654.03 Construction Requirements**

**654.04 Method of Measurement**

**654.05 Basis of Payment**

**654.01 Description.** This work consists of preparing a suitable seedbed by grading and renovating existing soil, and furnishing and placing commercial fertilizer, if specified.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

**654.02 Materials.** Use commercial fertilizer conforming to 659.04.

**654.03 Construction Requirements.** Prepare the surface area for seed according to 659.10.

If the Contract Documents require commercial fertilizer, place it according to 659.04.

**654.04 Method of Measurement.** The Department will measure Renovating Existing Soil by the number of M square feet (square meters) completed and accepted.

The Department will measure Commercial Fertilizer by the number tons (kilograms) completed and accepted.

**654.05 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
654	M Square Feet (Square Meter)	Renovating Existing Soil
654	Ton (Kilogram)	Commercial Fertilizer

**ITEM 656 ROADSIDE CLEANUP**

**656.01 Description**

**656.02 Intensity of Cleanup**

**656.03 Cleaning**

**656.04 Pruning**

**656.05 Disposal of Refuse**

**656.06 Method of Measurement**

**656.07 Basis of Payment**

**656.01 Description.** This work consists of cleaning up outside the excavated and filled areas and disposing of undesirable plants and other vegetative growth,

prunings, rubbish, stumps, conspicuous stones, all down timber, dead brush, logs and timbers; felling and destroying of all snags and such dangerous trees; and pruning trees, native shrubs and similar vegetation but does not include work to be performed under Item 201.

**656.02 Intensity of Cleanup.** Control the intensity of cleanup to effect a natural transition in cleanup treatment from the edge of the pavement outward to the limits of the Right-of-Way to avoid sharp demarcation between the artificial and the natural.

**656.03 Cleaning.** After removal of large objects, clean the designated areas with grubbing rakes or wide-spaced tooth rakes. Do not disturb or injure desirable grass, vines, or wild flowers.

**656.04 Pruning.** Prune trees 6 inches (150 mm) or less in diameter and native shrubs and similar vegetation according to Item 666. Consider the diameter of existing trees to be the diameter measured at 54 inches (1.4 m) above the ground.

**656.05 Disposal of Refuse.** Use removed materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

**656.06 Method of Measurement.** The Department will measure Roadside Cleanup by the number of M square feet (square meters) cleaned up and accepted.

The Department will determine the boundaries of the area to be cleaned up and the number of units.

**656.07 Basis of Payment.** The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
656	M Square Feet (Square Meter)	Roadside Cleanup

## ITEM 657 RIPRAP FOR TREE PROTECTION

**657.01 Description**

**657.02 Materials**

**657.03 Tree Wells in Fill**

**657.04 Walls in Cut**

**657.05 Hand-Laid Stone Riprap**

**657.06 Earthwork**

**657.07 Pipe Drains**

**657.08 Method of Measurement**

**657.09 Basis of Payment**

**657.01 Description.** This work consists of furnishing and placing riprap for protecting selected trees or shrubs by tree wells and retaining walls.

**657.02 Materials.** Furnish stone consisting of sandstone, limestone, or other natural rock with a maximum 30 percent single slab loss and a maximum 20

### 657.03

percent cumulative loss after testing to ASTM D 5240. Use an 8-inch slab test sample. The Department may waive testing when the stone source has a known durability history. Furnish embankment according to Item 203. Unless otherwise specified, use 4-inch (100 mm) pipe conforming to 603 Type E conduits.

**657.03 Tree Wells in Fill.** Where a fill around a tree or shrub not marked for removal will be 12 inches (0.3 m) or more in depth over the feeding root area or ground surface lying within the periphery of the tree, construct a dry hand-laid stone riprap tree well. Construct a wall, of the same height as the fill, circling the tree or shrub and 3 1/2 feet (1 m) from the tree trunk or as specified. Construct the wall so that the top of the wall follows the contour on the finished grade in a neat line.

Construct tree wells before placing the fill over the root area. However, the Contractor may bring up the fill with the wall after required aggregate for root aeration is in place according to Item 658.

**657.04 Walls in Cut.** Where the top of the slope in cut is within 6 feet (2 m) of the trunk of a tree not marked for removal, construct a dry hand-laid stone riprap wall. Toe the bottom of the wall into the ground 2 inches (50 mm) unless otherwise shown on the plans, and make the top of the wall even with the original ground line at the base of the tree. Extend the length of the wall far enough from the tree to amply cover the roots, or according to the shape and size as shown on the plans. Flare the ends of the wall back, and taper or fade them out into the finished grade of the slope in a neat line.

**657.05 Hand-Laid Stone Riprap.** Construct the earth bed on which riprap is to be placed to a slope of 1 foot (300 mm) vertical to 2 inches (50 mm) horizontal. Dress the earth bed to a true plane. Where riprap is to rest against a fill, tamp the embankment against the back of the stone.

Construct riprap for walls or wells according to the arrangements and dimensions shown on the plans. Lay each course with the long dimensions of each stone perpendicular to the slope or batter.

Use individual stones that are roughly rectangular in cross-section and are a minimum of 3 inches (75 mm) in the vertical depth with a horizontal dimension of not less than 15 inches (0.4 m). Place the individual stones by hand, one upon the other so that they break joints with the stone in the course below. Where it is necessary to use more than one stone to provide the specified thickness or depth of the wall, thereby resulting in joints parallel to the face of the wall, place such stones to break joints with the adjacent stones.

Fill the space between the larger stones with spalls rammed into place. Ensure that the surface of the finished riprap does not vary more than 3 inches (75 mm) from that shown on the plans, and that it presents an even, tight surface, pleasing in appearance.

**657.06 Earthwork.** Perform excavation and embankment, as necessary, according to Item 203.

**657.07 Pipe Drains.** Drain tree wells with pipe starting on the original ground surface and lay to drain beyond the toe of the fill. Install pipe for drains according to Item 603.

**657.08 Method of Measurement.** The Department will measure Riprap for Tree Protection by the number of square yards (square meters) in place, completed and accepted. The Department will measure parallel to the face of the wells or walls.

**657.09 Basis of Payment.** The Department will pay for embankment and excavation under Item 203 and the pipe for drains under Item 603.

The Department will pay for accepted quantities at the contract price for as follows:

Item	Unit	Description
657	Square Yard (Square Meter)	Riprap for Tree Protection

## ITEM 658 TREE ROOT AERATION

**658.01 Description**

**658.02 Materials**

**658.03 Preparation**

**658.04 Aeration for Trees Not Welled**

**658.05 Aeration with Tree Wells**

**658.06 Earth Embankment**

**658.07 Method of Measurement**

**658.08 Basis of Payment**

**658.01 Description.** This work consists of furnishing and placing the necessary aggregate and tile for the protection and aeration of the roots of trees and shrubs.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

**658.02 Materials.** Furnish aggregate for tree root aeration and protection consisting of No. 4 or 467 limestone or gravel with a maximum sodium soundness loss of 15 percent.

Furnish 4-inch (100 mm) pipe conforming to 603 Type E conduit. Furnish embankment conforming to Item 203.

**658.03 Preparation.** The feeding root area to be protected and aerated is the ground surface area lying within the periphery of the tree or shrub not marked for removal. Prepare these areas by excavating all vegetation, wood, brush, and debris.

**658.04 Aeration for Trees Not Welled.** Where the earth fill is less than 12 inches (300 mm) and more than 4 inches (100 mm) over the feeding root area,

**658.05**

loosely spread an aggregate aeration course of one-half the height of fill, but not less than 3 inches (75 mm), over this area. At the tree trunk, increase the thickness to the height of the fill and extend it outward from the tree trunk in collar form for a distance of 15 inches (0.4 m). Place a 2-inch (50 mm) layer of straw or hay over the aggregate.

**658.05 Aeration with Tree Wells.** Place an aeration course of aggregate while constructing the tree wells and before any other filling. Do not place any aggregate inside the tree well (between the wall and the tree trunk). Place the aggregate over the entire feeding root area outside of the tree wells to a total depth of 6 inches (150 mm) for each 12 inches (300 mm) of earth fill, or proportion thereof, but place a minimum depth of 6 inches (150 mm) regardless of depth of overlying fill. Place a 2-inch (50 mm) layer of straw or hay over the aeration layer.

**658.06 Earth Embankment.** Perform excavation and embankment, as necessary, according to Item 203.

**658.07 Method of Measurement.** The Department will measure Tree Root Aeration by the number of cubic yards (cubic meters), measured in the carrier or truck according to 109, of the aggregate furnished, placed, completed, and accepted.

**658.08 Basis of Payment.** The Department will pay for embankment and excavation under Item 203 and the pipe under Item 603.

The Department will pay for accepted quantities at the contract price as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
658	Cubic Yard (Cubic Meter)	Tree Root Aeration

**ITEM 659 SEEDING AND MULCHING**

- 659.01 Description**
- 659.02 Testing of Soil or Topsoil**
- 659.03 Lime**
- 659.04 Commercial Fertilizer**
- 659.05 Topsoil**
- 659.06 Compost**
- 659.07 Seeds**
- 659.08 Legumes**
- 659.09 Native Grasses and Wildflowers**
- 659.10 Site Preparation**
- 659.11 Placing Topsoil**
- 659.12 Seeding Methods**
- 659.13 Mulching Operation**
- 659.14 Straw Mulch**
- 659.15 Wood Fiber Mulch**
- 659.16 Compost Mulch**
- 659.17 Watering**

- 659.18 Maintenance**
- 659.19 Mowing**
- 659.20 Repair Seeding and Mulching**
- 659.21 Inter-Seeding**
- 659.22 Fertilization: 2<sup>nd</sup> Application**
- 659.23 Performances**
- 659.24 Method of Measurement**
- 659.25 Basis of Payment**

**659.01 Description.** This work consists of placing topsoil, preparing the seed bed, and placing and incorporating seed, agricultural lime, commercial fertilizer, and placing mulching material.

Perform this work in stages according to Item 207.

Perform this work in areas shown on the plans for seeding and mulching.

Perform seeding and mulching after completing all work in the area and within 7 days of obtaining final grade. If it is anticipated that future work may disturb an area, place temporary seed (Class 7), and provide mulch according to Item 207 and perform seeding and mulching after all work is completed. If the Contractor disturbs a final area, then the Contractor shall restore this area.

Use all excavation material in the work. Alternatively legally use, recycle, or dispose of all excavated materials according to 105.16 and 105.17.

**659.02 Testing of Soil or Topsoil.** When a Soil Analysis Test of the soil or topsoil is required in the plans, use the following sampling frequency to determine the lime required:

A. When an area is near final grade, perform Standard Soil Analysis Test to measure the soil acidity or alkalinity (pH) if no topsoil is to be placed. This testing will determine the soil requirements for lime. If the soil requirements are different than the standard lime mixture ratio application rates then the standard application rate shall be adjusted up or down such that the soil requirements are met. If liquid lime is used then use the following application table to achieve a pH of 6.5 or greater. Calculate the difference between the soil pH and 6.5 pH.

Difference	0.25	0.50	0.75	1.0
Application rate in gals/ac (L/ha)	2.5 (4)	5 (8)	10 (15)	20 (30)

Example: Soil Analysis Test pH=5.75 required pH=6.5 difference= .75 required application rate is 10 gals/ac (15L/ha) Only use Liquid lime on the QPL list. Provide the Engineer with the Liquid Lime manufacturers written application rate. The Engineer will only accept printed application rates.

There will be no change in the mixture ratio. The sampling frequency is one sample every 10 acres (4.0 ha) per project side or one sample per project side whichever is greater. A sample consist of 15 soil cores in a random pattern spaced at a minimum of 500 feet (153 m) apart. Sample any change in soil. Soil changes can be seen as color and/or texture changes.

B. If placing topsoil, perform the Standard Soil Analysis Test from topsoil stockpiles to measure the topsoil acidity or alkalinity (pH). This testing will

**659.03**

determine the soil requirements for lime. If the topsoil requirements are different than the standard lime mixture ratio application rates then the standard application rate shall be adjusted up or down such that the topsoil requirements are met.

If liquid lime is used then use the following application table to achieve a pH of 6.5 or greater. Calculate the difference between the soil pH and 6.5 pH.

Difference	.25	.50	.75	1.0
Application rate in gals/ac (L/ha)	2.5 (4)	5 (8)	10 (15)	20 (30)

Example: Soil Analysis Test pH=5.75 required pH=6.5 difference= .75 required application rate is 10 gals/ac (15L/ha) Only use Liquid lime on the QPL list. Provide the Engineer with the Liquid Lime manufacturers written application rate. The Engineer will only accept printed application rates.

There will be no change in the mixture ratio. The sampling frequency is one sample every 10,000 cubic yards (7600 m<sup>3</sup>) of a topsoil stockpile, or at least two samples per stock pile whichever is greater. Test each stockpile. A sample consisting of 15 soil cores in a random pattern spaced evenly throughout the stockpile.

Mix the 15 cores from each sample and then remove 1 pint (0.5 L) for testing.

The Ohio County Extension offices can provide the Contractor with a soil sample kit and testing laboratory locations.

The Department will review the sample test results and approve application rates for the standard mixture ratios provided by the Contractor.

If a Soil Analysis Test of the soil is not required by the plans, use the standard application rates for lime and commercial fertilizer.

**659.03 Lime.** Obtain granular or liquid lime from a agricultural lime dealer or manufacturer whose brands are grades registered or licensed by the State of Ohio, Department of Agriculture. The granular or liquid lime standard grade is Ag-ground 90+. Ag-ground 90+ is defined as agricultural ground limestone, having a total neutralizing power (TNP) of 90 percent or more, at least 40 percent passing a No. 100 (150 μm) sieve and 95 percent passing a No. 8 (2.36 mm) sieve. Test granular or liquid lime according to Supplement 1007. Apply the granular or liquid lime standard grade Ag-ground 90+ at the standard application rate of 92 pounds per 1000 square feet (2 tons per acre) [0.45 kg/m<sup>2</sup> (9 metric tons/ha)].

The Contractor may provide other lime grade materials. The lime grade materials provided will meet Table 7-10 “Equivalent Amounts of Liming Materials” found in Bulletin 472, *Ohio Agronomy Guide*, published by the Cooperative Extension Service, The Ohio State University. Based on the type of lime grade material provided, determine the increase or decrease in the standard application rate from Table 7-10 “Equivalent Amounts of Liming Materials” found in Bulletin 472, “Ohio Agronomy Guide”, published by the Cooperative Extension Service, The Ohio State University.

If using liquid lime apply liquid lime at a rate of 5 gals/acre (8 L/ha) unless otherwise required per the soil or topsoil Soil Analysis Test. Provide the Engineer

with the Liquid Lime manufacturers written application rate. The Engineer will only accept printed application rates. Only use Liquid lime on the QPL list.

If testing of the soil or topsoil was performed, the lime required will be such that a growing environment of slightly acidic (pH 6.5) can be reached. The application rate of the standard grade lime Ag-ground 90+ will be adjusted up or down to achieve this condition and reported to the Department for approval. No lime is required for the soil or topsoil if the test shows a slightly acidic condition.

**659.04 Commercial Fertilizer.** Obtain commercial fertilizer from a dealer or manufacturer whose brands are grades registered or licensed by the State of Ohio, Department of Agriculture.

Commercial fertilizer may be dry or liquid. Apply standard commercial fertilizer 10-20-10 evenly over the surface at a standard dry application rate of 20 pounds per 1000 square feet (0.1 kg/m<sup>2</sup>). Furnish liquid application rates for approval by the Department.

The Contractor may provide other commercial fertilizer mixture ratios, however, ensure that the ratio meets or exceeds the standard commercial fertilizer ratio of 10-20-10 by providing an application rate specific for that ratio. The Department will approve this application rate that is specific to that ratio provided by the Contractor.

For areas of inter-seeding apply commercial fertilizer 12-12-12 over the affected area at the above rate.

For commercial fertilizer second application the method, mixture, and rate is broadcast 12-12-12 evenly over the surface without incorporation into the soil at a rate of 10 pounds per 1000 square feet (0.05 kg/m<sup>2</sup>).

**659.05 Topsoil.** If placing topsoil as specified in the plan, then stockpile off project site topsoil for testing and/or stockpile stripped topsoil from the project for testing. Perform the Soil Analysis Test from these stockpiles to determine the percent of organic matter present. The topsoil shall contain between 4 percent and 20 percent organic matter as determined by loss on ignition of samples oven dried to constant weight at 212 °F (100 °C) and consist of fertile, loose, friable, and loamy material that contains humus material. For topsoil to be considered loamy, ensure that the fraction passing the No. 10 (200) sieve does not contain more than 40 percent clay. Test topsoil according to Supplement 1016.

The Department will review the sample test results and approve the stockpiles for use. Stockpiles outside the above limits will not be used.

Stripped topsoil from the R/W limits will be from the upper most layers of the excavation areas. Remove all heavy grass, weeds, and other vegetation before stripping topsoil from the excavation areas.

A mixture of 1 part compost and 2 parts topsoil will be treated as topsoil.

**659.06 Compost.** Acceptable compost shall include Ohio EPA rated Class IV compost, EQS biosolids compost, or a Department approved equal. Furnish compost with a nitrogen content of 1.4 percent or above. Obtain compost from an

**659.07**

Ohio EPA approved facility. Before delivering compost, provide the Engineer with the facility name and location.

**659.07 Seeds.** Furnish grass seed from a grass seed dealer or grower whose brands are grades registered or licensed by the State of Ohio, Department of Agriculture or from the approved list of grass seed dealers or growers on file with Department. Furnish the kind and type of grass seed required that meets current specifications on file with the Department as to percentage purity, percentage weed seed, and percentage germination.

Turf grass germination rates specifications are shown below in Table 659.07-1 to provide an understanding of the specifications on file with the Department along with information to understand what is required.

**TABLE 659.07-1 GERMINATION RATES**

Species	Minimum Percent	High Quality Percent
Kentucky Bluegrass	80	85
Fine Fescue	85	90
Perennial Ryegrass	85	90
Annual Ryegrass	85	90
Tall Fescue	85	90
Creeping Red Fescue	85	90

If high quality is not shown on the plans, then the minimum germination rate is required.

Mark the test date on seed bags. Furnish seeds as separate species and cultivars, packaged together or bagged separately, and labeled, tagged, or marked according to ORC 907.03. Sow seeds within 9 months of the testing date. The Department reserves the right to test, reject, or approve all seed after delivery.

**659.08 Legumes.** Inoculate or treat all leguminous seeds (crown vetch) with the proper amount of pure nitrogen-fixing bacteria and mix with sufficient water to thoroughly wet the seed. The bacteria selected will be for maximum vitality and shall not be more than one-year old. All culture records will be provided with the leguminous seeds.

If sown hydraulically, use 4 times the inoculant rate specified by the inoculant manufacturer. If pre-inoculated seed is used then use 3 times the inoculant rate specified by the inoculant manufacturer. Immediately before seeding, add inoculant and sticking agent directly into the slurry, and thoroughly mix the slurry. Sow seed as soon as possible after inoculation. If left standing for more than 24 hours, reinoculate seed before sowing. Mix all seed on the project. Sixty days before seeding, provide a written description for the Class 3C mixture showing the percentage by weight (mass) of each kind of seed for the Engineer's approval.

Include the following with the description:

- A. Name and location of the seed supplier.
- B. Origin and date of harvest of each kind of seed.

- C. A statement of the purity and germination of each seed.
- D. Testing date for each seed.
- E. How and when seeds were mixed.

**659.09 Native Grasses and Wildflowers.** Table 659.09-1 lists the seed quantities by weight per area. Use Classes 4, 5, and 6 in the amounts of pure live seed (PLS) for each species listed. If seed tests show that the seed has an actual pure live seed (PLS) yield less than the intended yield, adjust the specified quantity to provide the intended PLS yields.

For Class 4, 5, and 6 mixtures, provide seed specifically grown for the Ohio climate.

Use cool season turf Classes 1, 2, 3A, and 3B as listed in Table 659.09-1 composed of no less than two and no more than four cultivars of the same species. Sixty days before seeding, provide a written description for the Class 1, 2, and 3A mixtures showing the percentage by weight (mass) of each kind of seed for the Engineer's approval. Mix all seed on the project. Sixty days before seeding, provide a written description for the Classes 1, 2, 3A, 3B, 4, 5, and 6 mixtures showing the percentage by weight (mass) of each kind of seed for the Engineer's approval.

Include the following with the description:

- A. Name and location of the seed supplier.
- B. Origin and date of harvest of each kind of seed.
- C. A statement of the purity and germination of each seed.
- D. Testing date for each seed.
- E. How and when seeds were mixed.

TABLE 659.09-1 GRASS AND WILDFLOWER SEED MIXES

Class	Mix Type Seeds	Weight per Area	
		lb 1000 ft <sup>2</sup>	kg 1000 m <sup>2</sup>
1	Lawn Mixture Use for areas in front of residences, commercial properties, etc. between curb and sidewalk with slopes 3:1 or flatter.		
	Kentucky Bluegrass ( <i>Poa pratensis</i> )	3	14.64
	Creeping Red Fescue ( <i>Festuca rubra</i> )	3	14.64
	Annual Ryegrass ( <i>Lolium multiflorum</i> )	2	9.76
	Perennial Ryegrass, turf type ( <i>Lolium perenne</i> )	2	9.76
2	Roadside Mixture		
	Kentucky Bluegrass ( <i>Poa pratensis</i> )	1.5	7.32
	Kentucky 31 Fescue ( <i>Festuca arundinacea</i> var. KY 31)	2	9.76
	Perennial Ryegrass ( <i>Lolium perenne</i> )	1.5	7.32
3A	Slope Mixtures Use for slopes flatter than or equal to 3:1. Use Class 2, 3B, 3C, or 4B mixtures		
3B	Low Growing Slope Mixture Use for slopes steeper than 3:1 when low growing species are required		
	Hard Fescue ( <i>Festuca longifolia</i> )	1.3	6.35
	Creeping Red Fescue ( <i>Festuca rubra</i> )	0.8	3.9
	Annual Ryegrass ( <i>Lolium multiflorum</i> )	0.23	1.12
3C	Crown Vetch Mixture Use for slopes steeper than 3:1 and shale or rock slopes.		
	Crown Vetch ( <i>Coronilla varia</i> )	0.9	4.39
	Perennial Ryegrass ( <i>Lolium perenne</i> )	1.8	8.79
	Annual Ryegrass ( <i>Lolium multiflorum</i> )	0.3	1.46
4A	Native Grass Mixture Use for slopes flatter than 2:1 and seeding for wildlife habitat mitigation.		
	Big Bluestem ( <i>Andropogon gerardii</i> )	0.07	0.34
	Indiangrass ( <i>Sorghastrum nutans</i> )	0.09	0.44
	Switchgrass ( <i>Panicum virgatum</i> )	0.02	0.09
	Annual Ryegrass ( <i>Lolium multiflorum</i> )	spring	0.11
		fall	0.34
			1.66
4B	Low Growing Native Grass Mixture Use for slopes flatter than 2:1 and seeding for wildlife habitat mitigation when low growing species are required.		



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Class	Mix Type Seeds	Weight per Area	
		lb 1000 ft <sup>2</sup>	kg 1000 m <sup>2</sup>
	Annual Ryegrass ( <i>Lolium multiflorum</i> )	0.92	4.49
6	Wildlife Mixture Use for slopes flatter than 2:1 and seeding for wildlife habitat mitigation.		
	Big Bluestem ( <i>Andropogon gerardii</i> )	0.13	0.63
	Little Bluestem ( <i>Schizachyrium scoparium</i> )	0.18	0.88
	Indiangrass ( <i>Sorghastrum nutans</i> )	0.13	0.63
	Ox-eye Sunflower ( <i>Heliopsis helianthoides</i> )	0.18	0.88
	Prairie Dock ( <i>Silphium terebinthinaceum</i> )	0.18	0.88
	Purple Coneflower ( <i>Echinacea purpurea</i> )	0.18	0.88
	Whorled Rosinweed ( <i>Silphium trifoliatum</i> )	0.11	0.54
	Downy Sunflower ( <i>Helianthus mollis</i> )	0.07	0.34
	New England Aster ( <i>Aster novae-angliae</i> )	0.07	0.34
	Annual Ryegrass ( <i>Lolium multiflorum</i> )	spring fall	0.11 0.34
			0.54 1.66
7	Temporary Erosion Control Mixture Annual Ryegrass ( <i>Lolium multiflorum</i> )	2.02	9.86

**659.10 Site Preparation.** Before placing topsoil or seed remove rock or other foreign material of 3 inches (75 mm) or greater in any dimension, from all areas except as listed below.

- A. Remove stones 1-inch (25 mm) or greater in any dimension from all seed areas from in front of residences, commercial properties, etc.; between curb and sidewalks; or as shown on the plans.
- B. Remove nothing in shale cuts, but allow the shale to deteriorate to a soil type surface before seeding or placing topsoil.

Finish the area in such a manner that seeding, place sod, planting, or, placing topsoil can proceed without additional soil preparation.

Apply commercial fertilizer, lime, or other soil amendments including compost to the soil or topsoil surface in separate operations. Incorporate the commercial fertilizer, granular lime, or other soil amendments, including compost either separately or together, into the soil or topsoil to a depth of 2 to 4 inches (50 to 100 mm). Do not mix Liquid lime into the soil or topsoil. Only apply liquid lime to the top of the soil or topsoil. Furnish a smooth surface for the seed or topsoil by tracking with a dozer or by other methods. If the site is inaccessible to a dozer and other methods do not provide results equivalent to hand raking, hand rake these areas. Ensure that the surface is uniform, free of gullies, rivulets, crusting, and caking. Finely grade the surface for seed or topsoil for slopes 4:1 or flatter, and grade all other slopes. Rake or open the surface with a dozer cleats or otherwise loosen the surface of these areas to a depth of 1 inch (25 mm) immediately before covering with topsoil. Remove raked up material from the area.

**659.11 Placing Topsoil.** If shown on the plans, place topsoil in loose lifts that construct a 4-inch (100 mm) compacted depth. The surface of the topsoil shall be such that the final grade as shown on the cross-sections is met. Use the following methods or combination of any of the methods to produce the required space to place the topsoil.

A. The 203 Items can be cut or placed to the final grade, which will match the plan quantities for Items 203, and then remove a 4-inch (100 mm) thickness for the topsoil.

B. The 203 Items can be cut or placed to a 4-inch (100 mm) height below the final grade. There will be no change from the plan quantities in the 203 Items for this method.

Track the area with a dozer to compact and provide good contact between the topsoil and the surface.

The Contractor may place topsoil by using pneumatic, or hydraulic methods. If using pneumatic or hydraulic methods to place the topsoil, the Contractor may place the top 1-inch (25 mm) with a mix of seed, commercial fertilizer, lime, and other soils amendments. This mixture will be 1 part compost and 2 parts topsoil. Do not apply mulch to this surface. The compost is the mulch.

**659.12 Seeding Methods.** Apply seed to prepared areas. If the prepared areas to be seeded become compacted before seeding, loosen the surface using disks, rakes, or other methods.

Thoroughly mix all seed, and evenly sow the seed over the prepared areas at the required rates. Do not sow seed during high winds. For slopes subject to windy conditions, seed using hydraulic methods only. Operate equipment in a manner to ensure complete coverage of the entire area to be seeded.

If broadcast seeding, seed Classes 1, 2, 3A, and 3B between August 15 to October 30. If necessary to seed Classes 1, 2, 3A, or 3B before August 15, but after March 1 increase the seeding rates by 5 percent.

Between March 1 and October 30, the Contractor may use hydro seeding, which applies the mulch, seed, water, and commercial fertilizer in the same operation, for Classes 1, 2, 3A, 3B, 3C, and 7.

Between October 30 and March 1, apply temporary seed according to Item 207. With the Engineer's approval, the Contractor may apply permanent seed between October 30 and March 1 on projects started and completed within the same calendar year.

Seed before or concurrently with all required erosion control items.

Do not apply crown vetch seed from September 1 to October 31.

Wildflower Classes 5 and 6 seed from September 1 to October 30, unless the Engineer allows seeding from March 1 to May 31.

Seed Class 4 wildflowers from March 1 to May 31.

Seed native grasses and wildflowers in Classes 4, 5, and 6 with a rangeland type, slit seeder or native seed grass drill. Seed native grasses with no less than

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two passes in different directions and by equally splitting the seed application rate to each pass. Use broadcast seeding, along with cultipacking or rolling, only with the Engineer’s approval.

If broadcast seeding, perform the following, immediately after sowing, to provide good seed-soil contact:

- A. For flat surfaces, lightly rake the area then roll.
- B. For slopes, track the area with a dozer.

**659.13 Mulching Operation.** Mulch materials consist of straw, compost, or wood fiber for 3:1 or flatter slopes. The Contractor may specify which mulch to use, if it is not shown on the plans. Use mulch that is reasonably free of weed seed, foreign materials, or other materials that would prohibit seed germination. Do not mulch during high winds. For slopes subject to windy conditions mulch using hydraulic methods only. Within 24 hours after seeding an area, evenly place mulch. Immediately replace mulch that becomes displaced.

**659.14 Straw Mulch.** Straw mulch consists of straw. Evenly place straw mulch over all seeded areas at the following rates:

Seeding Period	Rate
From March 15 to October 30	2 tons per acre (0.5 metric ton/1000 m <sup>2</sup> )
From October 31 to March 14	3 tons per acre (0.7 metric ton/1000 m <sup>2</sup> )

Keep straw mulching materials in place by applying an asphalt emulsion at a minimum rate of 60 gallons per ton (250 L/metric ton) of straw mulch or by applying tackifiers according to the manufacturer’s recommendations. Apply an additional application at a rate of 30 gallons per ton (125 L/metric ton) of straw mulch to shoulder areas, starting at the berm edge and extending out for a distance of 10 feet (3 m). Use an emulsion that is nontoxic to plants and prepared in a manner that will not change during transportation or storage.

**659.15 Wood Fiber Mulch.** Wood fiber mulch consists of pure wood fibers manufactured expressly from clean wood chips. Ensure that the chips do not contain lead paint, varnish, printing ink, and petroleum based compounds. Do not use wood fiber mulch manufactured from recycled materials of unknown origin such as sawdust, paper, cardboard, or residue from chlorine-bleached pulp and paper mills.

Ensure that the wood fiber mulch maintains uniform suspension in water under agitation and blends with grass seed, commercial fertilizer, and other additives to form a homogeneous slurry. Use manufacturer-approved tackifiers.

Using standard hydraulic mulching equipment, evenly apply the slurry over the soil surface in a one-step operation. Apply slurry from March 1 to October 30 at the following rates:

Surface	Rate
Slopes 3:1 or flatter	46 pounds per 1000 square feet (225 kg/1000 m <sup>2</sup> )

**659.16 Compost Mulch.** The Contractor may provide compost applied to a minimum depth of 1/4-inch (6 mm) over the prepared seed areas. The Contractor

may also mix the grass seed with the compost and using pneumatic equipment, place this mixture to a minimum depth of 1/4-inch (6 mm) over the prepared seed areas. If using compost no tackifiers or asphalt emulsion are required.

**659.17 Watering.** Thoroughly water all permanent seeded areas (Classes 1 to 6) after the seed has germinated. Apply a total rate of 300 gallons per 1000 square feet (12.2 m<sup>3</sup>/1000 m<sup>2</sup>) in at least 2 applications spread over 7 days. Apply the water using a hydro-seeder or a water tank under pressure with a nozzle that produces a spray that will not dislodge the mulch material.

Perform a secondary water application between 7 and 10 days after the primary applications. If 1/2-inch (13 mm) or greater of rainfall has occurred within the first 7-day period, the Contractor may delay or omit the secondary application, depending on weather conditions.

**659.18 Maintenance.** Maintain all seeded and mulched areas until final inspection. Repair damaged areas to the original condition and grade.

**659.19 Mowing.** The Engineer may require mowing before permanent seeding and during the growing season following permanent seeding. The Engineer will notify the Contractor of when to begin each mowing. Use suitable mowing equipment of the rotary, flail, disk, or sickle type. Do not bunch or windrow mowed vegetation. Mow to a final cutting height of no less than 6 inches (150 mm). If necessary to achieve the cutting height, make more than one pass with the mower.

**659.20 Repair Seeding and Mulching.** Repair all damage or erosion of the seeded and mulched areas before the completion of the project.

Rework or reshape slopes, and bring in additional material, as necessary, using whatever equipment is necessary to restore slopes to grade. Seed and mulch repaired areas according to this specification. As an alternative, the Contractor may apply compost to repair areas as specified in Item 659.

**659.21 Inter-Seeding.** Inter-seeding is seeding existing thin and spotty growing turf using a slit or drill type seeder. Perform inter-seeding only from March 15 to May 15 and from September 1 to October 15. If necessary to achieve good seed-soil contact, mow before seeding according to Item 659.

For seeding steep slopes or inaccessible areas, the Contractor may use broadcast or hydraulic seeding methods. Broadcast commercial fertilizer over affected areas as specified in Item 659. Water affected areas at the rate specified in 659 to aid in seed-soil contact.

**659.22 Fertilization: 2nd Application.** Once all repair seeding and mulching, and inter-seeding is complete and no earlier than 3 months after seeding, perform a Soil Analysis Test if shown on the plans to determine the need for a second application of commercial fertilizer. Do not apply the second application of commercial fertilizer unless the grass has germinated. Broadcast commercial fertilizer of 12-12-12 evenly over the surface without incorporation at a rate of 10 pounds per 1000 square feet (0.05 kg/m<sup>2</sup>).

**659.23 Performance.** The Department will inspect all seeded areas no earlier than 6 months and no later than 12 months after final seeding. For any area

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identified without a uniform density of at least 70 percent grass cover, repair seeding and mulching as specified in 659 or perform inter-seeding as specified in 659, and fertilize as specified in this subsection.

Also repair seeding and mulching or perform inter-seeding, and fertilize seeded areas damaged by traffic or erosion, due to no fault or negligence of the Contractor.

**659.24 Method of Measurement.** The Department will measure Soil Analysis Test by the number of tests submitted to the Engineer.

The Department will measure the compacted topsoil by the number of cubic yards (cubic meters).

The Department will measure Commercial Fertilizer by the number of tons (kilograms) of each quantity of furnished, spread, and incorporated into the soil or topsoil. This measure will be converted to the standard application rate for the standard mixture ratio.

The Department will measure lime or liquid lime by the number of acres (ha) furnished, spread, and incorporated into the soil or topsoil. The measure will be converted to the standard application rate for the standard mixture ratio.

The Department will measure Seeding and Mulching by the number of square yards (square meters).

The Department will measure Repair Seeding and Mulching by the number of square yards (square meters) of damaged or eroded areas reshaped, seeded, and mulched. If compost is substituted for mulch to repair areas, the Department will include such work under Repair Seeding and Mulching.

The Department will measure Water by the number of 1000 gallon units (cubic meters) applied. The Department will measure water in tanks, tank wagons, or trucks of predetermined capacity, or by means of meters of a type satisfactory to the Engineer and furnished and installed by the Contractor at expense to the Department, or determined by weight conversion.

The Department will measure Inter-Seeding by the number of square yards (square meters) of the seeded area.

The Department will measure mowing by the number of M square feet (square meters) satisfactorily mowed.

If seeded areas are damaged by traffic or erosion, due to no fault or negligence of the Contractor, the Department will measure for such work and mobilization by Supplemental Agreement.

The Department will not measure for repairs to seeding and mulching if damage or erosion of the areas occurs as a result of fault or negligence of the Contractor.

**659.25 Basis of Payment.** The Department will pay the plan quantity for compacted topsoil. The Department will not adjust topsoil quantities when the volume between two consecutive cross-sections differs by less than 5 percent from the plan quantity. For quantity differences greater than 5 percent, submit supporting documentation to the Engineer.

The Department will pay the plan quantity for Seeding and Mulching. The Department will not adjust Seeding and Mulching quantities when the area between two consecutive cross-sections differs by less than 5 percent from the plan quantity. For quantity differences greater than 5 percent, submit supporting documentation to the Engineer.

The Department will pay for accepted quantities at the contract prices as follows (M=1000):

<b>Item</b>	<b>Unit</b>	<b>Description</b>
659	Each	Soil Analysis Test
659	Cubic Yard (Cubic Meter)	Topsoil
659	Ton (Kilogram)	Commercial Fertilizer
659	Acres (ha)	Lime
659	Square Yard (Square Meter)	Seeding and Mulching
659	Square Yard (Square Meter)	Seeding and Mulching for Wildlife
659	Square Yard (Square Meter)	Seeding and Mulching Class ____
659	Square Yard (Square Meter)	Repair Seeding and Mulching
659	M Gallons (Cubic Meters)	Water
659	Square Yard (Square Meter)	Inter-Seeding
659	M Square Feet (Square Meter)	Mowing

## **ITEM 660 SODDING**

### **660.01 Description**

### **660.02 Materials**

### **660.03 Lifting Sod**

### **660.04 Preparation of Areas to be Sodded**

### **660.05 Placing Sod on Slopes 3 to 1 or Flatter**

### **660.06 Placing Sod on Slopes Steeper Than 3 to 1 But Flatter Than 2 to 1**

### **660.07 Placing Sod in Ditches**

### **660.08 Placing Reinforced Sod On Slopes 2 to 1 or Steeper**

### **660.09 Watering**

### **660.10 Method of Measurement**

### **660.11 Basis of Payment**

**660.01 Description.** This work consists of furnishing, hauling, excavating for and preparing the bed, and placing sod.

**660.02 Materials.** Furnish sod consisting of well-rooted Kentucky Blue Grass (*Poa pratensis*) or Canadian Blue Grass (*Poa compressa*) containing a growth of

### 660.03

not more than 30 percent of other grasses and clovers, and free from all noxious weeds such as wild mustard, thistles, quack grass, and Johnson grass, and reasonably free from dandelions and crab grass.

Ensure that all sod is certified by the sod supplier that it complies with this item. Ensure that the sod was recently mowed to a height of not more than 3 inches (75 mm). Furnish a certificate with each shipment, and furnish the following additional information from the sod supplier:

- A. The name of the producer.
- B. The amount of sod shipped in square yards (square meters).
- C. The location of sod field.
- D. The location of job site.
- E. The date sod was cut.
- F. The thickness the sod was cut.

Furnish wood stakes that are at least  $1/2 \times 3/4 \times 12$  inches ( $13 \times 19 \times 300$  mm).

Furnish T-pins that are 18-inch (450 mm) in length and  $1/4$  inch (6 mm) in diameter and have a 3-inch (75 mm) tee.

Furnish round pins that are 18-inch (450 mm) in length and  $1/4$  inch (6 mm) in diameter and have a 1.5-inch (38 mm) washer.

Furnish galvanized poultry netting 50 inches (1200 mm) wide with 2-inch (50 mm) mesh and No. 20 gage minimum wire.

Furnish fertilizer and lime according to Item 659.

Furnish sod materials according to the Department's Qualified Product List (QPL).

**660.03 Lifting Sod.** Furnish sod strips that are not less than 3 feet (0.9 m) and not over 6 feet (1.8 m) in length with a uniform width of not over 24 inches (0.6 m). Furnish sod strips that lay flat on skids. The Contractor may elect to deliver sod rolls of up to 25 feet (7.6 m) in length. Furnish sod rolls that are pre-rolled on skids. Furnish sod cut to a depth equal to the growth of the fibrous roots but in no case less than 1 inch (25 mm).

Deliver sod to the job within 24 hours after being cut, and install it within 48 hours after being cut.

During wet weather, allow the sod to dry sufficiently to prevent tearing during handling and placing. During dry weather, water the sod before lifting to ensure its vitality and to prevent the dropping off of the soil in handling.

**660.04 Preparation of Areas to be Sodded.** Before placing the sod, excavate the sod bed to a depth that when the sod is in place the top of the sod is flush with the surrounding grade and conforms to the typical cross-section. If specified, place the topsoil according to Item 659. If specified under Item 659, apply commercial fertilizer and agricultural liming material. Incorporate these materials in the areas to be sodded at the rate specified in 659.03 and 659.04 to a depth of not less than 1 inch (25 mm). Incorporate these materials within 48 hours prior to placing the sod.

Immediately before placing the sod, rake the area or otherwise bring it to an even surface forming a proper sod bed. If the area is dry, thoroughly water the sod bed.

**660.05 Placing Sod On Slopes 3 to 1 or Flatter.** Do not place any sod when the temperature is below 32 °F (0 °C). Do not place any frozen sod, and do not place any sod upon frozen soil. When placing sod between June 1 and October 15, cover it immediately with straw mulch 1 inch (25 mm) thick, loose measurement.

Lift sod from trucks or storage piles, and place it by hand with close joints and no overlapping. Plug all gaps between sections of sod and openings at angles with sod. After laying, thoroughly water the sod, and tamp the sod with approved sod tampers sufficiently to bring the sod into close contact with the sod-bed and to ensure tight joints between the sections or strips. Upon placing the sod, ensure that the surface of the sodded areas coincides with the finished grade.

**660.06 Placing Sod on Slopes Steeper Than 3 to 1 But Flatter Than 2 to 1.** Place sod on slopes steeper than 3 to 1 but flatter than 2 to 1 according to 660.05, with the following modifications.

Lay sod with the long edges of the strip parallel to the contour starting at the bottom of the slope. Neatly match successive strips, and stagger all joints by at least 12 inches (300mm).

For sod placed 6 feet (1.8 m) or greater in height (measured along the slope), stake each strip or roll securely along all sides with stakes not more than 2 feet (0.6 m) apart with the flat side against the slope or with pins not more than 2 feet (0.6 m) apart. Drive the wooden stakes so that the last 1 inch (25 mm) remains above the top of the sod. Drive pins 1 inch (25 mm) below the top of the grass.

After laying, thoroughly water the sod, and tamp the sod with approved tampers sufficiently to bring the sod into close contact with the sod-bed and to ensure tight joints between the sections or strips.

**660.07 Placing Sod in Ditches.** Place sod in ditches according to 660.05, with the following modifications.

Place sod in ditches with joints staggered at least 12 inches (300 mm). Stake each strip or roll securely along all sides with wooden stakes not more than 2 feet (0.6 m) apart with the flat side against the slope. Drive the wooden stakes so that the last 1 inch (25 mm) remains above the top of the sod.

**660.08 Placing Reinforced Sod On Slopes 2 to 1 or Steeper.** Place reinforced sod on slopes 2 to 1 or steeper or as specified in the plans according to 660.05, with the following modifications. Before placing the sod, place the galvanized poultry netting or equivalent. Stake the galvanized poultry netting or equivalent securely to the subgrade by using pins or wood stakes. Place the pins or wooden stakes at 4 foot (1.2m) intervals. Fasten the netting to the wooden stakes with staples. Where the sod width is from 8 to 10 feet (2.4 to 3 m) wide, the Engineer will allow two strands of netting for a total width of 8 feet (2.4 m). For sod, stake each strip or roll securely along all sides with wooden stakes not more than 2 feet (0.6 m) apart with the flat side against the slope or with pins not more than 2 feet (0.6 m) apart. Drive the wooden stakes so that the last 1 inch (25 mm) remains above the top of the sod. Drive pins 1 inch (25mm) below the top of the grass.

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**660.09 Watering.** Keep all sodded areas thoroughly moist for 30 days after sodding. Repair any areas damaged following installation. Ensure that sod is in place for at least 30 days before final acceptance.

**660.10 Method of Measurement.** The Department will measure Sodding Unstaked, Sodding Staked, and Sodding Reinforced by the actual number of square yards (square meters) of area sodded, completed and accepted.

**660.11 Basis of Payment.** If required, the Department will pay for topsoil liming and fertilizing under Item 659.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
660	Square Yard (Square Meter)	Sodding Unstaked
660	Square Yard (Square Meter)	Sodding Staked
660	Square Yard (Square Meter)	Sodding Reinforced

**ITEM 661 PLANTING TREES, SHRUBS, AND VINES**

- 661.01 Description**
- 661.02 Plant Materials**
- 661.03 Labeling**
- 661.04 Inspection**
- 661.05 Location and Source of Supply**
- 661.06 Scheduling**
- 661.07 Transportation, Storage, and Handling**
- 661.08 Layout of Plant Materials**
- 661.09 Planting Holes**
- 661.10 Planting Beds**
- 661.11 Backfill Mix**
- 661.12 Planting**
- 661.13 Mulch**
- 661.14 Pruning**
- 661.15 Wrapping**
- 661.16 Bracing**
- 661.17 Period of Establishment**
- 661.18 Removal of Stakes and Wrapping**
- 661.19 Method of Measurement**
- 661.20 Basis of Payment**

**661.01 Description.** This work consists of furnishing and planting trees, shrubs, vines, and other materials.

**661.02 Plant Materials.** Plant materials include all trees, shrubs, vines, and plants required for the project. Ensure that all plant materials conform to the

current edition of the *American Standard for Nursery Stock*, as published by the American Nursery and Landscape Association.

Ensure that all plants are healthy representatives, typical of their species or variety, and exhibit a normal habit of growth. Ensure that all plants are hardy under climatic conditions and grow in the same hardiness zone or colder as the one in which the project is located.

**661.03 Labeling.** Attach legible labels to all specimens, or boxes, bundles, and other containers, indicating detailed information covering the botanical genus and the species name, the common name, the size or age of each species or variety, and the quantity contained in the individual bundles, boxes, and bales. Remove all labels before the completion of the establishment period.

**661.04 Inspection.** The Engineer will inspect and seal all plant materials on the project site with Department seals before use or planting. The Engineer will inspect all plants to ensure they are healthy, vigorous, and free from harmful defects, decay, disfigured stems and roots, plant diseases, and insect pests.

The Department will give final acceptance of all plant materials only after the materials are planted and have met all the requirements of this item. Remove the Department seals from the plant materials after the final inspection.

**661.05 Location and Source of Supply.** Supply the Engineer with complete and detailed information concerning the source of supply for each item of required plant material within 15 days after receiving the notice of award of the Contract.

**661.06 Scheduling.** Dig and plant all plants after September 15 and before June 1. Plant replacement plants after September 15 and before June 1. Water according to Item 662.

**661.07 Transportation, Storage, and Handling.** Transport all plants from nursery sources to the project site with the entire load completely covered for protection from drying winds.

Thoroughly water all plants that cannot be immediately planted so as to keep the roots continually moist. The Engineer may reject plants that are not adequately protected during transportation and storage. Handle all plant materials by the root ball or container.

**661.08 Layout of Plant Materials.** Before digging, use suitable staking to lay out the locations of all planting holes and beds. Obtain the Engineer's approval of these locations before digging.

**661.09 Planting Holes.** Dig planting holes that have sloped side walls 'bowl shaped'. Slopes of the side walls shall have a minimum of 1:1 side slopes. The top of the planting holes shall be two times the diameter of the root ball. Planting holes shall be dug to the same depth as the root ball structure. The earth under root balls shall be compacted or unexcavated soil to prevent settlement.

See 661.12 for depth of planting.

Dig planting holes for vines and perennials to a minimum depth and diameter of 6 inches (150 mm). Make planting holes for rooted cuttings and tree seedlings large enough to accommodate the root system.

## 661.10

**661.10 Planting Beds.** One month before cultivation, treat all planting beds that are to be developed in areas of existing turf with pre-emergent and post-emergent type herbicides. Use a State-licensed pesticide applicator to apply the herbicide according to the manufacturer's instructions.

Before planting, top dress all planting beds with a minimum of 2 inches (50 mm) of backfill mix, then cultivate it to a depth of 6 inches (150 mm) using a plow, disc, or roto-tiller.

**661.11 Backfill Mix.** For all plantings, use backfill mix consisting of the following:

- A. One part excavated soil.
- B. One part sphagnum peat moss, shredded pine bark, or EPA rated Class IV compost.
- C. One part sand.
- D. A slow release commercial fertilizer (0-20-20 or equal) added at a rate of 5 pounds per cubic yard (3 kg/m<sup>3</sup>) to the backfill mix.

Do not use backfill mix in a frozen or muddy condition. Mix backfill on the project site.

### 661.12 Planting.

A. **Planting Trees & Shrubs:** Set each plant in the center of the planting hole, plumb, and straight at a level such that the top of the root structure (i.e., trunk flare or root collar) is 1 inch (25 mm) above the surrounding soil. Prior to backfilling the hole, remove all twine, bags, and roping. For trees shipped with wire baskets supporting the root structure, remove the top two-third of the wire basket from root balls. Remove all rot-proof burlap. Remove or fold down the top one-third of standard (biodegradable) burlap. Great care must be taken to not separate the soil of the root ball from the plants root system. Circling roots shall be cut or removed prior to planting.

Backfill the planting hole with the backfill mix. Fill the hole gradually and settle the backfill with water to the top of the root structure. Do not place backfill mix in direct contact with the trunks or stems. Add backfill mix around the root structure so that the edges of the root structure are covered by a minimum of 12 inches (300 mm).

Do not plant groundcovers, vines, or perennials closer than 12 inches (300 mm) to tree trunks and shrub stems or within 6 inches (150 mm) of the edge of planting beds.

Locate Trees and Shrubs as specified in the plan.

B. **Planting Seedlings, Groundcovers, Vines or Perennials:** For planting seedlings, groundcovers, vines, or perennials in a planting bed see 661.10. Prior to planting seedlings, groundcovers, vines, or perennials in existing turf, remove all grass and weeds by scalping an area that has a minimum diameter of 12 inches (300 mm). Plant seedlings or perennials in the center of the scalped area using a spade or planting bar.

Locate Seedlings, Groundcovers, Vines or Perennials as specified in the plan.

**661.13 Mulch.** Smooth and shape the backfill mix to form a shallow basin slightly larger than the planting hole. Mulch these areas with a 4-inch (100 mm) layer of finely shredded hardwood bark of uniform texture and size. Mulch shall not be placed in direct contact with the trunk of the tree. Use shredded bark aged at least one year. Rake and smooth the entire area of the planting beds.

After mulching and before watering, add a slow release commercial fertilizer (12-12-12 or equal), in granular form, to the top of the mulch at a rate of 5 pounds per 100 square feet ( $0.25 \text{ kg/m}^2$ ). Do not allow the fertilizer to contact the stems, trunk, branches, or leaves of the plants.

Water thoroughly as per 661.17.

**661.14 Pruning.** To balance the loss of roots after planting, prune the branches of deciduous plants to preserve the natural characteristics of the species, following standard horticultural practices. Remove broken, damaged, and unsymmetrical branches and other growth to ensure healthy and symmetrical growth of new wood. Do not trim the central leader of the trees.

**661.15 Wrapping.** Wrap all single deciduous tree trunks of 1 inch (25 mm) caliper and larger. Before wrapping, inspect for insect infestation and take corrective measures. Wrap trees within 48 hours after planting, using a double-layered, bituminous-cemented, waterproof, crinkled paper. Start at the ground and wrap the trunk neatly and snugly to the height of the first branches, then attach securely. With each turn of the wrapping, overlap the previous turn by half the width of the paper.

**661.16 Bracing.** Brace all trees by staking as shown on the Standard Construction Drawing LA-1.2. Only flexible or biodegradable ties shall be used when staking trees. Staking should only be used in areas where mower damage, vandalism, or windy conditions are a concern or as directed by the Engineer. The ties shall be loose fitting, (as not to girdle the trunk) attached to the lower half of the tree, and allow trunk movement and growth. All staking and wrapping materials shall be removed at the end of the establishment period.

**661.17 Period of Establishment.** Before final inspection, place all plants and care for them for a period of establishment. The period of establishment begins immediately upon completion of the planting operations and continues until October 1. The minimum period of establishment is one growing season, June 1 through October 1.

During the period of establishment, follow standard horticultural practices to ensure the vigor and growth of the transplanted material. Water, remulch, restake, and cultivate as necessary. Perform at least two weeding and mowing programs (around trees, shrubs, and bed edges) of such intensity as to completely rid the planted and mulched areas of weeds and grasses. Begin the first program on or about June 15 and the second approximately 8 weeks later.

On or about September 15, the Engineer will inspect the planting and supply the Contractor with a list of plants that have fallen over or are tilted from plumb, missing or, dead; and those that have died back beyond normal pruning lines.

**661.18**

Replant as required according to the specifications of the original material. Replacement plants are subject to a new period of establishment. Immediately replace plants planted initially in the fall that have died before the spring planting season. Care for the replacement plants during the new establishment period.

**661.18 Removal of Stakes and Wrapping.** Remove all stakes and wrapping material from all plants just before the final inspection, with the exception of the replacement plantings that have not been in place for a full growing season. Take ownership of removed items. Use removed materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

**661.19 Method of Measurement.** The Department will measure the number of plant materials of each species and size, completed and accepted, in place.

**661.20 Basis of Payment.** The Department will pay 50 percent of the bid price when delivered to the project site and the remaining 50 percent of the bid price when planted.

At the end of the establishment period, the Department will make the final inspection and determine the actual number of living plants. The Department will pay an additional 20 percent of the bid price for all plants living at the end of the establishment period. The Department will not pay the additional 20 percent payment for plantings that did not survive the establishment period. Replace all plants not surviving the establishment period at no additional cost to the Department. The Department will extend the establishment period for all replacement plantings with no additional payment.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
661	Each	Tree Seedling, ( <i>Size</i> ), ( <i>Species</i> )
661	Each	Perennials, ( <i>Size</i> ), ( <i>Species</i> )
661	Each	Groundcover and Vines, ( <i>Size</i> ), ( <i>Species</i> )
661	Each	Deciduous Shrub, ( <i>Size</i> ), ( <i>Species</i> )
661	Each	Evergreen Shrub, ( <i>Size</i> ), ( <i>Species</i> )
661	Each	Deciduous Tree, ( <i>Size</i> ), ( <i>Species</i> )
661	Each	Evergreen Tree, ( <i>Size</i> ), ( <i>Species</i> )

**ITEM 662 LANDSCAPE WATERING**

**662.01 Description**

**662.02 Watering**

**662.03 Method of Measurement**

**662.04 Basis of Payment**

**662.01 Description.** This work consists of furnishing, delivering, applying, measuring, and scheduling a sufficient amount of water necessary to keep each plant included in Item 661 in a healthy growing condition throughout the period of establishment and the Contract.

**662.02 Watering.** Furnish the water used in watering landscape plants. Thoroughly water all plant material at the time of planting regardless of soil moisture content. Continue to water throughout the period of establishment.

Saturate the root zone and mulched area of each plant without causing run-off according to Table 662.03-1. During fall planting, continue to water until the ground is frozen and recommence watering after the spring thaw. Furnish a rain gauge approved by the Engineer.

**662.03 Method of Measurement.** The Department will measure Landscape Watering by the number of gallons (liters) delivered to plants from approved metered tanks or individually measured containers as follows:

**TABLE 662.03-1 WATERING TABLE**

Plant Description	Gallons (L)
Shrubs:	
12 to 36 inches (300 to 900 mm), height	4 (15)
36 inches to 5 feet (900 mm to 1.5 m), height	7 (25)
Trees:	
5 to 8 feet (1.5 to 2.5 m), height	15 (55)
2 to 3 inches (50 to 75 mm), caliper	25 (95)
3 to 4 inches (75 to 100 mm), caliper	30 (115)
Greater than 4 inches (100 mm), caliper	35 (115)

**662.04 Basis of Payment.** The Department will pay for the accepted quantities at the contract price as follows:

Item	Unit	Description
662	Gallon (Liter)	Landscape Watering

## ITEM 666 PRUNING EXISTING TREES

**666.01 Description**

**666.02 Wound Dressing**

**666.03 Pruning**

**666.04 Painting**

**666.05 Removal of Foreign Materials from Trees**

**666.06 Removal of Rubbish**

**666.07 Method of Measurement**

**666.08 Basis of Payment**

**666.01 Description.** This work consists of pruning trees.

**666.02 Wound Dressing.** Use approved material specifically manufactured for tree wound dressing.

**666.03 Pruning.** Prune all trees to make them shapely, typical of the species, using standard drawings on the plans as a guide. Use approved pruning tools and methods.

## 666.04

Remove all dead wood and dead branches 1 inch (25 mm) or more in diameter. Remove all branches interfering with or hindering the healthy growth of the tree with a good clean cut made flush with the parent trunk. Remove all diseased branches. For branches that may be partly dead, yet have a good healthy lateral branch between the dead part and the base, cut off the branch with a good clean slanting cut close to and beyond the healthy lateral branch.

Remove low hanging, unsound, or unsightly branches on trees or shrubs designated to remain. Remove all branches or growth interfering with the free traffic movement on the highway. Trim branches of trees extending over the roadbed to provide a clear height of 20 feet (6 m) above the roadbed surface.

Cut off all stubs or improper cuts resulting from former pruning or limbs that have been broken flush with the trunk or limb of the tree in order to ensure proper healing.

**666.04 Painting.** Paint all cuts or wounds measuring 1 inch (25 mm) or more in diameter and all exposed wood and scars resulting from previous work or damage with approved tree wound dressing.

**666.05 Removal or Foreign Materials from Trees.** Remove all nails, spikes, bolts, wire, or other foreign materials driven into or fastened to the trunk or branches of the tree, or, if directed by the Engineer, cut them flush with the bark of cambium layer to ensure complete healing over.

**666.06 Removal of Rubbish.** Legally use, burn, or dispose of all material according to 105.16 and 105.17.

**666.07 Method of Measurement.** The Department will measure Pruning Existing Trees by the number of each size, completed and accepted.

**666.08 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
666	Each	Pruning Existing Trees, 3 to 8-inch (80 to 200 mm) Diameter
666	Each	Pruning Existing Trees, 8 to 16-inch (200 to 400 mm) Diameter
666	Each	Pruning Existing Trees, 16 to 24-inch (400 to 600 mm) Diameter
666	Each	Pruning Existing Trees, 24 to 36-inch (600 to 900 mm) Diameter
666	Each	Pruning Existing Trees, 36 inches (900 mm) and Over

## ITEM 670 EROSION PROTECTION

**670.01 Description**

**670.02 Materials**

**670.03 Construction**

**670.04 Maintenance**

**670.05 Method of Measurement**

**670.06 Basis of Payment**

**670.01 Description.** This work consists of furnishing, placing, and maintaining slope, ditch, and vegetated swale erosion protection as shown on the plans.

**670.02 Materials.** Furnish materials conforming to:

Sodding.....	660.02
Erosion Control Mats.....	712.11

For slope erosion protection, the Contractor may use any of the above materials. For ditch erosion protection, use only Item 660 Sodding or Item 671 Erosion Control Mat Type B, C, E, or G or as specified in the plans. For vegetated swale erosion protection, use only Item 671 Erosion Control Mat Type B or as specified in the plans.

**670.03 Construction.** Install sodding according to Item 660. Install erosion control mats according to Item 671.

**670.04 Maintenance.** Maintain sodded areas as specified in Item 660. Maintain erosion control mats as specified in Item 671.

**670.05 Method of Measurement.** The Department will measure Slope Erosion Protection, Ditch Erosion Protection, and Vegetated Swale Erosion Protection by the number of square yards (square meters) completed and accepted. The Department will determine the area based on the surface area covered by the slope, ditch, or swale erosion protection.

**670.06 Basis of Payment.** The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
670	Square Yard (Square Meter)	Slope Erosion Protection
670	Square Yard (Square Meter)	Ditch Erosion Protection
670	Square Yard (Square Meter)	Vegetated Swale Erosion Protection
670	Square Yard (Square Meter)	Slope Erosion Protection Mat Type __
670	Square Yard (Square Meter)	Ditch Erosion Protection Mat Type __
670	Square Yard (Square Meter)	Vegetated Swale Erosion Protection Mat Type ____

**ITEM 671 EROSION CONTROL MATS**

**671.01 Description**

**671.02 Materials**

**671.03 Construction**

**671.04 Maintenance**

671.01

**671.05 Method of Measurement**

**671.06 Basis of Payment**

**671.01 Description.** This work consists of furnishing, placing, and maintaining Types A through I erosion control mats. This work also consists of furnishing, placing, and maintaining seeding and mulching when the seeding and mulching is to be held in place with erosion control mats.

**671.02 Materials.** Furnish materials conforming to:

Seed and Mulch.....	659
Lime and Fertilizer.....	659
Erosion Control Mats.....	712.11

If the mat type is not specifically itemized, furnish any mat type listed in 712.11.

Furnish staples consisting of 12-inch (0.3 m) No. 11 gage steel wire bent into narrow U-shape with the ends of the staples approximately 1 inch (25 mm) apart producing a 6 inch staple or furnish pins conforming 18 inch (450 mm) long, ¼ inch [4.5mm] in diameter, with attached 1½ inch (38 mm) washer. Drive staples until the staple is flush with the ground surface. Drive pins until the attached washer is flush with the ground surface.

For clay, shale, and other heavy soils, furnish 3-inch (75 mm) steel staples, No. 9 gage or thicker with points approximately 1 inch (25 mm) apart, as required by the Engineer.

**671.03 Construction.** Before placing any type of temporary erosion control mats, prepare the surface, apply the fertilizer and lime if specified, and seed as specified in Item 659 or as shown on the plans. Place the temporary erosion control mat in the locations shown on the plans.

**A. Types A, B, C, D, E, F, and I.** Construct erosion control mat Types A, B, C, D, E, F, and I as follows:

1. Within 48 hours after seeding and before placing the mat, evenly place mulch over the specified area at the following rates:
  - a. For straw mulch, use 30 percent of the rate specified in 659.14.
  - b. For wood fiber mulch, use 30 percent of the rate specified in 659.15.
  - c. For compost, use the same rate as specified in 659.16.
  - d. Asphalt emulsion tack or tackifier is not required.
2. Immediately after mulching, lay the mat strips flat, loose, parallel to the flow of water, and with the mat contacting the ground at all points. For mats placed in ditches, start the construction at the downstream end.
3. Where more than one strip is required to cover the area, overlap the strips at least 4 inches (100 mm). Overlap the ends at least 6 inches (150 mm) with the upgrade strip on top.

4. Place upgrade slots at the upgrade end of each strip of mat by placing a tight fold of the mat at least 6 inches (150 mm) vertically into the soil. Firmly tamp the soil against the end and staple the mat. If directed by the Engineer, bury other edges exposed to more than normal flow in a similar manner.

5. Place end slots between the ends of strips by placing a tight fold of the mat at least 6 inches (150 mm) vertically into the soil. Firmly tamp the soil and staple the mat.

6. Place check slots by placing a tight fold of the mat at least 6 inches (150 mm) vertically into the soil. Firmly tamp the soil and staple the mat. Space check slots so that one check slot or an end slot occurs within each 50 feet (15 m) of slope for slopes 3 to 1 or steeper.

7. Bury the edges of the mat where the mat abuts catch basins and other structures.

8. Secure the mat in place with staples driven vertically into the soil. Do not stretch or draw the mat taut during the stapling operation. Install three rows of staples for each strip of mat, with one row along each edge and one row alternately spaced in the middle. Space staples not more than 3 feet (1 m) apart in each row. Staple all upgrade slots, end slots and check slots across the width, with staples spaced not more than 6 inches (150 mm) apart.

9. After completing the mat installation, seed over top of the mat in areas that the Engineer identifies as disturbed. Use a seed mixture conforming to Item 659 at the rate of 1 pound per 1000 square feet ( $5 \text{ g/m}^2$ ) or with a mixture or rate shown on the plans.

**B. Type G.** Construct erosion control mat Type G according to 671.03.A, with the following exceptions.

1. Do not use mulch under the mat.
2. Overlap edges and ends by 1 1/2 inches (40 mm).
3. Do not bury the upgrade end or top edge of each strip unless required by the Engineer due to special conditions in the field.
4. The Contractor may elect not to provide check slots. However upgrade slots and end slots will be furnished.
5. Place the mat in contact with the soil.

**C. Type H.** Construct erosion control mat Type H according to 671.03.A, with the following exceptions.

1. Clear the surface of rock, clods, or foreign material 1 1/2 inches (38 mm) or greater in size.
2. Do not use mulch under the mat.

**671.04 Maintenance.** Maintain the specified areas until all work in the Contract has been completed and the Engineer issues the final acceptance. Restore damaged areas to the condition and grade existing just before placing the mat.

**671.05**

Relime, refertilize, and reseed restored areas according to Item 659. Replace all damaged mats.

**671.05 Method of Measurement.** The Department will measure Erosion Control Mat, Type \_\_\_\_ by the number of square yards (square meters) completed and accepted. The Department will determine the area based on the surface area covered by the erosion control mat.

**671.06 Basis of Payment.** The Department will not pay for maintenance as detailed in 671.04 that is required due to the Contractor’s negligence, carelessness, or failure to install erosion controls.

If erosion control items in the Contract are properly placed according to the Contract Documents, the Department will pay for maintenance detailed in 671.04 or according to 109.05.

The Department will pay for liming and fertilizing of areas covered by the mats under Item 659. The Department will not pay for the seeding and mulching performed under or over the mats.

The Department will pay for accepted quantities at the contract prices as follows:

<b>Item</b>	<b>Unit</b>	<b>Description</b>
671	Square Yard (Square Meter)	Erosion Control Mat, Type ____
671	Square Yard (Square Meter)	Erosion Control Mat

## 700 MATERIAL DETAILS

### 700 MINIMUM REQUIREMENTS FOR SAMPLING MATERIALS

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
203	Embankment	Assure 203.02 Q and R materials conform to the individual material requirements. Sample materials when requested by the Engineer.  Follow S 1015 for acceptance  Soil Embankment: 50 lb (23 kg) Granular Embankment: 50 lb (23 kg)	TM
258	Dowel Bar Retrofit	Silicone Sealant– Obtain letter of certification stating that the material meets the requirements of item 258. Material to be shipped from manufacturer not more than 9 months prior to use.  Dowel Bar grout - Verify brand name of material is on QPL at the time of use.	
301 302	Asphalt Concrete Base	Project: Visually inspect delivered loads and newly placed mat  Plant: Test 1 sample in 4 days for verification. Observe other contractor QC sample and QC test 1 in 4 days. Plant: Conduct minimum monitoring requirements.	Project: Contact project Engineer/ DCE/DET immediately if problems are seen  Plant: Compare results per 403. Report on monitoring.
305	PC Concrete Pavement	Make two 6"x6"x4' beams for every 7500 yd <sup>2</sup> (6500 m <sup>2</sup> ) or fraction thereof daily. Field test beams for required load for the specification. Report results in CMS (Trns.port SiteManager™).	Core samples taken every 2000 sq. yds by Contractor. Conform to S 1064
307	Non Stabilized Drainage Base	Provide samples conforming to 703.12 for design verification. Provide in process samples as directed by the Engineer. Sample material conforming to 703.12	Determine locations for thickness tolerance checks according to S 1064.
308	Asphalt Treated Free Draining Base	Provide a JMF to the Lab for approval. Include 1 gal (4 L) sample of asphalt and 70 lb (32 kg) sample of aggregate	Determine locations for thickness tolerance checks according to S 1064.
409	Sawing and Sealing Asphalt Concrete pavement Joints	Assure backer rod is on QPL at the time of use. Inspect material for condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District testing and OMM
421	Micro Surfacing	Project: Conduct a test strip per 421.09, inspect per 421.10 and accept per 421.11.	
422	Chip Seal with Polymer Binder	Project: Conduct a test strip per 422.05. Clean the surface per 422.06. Verify binder and aggregate application per 422.07 and 422.08. Ensure contractor quality control per 422.10. Verify all of 422.11 is met for acceptance.	
423	Fibers for Asphalt Concrete: Polyester Propylene Polypropylene	Verify type and brand name of material is on QPL at the time of use. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use submit a use a 1 quart sample to the Laboratory.
424	Asphalt Concrete (Fine Graded Polymer)	For Type A see 301,302 procedures. For Type B see 448 procedures.	
442	Asphalt Concrete	Project and Plant: See requirements for 446 or 448 as specified for the 442 item.	
443	Asphalt Concrete (Stone Mastic)	See 446 requirements.	

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
446	Asphalt Concrete	Project: Visually inspect delivered loads and newly placed mat Project: Obtain daily mix sample for District test unless otherwise directed by the DET. Project: Obtain 10 cores for each lot (day) within 48 hours for District test. Locate cores for sampling. Project: See 702.04 or 702.13 for tack sample. Plant: Conduct minimum monitoring requirements. Plant: See 702.01 for PG binder sample	Project: Contact project Engineer/monitoring team immediately if problems seen. Project: Observe proper handling and quick delivery of the mix sample. Place cores in box flat side down, do not stack boxes, do not leave in weather, deliver to lab promptly. Plant: Report on monitoring.
448	Asphalt Concrete	Project: Visually inspect delivered loads and newly placed mat Project: Give lot sample location to the District monitoring team unless otherwise directed by the DET. Project: See 702.04 or 702.13 for tack sample. Project: Conduct density gauge QA per S 1055 Plant: Conduct minimum monitoring requirements. Plant: See 702.01 for PG binder sample	Project: Contact project Engineer/monitoring team immediately if problems seen. Project: Re Core for S 1055 if gauge change or JMF change. Plant: Report on monitoring.
451	PC Concrete Pavement	Make 6"x6"x4' beams for every 7500 yd <sup>2</sup> (6500 m <sup>2</sup> ) or fraction thereof daily. Make two beams if testing before 7 days. Field test beams for required load for the specification. Report results in CMS (Trns.port SiteManager™).	Core samples taken every 2000 sq. yds by Contractor. Conform to S 1064
451.08.B	Dowel Bond Breaking Material	Check new light form oil by labels on new cans. No sampling required	Report material as not approved and follow policy for non specification materials
452	PC Concrete Pavement	Make 6"x6"x4' beams for every 7500 yd <sup>2</sup> (6500 m <sup>2</sup> ) or fraction thereof daily. Make two beams if testing before 7 days. Field test beams for required load for the specification. Report results in CMS (Trns.port SiteManager™).	Core samples taken every 2000 sq. yds by Contractor. Conform to S 1064
499.02	Water	Potable water is satisfactory. If question about water quality, obtain 1 gallon sample. Document in CMS (Trns.port SiteManager™).	Notify District Testing if water appears to contain sewage, oil, acid, or other matter.
503.09	Excavation for Structures Backfill	Sampled only when requested by the Engineer per Section 203 Soil Embankment: 50 lb (23 kg) Granular Embankment: 50 lb (23 kg)	
504	Sheet Piling Left in Place	Use 711.03 materials	
507.03	Bearing Piles Steel Pile Points	Only use points from suppliers on the approved list incorporated into the project plans. Document in CMS (Trns.port SiteManager™) as needed.	Notify District Testing if material non-performs or looks defective during use. Notify the contractor with non-compliance issues.
509.08	Reinforcing Steel - Plastic support chairs	Assure plastic supports conform to 709.15.	Maximum spacing of supports in slabs, beams and girders to be 4 feet; or less to prevent substantial deflection.
511	Concrete for Structures	Make two 6"x12" cylinders for spans over 20 ft each day, each 200 yd <sup>3</sup> . For spans 20 ft span and under, make two 6"x12" cylinders each 50 yd <sup>3</sup> or less. Document in CMS (Trns.port SiteManager™). Field or Standard Cure according to ACI/ODOT specifications.	Within 24 to 48 hours after sampling, ship cylinders to Laboratory with required documentation.
515	Prestressed Concrete Bridge Members	Assure products are supplied by a source on the Certified List for S-1079 maintained by OMM. Received with TE-24. Check dimension and condition Document in CMS (Trns.port SiteManager™).	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM, Cement and Concrete section,

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
515.15	Prestressed Concrete Bridge Members - Corrosion Inhibitors	Verify company and brand name of material is on QPL at the time of use. Document in CMS (Trns.port SiteManager™).	For Precast beams delivered on TE-24, verification performed by OMM.
526	Approach Slabs	Make 6"x12" cylinders for each day, each 200 yd <sup>3</sup> . Document in CMS (Trns.port SiteManager™). Make two beams if testing before 7 days. Field or Standard Cure according to ACI/ODOT specifications.	Within 24 to 48 hours after sampling, ship cylinders to Laboratory with required documentation.
601.12	Tied Concrete Block Mats (Slope/Channel Protection)	Verify company and brand name of material is on QPL at the time of use. Ensure proper type and inspect material for condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use submit a representative qty of defective material to the Laboratory.
603.02	External Sealing Bands Joint Wrap	Verify company and brand name of material is on QPL at the time of use. Inspect material for condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use submit a representative qty of defective material to the OMM.
609.02	Curbing, Concrete Medians, and Traffic Islands - Stone Curbs	Contact District Testing and OMM Aggregate Section to assure stone curb conforms to requirements of 609.02	
610	Cellular Retaining Walls	610.04.A Cellular Products will be supplied by a source on the Certified Lists for S-1073 maintained by OMM. Received with TE-24. Check dimension, condition and compliance with approved drawings. 610.04.B Cellular Products accept by certified test data documentation at the Project . Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
613	Low Strength Mortar Backfill	Supplier to perform trial batches of 1 cy to ensure flowable consistency and yield. Refer to Item 613.05 for alternate mix design. Alternate mix designs will be submitted for approval 30 days prior to placement. Submit written permission form to EPA 10 days prior to placement.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
632.11	Traffic Signal Equipment Loop Detector Sealant	Verify manufacturer is on QPL. Inspect for condition, appearance and package markings. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
633	Traffic Signal Controllers	Inspect material for condition and conformance to shop drawings. Manufacturer's certified test data required for acceptance. Refer to Handbook of Procedures for Contractor Certification of Lighting, Signing & Traffic Signal Working Drawings on OMM Manual website.	Notify District Testing if rejecting material.
653.02	Topsoil	Obtain one (1) pint sample of material from each source and/or stockpile of visually different material from same source. Use friction top, air tight metal container supplied by the Department. Submit to Office of Geotechnical Engineering Operations. Samples will include a TE-31 form or CMS (Trns.port SiteManager™) print screen	
657.02	RipRap for Tree Protection	Confirm with DET that the aggregate source has a acceptable performance history. For sources with poor performance require test data conforming to ASTM D5240	

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
658.02	Tree Root Aeration - Aggregate	Assure source on the Certified List for S 1069 maintained by OMM Assure aggregate meets soundness requirements. Sample sources with no soundness history and obtain a 100 lb (45 kg) sample	
659.03	Seeding and Mulching - Liming Materials	Only accept materials from suppliers licensed in Ohio. See OMM website for list of Ohio Department of Agriculture list of licensed suppliers. Document in CMS (Trns.port SiteManager™)	
659.04	Seeding and Mulching - Commercial Fertilizer	Only accept materials from suppliers licensed in Ohio. See OMM website for list of Ohio Department of Agriculture list of licensed suppliers. Inspect material for certified analysis and condition. Non-standard application rate require approval prior to use Document in CMS (Trns.port SiteManager™).	Licensing is required. Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing & OMM.
659.07 659.08 659.09 S1022	Seeding and Mulching Seeds Legumes Native Grasses and Wildflowers	Verify manufacturer is on certified supplier List maintained by OMM. Received with TE-24 and description bill of lading. Document in CMS (Trns.port SiteManager™).	Verify District approval of seed mixture.
659.14 659.15 659.16	Seeding and Mulching - Mulch	Material should be reasonably free from foreign matter that would inhibit seed germination.	Notify District if rejecting material.
660.02	Sodding	Verify company and brand name of material is on QPL at the time of use. Certification required for each shipment. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material.
661	Planting Trees Shrubs and Vines [Trees] [Shrubs] [Vines]	Verify company and brand name of material is on QPL at the time of use. Inspect material for condition. Plant material should be sealed until use. Document in CMS (Trns.port SiteManager™).	Final acceptance should take place after period of establishment. Notify District Testing if rejecting material.
STANDARD MATERIALS SPECIFICATIONS			
701.01 701.02 701.04 701.05 701.07 701.09	Cement, Hydraulic ASTM Types I, IA, II, III Masonry Type IS(<25)	Verify manufacturer on Concrete Plant Batch Ticket is on Certified List for S 1028 maintained by OMM. Verify material against bill of lading description. Document in CMS (Trns.port SiteManager™).	Obtain one ½ gallon sample and original bill-of-lading per concrete plant every 180 days for QA. Ship sample to OMM laboratory. Ensure that sample container is filled to capacity prior to transport.
701.10	Micro-Silica	Verify manufacturer on Concrete Plant Batch Ticket is on Certified List for S 1045 maintained by OMM. Verify material against bill of lading description Document in CMS (Trns.port SiteManager™).	Obtain one ½ gallon sample and original bill-of-lading per concrete plant every 180 days for QA. Ship sample to OMM laboratory. Ensure that sample container is filled to capacity prior to transport.
701.11	Ground Granulated Blast Furnace (GGBF) Slag	Verify manufacturer on Concrete Plant Batch Ticket is on Certified List for S 1034 maintained by OMM. Verify material against bill of lading description Document in CMS (Trns.port SiteManager™).	Obtain one ½ gallon sample and original bill-of-lading per concrete plant every 180 days for QA. Ship sample to OMM laboratory. Ensure that sample container is filled to capacity prior to transport.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
701.13	Fly Ash	Verify manufacturer on Concrete Plant Batch Ticket is on Certified List for S 1026 maintained by OMM. Verify material against bill of lading description Document in CMS (Trns.port SiteManager™). If high LOI fly ash verify manufacturer on Concrete Plant Batch Ticket is on List for S 1115.	Obtain one ½ gallon sample and original bill-of-lading per concrete plant every 180 days for QA. Ship sample to OMM laboratory. Ensure that sample container is filled to capacity prior to transport.
702.01	Asphalt Binder	Certified asphalt PG binder: As directed by the Lab. Plant: Minimum of one sample per project per season, except for inconsequential quantities. Non-Certified PG binder: Will be sampled and approved by the Department before use.	Certified binder: Plant: Submit sample to Lab. Non-certified binder: Submit to Lab. Do not allow asphalt production until material is approved.
702.02 702.03 702.04 702.07 702.13	Cut Back Asphalt Cut Back Asphalt Emulsions Emulsified Asphalts Asphalt Emulsion MWS Rubberized Asphalt Emulsion	Certified material: At the refinery or source as directed by the Lab. Project and/ or Plant: Min. one sample per each 25,000 gallons. None for less than 300 gallons. Non-certified material: Will be sampled and approved by the Department before use.	Certified material: Submit to Lab. Non-certified material: Submit to Lab. Do not use until approved by Lab.
702.05 702.06	Asphalt Primer Waterproofing Asphalt Waterproofing	Each batch sampled and pre-approved per TE 24. Lab contacted by supplier for test.	Project: Do not accept on project without TE 24.
702.14	Rubber Compound	Certified test data	
702.16	Polymer Emulsified Binder	Certified test data	
702.17	Crack Sealant	Material is pre-tested and approved. Will be shipped with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use Notify District Testing and OMM Asphalt Section.
703.02 703.04 703.05 703.08	Coarse Aggregate from Certified Stock	Coarse Aggregate will be supplied by a Pre-Qualified producer/supplier (S1069). Verify the producer/supplier is Pre-Qualified using the Pre-Qualified Producer/Supplier list maintained by OMM (website). Document in CMS.	60 to 75 lb. QC sample taken by District lab at source a minimum four (4) times per year. No project sampling required except if project believes there is a problem with the material [either gradation or quality]
703.02 703.04 703.05 703.08	Coarse Aggregate from Non-Certified Stock	Coarse Aggregate will be supplied by a Pre-Qualified producer/supplier (S1069). Verify the producer/supplier is Pre-Qualified using the Pre-Qualified Producer/Supplier list maintained by OMM (website).60 to 70 lb. QC sample taken from each 2600 ton (2360 metric ton) stockpile, submitted to OMM Aggregate Section. 100 lb QC sample for sizes 1,2, and 24. Document in CMS. Do not use until tested and approved.	No additional project sampling required for approved, sampled tonnage except if project believes there is a problem with the material [either gradation or quality]
703.02 703.03 703.04 703.05 703.06 703.10	Fine Aggregate from Certified Stock	Fine Aggregate will be supplied by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. Document in CMS (Trns.port SiteManager™).	30 to 40 lb. QC sample taken by District lab at source a minimum four (4) times per year. No project sampling required except if project believes there is a problem with the material [either gradation or quality]

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Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
703.02 703.03 703.04 703.05 703.06 703.10	Fine Aggregate from Non-Certified Stock	Fine Aggregate will be supplied by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. 30 to 40 lb. QC sample taken from each 1800 ton (1640 metric ton) stockpile, submitted to OMM Aggregate Section. Document in CMS (Trns.port SiteManager™). Do not use until tested and approved.	No additional project sampling required for approved, sampled tonnage except if project believes there is a problem with the material [either gradation or quality]
703.02 703.04 703.05	Dense Graded Aggregate from Certified Stock	Dense Graded Aggregate will be supplied by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. Document in CMS (Trns.port SiteManager™).	90 to 100 lb. QC sample taken by District lab at source a minimum four (4) times per year. No project sampling required except if project believes there is a problem with the material [either gradation or quality]
703.02 703.04 703.05	Dense Graded Aggregate from Non-Certified Stock	Dense Graded Aggregate will be supplied by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. 90 to 100 lb. QC sample taken from each 5200 ton (4720 metric ton) stockpile, submitted to OMM Aggregate Section. Document in CMS (Trns.port SiteManager™). Do not use until tested and approved.	No additional project sampling required for approved, sampled tonnage except if project believes there is a problem with the material [either gradation or quality]
703.07	Materials Mineral filler	For limestone dust assure from a source on Certified List for S 1069. For Portland cement assure source is on Certified list for S 1028 For inert mineral filler sample for gradation. Submit to District Lab.	
703.11 Type 1	Structural Backfill for 603 Bedding and Backfill from Certified Stock	Assure materials provided by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. Document in CMS (Trns.port SiteManager™).	90 to 100 lb. QC sample taken by District lab at source a minimum four (4) times per year. No project sampling required except if project believes there is a problem with the material [either gradation or quality]
703.11 Type 1	Structural Backfill for 603 Bedding and Backfill from Non-Certified Stock	Assure materials provided by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. 90 to 100 lb. QC sample taken from each 5200 ton (4720 metric ton) stockpile, submitted to OMM Aggregate Section. Document in CMS (Trns.port SiteManager™). Do not use until tested and approved.	No additional project sampling required for approved, sampled tonnage except if project believes there is a problem with the material [either gradation or quality]
703.11 Type 2	Structural Backfill for 603 Bedding and Backfill from Certified Stock	Assure materials provided by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. Document in CMS (Trns.port SiteManager™).	90 to 100 lb. QC sample taken by District lab at source a minimum four (4) times per year. No project sampling required except if project believes there is a problem with the material [either gradation or quality]
703.11 Type2	Structural Backfill for 603 Bedding and Backfill from Non-Certified Stock	Assure materials provided by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. 90 to 100 lb. QC sample taken from 5200 ton (4720 metric ton) stockpile, submitted to OMM Aggregate Section. Document in CMS (Trns.port SiteManager™). Do not use until tested and approved.	No additional project sampling required for approved, sampled tonnage except if project believes there is a problem with the material [either gradation or quality]

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
703.11 Type 3	Structural Backfill for 603 Bedding and Backfill from Certified Stock	Assure materials provided by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. Document in CMS (Trns.port SiteManager™).	60 to 70 lb. QC sample taken by District lab at source a minimum four (4) times per year. No project sampling required except if project believes there is a problem with the material [either gradation or quality]
703.11 Type 3	Structural Backfill for 603 Bedding and Backfill from Non-Certified Stock	Assure materials provided by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. 60 to 70 lb. QC sample taken from each 5200 ton (4720 metric ton) stockpile, submitted to OMM Aggregate Section. Document in CMS (Trns.port SiteManager™). Do not use until tested and approved.	No additional project sampling required for approved, sampled tonnage except if project believes there is a problem with the material [either gradation or quality]
703.13	Coarse Aggregate for Items 451 and 452	Assure materials provided by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. Assure materials are on the OMM Freeze Thaw List Follow requirements of coarse aggregate 703.02 Document in CMS (Trns.port SiteManager™).	No project sampling required except if project believes there is a problem with the material [either gradation or quality]
703.14	Steel Slag Aggregate for Non-Pavement Use	Assure materials from a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. Stockpile and sample each 2500 tons (2300 metric tons). Notify the District laboratory for inspection of sources and to obtain split samples. Test for expansion	No additional project sampling required for approved, sampled tonnage except if project believes there is a problem with the material [either gradation or quality]
703.16	Suitable Materials for Embankment Construction	Multiple materials listed. Follow the requirements of the individual material specification	Follow the requirements of the individual material specification
	Modification required for 703.16		
703.17	Dense Graded Aggregate for Item 304 from Certified Stock	Products will be supplied by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. Document in CMS (Trns.port SiteManager™).	90 to 100 lb. QC sample taken by District lab at source a minimum four (2) times per year. No project sampling required except if project believes there is a problem with the material [either gradation or quality]
703.17	Dense Graded Aggregate for Item 304 from Non-Certified Stock	Products will be supplied by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. 90 to 100 lb. QC sample taken from each 5200 ton (4720 metric ton) stockpile, submitted to OMM Aggregate Section. Document in CMS (Trns.port SiteManager™). Do not use until tested and approved.	No additional project sampling required for approved, sampled tonnage except if project believes there is a problem with the material [either gradation or quality]
703.18	Aggregate for Items 410, 411, and 617 from Certified Stock	Products will be supplied by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. Document in CMS (Trns.port SiteManager™).	90 to 100 lb. QC sample taken by District lab at source a minimum four (4) times per year. No project sampling required except if project believes there is a problem with the material [either gradation or quality]

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Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
703.18	Aggregate for Items 410, 411, and 617 from Non-Certified Stock	Products will be supplied by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. 90 to 100 lb. QC sample taken from each 5200 ton (4720 metric ton) stockpile, submitted to OMM Aggregate Section. Document in CMS (Trns.port SiteManager™). Do not use until tested and approved.	No additional project sampling required for approved, sampled tonnage except if project believes there is a problem with the material [either gradation or quality]
703.19.A	Crushed Aggregate Slope Protection and Filter Aggregate for Dump Rock Fill	Products will be supplied by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. Document in CMS (Trns.port SiteManager™).	No sampling required except if project believes there is a problem with the material [either gradation or quality]
703.19.B	Dumped Rock Fill and Rock Channel Protection	Products will be supplied by a supplier on the Pre-Qualified Supplier List for S 1069 maintained by OMM. Confirm with OMM laboratory source has know durability history Sample on direction of the OMM laboratory Document in CMS (Trns.port SiteManager™).	No sampling required except if project believes there is a problem with the material [either gradation or quality]
704.01 704.02 704.03	Block: Brick Concrete Masonry Shale	Verify type of material is on QPL at the time of use. Inspect for condition and defects. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. When material non-performs or looks defective during use reject material and sample 12 brick representative of defect to OMM for QA follow-up.
705.01	Fiber Reinforced Polymer (FRP) Dowel Bars	Certified test data from an accredited testing facility will accompany each shipment. Document in CMS (Trns.port SiteManager™).	Notify District Testing upon receipt of shipment.
705.03	Joint Filler Preformed	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, appearance and dimension. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use send one (1) 1.5'x2.5' sample representative of defect to OMM for QA follow-up.
705.04	Joint and Crack Sealer Hot Applied	Material is pre-tested and approved. Will be shipped with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM Asphalt Section for sampling requirements.
705.05	Burlap Cloth Materials	Inspect for condition, appearance and dimension. Documenting in CMS (Trns.port SiteManager™) is not required Only sample if there if questioning material meet specification	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
705.06	Sheet Curing Materials	Inspect for condition, appearance and dimension. Documenting in CMS (Trns.port SiteManager™) is not required. Only sample if there if questioning material meet specification	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
705.07	Concrete Curing Compounds	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and appearance. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use send one (1) quart sample representative of defect to OMM, Cement and Concrete section, for QA follow-up.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
705.10	Air Entraining Admixtures	Verify type and brand name of material listed on Concrete Plant Batch Ticket is on QPL at the time of use. Document in CMS (Trns.port SiteManager™).	Storage: Admixtures should be stored at concrete producer in such a manner to permit easy access for proper identification in weather resistant units. Provide minimum QA sample of one (1) every 180 days per concrete plant, each material, each company. Minimum sample size one (1) quart
705.11	Joint Sealer Preformed Elastomeric	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, appearance, dimension and manufacturer trademark. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material because material non-performs or looks defective during use.
705.12	Chemical Admixtures for Concrete	Verify type and brand name of material is on QPL at the time of use. Document in CMS (Trns.port SiteManager™).	Storage: Admixtures should be stored at concrete producer in such a manner to permit easy access for proper identification in weather resistant units. Provide minimum QA sample of one (1) every 180 days per concrete plant, each material, each company. Minimum sample size one (1) quart.
705.15	High Molecular Weight Methacrylate (HMWM)	Verify type and brand name of material is on QPL at the time of use. Document in CMS (Trns.port SiteManager™).	
705.20	Non Shrink, Non Metallic Grout	Verify type and brand name of material is on QPL at the time of use. Ensure mixing is performed in accordance with manufacturer's recommendations on the container. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM for sampling requirements.
705.21	Quick Setting Concrete Mortar	Verify type and brand name of material is on QPL at the time of use. Ensure mixing is performed in accordance with manufacturer's recommendations on the container. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM for sampling requirements.
705.22	Non-shrink Mortar	Verify manufacturer is on the Approved List maintained by OMM. Ensure mixing is performed in accordance with manufacturer's recommendations on the container. Make three (3) or more 3"x6" cylinders from keyway mix. Ship to OMM Concrete Section. Document in CMS (Trns.port SiteManager™).	Sample will be tested at 3, 7 and 28 days. Do not open structure to traffic until a compressive strength of 5000 psi (34.5 MPa) is achieved.
705.23 A	Epoxy-urethane Sealers	Verify type and brand name of material is on QPL at the time of use. Ensure mixing is performed in accordance with manufacturer's recommendations on the container. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use obtain 1 qt (1 L) samples in a sealed container and send to OMM.
705.23 B	Non Epoxy Sealers	Verify type and brand name of material is on QPL at the time of use. Ensure mixing is performed in accordance with manufacturer's recommendations on the container. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use obtain 1 qt (1 L) samples in a sealed container and send to OMM.
705.24	Soluble Reactive Silicate	Verify type and brand name of material is on QPL at the time of use. Ensure mixing is performed in accordance with manufacturer's recommendations on the container. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material.

700.00

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
705.25	Gravity Fed Resin	Verify type and brand name of material is on QPL at the time of use. Ensure mixing is performed in accordance with manufacturer's recommendations on the container. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use obtain 1 qt (1 L) samples in a sealed container and send to OMM.
705.26	Epoxy injection Resin	Verify type and brand name of material is on QPL at the time of use. Make sure that ports are properly installed and ensure mixing is performed in accordance with manufacturer's recommendations Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material.
706.01	Non-Reinforced Concrete Pipe	Assure products are supplied by a source on the Certified List for S-1074 maintained by OMM. Received with TE-24. Check dimension, markings, roughness or excessive cracks. Document in CMS (Trns.port SiteManager™).	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM , Cement and Concrete section,
706.02	Reinforced Concrete Circular Pipe	Assure products are supplied by a source on the Certified List for S-1074 maintained by OMM. Received with TE-24. Check dimension, markings, roughness or excessive cracks. Document in CMS (Trns.port SiteManager™).	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM , Cement and Concrete section,
706.03	Reinforced Concrete Pipe, Epoxy Coated	Assure products are supplied by a source on the Certified List for S-1074 maintained by OMM. Received with TE-24. Check dimension, markings, roughness or excessive cracks. Document in CMS (Trns.port SiteManager™).	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM , Cement and Concrete section,
706.04	Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe	Assure products are supplied by a source on the Certified List for S-1074 maintained by OMM. Received with TE-24. Check dimension, markings, roughness or excessive cracks. Document in CMS (Trns.port SiteManager™).	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM , Cement and Concrete section,
706.05	Precast Reinforced Concrete Box Sections	Assure products are supplied by a source on the Certified List for S-1073 maintained by OMM. Received with TE-24. Check dimension, markings, roughness or excessive cracks. Document in CMS (Trns.port SiteManager™).	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM , Cement and Concrete section,
706.051	Precast Reinforced Concrete Three-Sided Flat Topped Culverts	Assure products are supplied by a source on the Certified List for S-1073 maintained by OMM. Received with TE-24. Check dimension, markings, roughness or excessive cracks. Document in CMS (Trns.port SiteManager™).	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM , Cement and Concrete section,
706.052	Precast Reinforced Concrete Arch Sections	Assure products are supplied by a source on the Certified List for S-1073 maintained by OMM. Received with TE-24. Check dimension, markings, roughness or excessive cracks. Document in CMS (Trns.port SiteManager™).	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM , Cement and Concrete section,
706.06	Perforated Concrete Pipe	Assure products are supplied by a source on the Certified List for S-1074 maintained by OMM. Received with TE-24. Check dimension, markings, roughness or excessive cracks. Document in CMS (Trns.port SiteManager™).	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM , Cement and Concrete section,

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
706.07	Concrete Drain Tile	Assure products are supplied by a source on the Certified List for S-1074 maintained by OMM. Received with TE-24. Check dimension, markings, roughness or excessive cracks. Document in CMS (Trns.port SiteManager™).	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM , Cement and Concrete section.
706.08	Vitrified Clay Pipe	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, appearance and dimension. Document in CMS (Trns.port SiteManager™).	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM , Cement and Concrete section.
706.09	Clay Drain Tile	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, appearance and dimension. Document in CMS (Trns.port SiteManager™).	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM , Cement and Concrete section.
706.10	Bituminous pipe joint filler	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, appearance and dimension. Document in CMS (Trns.port SiteManager™).	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM , Asphalt Concrete section.
706.11	Resilient and Flexible Gasket Joints	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, appearance and dimension. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, Structural Metals and Welding section, if rejecting material because material non-performs or looks defective during use.
706.12	Resilient and Flexible Joints	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, appearance and dimension. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM Structural Metals and Welding section, if rejecting material because material non-performs or looks defective during use.
706.13	Precast Reinforced Concrete Manhole Riser Sections, Catch Basins and Inlet Tops, and Temporary Barriers	Assure products are supplied by a source on the Certified List for S-1073 maintained by OMM Received with TE-24. Check dimension, markings, roughness or excessive cracks. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM , Cement and Concrete section, if rejecting material because material non-performs or looks defective during use.
706.14	Flexible Plastic Gaskets	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, appearance and dimension. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, Structural Metals and Welding section, if rejecting material because material non-performs or looks defective during use.
706.15	Precast Reinforced Concrete Outlets	Assure products are supplied by a source on the Certified List for S-1073 maintained by OMM Received with TE-24. Check dimension, markings, roughness or excessive cracks. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM , Cement and Concrete section, if rejecting material because material non-performs or looks defective during use.
707.01	Metallic Coated Corrugated Steel Conduits and Underdrains [½ inch and 1/4 depth corrugations]	Products will be supplied by a source on the Certified List for S-1019 maintained by OMM. Received with TE-24. Check dimensions and markings. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
707.02	Metallic Coated Corrugated Steel Conduits [1 inch depth corrugation]	Products will be supplied by a source on the Certified List for S-1019 maintained by OMM. Received with TE-24. Check dimensions and markings. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
707.03	Structural Plate Corrugated Steel Structures	Products will be supplied by a source on the Certified List for S-1019 maintained by OMM. Received with TE-24. Check dimensions and markings. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
707.04	Precoated, Galvanized Steel Culverts	Products will be supplied by a source on the Certified List for S-1019 maintained by OMM. Received with TE-24. Check dimensions and cracks. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use
707.05 705.07	Bituminous Coated Corrugated Steel Pipe and Arches with Paved Invert [½ inch depth corrugations] [1 inch depth corrugations]	Products will be supplied by a source on the Certified List for S-1019 maintained by OMM. Received with TE-24. Check dimensions and markings. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
707.10	Steel Tubing Square and Rectangular	Generally a fabricated component received with TE-24. Check dimensions and markings. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
707.11	Mortar Lined Corrugated Steel Pipe [any corrugation depth]	Products will be supplied by a source on the Certified List for S-1019 maintained by OMM. Received with TE-24. Check dimensions and markings. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
707.12	Corrugated Steel Spiral Rib Conduits	Products will be supplied by a source on the Certified List for S-1019 maintained by OMM. Received with TE-24. Check dimensions and markings. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use
707.13 707.14	Bituminous Lined Corrugated Steel Pipe [½ depth corrugations] [1 depth corrugations]	Products will be supplied by a source on the Certified List for S-1019 maintained by OMM. Received with TE-24. Check dimensions and markings. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
707.15	Corrugated Steel Box Culverts	Products will be supplied by a source on the Certified List for S-1019 maintained by OMM. Received with TE-24. Check dimensions and markings. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
707.21	Corrugated Aluminum Alloy Conduits and Underdrains [1/4, 7/16 & ½ inch depth corrugations]	Products will be supplied by a source on the Certified List for S-1019 maintained by OMM. Received with TE-24. Check dimension and markings. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
707.22	Corrugated Aluminum Alloy Conduits	Products will be supplied by a source on the Certified List for S-1019 maintained by OMM. Received with TE-24. Check dimension and markings. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
707.23	Aluminum Alloy Structural Plate Conduits	Products will be supplied by a source on the Certified List for S-1019 maintained by OMM. Received with TE-24. Check dimensions and markings. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
707.24	Corrugated Aluminum Spiral Rib Conduits	Products will be supplied by a source on the Certified List for S-1019 maintained by OMM. Received with TE-24. Check dimensions and markings. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
707.25	Corrugated Aluminum Box Culverts	Products will be supplied by a source on the Certified List for S-1019 maintained by OMM. Received with TE-24. Check dimensions and markings. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
707.31 707.32 707.33	Polyethylene Corrugated Pipe	Products will be supplied by a source on the Certified List for S-1066 maintained by OMM. Received with TE-24. Check dimension and markings. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, asphalt section, if rejecting material because material non-performs or looks defective during use.
707.41	Polyvinyl Chloride Plastic Pipe	If material is shipped with TE24, accept based on inspection of material for type, condition and dimension. Document in CMS (Trns.port SiteManager™). If no TE24, accept based on inspection of material for type, condition, dimension, receipt and verification of manufacturer's certified test data. Document in CMS (Trns.port SiteManager™)	Notify District Testing if rejecting material.
707.42	Polyvinyl Chloride Corrugated Smooth Interior Pipe	If material is shipped with TE24, accept based on inspection of material for type, condition and dimension. Document in CMS (Trns.port SiteManager™). If no TE24, accept based on inspection of material for type, condition, dimension, receipt and verification of manufacturer's certified test data. Document in CMS (Trns.port SiteManager™)	Notify District Testing if rejecting material.
707.43	Polyvinyl Chloride Profile Wall Pipe	If material is shipped with TE24, accept based on inspection of material for type, condition and dimension. Document in CMS (Trns.port SiteManager™). If no TE24, accept based on inspection of material for type, condition, dimension, receipt and verification of manufacturer's certified test data. Document in CMS (Trns.port SiteManager™)	Notify District Testing if rejecting material.
707.44	Polyvinyl Chloride Sanitary Pipe	If material is shipped with TE24, accept based on inspection of material for type, condition and dimension. Document in CMS (Trns.port SiteManager™). If no TE24, accept based on inspection of material for type, condition, dimension, receipt and verification of manufacturer's certified test data. Document in CMS (Trns.port SiteManager™)	Notify District Testing if rejecting material.
707.45	Polyvinyl Chloride Solid Wall Pipe	If material is shipped with TE24, accept based on inspection of material for type, condition and dimension. Document in CMS (Trns.port SiteManager™). If no TE24, accept based on inspection of material for type, condition, dimension, receipt and verification of manufacturer's certified test data. Document in CMS (Trns.port SiteManager™)	Notify District Testing if rejecting material.
707.46	Polyvinyl Chloride Drain Waste and Vent Pipe	If material is shipped with TE24, accept based on inspection of material for type, condition and dimension. Document in CMS (Trns.port SiteManager™). If no TE24, accept based on inspection of material for type, condition, dimension, receipt and verification of manufacturer's certified test data. Document in CMS (Trns.port SiteManager™)	Notify District Testing if rejecting material.

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Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
707.47	ABS and Polyvinyl Chloride Composite Pipe	If material is shipped with TE24, accept based on inspection of material for type, condition and dimension. Document in CMS (Trns.port SiteManager™). If no TE24, accept based on inspection of material for type, condition, dimension, receipt and verification of manufacturer's certified test data. Document in CMS (Trns.port SiteManager™)	Notify District Testing if rejecting material.
707.51	ABS Drain Waste and Vent Pipe	If material is shipped with TE24, accept based on inspection of material for type, condition and dimension. Document in CMS (Trns.port SiteManager™). If no TE24, accept based on inspection of material for type, condition, dimension, receipt and verification of manufacturer's certified test data. Document in CMS (Trns.port SiteManager™)	Notify District Testing if rejecting material.
707.52	ABS Sewer Pipe	If material is shipped with TE24, accept based on inspection of material for type, condition and dimension. Document in CMS (Trns.port SiteManager™). If no TE24, accept based on inspection of material for type, condition, dimension, receipt and verification of manufacturer's certified test data. Document in CMS (Trns.port SiteManager™)	Notify District Testing if rejecting material.
707.70	Welded and Seamless Steel Pipe	Verify type and brand name of material is on QPL at the time of use. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural metals and Welding section, if rejecting material because material non-performs or looks defective during use.
708.01	Inorganic Zinc Silicate Primer Paint	Products will be supplied by a source on the Certified List for S-1084 maintained by OMM. Verify type and brand name of material is on QPL at the time of use. Inspect material container for markings, expiration date and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, chemical section, if rejecting material because material non-performs or looks defective during use. Obtain a 1 qt (1 L) sample representative of the defects.
708.02 708.02B 708.02C 708.02D	OZEU Structural Steel Pant Organic Zinc Prime Coat Epoxy Intermediate Coat Urethane Finish Coat	Products will be supplied by a source on the Certified List for S-1084 maintained by OMM. Verify type and brand name of material is on QPL at the time of use. Inspect material container for markings, expiration date and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, chemical section, if rejecting material because material non-performs or looks defective during use. Obtain a 1 qt (1 L) sample representative of the defects.
709.01	Deformed and Plain Billet Steel Bars for Concrete Reinforcement	Products will be supplied by a source on the Certified List for S-1068 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain three (3) 30" (.8 m) long samples of each rebar size, with markings, and submit for QA testing by the Laboratory.
709.03	Rail Steel Deformed and Plain Bars for Concrete Reinforcement	Products will be supplied by a source on the Certified List for S-1068 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain three (3) 30" (.8 m) long samples of each rebar size, with markings, and submit for QA testing by the Laboratory.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
709.05	Axle Steel Deformed and Plain Bars for Concrete Reinforcement	Products will be supplied by a source on the Certified List for S-1068 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain three (3) 30" (.8 m) long samples of each rebar size, with markings, and submit for QA testing by the Laboratory.
709.08	Cold-Drawn Steel Wire for Concrete Reinforcement	Products will be supplied by a source on the Certified List for S-1068 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain three (3) 30" (.8 m) long samples of each diameter and submit for QA testing by the Laboratory.
709.09	Fabricated Steel Bar or Rod Mats for Concrete Reinforcement	Products will be supplied by a source on the Certified List for S-1068 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain 3 ft x 3 ft (1 m x 1 m) of the mat and submit for QA testing by the Laboratory.
709.10	Welded Steel Wire Fabric for Concrete Reinforcement	Products will be supplied by a source on the Certified List for S-1068 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain 3 ft x 3 ft (1 m x 1 m) of the mat and submit for QA testing by the Laboratory.
709.11	Deformed Steel Wire for Concrete Reinforcement	Products will be supplied by a source on the Certified List for S-1068 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain 3 ft x 3 ft (1 m x 1 m) of the mat and submit for QA testing by the Laboratory.
709.12	Welded Deformed Steel Wire Fabric for Concrete Reinforcement	Products will be supplied by a source on the Certified List for S-1068 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain 3 ft x 3 ft (1 m x 1 m) of the mat and submit for QA testing by the Laboratory.
709.13	Coated Dowel Bars	Products will be supplied by a source on the Certified List for S-1068 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain 3 dowel bars and submit for QA testing by the Laboratory.
709.14	Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement	Products will be supplied by a source on the Certified List for S-1068 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain 3 ft x 3 ft (1 m x 1 m) of the mat and submit for QA testing by the Laboratory.
709.15	Plastic Supports for Reinforcing Steel	Products will be supplied by a source on the Approved List maintained by OMM. Inspect for dimension and condition.	Notify District Testing if rejecting material that non-performs or looks defective during use.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
709.16	Galvanizing Steel Option for Bridge Spirals	Products will be supplied by a source on the Certified List for S-1068 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain three (3) 30" (.8 m) long samples of each rebar size, with markings, and submit for QA testing by the Laboratory.
710.01.A 710.01 B	Barbed Wire	Products will be supplied by a source on the Certified List for S-1067 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain a 5 ft (1.5 m) length of barbed wire and submit for QA testing by the Laboratory.
710.02	Woven Steel Wire Fence, Type 47	Products will be supplied by a source on the Certified List for S-1067 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain 4 ft (1.2 m) width of fencing and submit for QA testing by the Laboratory.
710.03	Chain-Link Fence [ including Fittings and Accessories ]	Products will be supplied by a source on the Certified List for S-1067 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain samples as directed by the Laboratory.
710.06	Deep Beam Rail	Products will be supplied by a source on the Certified List for S-1042 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain three (3) 1 ft (0.3 m) lengths of guardrail from the same section and submit for QA testing by the Laboratory.
710.09	Wire Rope Rail	Inspect for dimension, condition, appearance and markings on tag or reel. Submit one (1) six (6) ft. sample to OMM. Document in CMS (Trns.port SiteManager™).	Approval required prior to use. Notify District Testing and OMM.
710.11	Fence Posts and Braces [Lumber] [Steel]	Products will be supplied by a source on the Certified List for S-1067 and S-1072 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
710.12	Square-Sawed and Round Guardrail Posts	Products will be supplied by a source on the Certified List for S-1042 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
710.14	Pressure Treated Guardrail and Fence Posts, Braces, and Blocks	Products will be supplied by a source on the Certified List for S-1042 and S-1067 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
710.15	Steel Guardrail Posts	Products will be supplied by a source on the Certified List for S-1042 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
710.16	Guard Posts	Products will be supplied by a source on the Certified List for S-1042 and S-1067 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
711.01 711.04 711.07	Structural Steel Cold Rolled Steel Steel Castings	Material supplied by a Fabricator source on the Certified List for Items 513, 516, 517 & 518 maintained by OMM. Structural Steel Members are received with TE-24.	If questions concerning structural steel materials, contact OMM Structural Steel Section and notify District Testing.
711.02	Galvanized Steel	Any material supplied with galvanizing will conform to this specification. Randomly inspect galvanizing for appearance and thickness of coating.	Notify District Testing if rejecting material.
711.03	Steel for Sheet Piling	Certified Mill Test Data required for new material. Verify tensile and chemical properties meet requirements. Inspect all material for dimension and condition. Used material is not acceptable for permanent installations. Document field inspection.	
711.08	Arc-welding Electrode & Fluxes	Verify manufacturer is on Approved List maintained by OMM. Inspect for dimension, condition and markings. Document in CMS (Trns.port SiteManager™).	If material is not on Approved List, certification and test data from supplier will be submitted to OMM. Do not use until approval has been received.
711.09	High Strength Bolts Nuts and Washers	Received with TE-24. Inspect material for dimension, condition and markings. Reject defective material. Perform field testing of assembly combination per S-1080. Document field inspection & testing in CMS (Trns.port SiteManager™).	If field test does not meet requirements of S 1080, retest bolt, nut and washer combination after application of a lubricant. Notify District Testing if rejecting material.
711.10	Machine Bolts	General specification for many common bolts. Verify material is component of certified supplier shipment like S-1042 for Guardrail Suppliers or S-1067 for Fence Suppliers. Inspect for condition and coating. Reject defective material.	Notify District Testing if rejecting material.
711.12 711.13 711.14	Gray Iron Castings Ductile Iron Castings Gray Iron & Ductile Iron Castings	Verify manufacturer is on Approved List maintained by OMM. Received with TE-24. Inspect for condition and defect.	Notify District Testing if rejecting material
711.15 711.16 711.17 711.18 711.19	Sheet Copper Phosphor Bronze Plate Cast Bronze Leaded Bronze Sheet Lead	Material supplied by a Fabricator source on the Certified List for Items 513, 516, 517 & 518 maintained by OMM. Structural Steel Members are received with TE-24. Document in CMS (Trns.port SiteManager™).	If questions concerning structural steel materials, contact OMM Structural Steel Section and notify District Testing.
711.20	Aluminum for Railings	Material supplied by a Fabricator source on the Certified List for Items 513, 516, 517 & 518 maintained by OMM. Structural Steel Members are received with TE-24. Document in CMS (Trns.port SiteManager™).	If questions concerning structural steel materials, contact OMM Structural Steel Section and notify District Testing.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
711.21	Preformed Bearing Pads	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in CMS (Trns.port SiteManager™).	If material non-performs or looks defective during use notify District Testing and OMM.
711.23	Elastomeric Bearings	Only accept elastomeric bearings shipped by TE-24. and provided by certified suppliers conforming to S1081. Notify district testing. to inspect material to check location and number of internal shims utilizing an ice pick or similar tool. Five (5) Durometer Gage readings should be taken and averaged to determine compliance with design plans. Document in CMS (Trns.port SiteManager™).	Field acceptable for durometer. Reading average range: +/- 7 points of design plan number.
711.24	Waterproofing fabric	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material.
711.25	Type 2 Membrane Waterproofing	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use send one (1) 4 ft <sup>2</sup> sample representative of defect to OMM for QA follow-up.
711.26	Structural Timber, Lumber and Piling	Products will be supplied by a source on the Certified List for S-1072 maintained by OMM. Received with TE-24 and supplier bill of lading. Check dimension, quantity and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
711.27	Prestressing Steel	Material supplied by a Fabricator source on the Certified List for Items 515 maintained by OMM. Prestressed Concrete Members are received with TE-24.	If questions concerning prestressed concrete or prestressed
711.28	Cellular Polyvinyl Chloride Sponge	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use send one (1) 1.5'x2.5' sample representative of defect to OMM for QA follow-up.
711.29	Type 3 Membrane Waterproofing	Verify type and brand name of material is on QPL at the time of use. Membrane primer is 705.04 material Inspect for condition and defect. Verify dimension conform to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use send one (1) 4 square ft sample representative of defect to OMM for QA follow-up.
711.30	Aluminum for Steps	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
711.31	Reinforced Propylene Plastic Manhole Steps	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
712.01	Expansion Shield Anchors	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain three(3) samples representative of defect to OMM for QA follow-up.
712.02	Calcium Chloride	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use contact OMM.
712.03	Sodium Chloride	Inspect material for condition. Submit one (1) pint sample per Each Purchase Order to OMM. Document in CMS (Trns.port SiteManager™).	If additional samples required for material quantities exceeding 3000 tons, Notify District Testing.
712.04 A	Lime [masonry]	Sample & Inspect material for condition with 24 hrs of receipt. One (1) five (5) lb sample. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material.
712.04 B	Lime [Quick] for Stabilization	Assure provided material is from suppliers certified under Supplement 1087 and documentation for m S1087 is complete. Document in CMS (Trns.port SiteManager™). If questions on material quality sample. One (1) ten (10) lb sample of Quicklime. Send to Geotechnical Engineering.	Notify District Testing if rejecting material. Samples may be taken in triplicate, if required. Contact Geotechnical Engineering.
712.04 C	Lime Kiln Dust for Stabilization	Assure provided material is from suppliers certified under Supplement 1087 and documentation for m S1087 is complete. Document in CMS (Trns.port SiteManager™). If questions on material quality sample. One (1) ten (10) lb sample of Lime Kiln Dust. Send to Geotechnical Engineering	Notify District Testing if rejecting material. Samples may be taken in triplicate, if required. Contact Geotechnical Engineering.
712.06	Preservative Treatment for Structural Timber	Component material of pressure treated lumber. No approval required.	If questions on pressure treated lumber check the specific material item and follow those instructions
712.09	Geotextile Fabrics	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use submit one (1) 4' x 4' sample representative of defect to OMM.
712.10	Prefabricated Edge Underdrain	Inspect material for condition and dimension. Manufacturer's certified test data required for acceptance. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material.
712.11	Temporary Erosion Control Mats Material [Types A through I]	Inspect material for condition and dimension. Manufacturer's certified test data required for acceptance. Field Acceptance item Refer to Temporary Materials Policy for documentation requirements.	Notify District Testing if rejecting material.
720.01	Rectangular Reflectors	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, color requirements and defect. Verify dimension conform to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM Chemical section, if rejecting material because material non-performs or looks defective during use.
720.03	Flexible Delineator Posts	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM Chemical section, if rejecting material because material non-performs or looks defective during use.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
720.04	Barrier Reflectors	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM Chemical section, if rejecting material because material non-performs or looks defective during use.
721.01	Raised Pavement Marker Castings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify type conforms to pre-qualification requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain one (1) 4x2x0.48 in. sample representative of defect to OMM for QA follow-up.
721.02	Prismatic Retroreflector and Adhesive	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify type conforms to pre-qualification requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use. Obtain one (1) sample representative of defective RPM casting to OMM for QA follow-up.
721.03	Casting Adhesive	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM Chemical section, if rejecting material because material non-performs or looks defective during use.
725.02	Wire and Cables	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, markings and conformance to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use send a sample representative of non-compliance or defect to OMM for QA follow-up.
725.03	Unit Type Duct-Cable Systems	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, markings and conformance to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use send a 10 ft. sample representative of non-compliance or defect to OMM for QA follow-up.
725.04	Rigid Ferrous Metal Electrical Conduit and Fittings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition of coating and conformance to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use send a sample representative of non-compliance or defect to OMM for QA follow-up.
725.051	Polyvinyl Chloride Conduit and Fittings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, markings and conformance to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use send a sample representative of non-compliance or defect to OMM for QA follow-up.
725.052	Polyethylene Conduit and Fittings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, markings and conformance to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use send a sample representative of non-compliance or defect to OMM for QA follow-up.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
725.06	Polymer Concrete Pull Boxes	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use send a sample representative of non-compliance or defect to OMM for QA follow-up.
725.07	Plastic Pull Box	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.08	Portland Concrete Pull Boxes	Products will be supplied by a source on the Certified List for S-1073 maintained by OMM. Received with TE-24. Check dimension, markings, roughness or excessive cracks. Item 604 Installation documented on CA-P-3 Inspection Form. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.10	Junction Boxes	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.11 B	Lamps for Luminaires	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, markings and conformance to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.11 E	Luminaires for High Intensity Discharge Lamps (including Optical system, lamp, ballast and housing)	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.11 F	Wall Mounted Underpass Luminaires (including Optical system, lamp, ballast and housing)	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.11 G	High Mast/Low Mast Luminaire (including Optical system, lamp, ballast and housing)	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.12	Polyethylene, Fiberglass reinforced, Pull Box with Polymer concrete cover and support ring	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.15	Circuit Cable Connections and terminations	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.16	Ground Rods	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use contact OMM.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
725.19 I	Power Service Components Wood Pole	Products will be supplied by a source on the Certified List for S-1072 maintained by OMM. Received with TE-24 and supplier bill of lading. Check dimension, quantity and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing and OMM, structural welding and metals section, if rejecting material because material non-performs or looks defective during use.
725.20	Multiple Cell Polyvinyl Chloride Conduit and Fittings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.21 A	Luminaire Supports Light Poles	Inspect material for condition and conformance to plan requirements. Verify pole provided by Certified Manufacturer under Supplement 1091. Accept with TE-24 Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.21 B	Luminaire Supports Light Towers	Inspect material for condition and conformance to plan requirements. Verify pole provided by Certified Manufacturer under Supplement 1091. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.21B9	Luminaire Support Anchor Bolts	OPTION 1 Verify type and brand name of material is on QPL at the time of use. Inspect for condition, and conformance to plan requirements. OPTION 2 Verify pole provided by Certified Manufacturer under Supplement 1091. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.01	Steel Tube and Pipe	This item typically is a component of a sign support. Inspect total component for condition and conformance to shop drawings. Document in CMS (Trns.port SiteManager™)	Notify District Testing if rejecting material.
730.015	U-Channel Posts	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District testing and OMM.
730.016	Square Posts	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.02	Steel Anchor Bolts and Nuts	OPTION 1 Verify type and brand name of material is on QPL at the time of use. Inspect for condition, and conformance to plan requirements. OPTION 2 Verify pole provided by Certified Manufacturer under Supplement 1093. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.03	Steel Poles and Arms	Component material provided by Certified Manufacturer under Supplement 1093. Verify manufacturer is on 1093. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.04	Base and Arm Plates	Component material provided by Certified Manufacturer under Supplement 1093. Verify manufacturer is on 1093. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
730.05	Handhole Covers	Component material provided by Certified Manufacturer under Supplement 1093. Verify manufacturer is on 1093. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.06	Pole Caps	Component material provided by Certified Manufacturer under Supplement 1093. Verify manufacturer is on 1093. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.07	Arm Caps	Component material provided by Certified Manufacturer under Supplement 1093. Verify manufacturer is on 1093. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.08	Steel Hardware	Component material provided by Certified Manufacturer under Supplement 1092 or 1093. Verify manufacturer is on 1092 or 1093. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.09	Stainless Steel	Component material provided by Certified Manufacturer under Supplement 1092 or 1093. Verify manufacturer is on 1092 or 1093. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.10	Stainless Steel Hardware	Component material provided by Certified Manufacturer under Supplement 1092 or 1093. Verify manufacturer is on 1092 or 1093. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.11	Aluminum Sheet and Plate	Component material provided by Certified Manufacturer under Supplement 1092 or 1093. Verify manufacturer is on 1092 or 1093. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.12	Aluminum Extrusions	Component material provided by Certified Manufacturer under Supplement 1092 or 1093. Verify manufacturer is on 1092 or 1093. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.13	Aluminum Tube and Pipe	Component material provided by Certified Manufacturer under Supplement 1092 or 1093. Verify manufacturer is on 1092 or 1093. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.14	Aluminum Castings	Component material provided by Certified Manufacturer under Supplement 1092 or 1093. Verify manufacturer is on 1092 or 1093. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.15	Aluminum Forgings	Component material provided by Certified Manufacturer under Supplement 1092 or 1093. Verify manufacturer is on 1092 or 1093. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.16	Aluminum Welding Rods	Normally only applies to shop fabrication. If performing field aluminum welding contact District Testing and OMM for recommendations.	Notify District Testing if rejecting material.
730.17	Aluminum Hardware	Component material provided by Certified Manufacturer under Supplement 1092. Verify manufacturer is on 1092. Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.

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Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
730.18	Reflective Sheeting Type F	Use if certification provided. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.19	Reflective Sheeting Type G	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.191	Reflective Sheeting Type G reboundable	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.192	Reflective Sheeting Type H	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.193	Reflective Sheeting Type J	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.20	Nonreflective Sheeting	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.22	Silk Screen Inks	No field acceptance requirements.- part of 730.19,191,192 or 193 items.	
730.23	Transparent Electronic Cuttable Films	No field acceptance requirements.- part of 730.19,191,192 or 193 items No field requirements.	
731.03	Changeable Message Sign, Electrical Type	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
731.05	Internally Illuminated Fixed Message Sign	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
731.06	Sign Flasher Assembly	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
731.07	School Speed Limit Sign Assembly	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
731.08	Flexible Conduit	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
731.10	Timer with Enclosure	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
732.01	Vehicular Signal Heads, Conventional	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.02	Vehicular Signal Heads, Optically Programmed, 12-inch (300 mm) Lens	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.03	Vehicular Signal Heads, Optically Programmed, 8-inch (200 mm) Lens	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.04 A	Optically Programmed And Pedestrian Incandescent Signal Lamps	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.04 B	Vehicular Signal Incandescent Lamps	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.04 C	Vehicular and pedestrian light Emitting Diode Lamps	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.05	Pedestrian Signal Heads [Type A1] [Type A2] [Type D2]	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.06	Pedestrian Pushbuttons	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.07 A	Loop Detector Units Nema TS 1	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.07 B	Loop Detector Units Nema TS 2	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.08	Loop Detector Units, Delay and Extension Type	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.09	Magnetometer Detector Units	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.10	Magnetometer Sensor Probes	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
732.11	Signal Supports	Check provided by Certified Manufacturer under Supplement 1094 Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.12	Strain Poles	Check provided by Certified Manufacturer under Supplement 1094 Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.13	Wood Poles	Check provided by Certified Manufacturer under Supplement 1072 Accept with TE-24. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.14	Down Guy Assemblies	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.15	Pedestals	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.16	Conduit Risers	See 725.04 requirements.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.17	Cable Support Assemblies	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.18	Messenger Wire	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.19	Cable and Wire	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.20	Power Service	See 725.04 requirements	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.21	Disconnect Switch with Enclosure	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
733.02 A	Controller Unit Type TS2/A1	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
733.02 B	Controller Unit Type TS2/A2	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
733.02 C	Controller Unit Type 170E	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
733.02 D	Controller Unit Type 2070L and LC	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
733.03 A	Cabinet Type TS 1	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
733.03 B	Cabinet Type TS 2	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
733.03 C	Cabinet Type 332	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
733.03 D	Cabinet Type 334	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
733.03 E	Cabinet Type 336	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
733.04 A	Cabinet Riser for TS 1 – TS 2 cabinet	Field inspect for 1/4 aluminum thickness and accept.	Notify District Testing if rejecting material.
733.04 B	Cabinet Riser for Types 332, 334 or 336	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
733.05	Flasher Controller	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
733.06	Controller, Master, Traffic Responsive	Assure the same manufacturer as the supplied controller unit 733.02.	Notify District Testing if rejecting material.
733.07	Remote Monitoring Station	Compatible with the supplied 733.02 and 733.06 unit.	Notify District Testing if rejecting material.
740.02	Traffic Paint	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in CMS (Trns.port SiteManager™).	If rejecting for performance provide 1 qt (1 L) sample and notify District.
740.03	Polyester Pavement Marking	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in CMS (Trns.port SiteManager™).	If rejecting for performance provide 1 qt (1 L) sample and notify District.

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Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
740.04	Thermoplastic Pavement Marking	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in CMS (Trns.port SiteManager™).	If rejecting for performance provide 1 qt (1 L) sample and notify District.
740.05	Preformed Pavement Marking	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in CMS (Trns.port SiteManager™).	If rejecting for performance provide 1 qt (1 L) sample and notify District.
740.06	Work Zone Pavement Marking [Type 1 Removable] [Type 2 Non-Removable]	Materials accepted by Engineer. Inspect material for uniform consistency. Document in CMS (Trns.port SiteManager™).	If rejecting for performance provide 1 qt (1 L) sample and notify District.
740.07	Epoxy Pavement Marking Material	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in CMS (Trns.port SiteManager™).	If rejecting for performance provide 1 qt (1 L) sample and notify District
740.08	Heat-Fused Preformed Plastic Pavement Marking Material	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in CMS (Trns.port SiteManager™).	If rejecting for performance provide 1 qt (1 L) sample and notify District
740.09 A	Glass Beads – for 740.02	Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in CMS (Trns.port SiteManager™).	Accept if accompanied by a TE-24
740.09 B	Glass Beads – for 740.03	Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in CMS (Trns.port SiteManager™).	Accept if accompanied by a TE-24
740.09 C	Glass Beads – for 740.04	Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in CMS (Trns.port SiteManager™).	Accept if accompanied by a TE-24
740.09 D	Glass Beads – for 740.07	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in CMS (Trns.port SiteManager™).	Accept if accompanied by a TE-24
748.01	Ductile Iron Pipe, Joints, and Fittings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.02	Polyvinyl Chloride (PVC) Pipe, Joints, and Fittings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.03	Polyethylene (PE) Service Branches and Fittings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.

Spec No.	Material	Material only Inspection or Sampling Requirements	Post Inspection Instructions
748.05	Copper Service Branches and Fittings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.06	Steel Pipe Encasement	Basis of acceptance is certified test data containing documentation of domestic origin from manufacturer.	Notify District Testing if rejecting material
748.07	Polyethylene Encasement	Verify manufacturer certification conforms to ANSI/AWWA C105/A21.5 Inspect condition, dimension, suitability for intended use.	Notify District Testing if rejecting material.
748.08	Gate Valve and Valve Box	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.09	Inserting Valve and Valve Box	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.10	Cutting-in Sleeve, Valve, and Valve Box	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.11	Tapping Sleeve, Valve, and Valve Box	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.12	Tapping Saddle and Corporation Stop	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.13	Service Stop and Service Box	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.14	Meter, Setting, Stop, and Chamber	Inspect for condition, dimension, suitability for intended use. Acceptance based on manufacturer's statement of conformity.	
748.15	Fire Hydrant	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in CMS (Trns.port SiteManager™).	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.

## 701 CEMENTITIOUS MATERIALS

**701.00 Acceptance.** Provide cements meeting 701.01, 701.02, 701.04, 701.05, 701.07 and 701.09 and certified according to Supplement 1028; fly ash meeting 701.13 and certified according to Supplement 1026; ground, granulated blast furnace slag meeting 701.11 and certified according to Supplement 1034; and micro silica meeting 701.10 and certified according to Supplement 1045 without prior sampling, testing and approval by the Department. Lists for certified cement, fly ash, GGBF slag and micro silica sources are maintained by the Laboratory.

**701.01 Air-Entraining Portland Cement.** Provide air-entraining portland cement according to ASTM C 150, Type IA. The Gillmore time of set and the air permeability (fineness) tests will govern.

**701.02 Portland Cement.** Provide portland cement according to ASTM C 150, Type II. The Gillmore time of set and the air permeability (fineness) tests will govern.

**701.04 Portland Cement.** Provide portland cement according to ASTM C 150, Type I. The Gillmore time of set and the air permeability (fineness) tests will govern.

**701.05 High Early Strength Portland Cement.** Provide high early strength portland cement according to ASTM C 150, Type III. The Gillmore time of set test shall govern.

**701.07 Masonry Cement.** Provide masonry cement according to ASTM C 91.

**701.09 Slag Modified Portland Cement.** Provide slag modified portland cement according to ASTM C 595, Type IS (< 25).

**701.10 Micro-Silica.** Provide micro-silica according to ASTM C 1240. Do not use micro-silica admixtures in dissolvable bags.

**701.11 Ground Granulated Blast Furnace (GGBF) Slag.** Provide ground granulated blast furnace (GGBF) according to ASTM C 989, Grade 100 minimum.

**701.13 Fly Ash for Use in Portland Cement Concrete.** Provide fly ash according to ASTM C 618, Class C or F, except ensure a maximum loss on ignition (LOI) of 3 percent.

Fly ash from sources certified according to Supplement 1026 and with an LOI greater than 3 percent may be approved for use by the Department if the fly ash is treated with a chemical conforming to Supplement 1115.

## 702 ASPHALT MATERIAL

**Acceptance.** Asphalt binders 702.01 and liquid asphalts 702.02, 702.03, and 702.04 may be acceptable for shipment to and immediate use in construction projects. Acceptance is according to Supplement 1032.

**702.00 Application Temperatures.** Apply asphalt materials, according to the temperature ranges specified in Table 702.00-1.

**TABLE 702.00-1**

Type and Grade of Material	Application Temperature Range °F (°C)	
	Spray	Mix
MC-30	50 to 120 (10 to 49)	---
MC-70	75 to 150 (24 to 66)	---
MC-250	100 to 225 (38 to 107)	100 to 225 (38 to 107)
MC-800	150 to 250 (66 to 121)	150 to 225 (66 to 107)
MC-3000	225 to 275 (107 to 135)	200 to 250 (93 to 121)
All Emulsions	50 to 160 (10 to 71)	50 to 140 (10 to 60)
Asphalt Primer for Waterproofing	50 to 80 (10 to 27)	---
Asphalt for Waterproofing	300 to 350 (149 to 177)	---
CBAE 350, CBAE 350 SP	100 to 150 (38 to 66)	100 to 150 (38 to 66)
CBAE 800, CBAE 800 SP	125 to 175 (52 to 79)	125 to 175 (52 to 79)
Primer 20	60 to 120 (16 to 49)	---
Primer 100	75 to 125 (24 to 52)	---
Asphalt Binders	350 (177) Max.	325 (163) Max.
Asphalt Binders-Polymer modified with SB, SBR, or SBS	375 (190) Max	350 (177) Max.

### 702.01 Asphalt Binders.

General. According to AASHTO M 320-05 except as follows.

PG Binders with the suffix “M” (e.g., PG 70-22M, PG 76-22M) will meet the requirements of Table 702.01-1. When a PG 64-28 is made thru modification ensure it meets the test requirements of Table 702.01-1.

An independent laboratory will not be owned or operated, in whole or part, by the binder supplier, Contractor, or affiliates of either.

Materials and Manufacture. Replace the requirements of AASHTO M 320-05 Section 5 “Materials and Manufacture” Section with the following:

5.1 Supply PG Binder from the refining of crude petroleum, or combination of asphalt binders from the refining of crude petroleum, or asphalt binders and suitable liquid from the refining of crude petroleum, and possible organic modifiers for performance enhancement. Material from the crude refining stream is considered neat. Liquid from crude refining may be used for adjustments, but do not used liquid from crude refining for the purpose of substitution of crude refined asphalt binder in a PG Binder. In the event of a failure investigation where asphalt binders exhibit unusual properties a supplier

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may be requested by the Laboratory to supply information about the makeup of a PG Binder. Failure to cooperate will mean removal from Supplement 1032 certification.

5.2 A modifier may be any organic material of suitable manufacture that is proven compatible with asphalt binder (does not separate appreciably in routine storage), and that is dissolved, dispersed or reacted in asphalt binder to improve its performance. Performance enhancement is defined as a decrease in the temperature susceptibility of the asphalt binder while maintaining or improving desirable properties in a neat asphalt binder such as coatability, adhesiveness and cohesiveness. Limit modifiers to no more than 6.0 percent by PG Binder weight.

5.3 The use of previously used materials in a PG Binder must be approved by the Department. Since no standard test procedures exist for reprocessed materials (and original tests were not developed with the use of such materials in mind), appropriate test methods may be chosen by the Department for review. Department approval does not relieve the binder supplier from full responsibility for content and use of any previously used material in a PG Binder nor guarantee suitable performance enhancement as defined above. The detected presence in a PG Binder sample of any unapproved previously used material will mean immediate removal from Supplement 1032 certification. Limit approved reprocessed materials to 6.0 percent by PG Binder weight.

5.4 Ensure the PG Binder is homogeneous, free from water and deleterious materials, and does not foam when heated to 350 °F (175 °C). Prove the asphalt binder (before modification or after modification if liquid modifier used) is fully compatible with a negative result by means of the Spot Test per AASHTO T 102 using standard naphtha solvent. If standard naphtha shows a positive result, a retest using reagent grade 35 percent Xylene/ 65 percent Heptane (volume) may be used.

5.5 Ensure the PG Binder is at least 99.0 percent soluble as determined by ASTM D 5546 or D 2042. Ensure any insoluble component is free of fibers or discrete particles more than 75 µm.

5.6 Ensure flash point is 500 °F (260 °C) minimum. Ensure mass loss on RTFO of the final PG Binder grade is 0.5 percent maximum.

5.7 Ensure that PG 64-22 has a Penetration (ASTM D5) of no more than 75.

5.8 Direct Tension testing is not required, unless otherwise required in this specification.

**Requirements for PG Modified Binder.** Furnish PG Modified Binder according to the requirements of Table 702.01-1 by modifying a non-oxidized, non-air blown, neat asphalt binder by using a styrene butadiene latex rubber compound (SBR polymer) or a styrene butadiene styrene polymer block copolymer (SBS polymer). The polymer supplier will certify to the refiner and Contractor that the polymer used meets a minimum 68 percent by weight butadiene content. Perform SBS polymer modification prior to shipment to the asphalt concrete mixing plant (preblend). Perform SBR polymer modification at

the asphalt concrete mixing plant (postblend) or prior to shipment to the asphalt concrete mixing plant (preblend).

For each project, the PG Modified Binder supplier will give the Contractor a handling guide specifying temperature, circulation, shelf life, and other requirements for assuring the PG Modified Binder will perform as desired. Give this handling guide to the Monitoring Team and place a copy in the plant control room and plant laboratory.

If PG Modified Binder is retained at the asphalt concrete mixing plant for more than two weeks before use or beyond the supplier recommended shelf life, whichever is less, a top and bottom sample test (material property difference between samples taken from the top and bottom of the storage tank) will be performed by the Laboratory on samples retrieved by the Contractor at the District's direction. Do not use material on hand until approved.

**Table 702.01-1**  
**Material Requirements for PG Modified Binder**

<b>Test / Requirement</b>	<b>SBR Polymer</b>		<b>SBS Polymer</b>		<b>Note</b>
Final PG Binder Grade	70-22M (a, b)	64-28 (b)	70-22M (a)	76-22M (a)	c
Final PG Binder Grade			64-28 (a)		
Actual Pass Temperatures	Report		Report		i
RTFO Mass Loss, percent max	.05		.05	.05	d
Phase Angle, max	76		80	76	d
Elastic Recovery, min			65	75	e
Toughness, in lb	118	105			f, d
Tenacity, in lb	70	80			f, d
Elongation, in, min	20	20			f, d
Ductility, in, min	28	28			j, d
Separation, F max	10		10		g
Homogeneity			None Visible		h, d

a. Preblended Binder with a base binder of at least -22 grade or stiffer for 70-22M and 76-22M.

b. Post blended Binder made from neat Supplement 1032 certified or preapproved standard PG Binder grade and rubber solids amount equal to or above 3.5 percent by weight of total binder to achieve the PG Binder grade.

c. Without Direct Tension, graded with actual pass temperatures

d. PG Modified Binder

e. ASTM D 6084, 10cm @ 77 °F (25 °C), hold 5 min. before cutting, on RTFO material

f. ASTM D 5801, 50cm/min @ 77 °F (25 °C)

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g. Softening point difference of top and bottom of tube sample conditioned at 340 °F (171 °C) for 48 hours. Compatibility of polymer and neat binder is sole responsibility of supplier. Formulate PG Modified Binder to retain dispersion for 3 days minimum.

h. Heat a minimum 400 gram sample at 350 °F (177 °C) for 2.5-3 hours. Pour entire sample over a hot No 50 (300 μm) sieve at 340°F (171 °C). Look for retained polymer lumps.

i. Actual high and low temperature achieved by PG Modified Binder beyond required grade, but will not grade out to the next standard PG Binder grade for low temperature.

j. ASTM D 113, @ 39 °F (4 °C), 1 cm/min

**702.02 Cut-Back Asphalt.** Provide medium curing cut-back asphalt according to AASHTO M 82. Instead of viscosity on the residue, the penetration in note 2 (AASHTO M 82) will govern.

**702.03 Cut-Back Asphalt Emulsions.** Prepare emulsions by compounding a suitable volatile solvent and water with 702.01 asphalt to produce emulsions according to Table 702.03-1.

**TABLE 702.03-1**

	<b>CBAE-350</b>	<b>CBAE-350 Special</b>	<b>CBAE-800</b>	<b>CBAE-800 Special</b>	<b>Primer 20</b>	<b>Primer 100</b>
Kinematic Viscosity at 60 °C, Centistokes	350-700	350-700	800-1600	800-1600	20-40	100-200
Water Content <sup>[1]</sup> , %	4-12	4-12	4-12	4-12	3-8	3-8
Volatile Solvent <sup>[1]</sup> , %	12-25	12-25	10-20	10-20		
Asphalt Content <sup>[1]</sup> , %	67+	67+	72+	72-	45+	60-
Adhesion Test <sup>[1]</sup>	[2]	[2]	[2]	[2]		
Wet Stone Coating Test <sup>[1]</sup>		[2]		[2]	[2]	[2]
Stripping Test <sup>[1]</sup>		[2]		[2]		
	Tests on Residue From Distillation					
Penetration at 25 °C	80-150	80-150	80-150	80-150	100-200	100-200
Ductility at 25 °C, in cm	100+	100+	100+	100+	100+	100+
Total Binder (Sol. in CSx), %	99+	99+	99+	99+	99+	99+
[1] Perform tests according to Supplement 1014.						
[2] Meets						

**702.04 Emulsified Asphalts.** Provide emulsified asphalts according to AASHTO M 140 or AASHTO M 208.

**702.05 Asphalt Primer for Waterproofing.** Provide asphalt primer for waterproofing according to ASTM D 41.

**702.06 Asphalt for Waterproofing.** Provide asphalt for waterproofing according to ASTM D 312, Type III.

**702.07 Asphalt Emulsion MWS.** Prepare asphalt emulsion MWS from a base material according to 702.01, except vary the penetration to meet the float test and penetration specified below. Ensure that the emulsion coats the aggregate readily, thoroughly, and uniformly. Ensure that the specified characteristics do not change during transportation or normal storage and that the emulsion is according to the following when tested according to AASHTO T 59:

Saybolt furol viscosity at 77 °F (25 °C), seconds	50+ <sup>[1]</sup>
Asphalt residue, percent	68+
Settlement, 7 days, percent	5-
Sieve test	0.1-
Coating test	<sup>[2]</sup>
Oil distillate, percent	7-
Withstand freezing to	-10 °F (-23 °C) <sup>[3]</sup>
Particle charge	Negative
Penetration, 77 °F (25 °C) <sup>[6]</sup>	<sup>[4]</sup>
Float test at 140 °F (60 °C), seconds <sup>[6]</sup>	1200+ <sup>[5]</sup>
Total bitumen soluble CS <sub>2</sub> <sup>[6]</sup>	97.5+
Ash content, percent <sup>[6]</sup>	2.0-
[1] Pumpable.	
[2] Use aggregates to test the emulsion that are from sources standardized by the Laboratory. Use aggregates consisting of 100 percent passing a 3/8 inch (9.5 mm) sieve and 0 percent passing a 1/4 inch (6.3 mm) sieve. Wash the standard reference aggregates with distilled water until free of dust, and dry them. Weigh 3.280 ounces (93 grams) of the dry graded reference aggregate into a suitable container. Weigh 0.247 ounces (7 grams) of the emulsion onto the aggregate in the container, and vigorously mix the contents for 5 minutes. After mixing, thoroughly coat the stone. Completely immerse the mixture in tap water, and immediately pour off the tap water. Ensure that the aggregate surface area is at least 90 percent coated.	
[3] When shipped after October 1 and before April 15, except if the emulsion is stored and mixed at temperatures of emulsion, aggregate, and atmosphere above 40 °F (5 °C).	
[4] Select the penetration within the following ranges of the designation specified:	
[5] AASHTO T 50, except immediately pour residue from distillation into the float collar at 500 °F (260 °C); or if the residue has been allowed to cool, heat it again to 500 °F (260 °C) and pour it into the float collar.	
[6] Test on residue from distillation.	

Designation	Penetration at 77 °F (25 °C)
MWS 300	300+
MWS 150	150 to 300
MWS 90	90 to 150
MWS 60	60 to 90

**702.13 Rubberized Asphalt Emulsion.** Provide material consisting of asphalt emulsion SS-1 or SS-1h, according to 702.04, blended with rubber compound,

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according to 702.14, to produce a residual mixture of asphalt and rubber solids having a composition of 95 ± 0.3 percent asphalt and 5 ± 0.3 percent rubber solids by weight.

Furnish a certification to the Laboratory showing the following:

- A. The weight of rubber compound blended with the emulsion.
- B. The weight of SS-1 or SS-1h emulsion blended with the rubber compound.
- C. The Laboratory Report Number and/or the approved Notice of Shipment Number of the SS-1 or SS-1h emulsion.
- D. The certified lot or batch number of the rubber compound.
- E. The percent of asphalt in the emulsion residue by distillation.
- F. The percent of rubber solids in rubber compound.
- G. The percent of rubber solids in the mixture of asphalt residue by distillation and rubber solids.

Determine the weight of the rubber compound to be added to a designated weight of SS-1 or SS-1h emulsion to provide the percent of rubber solids in the mixture of asphalt residue by distillation and rubber solids specified herein using the following formula:

$$X = \frac{0.0526(B)(W)}{(A)}$$

where:

- X = pounds (kilograms) of rubber compound
- A = percent of rubber solids in the rubber compound
- B = percent of asphalt residue by distillation of SS-1 or SS-1h emulsion
- W = pounds (kilograms) of SS-1 or SS-1h emulsion

**702.14 Rubber Compound.** Provide a dispersible rubber compound consisting of unvulcanized virgin synthetic rubber in the liquid latex form. The manufacturer of the rubber compound will furnish a written certification of the total rubber solids content of the rubber compound and provide written certification containing actual test results showing compliance with the requirements of these Specifications.

Provide a rubber compound according to the following:

- A. Rubber compound:
  - Total rubber solids, % by weight (Certification) ..... 49+
  - Ash, % of total rubber solids (ASTM D 297)..... 3.5-
- B. Combination of rubber compound with reference asphalt, mixed according to Supplement 1012.02:
  - Flow, cm..... 5-
  - Softening point, °C raise from  
reference asphalt, ASTM D 36 ..... 12+

Penetration @ 77 °F (25 °C), 100 g, 5 sec.,  
 mm/10 drop from reference asphalt, ASTM D 5.....10+  
 Viscosity, Brookfield units, Model RVF,  
 spindle No. 7 @ 10 RPM @ 94 °C \* .....175,000+  
 Toughness inch-pounds (N-m).....150+ (17+)  
 Tenacity, inch-pounds (N-m) .....90+ (10+)  
 Peak load, pounds (N).....65+ (289+)  
 Elongation, inches (mm).....20+ (500+)  
 Ductility @ 39 °F (4 °C), 1 cm/min, ASTM D 113 ...150+

\* Take the reading 60 seconds after spindle is actuated.

C. Mixture of the rubber compound with the reference asphalt and reference aggregate:

Dispersion of rubber, number  
 of remaining black rubbery  
 particles visible to the naked eye..... None  
 Resistance to flexure fatigue,  
 number of flexural units .....1500+

Perform the testing according to Supplement 1012

### 702.16 POLYMER EMULSIFIED BINDER

Emulsion (ASTM D 244)	Type A (b)	Type B (b,c,g)
Saybolt Furol Viscosity	100-400 (50 °C)	20-100 (25 °C)
Storage stability, 24 hrs., % difference, max (a)	1	1
Demulsibility, 35 ml of 0.8% Dioctyl Sodium Sulf., min	50	60
Demulsibility, 35 ml of 0.02N, CaCl <sub>2</sub> , %, min		60
Sieve test, (distilled water), %, max	0.1	0.05
Distillation to 190 °C, residue % solids (d) symbol	68	63
Oil distillate, %, max	2	2
Distillation Residue		
Penetration, 100g, 5 sec @77 °F( 25°C)ASTM D 5	70-100	90-150
Softening point, ° C, min ASTM D 36	60	
Solubility in TCE, %, min ASTM D 2042 or D 5546	97.5	97.5
Elastic Recovery, 50 °F (10° C), %, min ASTM D 113, (e),(j)	70	58
Toughness/Tenacity, 77 °F (25° C), 50 cm/min, Nm ASTM D 5801 (f)	report 16.0/ 9.0	
Ductility, 39 °F (4° C),1cm/min, min ASTM D 113, (f)	70	

Notes:

- (a) After standing undisturbed for 24 hours, the surface will show no white, milky colored substance, but will be a smooth homogeneous color throughout.
- (b) CRS-2P, test within 20 days of shipment.
- (c) HFRS-2P, test within 20 days of shipment.

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- (d) Maximum of 374 °F (190 °C) held for 15 minutes.
- (e) Straight molds. Hold at test temperature for 90 minutes. Place in ductilometer and elongate 10 cm at 5 cm/min. Hold for 5 minutes and cut. After 1 hour retract the broken ends to touch and note elongation in cm (X). Percent Recovery = ((10-X)/10) x 100.
- (f) SBR
- (g) SBS, SB

**702.17 Crack Sealant**

**A. Type I Crack Sealant.** Conform to 705.04

**B. Type II Crack Sealant.** Provide a mixture of PG 64-22 certified binder (Supplement 1032) and polyester fibers (recycled fibers not permitted) according to the following requirements:

- Denier; ASTM D 1577\* ..... 3.0 to 6.0
- Length ..... 0.25 0.02 inch (6.35 0.51 mm)
- Crimps; ASTM D 3937 ..... None
- Tensile str, min. ASTM D2256\* ..... 70,000 psi (483 Mpa)
- Specific gravity ..... 1.32 to 1.40
- Minimum melting temperature ..... 475 °F (256 °C)
- Ignition temperature ..... 1000 °F (538 °C) min.

\* This data must be obtained prior to cutting the fibers.

The fiber and fiber manufacturer must be on the Qualified Products List.

Combine materials so the fibers are a minimum of 5.0 percent by total weight of the asphalt binder. Ensure combined materials are according to the following properties:

- Strength (at break) at 72 °F (22 °C) 350 psi (2.4 MPa) min.  
at 0 °F (-18 °C) 500 psi (3.5 MPa) min.
- Elongation (at break) at 72 °F (22 °C) 50 percent min.  
at 0 °F (-18 °C) 20 percent min.

The option for using premixed and prepackaged Type II crack sealant is permitted provided (1) the fibers and the fiber binder are according to the requirements as shown and, (2) the fiber binder is according to the manufacturer’s specifications. Furnish certified test data from the fiber binder manufacturer annually to the Laboratory, and when requested by the Laboratory. Furnish a letter of certification with each shipment stating that the material complies with specification requirements.

**C. Type III Crack Sealant.** Provide a mixture of PG 64-22 certified binder (Supplement 1032) and polypropylene fibers (recycled fibers not permitted) according to the following requirements:

- Denier; ASTM D 1577\* ..... 15 3

Length,.....	0.390.08 inch (9.91 2.0 mm)
Crimps; ASTM D 3937.....	None
Tensile strength, min, ASTM D 2256*40,000 psi (276 MPa)	
Specific gravity.....	0.910.04
Minimum melting point.....	320 °F (160 °C)

\* This data must be obtained prior to cutting the fibers.

The fiber and fiber manufacturer must be on the Qualified Products List.

Combine materials so the fibers are a minimum of 7.0 percent by total weight of the asphalt binder. Ensure combined materials are according to the following properties:

Strength (at break) at 72 °F (22 °C)	350 psi (2.4 MPa) min.
at 0 °F (-18 °C)	500 psi (3.5 MPa) min.
Elongation (at break) at 72 °F (22 °C)	50 percent min.
at 0 °F (-18 °C)	20 percent min.

**D. Type IV Crack Sealant.** Provide a prepackaged, preapproved mixture of modified binder according to the following properties and minimum 2.0 percent polyester fibers (recycled fibers not permitted) according to the following properties. Place sealant with a manufacturer's representative for the fiber binder on site to ensure proper application and conditions.

Modified binder:

Cone penetration, 77 °F(25 °C).....	50-90
Flow, 140 °F (60 °C).....	1.0 cm max
Resilience, 77 °F (25 °C).....	25-60 percent
Ductility, 77 °F (25 °C).....	40 cm min
Bond, 0 °F (-18 °C), 100 percent ext. Pass .....	5 cycles
Impact, 0 °F (-18 °C) .....	Pass
Compression recovery.....	0.40 min
Recommended pour temperature.....	380 °F (193 °C)
Safe heating temperature .....	410 °F (210 °C)

Fiber must meet requirements for Type II polyester fiber. Fiber and fiber manufacturer must be on the Qualified Products List.

Safe heating temperature .....	400 °F (204 °C)
Softening point .....	190 °F (88 °C)
Viscosity, 400° F(225 °C).....	3000 cp min
Cone penetration, 77 °F(25 °C).....	25-45
Workability	Capable of being melted and applied through a pressure feed, indirect heated and agitated melter
Flexibility* .....	Pass

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\* 1 inch (25mm) sample at -20 °F(-30 °C), 90 degree bend, 10 sec

Crack sealant and crack sealant manufacturer must be on the Qualified Products List

703 AGGREGATE

703.01 General.

The following abbreviations apply:

CCS	Crushed Carbonate Stone.
ACBFS	Air Cooled Blast Furnace Slag
GS	Granulated Slag
RACP	Reclaimed Asphalt Concrete Pavement
RPCC	Recycled Portland Cement Concrete
OH	Open Hearth Slag
EAF	Electric Arc Furnace Slag
BOF	Basic Oxygen Furnace Slag
PCS	Petroleum Contaminated Soil

A. **Soundness.** When the major portion of the unsound material in a coarse aggregate acquires a mud-like condition when tested for soundness, ensure that the maximum loss for all uses is 5 percent.

B. **Stockpiles.** Use stockpiling and loading methods that permit ready identification of the aggregates and to minimize segregation. Clean the sites for stockpiles before storing materials. Do not remove aggregates from stockpiles within 1 foot (0.3 m) of the ground until final cleanup of the work. Do not use material that has become mixed with foreign matter, wood or other size or grades of aggregates.

Handle aggregates in such a manner that the moisture content is reasonably uniform for each day's run.

C. **Size.** Provide aggregate according to the size specified in the material specification, the construction item, or as shown in AASHTO M 43.

D. **Method of Test.** Provide aggregate tested by the following methods:

Amount finer than No. 200 (75 µm) sieve.....	S1004
Clay lumps .....	S1017
Coal and lignite .....	AASHTO T 113
Crushed pieces .....	ASTM D 5821
Deleterious materials.....	S1029
Effect of organic impurities on strength of mortar .....	AASHTO T 71
Liquid limit .....	AASHTO T 89
Percent of wear, Los Angeles abrasion test.....	AASHTO T 96 or ASTM C 535
Plasticity index.....	AASHTO T 90
Sieve analysis .....	S1004, S1005
Sieve analysis of mineral filler.....	AASHTO T 37

Sodium sulfate soundness test, 5 cycle .....	AASHTO T 104
Specific Gravity and percent absorption for fine and coarse aggregate .....	S1031
Unit weight .....	AASHTO T 19
Lightweight chert in aggregates.....	AASHTO T 113
Sand equivalent.....	AASHTO T 176
Uncompacted void content .....	AASHTO T 304
Flat and elongated.....	ASTM D 4791
Rapid freezing and thawing ....	ASTM C 666, Procedure B
Insoluble residue of carbonate aggregates .....	ASTM D 3042
Compaction testing of Unbound Materials .....	S1015
In place gradation sampling .....	S1090
Sulfur leachate test.....	S1027
Soundness of aggregate by freezing and thawing.....	AASHTO T 103
Micro-Deval.....	AASHTO T 327
Silicon Dioxide.....	ASTM C 146
Sodium sulfate soundness test, Rock slabs.....	ASTM D 5240

**E. Steel Slag Aggregate.** Provide open-hearth (OH), basic oxygen furnace (BOF), and electric arc furnace (EAF) steel slag aggregate (known as steel slag) according to the following requirements when 703.04 aggregate for asphalt concrete base or 703.05 aggregate for asphalt intermediate course is specified. Do not use OH, BOF, or EAF slag as the fine or coarse aggregate (virgin or recycled) for asphalt surface courses.

Supply all steel slag from sources according to Supplement 1071. Furnish steel slag to a size meeting the specified grading requirements. Provide steel slag aggregate meeting the specified coarse or fine aggregate quality requirements. Ensure that measurements of soft pieces includes soft lime, lime oxide, or magnesia agglomerations or any foreign materials prone to rapid disintegration under construction processing and weathering conditions. Ensure that additional testing beyond those listed are performed or required any time poor quality steel slag is suspected due to visual inspection, testing, or field performance problems.

Provide a letter of certification to the Engineer from the steel slag processor for every shipment of steel slag to the Contractor. In addition the steel slag processor must provide the Engineer with the following:

Quality control records (created in accordance with Supplement 1071).

Documentation of the steel slag production, processing, and stockpile retrieval

Failure to follow the processor QC plan or continued problems with performance recognized by the Laboratory attributable to steel slag is cause for limiting steel slag use from that processor.

**F. Restrictions.** When an aggregate source is specially designated with a “SR or SRH” according to *Guidelines for Maintaining Adequate Pavement Friction in*

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*Surface Pavements*, the aggregate source will be restricted for use in surface pavement according to the methods in the guidelines. The document, *Guidelines for Maintaining Adequate Pavement Friction in Surface Pavements*, is available on the OMM website under “Material Information by Category, Aggregate”, or the Office of Pavement Engineering’s website.

TABLE 703.01-1 SIZE OF COARSE AGGREGATE (AASHTO M 43)

Size No.	Nominal size <sup>[1]</sup> square openings		Amounts finer than each laboratory sieve (square openings), percent by weight													No. 100	No. 50	No. 16	No. 8	No. 4	No. 3/8 in.	1/2 in.	3/4 in.	1 in.	1 1/2 in.	2 in.	2 1/2 in.	3 in.	3 1/2 in.	4 in.							
	inch	mm	100 mm	90 mm	90 to 100	75 mm	63 mm	50 mm	37.5 mm	30 mm	25 mm	19 mm	15 mm	12.5 mm	9.5 mm	4.75 mm	3/8 in.	1/2 in.	3/4 in.	1 in.	1 1/2 in.	2 in.	2 1/2 in.	3 in.	3 1/2 in.	4 in.	100 mm	300 μm	150 μm								
1	3 1/2 to 1 1/2	90 to 37.5	100	90 to 100																																	
2	2 1/2 to 1 1/2	63 to 37.5																																			
24	3 1/2 to 3/4	63 to 19																																			
3	2 to 1	50 to 25																																			
357	2 to No. 4	50 to 4.75																																			
4	1 1/2 to 3/4	37.5 to 19																																			
467	1 1/2 to No. 4	37.5 to 4.75																																			
5	1 to 1/2	25 to 12.5																																			
56	1 to 3/8	25 to 9.5																																			
57	1 to No. 4	25 to 4.75																																			
6	3/4 to 3/8	19 to 9.5																																			
67	3/4 to No. 4	19 to 4.75																																			
68	3/4 to No. 8	19 to 2.36																																			
7	1/2 to No. 4	12.5 to 4.75																																			
78	1/2 to No. 8	12.5 to 2.36																																			
8	3/8 to No. 8	9.5 to 2.36																																			
89	3/8 to No. 16	9.5 to 1.18																																			
9	No. 4 to 16	4.75 to 1.18																																			
10	No. 4 to 0 <sup>[2]</sup>	4.75 to 0 <sup>[2]</sup>																																			

[1] Numbered sieves are those of the United States Standard Sieve Series.

[2] Screenings.

Where standard size of coarse aggregate designated by two or three digit numbers are specified, obtain the specified gradation by combining the appropriate single digit standard size aggregates by a suitable proportioning device which has a separate compartment for each coarse aggregate combined. Perform the blending as directed by the Laboratory.

**703.02 Aggregate for Portland Cement Concrete.**

**A. Fine Aggregate.**

1. Provide fine aggregate consisting of natural sand or sand manufactured from stone.
2. Sieve analysis.

Sieve Size	Total Percent Passing
3/8 inch (9.5 mm)	100
No. 4 (4.75 mm)	95 to 100
No. 8 (2.36 mm)	70 to 100
No. 16 (1.18 mm)	38 to 80
No. 30 (600 μm)	18 to 60
No. 50 (300 μm)	5 to 30
No. 100 (150 μm)	0 to 10
No. 200 (75 μm)	0 to 5

Should the fineness modulus of a job control sample of sand from any source vary by more than 0.20 percent from that of the representative sample from that source, the sand may be rejected.

3. Physical properties.

	Maximum
Loss, sodium sulfate soundness test	
Item 305	12 %
Items 255, 256, 451, 452, 511, 515, 519, 526, 602, 603, 604, 608, 609, 610, 622, and 625	10 %
Aggregations of soil, silt, etc. by weight	0.5 %

When tested for the effect of organic impurities on strength of mortar, ensure that the compressive strength at 3 and 7 days of mortar made with untreated sand is not less than 95 percent of the compressive strength of mortar made with treated sand.

Provide fine aggregate for Items 255, 256, 451, 452, 526, and 511 deck slabs with at least 25 percent siliceous particles as determined by the acid insoluble residue test [ASTM D3042]. Ensure material has been tested and results are on file at the Laboratory. For sources not tested and on file at the laboratory, submit certified test data from an AMRL accredited independent laboratory verifying the minimum 25 percent.

**B. Coarse Aggregate.**

1. Provide coarse aggregate consisting of washed gravel, CCS, or crushed ACBFS.

## 2. Physical properties.

Percent of wear, Los Angeles test, maximum (CCS or washed gravel)	40 %
Unit weight, compacted, minimum (slag)	70 lb/ft <sup>3</sup> (1120 kg/m <sup>3</sup> )
Loss, sodium sulfate soundness test, maximum:	
Item 305	15 %
Items 255, 256, 451, 452, 511, 519, 526, 602, 603, 604, 609, 610, 622, and 625	12 %
Item 515	10 %

Deleterious substances shall not exceed the following:

Material Type	Percent by Weight	
	Super- Structure	All Other Concrete
Soft pieces	2.0	3.0
Coal and lignite	0.25	1.0
Clay lumps	0.25	0.25
Pieces having a length greater than 5 times the average thickness	15	15
Shale and shaly material	0.5	1.0
Limonitic concretions	0.5	1.0
Alkali	0.5	1.0
Metallic particles	0.5	1.0
Chert, that disintegrates in 5 cycles of the soundness test	0.5	1.0

3. Amount passing the No. 200 (75  $\mu$ m) sieve. Ensure that the percent by weight of material passing the No. 200 (75  $\mu$ m) sieve in the aggregate portion of the concrete mix does not exceed the following:

Material Type	Percent by Weight	
	Super- Structure	All Other Concrete
CCS and crushed ACBFS	3.4	3.8
Washed gravel	2.0	2.2

### 703.03 Fine Aggregate for Mortar or Grout.

A. Provide fine aggregate consisting of natural sand or sand manufactured from stone or ACBFS.

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**B. Sieve Analysis.**

Sieve Size	Natural Sand	Manufactured Sand
	Total Percent Passing	
No. 4 (4.75 mm)	100	100
No. 8 (2.36 mm)	95 to 100	95 to 100
No. 50 (300 μm)	10 to 40	20 to 40
No. 100 (150 μm)	0 to 15	10 to 25
No. 200 (75 μm)	0 to 5	0 to 10

**C. Physical properties.**

	Maximum
Loss, sodium sulfate soundness test	10 %
Aggregations of soil, silt, etc. by weight	0.5 %

When tested for the effect of organic impurities on strength of mortar, ensure that the compressive strength of mortar made with untreated sand is not less than 95 percent of the compressive strength of mortar made with treated sand.

**703.04 Aggregate for Asphalt Concrete Base (301 and 302).**

**A.** Provide coarse aggregate for asphalt concrete base used in combination with rigid pavement consisting of CCS, gravel, or crushed ACBFS.

Provide coarse aggregate for asphalt concrete base used in flexible pavements consisting of CCS, gravel (see note [1] in table below), or crushed ACBFS. Provide fine aggregate for asphalt concrete base consisting of natural sand or sand manufactured from stone, gravel, or ACBFS. Crushed Steel Slag (OH, EAF or BOF) conforming to 703.01.E and 401.03 may be used for coarse and fine aggregate in asphalt concrete base used in flexible pavements.

**B. Physical properties.**

Percent of wear, Los Angeles test, maximum (CCS or washed gravel)	50 %
Unit weight, compacted, minimum (slag)	65 lb/ft <sup>3</sup> (1040 kg/m <sup>3</sup> )
Loss, sodium sulfate soundness test, maximum	15 %
Percent by weight of fractured pieces (one or more faces), minimum	40 %
Micro-Deval Abrasion Loss test, maximum (for coarse aggregate gravel only)	22 % [1]

[1] If the MD value is greater than the specification limit conform to Supplement 1010.

Deleterious substances shall not exceed the following:

703.05	
Material Type	Percent by Weight
Soft pieces	3.0
Coal and lignite	1.0
Clay lumps	0.25
Pieces having a length greater than 15 5 times the average thickness	
Shale and shaly material	2.5
Chert that disintegrates in 5 cycles of the soundness test	2.5

**703.05 Aggregate for Asphalt Concrete** (Intermediate and Surface Courses), Prime Coat (408), Chip Coat (422), and Microsurfacing (421).

**A. Fine Aggregate.**

1. Provide fine aggregate consisting of natural sand or sand manufactured from stone, gravel, ACBFS or, for intermediate courses only, steel slag (OH, EAF or BOF) conforming to 703.01.E and 401.03.

2. Sieve analysis.

Sieve Size	Total Percent Passing
3/8 inch (9.5 mm)	100
No. 4 (4.75 mm)	90 to 100
No. 8 (2.36 mm)	65 to 100
No. 16 (1.18 mm)	40 to 85
No. 30 (600 µm)	20 to 60
No. 50 (300 µm)	7 to 40
No. 100 (150 µm)	0 to 20
No. 200 (75 µm)	0 to 10

3. Physical properties.

	Maximum
Loss, sodium sulfate soundness test	15 %
Aggregations of soil, silt, etc., by weight	0.5 %

**B. Coarse Aggregate.**

1. Provide coarse aggregate consisting of CCS, crushed ACBFS, washed gravel, or for intermediate courses only, steel slag (OH, EAF or BOF) conforming to 703.01.E and 401.03.

2. Physical properties.

703.06

Percent of wear, Los Angeles test, maximum (CCS or washed gravel)	40 %
Unit weight, compacted, minimum (slag): Asphalt Concrete, 408 and 422	70 lb/ft <sup>3</sup> (1120 kg/m <sup>3</sup> )
Loss, sodium sulfate soundness test, maximum: Asphalt Concrete and 422	12 %
421	15 %
Percent by weight of fractured pieces (one or more faces), minimum	40 %
Micro-Deval Abrasion Loss test, maximum (for gravel only)	20 % <sup>[1]</sup>
[1] If the MD value is greater than the specification limit conform to Supplement 1010.	

Deleterious substances shall not exceed the following:

Material Type	Percent by Weight
Soft pieces	3.0
Coal and lignite	1.0
Clay lumps	0.25
Amount finer than No. 200 (75 µm) sieve	3.0
Pieces having a length greater than 5 times the average thickness	15
Shale and shaly material	2.5
Limonitic concretions	2.5
Alkali	2.5
Chert that disintegrates in 5 cycles of the soundness test	2.5

**C. General Requirements for Fine Aggregate.** For fine aggregate calculate each individual sieve fraction soundness loss and ensure that the fractional size does not exceed 13.0 percent for all surface courses, intermediate courses and any asphalt concrete course directly below an open graded friction course.

**703.06 Sand Cover (407 and 408).**

A. Furnish sand cover consisting of natural sand or sand manufactured from stone or ACBFS.

B. Sieve analysis.

Sieve Size	Total Percent Passing
No. 4 (4.75 mm)	90 to 100
No. 50 (300 µm)	7 to 40
No. 200 (75 µm)	0 to 10

**703.07 Mineral Filler.**

A. Furnish mineral filler consisting of limestone dust, portland cement, or other inert mineral matter. Ensure the mineral filler is thoroughly dry and free from lumps.

B. Sieve analysis.

Sieve Size	Total Percent Passing
No. 30 (600 $\mu$ m)	100
No. 50 (300 $\mu$ m)	95 to 100
No. 200 (75 $\mu$ m)	65 to 100

**703.08 Granulated Slag.**

A. Furnish Granulated Slag (GS) consisting of glassy, granular materials formed when molten blast furnace slag or electric-furnace slag is rapidly chilled, as by immersion in water. The Department may reject material containing mill waste, cinders, large pieces of ungranulated slag, or other matter foreign to the production of slag in the normal operation of the blast furnace or electric furnace.

Furnish material of such nature that it will compact to the satisfaction of the Engineer.

B. Sieve analysis.

Sieve Size	Total Percent Passing
2 inch (50 mm)	100
1 inch (25 mm)	85 to 100
No. 100 (150 $\mu$ m)	0 to 15

**703.10 Screenings.**

A. Furnish screenings for No. 10 size gravel, stone, or ACBFS. Where crushed material is specified, ensure that it is crushed from material larger than the 1/2-inch (12.5 mm) sieve.

B. Physical properties.

	Maximum
Loss, sodium sulfate soundness test	15 %

**703.11 Structural Backfill for 603 Bedding and Backfill.** Furnish structural backfill for 603 bedding and backfill consisting of CCS, gravel, natural sand, sand manufactured from stone, foundry sand, ACBFS, GS, or RPCC.

Furnish ACBF Slag according to Supplement 1027.

Furnish granulated slag according to 703.08.

Do not use GS for Type 3 Structural Backfill.

The use of RPCC is permitted without wear testing or sodium soundness testing requirements if the Contractor provides information proving the material met this specification at the time of its original incorporation. The use of RPCC is not

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permitted in conjunction with aluminum pipe or aluminum coated steel pipe. Ensure that the RPCC use does not contain more than two percent steel.

Reclaimed asphalt concrete is not allowed for any bedding or backfill materials.

Use foundry sand if the material meets these requirements and meets the requirements of the Ohio EPA, Division of Surface Water, Policy 400.007 "Beneficial use of Non-Toxic Bottom Ash, Fly Ash and Spent Foundry Sand and Other Exempt Waste," and all other regulations. Ten days before using foundry sand on the project, submit written permission from the Ohio EPA to the Engineer. Instead of written permission from the Ohio EPA, the Contractor may elect to have an independent consultant pre-qualified by ODOT in remedial design environmental site assessment review the proposed usage. The consultant will provide all documentation utilized to ensure that the proposed usage is according to all Ohio EPA regulations. Ensure that the consultant coordinates all EPA required meetings, documentation, and testing requirements. Ensure that the consultant certifies this to the Department.

**A. Structural Backfill Type 1 and 3.**

1. Furnish Type 1 structural backfill that meets the gradations of Items 304, 411, or 617, except 0 to 20 percent may pass the No. 200 sieve. Furnish Type 3 structural backfill that meets the gradations of Size No. 57 or 67 from Table 703.01-1.

2. Physical properties.

Percent of wear, Los Angeles test, maximum (CCS or washed gravel)	50 %
Loss, sodium, sulfate soundness test, maximum	15 %
Percent by weight of fractured pieces (one or more faces), minimum (Type 3 only)	90 %

Deleterious substances shall not exceed the following:

Material Type	Percent by weight
Shale and shaly material	5.0
Chert, that disintegrates in 5 cycles of the soundness test	5.0

Ensure that the portion of the material passing through the No. 40 (425 μm) sieve has a maximum liquid limit of 25 and a maximum plasticity index of 6.

Crush gravel for Type 3 from material retained on the 1/2 inch (12.5 mm) sieve.

**B. Structural Backfill Type 2.**

1. Furnish Type 2 structural backfill that meets the gradations of 703.05.A, 703.02.A, or one of the gradations below:

Sieve Size	Total Percent Passing	
2 1/2 inch(63 mm)	–	100
1 inch (25.0 mm)	–	70 to 100
3/4 inch (19.0 mm)	100	–
3/8 inch (9.5 mm)	80 to 100	–
No. 4 (4.75 mm)	60 to 100	25 to 100
No. 8 (2.36 mm)	45 to 95	–
No. 40 (425 μm)	–	10 to 50
No. 50 (300 μm)	7 to 55	–
No. 200 (75 μm)	0 to 15	5 to 15

2. Physical properties:

Percent of wear, Los Angeles test, maximum (CCS or gravel)	50 %
Loss, sodium sulfate soundness test, maximum	15 %

Ensure that the portion of the material passing through the No. 40 (425 mm) sieve has a maximum liquid limit of 25 and a maximum plastic index of 6.

**703.13 Coarse Aggregate for Items 305, 451 and 452.** In addition to the requirements of 703.02, the following aggregate requirements apply.

When the total combined quantity of the listed items is greater than 10,000 square yards (8000 m<sup>2</sup>), provide size No. 57 or 67 from Table 703.01-1. If the total combined quantity of the listed items is less than 10,000 square yards (8000 m<sup>2</sup>), then provide one of the following sizes from Table 703.01-1: No. 7, 78, 8, 57, or 67.

If gravel or limestone No. 57 or 67 size is selected in either of the above cases, then ensure that the coarse aggregate incorporated into the concrete is tested according to ASTM C 666, Procedure B. Ensure that the area generated under the curve obtained by plotting the expansions of test specimens versus the number of test cycles does not exceed 2.05 at 350 or less cycles.

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Ensure that the validity of results of freeze thaw-resistance testing is as outlined below:

<b>Range of Area under Curve<sup>[1]</sup></b>	<b>Status of Source Approval</b>
0.00 to 1.00	Valid for two years from date approved <sup>[2]</sup>
1.01 to 2.05	Valid for one year from date approved <sup>[2]</sup>
2.06 to 4.00	Not Approved, one retest allowed <sup>[3]</sup>
> 4.00	Not Approved, no retesting allowed <sup>[3]</sup>

[1] As measured at 350 cycles.

[2] If a notable change in the properties of the aggregate originating from the affected source is determined from quality control testing, a retest of freeze-thaw resistance may be requested before the original expiration date. The Laboratory will make the determination to retest.

[3] Except as noted, the Department will not retest the material unless the producer of the material sends a written request to the Department with substantiation that significant changes in operation have been made (e.g., new processing equipment, material from a new ledge, etc.).

The Laboratory will maintain a list of approved sources.

**703.14 Non Pavement Open-Hearth, Electric Arc Furnace, and Basic Oxygen Furnace Steel Slag Aggregate Use.** Provide steel slag according to the following requirements.

**1. Non-confined Applications.** When using OH, EAF, and BOF slag in applications where the steel slag will not be confined, ensure that the slag meets the requirements in 703.14.A (deleterious substances and crushing), and in 703.14.B (aging and stockpiling requirements). Recycled OH, EAF, or BOF slag from Department or non-Department projects may be used in applications where the recycled steel slag will not be confined.

**2. Confined Applications.** When using OH slag in applications where the OH slag will be confined, ensure the OH slag meets all requirements of 703.14. The use of recycled OH slag from Department or non-Department projects is not allowed in confined applications. Do not use BOF and EAF slag in applications where the BOF and EAF slag will be confined. However, BOF and EAF slag may be used for embankment material when blended in accordance with 703.16.

**A. Deleterious Substances (soft pieces).** Deleterious substances include soft lime, lime oxide, or magnesia agglomerations or any foreign materials prone to rapid disintegration under construction processing and weathering conditions.

Furnish steel slag with less than 3 percent deleterious substances (soft pieces) by weight. The Department will use Supplement 1029 (hand crushing of soft pieces) to determine the soft pieces.

Crushing of OH or BOF slag is not allowed.

**B. Aging and Stockpiling Requirements.** Stockpile and age all steel slag as follows:

1. Grade and stockpile the material into maximum size piles of 25,000 ton (23,000 metric tons). Before and during the stockpiling operation, add water to these materials to provide a uniform moisture content not less than their absorbed

moisture. Ensure that the stockpile is maintained in a moist condition during the required stockpiling period.

2. Ensure that the producer mixes the stockpile when the outside surface of the pile has crusted over. The Department will inspect the stockpile every 2 months to ensure no crusting occurs. Do not mix frozen stockpile material. Suspend the aging period when the stockpile is frozen for more than one month.

3. Ensure that this aging period is at least 6 months in duration and starts over if any new material is added to the pile during the aging period.

**C. Identification of OH Slag.** Clear, definitive, and undisputable identification of the OH slag is required.

The producer will show the Department evidence that the material supplied is OH slag. This information will consist of, but is not limited to, the following:

1. Steel producer.
2. Production dates.
3. Production rates.
4. Stockpiling dates.
5. Type of steel produced.
6. All known Department and non-Department projects where the material was previously used.

This identification of OH slag may be supplemented by other information approved by the Department or by using 10 years of good performance data. Ensure that the producer submits to the Department projects where the OH slag has been used without expansion or tufa problems. The Department will review the above projects as part of the identification approval process.

All OH slag not identified as OH slag will be considered BOF slag unless otherwise identified.

**D. Tufa Performance Verification of OH Slag.** Tufa is a precipitate form of calcium carbonate that can clog up the underdrain systems. Some OH slag sources clog up underdrain systems and some do not. Tufa performance verification is based on field performance and Department's inspection of the underdrain systems.

Tufa performance verification is required.

Ensure that the producer submits past projects that are at least 10 years old that used the proposed OH slag source to the Department. Ensure that the producer supplies the Department with construction plans with the underdrains and underdrain outlets marked on the plans, or other suitable method, approved by the Department, showing the underdrain system. Ensure that the producer marks the underdrain outlets in the field for inspection. The Department will inspect the underdrain systems for tufa deposits. If tufa deposits are found in the outlets or in the underdrain system, the Department will reject the OH slag source.

**E. Expansion Testing of OH Slag.** After the aging and stock piling requirements are met, expansion testing is required for OH Slag.

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Perform expansion testing according to Pennsylvania Department of Transportation PTM No. 130, the ODOT equivalent to this test or expansion testing acceptable to the Department.

Ensure that the producer hires an independent AASHTO accredited and Department approved laboratory to perform at least half of the expansion testing. At the producer's option, up to half of the required expansion testing may be performed by the producer's laboratory. The Laboratory will observe the expansion testing and approve each independent and producer laboratory.

Perform expansion testing for every 2500 tons (2300 metric tons) or fraction thereof of the material supplied.

The maximum allowable total expansion for each test is less than 0.50 percent. If any one test fails in the stockpile, the Department will reject the entire stockpile.

When sampling for expansion, ensure that the producer notifies the Department at least 48 hours before the sampling. The Department will verify that the sample came from the correct stockpile and take independent split samples, if required.

Submit the expansion test data and a suitably presented summary of the expansion test data to the Department for approval. The Department reserves the right to perform independent testing to verify the laboratory results at any time.

The Department expansion test data takes precedence over the producer or independent laboratory expansion testing results in the event of a conflict. The Department will make the final determination on all conflicting data.

If the material fails the expansion testing, then stockpile the material for a minimum of 2 additional months from the date of last sampling and retest for expansion. Only materials that pass the expansion test are approved for use.

**703.18 Suitable Materials for Embankment Construction.** Natural soil, natural granular material, granular material types, slag material, brick, shale, rock, random material, RACP, RPCC, or PCS as further defined below are suitable for use in embankment construction. The Engineer will submit samples of soils not identified from the plan subsurface investigation, from borrow sources or materials appearing questionable in the field.

Furnish ACBFS according to Supplement 1027.

Furnish RPCC with the reinforcing steel cut to a maximum length of 1 inch (25 mm) outside the pieces.

Ensure that pieces of RACP do not exceed 4 inches (100 mm) in the largest dimension.

Furnish OH, EAF, and BOF slag that are blended and according to 703.14. Furnish OH slag, EAF slag, BOF slag, RPCC, and RACP that are completely blended with natural soil or natural granular material as follows:

1. When using RACP, OH slag, or RPCC, make at least 30 percent of the blend natural soil or natural granular materials.

2. When using BOF or EAF slag, make at least 50 percent of the blend natural soil or natural granular material.

When using coal, completely blend it with natural soil or natural granular materials. Make at least 90 percent of the blend natural soil or natural granular materials.

**A. Natural Soils.** Furnish natural soils as defined in 203.02.I and classified as Department Group Classifications A-4-a, A-4-b, A-6-a, A-6-b, and A-7-6 as further defined below: Furnish soils with a maximum dry density of at least 90 pounds per cubic foot ( $1450 \text{ kg/m}^3$ ).

Do not use soils having a liquid limit in excess of 65 or soils identified as Department Group Classifications A-5, or A-7-5 in the work.

**B. Granular Embankment Materials.** Furnish natural granular materials as defined in 203.02.H and classified as Department Group Classifications A-1-a, A-1-b, A-3, A-3-a, A-2-4, A-2-6, or A-2-7.

Do not use granular material classified as A-2-5.

**C. Granular Material Types.** Furnish CCS, gravel, ACBFS, durable sandstone, durable siltstone, GS, or blended natural soil or natural granular materials blended with OH, BOF, EAF, or RPCC as detailed above. Furnish durable sandstone and siltstone with a slake durability index greater than 90 percent according to ASTM D 4644.

Except for GS, furnish the following gradations for the granular material types, by weight:

1. Granular Material, Type A. Furnish material having less than 25 percent by weight of the grains or particles passing the No. 200 ( $75 \mu\text{m}$ ) sieve.

2. Granular Material Type B. For Item 204, furnish the gradation of Items 304, 411, or 617. For Item 203, furnish the gradation of Items 304, 411, or 617 except 0 to 20 percent will be allowed to pass the No. 200 ( $75 \mu\text{m}$ ) sieve.

3. Granular Material Type C. Furnish well graded material that meets the following gradation:

Sieve Size	Total Percent Passing
3 inch (75 mm)	100
2 inch (50 mm)	70 to 90
1/2 inch (12.5 mm)	30 to 60
No. 200 ( $75 \mu\text{m}$ )	0 to 13

4. Granular Material Type D. Furnish the gradation of 100 percent passing the 8 inch (200 mm) sieve, less than 60 percent passing the 3 inch (76 mm) sieve, less than 40 percent passing the 3/4 inch (19 mm) sieve, and 0 to 20 percent passing the No. 200 ( $75 \mu\text{m}$ ) sieve.

5. Granular Material Type E. Furnish any of the coarse aggregates from No. 1 through 67 inclusive on Table 703.01-1.

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6. Granular Material Type F. Furnish material according to the following:
  - a. Well graded material.
  - b. A gradation with a top size from 8 inches (200 mm) to 3 inches (76 mm) and a bottom size of No. 200 (75  $\mu$ m) sieve.
  - c. An evenly graded material between the top and bottom size.
  - d. Compactable, stable, and serves the intended use.

**D. Shale.** Furnish shale as defined in 203.02 and as further defined below. Ensure that the shale is tested for durability to determine whether the shale is hard or soft shale. The Engineer will field test the shale according to the following:

1. The Engineer will obtain a typical 6-inch (150 mm) diameter piece of shale. If a 6-inch (150 mm) diameter sample cannot be obtained, then the shale is soft shale.

2. The Engineer will place the shale in a bucket of water. The Engineer will examine the deterioration or slaking after 48 hours.

3. After 48 hours if the material has not deteriorated, then the shale will be broken down by hand pressure. If the material retained on the 3/4 inch (19.0 mm) sieve is 75 percent or less, then the shale is soft shale.

4. If more than 75 percent of the shale is retained on the 3/4 inch (19.0 mm) sieve or if the material does not deteriorate, then the shale will be field tested for hardness. The field test for hardness will consist of compacting the shale with a steel drum roller with a minimum compressive force of 500 pounds per lineal inch (57 kN/mm) of roller drum width. Provide documentation to the Engineer to verify the steel drum meets the compressive force requirements.

- a. If more than 40 percent of the shale breaks down, by visual inspection, with six complete passes with a steel drum roller, then the shale is soft shale.
- b. If less than 40 percent of the shale breaks down with six complete passes with a steel drum roller, by visual inspection, the shale is hard shale.

**703.19 Aggregate Materials for 304.** Furnish aggregate that is CCS, crushed gravel, crushed ACBFS, GS, or OH slag.

Furnish GS according to the requirements of 703.08.

Furnish OH slag according to 703.14

Furnish ACBFS according to Supplement 1027.

Determine aggregate acceptance before incorporation into the work based on samples taken from stockpiles.

A. Furnish CCS, crushed gravel, crushed ACBFS, and OH slag that meets the following gradation:

Sieve Size	Total Percent Passing
2 inch (50 mm)	100
1 inch (25.0 mm)	70 to 100
3/4 inch (19.0 mm)	50 to 90
No. 4 (4.75 mm)	30 to 60
No. 30 (600 $\mu$ m)	9 to 33
No. 200 (75 $\mu$ m)	0 to 15 <sup>[1]</sup>
[1] Furnish OH slag that has 0 to 10 percent passing through the No. 200 (75 $\mu$ m) sieve	

Furnish gravel used under Item 304 that is crushed from material retained on the 1/2 inch (12.5 mm) sieve.

B. Furnish CCS, crushed gravel, ACBFS, and OH slag that meets the physical property requirements:

Percent of wear, Los Angeles test, maximum (CCS or crushed gravel)	50 %
Loss, sodium sulfate soundness test, maximum	15 %
Percent by weight of fractured pieces (one or more faces), minimum	90 % <sup>[1]</sup>
[1] Does not apply to OH slag	

Ensure deleterious substances in CCS, crushed gravel, and ACBFS do not exceed the following:

Material Type	Percent by weight
Shale and shaly material	5.0
Chert, that disintegrates in 5 cycles of the soundness test	5.0

Except for GS, ensure that the portion of the material passing through the No. 40 (425  $\mu$ m) sieve has a maximum liquid limit of 25 and a maximum plasticity index of 6.

**703.1: Materials for Items 410, 411, and 617.** Furnish CCS, gravel, ACBFS, GS, OH slag, BOF slag, EAF slag, RPCC, or RACP for materials.

If RPCC and RACP are used, provide the following information:

1. Specification item that the material was originally constructed under.
2. The applicable material requirements of the original construction item.

If the original construction requirements meet or exceed the requirements of this specification, then the shale, sodium soundness and Los Angeles abrasion test for RACP and RPCC may be waived. The plastic index and clay requirements are not required for RACP. Use RPCC that is free of steel.

**703.1:**

Furnish OH, BOF, and EAF slag according to 703.14

Use ACBFS according to Supplement 1027.

Furnish GS according to 703.08.

**A. Gradations.** Furnish for Items 617, 410, and 411 RACP materials according to the following gradation:

Sieve Size	Total Percent Passing
1 1/2 inch(37.5 mm)	100
3/4 inch (19.0 mm)	80 to 100
3/8 inch (9.5 mm)	60 to 90
No. 4 (4.75 mm)	30 to 90
No. 30 (600 μm)	3 to 20

Except for GS and RACP, use the following gradations for Items 410, 411, and 617.

Furnish materials for Item 410 according to one of the following gradations:

Sieve Size	Type A	Type B	Type C
	Total Percent Passing		
1 1/2 inch(37.5 mm)	100	100	Size
1 inch (25.0 mm)	90 to 100	75 to 100	No. 4 or 57
3/4 inch (19.0 mm)	60 to 100	60 to 100	from
3/8 inch (9.5 mm)	40 to 60	35 to 75	Table
No. 4 (4.75 mm)	15 to 30	30 to 60	703.01-1

Do not use RACP for Type C material.

Furnish materials for Item 411 according to the following gradation:

Sieve Size	Total Percent Passing
1 1/2 inch(37.5 mm)	100
1 inch (25.0 mm)	75 to 100
3/4 inch (19.0 mm)	60 to 100
3/8 inch (9.5 mm)	35 to 75
No. 4 (4.75 mm)	30 to 60
No. 30 (600 μm)	7 to 30
No. 200 (75 μm)	3 to 15

Furnish materials for Item 617 according to the following gradation:

Sieve Size		Total Percent Passing
1 inch	(25.0 mm)	100
3/4 inch	(19.0 mm)	60 to 100
3/8 inch	(9.5 mm)	35 to 75
No. 4	(4.75 mm)	30 to 60
No. 30	(600 μm)	9 to 33
No. 200	(75 μm)	0 to 15

## B. Physical properties.

	Item 410	Item 411	Item 617
Percent of wear, Los Angeles test, maximum	50 %	–	–
Loss, sodium sulfate soundness test, maximum	–	15 %	–
Percent by weight of fractured pieces (one or more faces), minimum	–	–	90 %
Gravel used, portion retained on a No. 4 (4.75 mm) sieve (one or more faces) minimum crushed	–	40 %	–
Maximum plasticity index of material passing No. 40 (425 μm) sieve	–	6	–

Deleterious substances shall not exceed the following:

Material Type	Percent by weight		
	Item 410	Item 411	Item 617
Shale and shaly material	–	5 % <sup>[1]</sup>	12 %
Clay	10 %	–	–

[1] Where the major portion of the material in a coarse aggregate, from a source on record at the Laboratory, has shown the characteristics of acquiring a mud-like condition when tested for soundness, test it for soundness and ensure that the maximum loss is 5 percent.

## 703.1; Rock and Aggregate Materials for Item 601.

A. Crushed Aggregate Slope Protection and Filter Aggregate for Dump **Rock Fill**. Furnish crushed gravel, limestone, sandstone, RPCC, ACBFS, OH slag, BOF slag, or EAF slag for crushed aggregate slope protection and filter aggregate for dump rock fill.

Use ACBFS slag according to Supplement 1027.

Use OH, BOF, and EAF slag according to 703.14

**703.3;**

Furnish Size No. 1 or 2 from Table 703.01-1, or according to the following gradation for crushed aggregate slope protection:

Sieve Size	Total Percent Passing
4 inch (100 mm)	100
3 1/2 inch(90 mm)	90 to 100
2 1/2 inch(63 mm)	25 to 90
1 1/2 inch(37.5 mm)	0 to 25
3/4 inch (19.0 mm)	0 to 10

For a filter for rock channel protection, use Size No. 3 or 4 from Table 703.01-1.

Physical properties.

Percent of wear, Los Angeles Test, maximum (CCS or gravel)	50 %
Loss, sodium sulfate soundness test, maximum (except for RPCC)	15 %
Percent by weight of fractured pieces minimum (CCS or gravel)	90 %
Loss for RPCC, AASHTO T 103 Soundness of Aggregates by Freezing and Thawing	20 % <sup>[1]</sup>

[1] Use Method C using 25 cycles.

**B. Dumped Rock Fill and Rock Channel Protection.** Furnish gravel, broken recycled portland cement concrete (RPCC), broken sandstone, broken siltstone, and broken limestone for dumped rock fill and rock channel protection. Furnish sandstone, siltstone, and limestone that is free of laminations, seams, and fractures, or injury due to blasting.

Except for RPCC, test for soundness according to ASTM D 5240. Use materials having a maximum 30 percent single slab loss and a maximum 20 percent cumulative loss. Slab heights and lengths will be a minimum of 8 inches. For RPCC, test for soundness according to AASHTO T 103 as stated in 703.18.A.

The Department may waive testing when the stone source has a known durability history.

Do not use thin, slab-like pieces, or any pieces having a dimension larger than 36 inches (1 m). Do not use RPCC with reinforcing steel protruding more than 1 inch (25 mm) beyond the outside surface of the concrete pieces.

Furnish dumped rock fill and rock channel protection materials consisting of the four material types defined below:

1. Type A material has at least 85 percent of the total material by weight larger than an 18-inch (0.5 m) but less than a 30-inch (0.8 m) square opening and at least 50 percent of the total material by weight larger than a 24-inch (0.6 m) square opening. Furnish material smaller than an 18-inch (0.5 m) square opening that consists predominantly of rock spalls and rock fines, and that is free of soil.

2. Type B material has at least 85 percent of the total material by weight larger than a 12-inch (0.3 m) but less than a 24-inch (0.6 m) square opening and at least 50 percent of the total material by weight larger than an 18-inch (0.5 m) square opening. Furnish material smaller than a 12-inch (0.3 m) square opening that consists predominantly of rock spalls and rock fines, and that is free of soil.

3. Type C material has at least 85 percent of the total material by weight larger than a 6-inch (150 mm) but less than an 18-inch (0.5 m) square opening and at least 50 percent of the total material by weight larger than a 12-inch (0.3 m) square opening. Furnish material smaller than a 6-inch (150 mm) square opening that consists predominantly of rock spalls and rock fines, and that is free of soil.

4. Type D material has at least 85 percent of the total material by weight larger than a 3-inch (75 mm) but less than a 12-inch (0.3 m) square opening and at least 50 percent of the total material by weight larger than a 6-inch (150 mm) square opening. Furnish material smaller than a 3-inch (75 mm) square opening that consists predominantly of rock spalls and rock fines, and that is free of soil.

## 704 MASONRY UNITS

**704.01 Clay or Shale Brick.** Furnish clay or shale brick conforming to ASTM C 32, with the following modifications:

4.1 Furnish bricks of such size and shape as to allow their incorporation in the structure in conformance with the specified dimensions of the structure.

6.1 Furnish materials according to the Department's Qualified Products List (QPL).

**704.02 Concrete Brick.** Furnish concrete brick according to ASTM C 55, with the following modifications:

4.1.1 and 4.1.2 Use cement conforming to 701 Portland Cement.

4.2 Use aggregate that conforms to the quality requirements of 703.02.

8.1 Furnish materials according to the Department's Qualified Products List (QPL).

8.2 Sample and test the brick according to ASTM C 140. Furnish bricks of such size and shape as to allow their incorporation in the structure in conformance with the specified dimensions of the structure. Furnish bricks that have a rectangular cross-section with square corners. Ensure that the ends, edges, and one face are plain surfaces.

**704.03 Concrete Masonry Blocks.** Furnish concrete masonry blocks conforming to ASTM C 139, with the following modification:

4.1.1 and 4.1.2 Use cement conforming to 701 Portland Cement.

7.1 Furnish materials according to the Department's Qualified Products List (QPL).

7.2 Furnish blocks of such size and shape as to allow their incorporation in the structure in conformance with the specified dimensions of the structure.

## 705 CONCRETE INCIDENTALS

**705.01 Fiber Reinforced Polymer (FRP) Dowel Bars.** Furnish round and straight fiber reinforced polymer (FRP) dowel bars. Ensure that the resin used to manufacture the FRP bars consists of an acrylic modified epoxy resin with a minimum of 5 percent and a maximum of 7 percent tensile elongation at break. Ensure that the minimum glass fiber content is 70 percent by weight. Furnish dowels of a type meeting the dimensional requirements of the standard construction drawings Provide certified test data according to 101.03 with each shipment.

**705.03 Preformed Fillers.** Furnish preformed fillers according to AASHTO M 153 or AASHTO M 213, with the following modification:

5.7 For materials manufactured as described in 4.1.1 and 4.1.2, ensure that the producer certifies to the Engineer that the asphalt content is at least 35 percent by weight of the filler.

Furnish materials according to the Department's Qualified Products List (QPL).

**705.04 Hot Applied Joint Sealer,** Furnish hot applied joint sealer conforming to ASTM D 6690, Type II Use this material as the primer for Type 3 membrane.

**705.05 Burlap Cloth.** Furnish burlap cloth according to AASHTO M 182, Class 2.

**705.06 Sheet Materials for Concrete Curing.** Furnish sheet materials conforming to AASHTO M 171 for moisture loss and reflectance only.

**705.07 Liquid Membrane-Forming Compounds for Curing Concrete.** Furnish liquid membrane-forming compounds conforming to ASTM C 309, with the following modification:

5.3 In addition - liquid membrane-forming compounds will have a minimum solids content of 25% .

6.1 Water Retention- Liquid membrane-forming compound, when tested in accordance with 10.1, shall have a water loss of not more than: 0.15 kg/m<sup>2</sup> @ 24 hours and 0.40 kg/m<sup>2</sup> @ 72 hours.

7.1 Reflectance - Type 2 curing compound will have a minimum daylight reflectance of 65%.

10.4 In addition - Mix Type 2 curing compound until uniform in color and consistency, and then pour into a glass graduated cylinder (Kimax 150 ml) to the 150 ml mark. The Type 2 curing compound should have a rate of settling such that its uniformly white portion as visible to the eye is not less than 145 ml at 2 hours and not less than 125 ml at 24 hours after filling the Kimax cylinder . The test should be performed at 73.0 ± 3.5 °F (23 ± 2 °C). During this test the glass cylinder should be stoppered and left undisturbed.

11.1 In addition, Equip the containers for Type 2 white pigmented liquid membrane forming compounds with mechanical agitators. Assign each container in any batch or lot, a number as the container is being filled.

Furnish materials according to the Department's Qualified Products List (QPL)

**705.10 Air-Entraining Admixtures.** Provide air-entraining admixtures conforming to AASHTO M 154. Conform to Supplement 1001 for approval.

Furnish materials according to the Department's Qualified Products List (QPL)

**705.11 Preformed Elastomeric Compression Joint Seal for Concrete.**

**A. General.** Provide preformed elastomeric compression joint seal conforming to ASTM D 2628, with the following modifications:

5.1 Ensure that the size and design is as shown on the plans.

7.2 The Engineer will perform inspection at the project site.

7.3 If sampled, provide a minimum of 3 feet (1.0 m), with all manufacturers' markings,

12.1 In addition, ensure that markings are every 1 foot (305 mm). Use lubricants recommended by the seal manufacturer to install preformed compression seals.

**B. Qualification.** Obtain Department approval of each design, shape, width, depth, web, and shell thickness before use. Submit drawings of the seals showing all dimensions and dimension tolerances and weight per foot (meter) with the request for approval.

Furnish materials according to the Department's Qualified Products List (QPL)

**705.12 Chemical Admixture for Concrete.** Provide chemical admixtures conforming to ASTM C 494. Ensure that the minimum relative durability factor is 90.

Furnish materials according to the Department's Qualified Products List (QPL)

705.15

**705.15 High Molecular Weight Methacrylate (HMWM) Resin.** Provide low viscosity, non-fuming high molecular weight methacrylate (HMWM) resin conforming to the following:

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Viscosity	Less than 25 cps (Brookfield viscometer, Model RVT with UL adaptor or Model LVF, # spindle and UL adaptor C @ 77 °F (25 °C) (ASTM D 2849)
Density	Greater than 8.4 lb/gal Ca 77 °F (25 °C) (ASTM D 2849)
Flash Point	Greater than 200 °F (93 °C) (PenskyMartens CC) (ASTM D 93)
Vapor Pressure	Less than 1.0 mm Hg C @ 77 °F (25 °C) (ASTM D 323)
TG (DSC)	Greater than 135 °F (58 °C) (ASTM D3418)
Shelf Life	Must be 1 year minimum at manufacturers recommended environmental considerations
Gel Time	Greater than 40 min, 100 g mass (ASTM D 2471) (thin film)
Percent Solids	Greater than 90% by weight
Bond Strength	Greater than 1500 psi (10.5 MPa) (ASTM C 882)

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Furnish materials according to the Department’s Qualified Products List (QPL)

**705.20 Non Shrink, Non Metallic Materials.** Provide anchoring materials for installing anchor bolts, dowels and similar material in concrete which are non-shrink, 100% solids, two part (resin and hardener), fast setting, and moisture insensitive.

A. Provide certified test data according to 101.03 showing compliance with the following requirements. Include manufacturer’s installation and application requirements.

Test Description	Specification	Requirements	Notes
Bond Strength (dry)	ASTM C882	2 day, Min. 1800 psi	Average of three samples (1)
Bond Strength after subjected to 300 cycles freeze/thaw testing	ASTM C882 specimens subjected to ASTM C666 Method B testing and the tested conforming to C882	Min. 1600 psi	Average of three samples (1)
Heat Deflection	ASTM D648	7 day, Min. 130 °F	
Linear Coefficient of Shrinkage	ASTM C531	% Max. 0.005	
Pullout Strength Test (dry)	See Procedure below	24 hours, Min. Load 22500 lbs	Average of three cylinders in dry condition
Pullout Strength Test (wet)	See Procedure below	24 hours, Min. Load 22500 lbs	Average of three cylinders in wet condition

(1) a total of six samples will be made under C882. Three of the C882 samples will be tested under C666 Method B and those samples tested.

**Pullout Strength Test Procedure.** Perform pullout strength tests under dry and wet conditions as follows:

1. Dry Condition (epoxy steel)

Cast three concrete test blocks or cylinders, a minimum of 6 inches (150 mm) in width or diameter by 12 inch (300 mm) in depth. Use concrete with a compressive strength of 4000+/- 500 psi at 28-days. Center a 6 3/4 inch (170 mm) deep hole, drilled the diameter required by the manufacturer's requirements for installing a No. 6 (20M) rebar, in the block or cylinder by drilling or forming. Dry the hole surfaces and clean the holes following manufacturer instructions. Fill the hole with adhesive materials according to manufacturer recommendations. Insert a No. 6 (20M) deformed reinforcing bar 30 inches (760 mm) long, cleaned and degreased, into the hole. Hold and center the bar perpendicular to the concrete surface in the grout-filled hole during the curing period.

2. Wet Condition (epoxy steel)

Cast three concrete test blocks or cylinders, a minimum of 6 inches (150 mm) in width or diameter by 12 inch (300 mm) in depth. Use concrete with a compressive strength of 4000+/- 500 psi at 28-days. Center a 6-3/4 inch (170 mm) deep hole, drilled the diameter required by the manufacturer's requirements for installing a No. 6 (20M) rebar, in the blocks or cylinders by drilling or forming. Wet the hole's surfaces prior to applying the anchoring material by filling the hole with water and letting stand for five minutes. Turn the samples over for two minutes to allow the excess water to drain from the hole, Turn all samples over to

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the upright positions and immediately fill hole with adhesive materials according to manufacturer recommendations. Insert a No. 6 (20M) deformed reinforcing bar 30 inches (760 mm) long, cleaned and degreased into the hole. Hold and center the bar perpendicular to the concrete surface in the adhesive-filled hole during the curing period.

Cure Period. Cure the specimen at  $77 \pm 5$  °F ( $25 \pm 3$  °C) for 24 hours.

Pullout Strength Test Apply an axial load to the bar at a rate of 1/2 inch (13 mm) per minute until the bar pulls out of the specimen, or the concrete block or cylinder cracks or spalls. Record the failure mode and applied load.

B. Epoxy materials will also conform to ASTM C881, Type IV, Grade 3, Class A, B or C.

Supply the anchoring material in non-reactive containers and with their MSDS. Label containers with the name of the product, the manufacturer, the shelf life expiration date, the batch number, quantity, and provide application instructions.

Maintain storage areas between 40 and 100 °F (5 and 38 °C).

Only use materials on the Department's Qualified Products List (QPL).

**705.21 Quick Setting Concrete Mortar.** Provide prepackaged mortar material that requires the addition of water only.

Only use materials meeting the following criteria:

A. Capable of being extended 50 percent by dry mortar weight with aggregate meeting the following requirements:

(a) Gradation requirements of Table 703.01-1 for No. 8, 89, 9, or a combination thereof.

(b) AASHTO M 43, Maximum Passing No. 200 (75 µm) sieve - Not to exceed 0.2 percent.

(c) AASHTO T 84 and T 85, Absorption - Not more than 2 percent.

(d) AASHTO T 104, Soundness Loss - Not more than 2 percent.

1. Ensure that the material meets the following requirements:

<b>Test</b>	<b>Type 1</b>	<b>Type 2</b>
<b>Compressive Strength ASTM C 109<sup>[2]</sup></b>		
psi (MPa) @ 1 Hour	100 (0.7)	2000 (14)
@ 3 Hour	250 (1.7)	---
@ 24 Hours	2000 (14)	5000 (34)
@ 7 Days	---	7000 (48)
<b>Compressive Strength ASTM C 39<sup>[1],[2]</sup></b>		
psi (MPa) @ 1 Hour	100 (0.7)	(2000) (14)
@ 3 Hour	150 (1.0)	---
@ 24 Hours	1000 (10)	3500 (24)
@ 7 Days	---	6000 (41)
<b>Initial Set Time (min) ASTM C 266<sup>[2]</sup></b>		
	5 Minutes	10 Minutes
<b>Bond Strength, ASTM C 882<sup>[1]</sup></b>		
psi (MPa) @ 24 Hours	1000 (7)	1000 (7)
@ 7 Days	1500 (11)	1500 (11)
<b>Flexural Strength ASTM C 78<sup>[1]</sup></b>		
psi (MPa) @ 4 Hour	---	200 (1.4)
@ 3 Day	650 (4.5)	500 (3.4)
<b>Freeze and Thaw ASTM C 666 (use either Procedure B or A)<sup>[1]</sup></b>		
Procedure B (350 Cycles) Durability Factor	80%	80%
Procedure A (300 Cycles) Durability Factor	79%	79%

[1] Extend test specimens 50 percent by dry mortar weight with aggregate.

[2] Test the mortar as received with the addition of water. Ensure that the amount of water is designated on the packing container by the manufacturer.

B. Prequalify the material by placing and having the material evaluated conforming to Supplement 1070 for 3 years. At the end of the 3 year rating the material will meet the following criteria:

1. Percentage debonding/delamination  $\leq 5\%$
2. Percentage spalling  $\leq 5\%$
3. Mid panel average crack width  $\leq 1/16$  inch (1.6 mm) and total length of mid panel cracks  $\leq 20$  feet (6.1 m) total length
4. Edge Cracking/debonding average crack width  $\leq 1/16$  inch (1.6 mm) and total length of cracks  $\leq 12$  feet (3.6 m)

Furnish the Laboratory with a certified copy of test results from a recognized laboratory showing compliance with the requirements of this specification for item A. Furnish the laboratory written documentation of the method of surface preparation and any primers, adhesives, or activators used in the field test. Those will become requirements of the material system for subsequent approval or use. A recognized laboratory is one that is regularly inspected by the Cement and

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Concrete Reference Laboratory of the National Institute of Standards and Technology.

Provide quick setting concrete mortar packaged in strong moisture resistant paper bags or other suitable containers capable of withstanding shipping, normal handling, and storage without breakage. The package will protect the material from deterioration when stored in a dry condition for a period of 1 year. Each package or container must display information regarding the minimum nominal yield and instructions for mixing. Calculate volumetric yield determinations using the manufacturers' recommended water content.

Furnish materials listed on the Department's Qualified Products List (QPL).

**705.22 Nonshrink Mortar.** Provide nonshrink mortar conforming to ASTM C 1107, with the following modification:

9.1 In addition, ensure that the fluidity of the grout at the maximum water content is at least equal to a flowable mixture as defined in ASTM C 827, Section 8.2.2 and that the minimum flow is 125 @ 5 drops of the flow table in 3 seconds.

Furnish materials according to the Department's Approved materials list.

### 705.23 Concrete Sealers

A. Provide an Epoxy-Urethane sealer incorporating a two component cross linked urethane and conforming to the following requirements:

1. Absorption - ASTM C642 (non-air entrained concrete). Proportion and mix concrete according to ASTM C672. Sealed concrete, under total immersion, will not exceed 1.0% after 48 hours or 2.0% after 50 days

2. Scaling Resistance - ASTM C672 A rating of "No scaling" after 100 cycles on the sealed concrete (non-air entrained concrete) as compared to "Severe Scaling" on untreated concrete.

3. NCHRP 244, Series 11 - Cube Test

3.1 Weight gain - not to exceed 25% of untreated cube

3.2 Absorbed chloride - not to exceed 25% of untreated cube

4. NCHRP 244, Series IV - Southern Exposure

4.1 Absorbed chloride - not to exceed 10% of untreated concrete

5. Volatile Organic Compounds (VOC) maximum, ASTM D 3960, 3.33 lbs./gal(0.399 g/ml), as applied

Record and report the application rate (square footage/gallon) of sealer during the tests.

Provide test data from an approved independent testing facility. The sealer manufacturer funds the testing costs.

Furnish the test data, a one quart (one liter) sample, and the MSDS to the Office of Materials Management (OMM). OMM will determine material acceptance.

Furnish materials according to the Department's Qualified Products List (QPL)

B. Provide a Non-Epoxy sealer conforming to the following requirements:

1. Absorption - ASTM C642 (non-air entrained concrete). Proportion and mix concrete according to ASTM C672. Sealed concrete, under total immersion, will not exceed 1.0% after 48 hours or 2.0% after 50 days

2. Scaling Resistance - ASTM C672 A rating of "No scaling" after 100 cycles on the sealed concrete (non-air entrained concrete) as compared to "Severe Scaling" on untreated concrete.

3. NCHRP 244, Series 11 - Cube Test

3.1 Weight gain - not to exceed 25% of untreated cube

3.2 Absorbed chloride - not to exceed 25% of untreated cube

4. NCHRP 244, Series IV - Southern Exposure

4.1 Absorbed chloride - not to exceed 10% of untreated concrete

5. Volatile Organic Compounds (VOC) maximum, ASTM D 3960, 3.33 lbs./gal(0.399 g/ml), as applied

Record and report the application rate (square footage/gallon) of sealer during the tests.

Provide test data from an approved independent testing facility. The sealer manufacturer funds the testing costs.

Furnish the test data, a one quart (one liter) sample, and the MSDS to the OMM. OMM will determine material acceptance.

Furnish materials according to the Department's Qualified Products List (QPL).

**705.24 Soluble Reactive Silicate** Provide a soluble reactive silicate (SRS) that is a blend of Na/K/FI<sub>x</sub>SiO<sub>x</sub> (sodium, potassium, fluoro or other silicate), surfactants, polymers, and stabilizers capable of thoroughly saturating and sealing concrete. The treatment system will meet the following performance requirements:

A. Scaling Resistance - Treated concrete will pass ASTM C 672, Scaling Resistance test with a rating of 'No Scaling' after 100 cycles (non-air entrained concrete) as compared to "Severe Scaling" on untreated concrete.

B. Absorption - The absorption of treated concrete under total immersion will not exceed 1.0 percent after 48 hours or 2.0 percent after 50 days (ASTM C 642, non-air entrained concrete). Concrete should be proportioned and mixed in accordance with ASTM C 672.

C. Skid resistance - The skid resistance of treated concrete pavement will not be reduced by more than 10 percent as compared to the same untreated pavement. ASTM E 274 using ASTM E 501 ribbed tire at 40 mph (64 kph), five test average.

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D. AASHTO T 259 as modified. The standard T 259 Resistance of Concrete to Chloride Ion Penetration will; be modified as follows:

In addition to section 3.1, intentionally break the specimens so they have a full depth crack through the middle of the slab.

Install section 3.2 dams around the perimeter of the re-assembled, cracked, concrete specimens. Caulk around the perimeter of the dam to assure that only the crack and the concrete will allow water to pass through or be absorbed. After assembly, measure the crack width at three locations and report the crack width.

Perform the ponding of 3.4 until the 3% solution comes through the specimen's crack. Record and report the time required for the solution to appear through the specimen's crack. Remove the solution from the specimens and re-dry according to 3.3 (T 259).

After drying apply the SRS to the specimen's top surface at the manufacturer's recommended rate of application. Record and report the rate of application. Air dry the SRS coated dammed sample specimens for 7 days. After 7 days, re perform the ponding with 3% chloride solution until solution comes through the specimen's crack or 14 days. Record the time the till the ponded solution comes through the crack.

Acceptable SRS materials will have a value of 2 or more when the ponding time before SRS application is divided into the ponding time after SRS application.

Sections 3.5, 3.6, 4.1,4.2 and 5.1 (of T 259) will not apply.

Have tests performed by an approved independent testing facility acceptable to the Department.

Submit test data and a one quart (one liter) a technical data sheet and the MSDS to the OMM for approval

Furnish materials according to the Department's Qualified Products List (QPL).

**705.25 Gravity-Fed Resin** Provide non shrink, non metallic resin conforming to ASTM C 881, Type 1, Grade 1, Class B or C and the following:

The maximum viscosity at the lowest allowable temperature will be 250 cps. The manufacturer will provide test data to verify the viscosity at the lowest temperature for the class for which it is to be approved.

A minimum average sand retention of 95.0% for three samples tested according to the Sand Penetration Test Method described below.

Show no signs of cracking, debonding or insufficient curing during the sand penetration test

**A. SAND PENETRATION TEST METHOD.** This test will be conducted with the following equipment and materials:

1. 4 oz [118 ml] wax coated paper cup. Maximum top diameter 2 5/16"[59 mm]; bottom diameter 1 11/16" [43 mm]; height 2 3/8" [60 mm].

2. 20 - 30 grade sand (ASTM C 778)

3. 1 Pint non-absorbent container
4. 8 oz [240 ml] plastic cup
5. Stirring stick or spatula
6. Scale accurate to 0.1 g
7. Disposable gloves
8. Stop watch
9. Thermometer
10. Paint brush

**B. Perform the test as follows**

1. Assure the material and the room is at 73 °F [23 °C]
2. Determine and record the tare weight of the paper cup (1).
3. Introduce 100.0 grams of 20 - 30 graded sand (2) into the paper cup.
4. Record the weight of the cup and the sand.
5. Consolidate the sand in the cup by lifting the cup approximately ½ “ [13 mm] and dropping 25 to 30 times. Then lightly tap the sides of the cup 25 to 30 times with the fingers. The sample may also be placed on a vibrating table for 10 to 15 seconds.
6. Measure enough material into the 8 oz plastic cups (4) to make at least a 200 g sample.
7. Combine the components into the non-absorbent container (3) and mix according to the manufacturer’s recommendations using a spatula or stirring stick (5).
8. Pour 40.0g of material over the sand and record the weight of the resin, cup and sand
9. Allow the resin, sand and cup to set undisturbed for 24 hours at 73 °F [23 °C]. Re-weigh the resin, cup and sand
10. Remove as much of the paper cup from around the hardened resin and sand matrix as possible. Lightly brush any loose sand from the matrix. Weigh the hardened matrix.
11. Calculate the percent of sand retained [F] as follows:

$$F = [E / (D-A)] \times 100$$

[A] Tare weight of paper cup (g)

[B] Weight of cup and sand (g)

[C] Weight of fresh mixture of resin, cup and sand (g)

[D] Weight of cured mixture of resin, cup and sand (g)

[E] Weight of resin sand matrix as measured in step 10 (g)

12. Report the average of three specimens mixed separately

**705.26**

13. Also calculate and report the percent loss due to curing [G] as follows:

$$G = [(D - C) / (C - B)] \times 100$$

14. Examine the sand / resin matrix for signs of insufficient curing and bond, or excessive shrinkage.

Material Approval. The manufacturer will provide certified test data verifying compliance with the above requirements; technical data sheet; current MSDS for the material; 1 gallon sample; and a letter certifying that the product formulation will not be altered without notification to the Department and OMM.

OMM will determine materials acceptance and include in the Department's qualified Products list (QPL).

Furnish materials according to the Department's Qualified Products List (QPL).

**705.26 Epoxy injection Resin.** Provide epoxy injection resin capable of application, positive adherence and strength development when applied to moist or wet surfaces at temperatures of 33 °F (1 °C) and above.

Use products that contain 100% solids material and no non-reactive diluents, solvents or other fillers. Provide materials that meet the following requirements:

A. The injection material will meet the requirements of ASTM C 881 Type IV, Grade 1 and Class B or C and have a maximum viscosity of 600 cps at the lowest ambient material and substrate temperature to be used.

B. The paste materials will meet the requirements of ASTM C 881 Type I, Grade 3 and Class B or C.

Material Approval. The manufacturer of the materials is responsible for prequalifying the material and submitting the following to the OMM:

A. An Independent certified test data indicating that the materials, when mixed according to the manufacturer's recommendations, meet the requirements listed above.

B. Manufacturer's technical data sheet for the paste and injection materials.

C. MSDS for paste and injection materials.

D. 1 Gallon Sample or 2 kits of the injection materials

Furnish materials according to the Department's Qualified Products List (QPL).

## **706 CONCRETE AND CLAY PIPE**

**706.01 Non-Reinforced Concrete Pipe.** Provide non-reinforced concrete pipe conforming to ASTM C 14 (ASTM C 14M), with the following modifications:

5.3 Does not apply.

6.2 Provide cementitious materials conforming to 701, except 701.07.

6.3 Provide aggregate conforming to the quality requirements of 703.02.

10.2 Ensure that the manufacture furnishes the number of pipe shown in the “Minimum Requirements for Sampling Materials” table, section 700.

10.3 In addition, perform external load crushing strength tests with hard rubber blocks on wood strips with plaster of paris bedding fillets.

13 Perform inspection at the project site. Obtain random samples from materials delivered to the project site or at other locations designated by the Laboratory. Ensure that the manufacturers of these materials are certified by the Office of Materials Management according to Supplement 1074.

15 Ensure that the markings also include “P” to denote non-reinforced pipe.

Testing Equipment. Ensure that every manufacturer furnishing concrete pipe under these Specifications furnishes all facilities and personnel needed to perform the tests.

**706.02 Reinforced Concrete Circular Pipe.** Provide reinforced concrete circular pipe conforming to ASTM C 655 (ASTM C 655M), with the following modifications:

Ensure that the minimum D-Load of the reinforced concrete pipe is as follows:

Size	Minimum D-Load
12 in (300 mm)	2000 lb (100 kg)
15 in (375 mm)	2000 lb (100 kg)
18 in (450 mm)	1250 lb (62.5 kg)
21 in (525 mm)	1250 lb (62.5 kg)
24 in (600 mm)	1250 lb (62.5 kg)
27 in (675 mm) or larger	1000 lb (50 kg)

1 In addition, ensure that this pipe is circular reinforced concrete pipe with circular or elliptical reinforcement, with and without quadrant and “S” strip reinforcement.

4.1 The acceptability of the pipe design is determined according to Section 10. All designs in ASTM C 76 (ASTM C 76M), Tables 2 through 5, inclusive, are accepted designs with the 0.01-inch (0.3 mm) crack D-loads as follows:

ASTM C 76 (ASTM C 76M) Table No.	D-Load	
	0.01-inch Crack	(0.3 mm) Crack
2 (Class II)	1000	50
3 (Class III)	1350	65
4 (Class IV)	2000	100
5 (Class V)	3000	140

All designs in Tables 706.02-1 through 706.02-4 are accepted designs with noted 0.01-inch (0.3 mm) crack and ultimate D-loads. For intermediate D-loads, in Tables 2 through 5 of ASTM C 76 (ASTM C 76M), steel areas for a given wall thickness may be interpolated between Tables 2 and 3, 3 and 4, and 4

and 5 for a size and D-load as accepted designs. Where different concrete strengths are listed in the tables, use the higher concrete. In addition, steel areas, interpolated as above between Table 706.02-1 and Table 706.02-2, 36-inch (900 mm) through 108-inch (2700 mm) using the higher concrete strength, and interpolation of the circumferential steel between Table 706.02-3 and Table 706.02-4 using the wall thickness and stirrup designs in Table 706.02-4, are accepted designs. Pipe manufactured according to an accepted pipe design will be accepted, at the option of the Laboratory, according to the basis of acceptance described in Section 4.1.1 or 4.1.2.

Provide reinforced concrete pipe with S-stirrups according to Figure 1 (Figure 1M) and the following requirements:

1. Provide steel conforming to 709.08, 709.10, 709.11, or 709.12. Ensure that the wall thickness, amount of circular reinforcement, S-stirrup system, and concrete strength comply with Tables 706.02-2, 706.02-3, and 706.02-4. Ensure that the spacing center-to-center of adjacent inner rings of circumferential reinforcement in a cage does not exceed 4 inches (102 mm) for pipe up to and including pipe having a 4 inches (102 mm) wall thickness or exceed wall thicknesses for larger pipe and in no case exceed 6 inches (152 mm).

2. Ensure that each line of S-stirrups have a continuous “S” shape extending longitudinally from end to end of the pipe. Ensure that they extend from the inner cage toward the outer surface of the pipe for a distance not less than the minimum amplitude. Ensure that S-stirrups pass around and are in contact with each inside circumferential member of the inner cage. Ensure that each line of S-stirrups lie essentially in a plane passing through the longitudinal axis of the pipe.

3. Where more than one length of stirrup material is used per line, make a lap round one circumferential member of the inner cage. Ensure that the ends of “S” shaped stirrups at splices include an outer bend. Do not use more than three lengths of “S” material in a line and ensure that the minimum length of a section of S-stirrups is 30 inches (0.76 m).

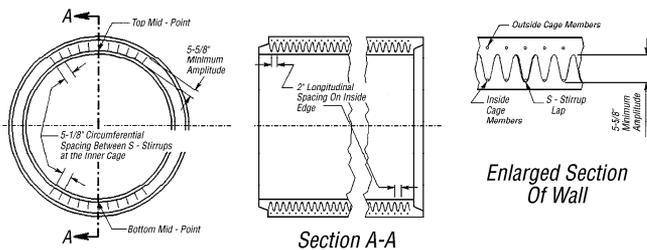


Fig. 1

**Illustrative Example of S-Stirrup Support System for 0.01-inch Crack D-load 3000, 102-inch diameter Pipe Minimum Area Per Support 0.053 square inch, 11 Lines Spaced @ 5 1/8 inches. For other classes and sizes, see Tables 706.02-2, 3, and 4.**

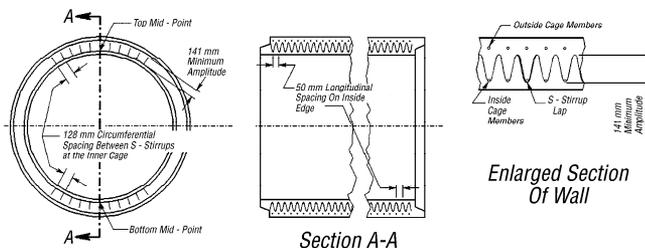


Fig. 1M

**Illustrative Example of S-Stirrup Support System for 0.3 mm Crack D-Load 140.0, 2550 mm diameter Pipe Minimum Area per Support 34 mm<sup>2</sup>, 11 Lines Spaced @ 128 mm. For other classes and sizes, see Tables 706.02-2M, 3M, and 4M.**

<b>TABLE 706.02-1</b>			
0.01-inch Crack D-Load 1000			
Ultimate Strength D-Load 1500			
Internal Diameter of Pipe (in)	Wall Thickness (in)	Circular Reinforcement in Circular Pipe	
		Inner Cage (in <sup>2</sup> /ft of pipe)	Outer Cage (in <sup>2</sup> /ft of pipe)
Reinforcing Steel 709.11 or 709.12 Only			
Concrete Strength 4000 psi			
36	4	0.09	0.07
42	4 1/2	0.11	0.08
48	5	0.13	0.09
54	5 1/2	0.16	0.12
60	6	0.19	0.14
66	6 1/2	0.21	0.16
72	7	0.23	0.17
78	7 1/2	0.25	0.19
84	8	0.29	0.21
90	8	0.33	0.24
96	8 1/2	0.37	0.26
Concrete Strength 5000 psi			
102	8 1/2	0.41	0.28
108	9	0.47	0.3
All Permitted Reinforcing Steel			
Concrete Strength 5000 psi			
114	9 1/2	0.56	0.42
120	10	0.61	0.46
126	10 1/2	0.65	0.49
132	11	0.7	0.52
144	12	0.8	0.6

<b>TABLE 706.02-1M</b>			
0.3 mm Crack D-Load 50.0 Ultimate Strength D-Load 75.0			
Internal Diameter of Pipe (mm)	Wall Thickness (mm)	Circular Reinforcement in Circular Pipe	
		Inner Cage (cm <sup>2</sup> /m of pipe)	Outer Cage (cm <sup>2</sup> /m of pipe)
Reinforcing Steel 709.11 or 709.12 Only Concrete Strength 27.6 MPa			
900	100	1.9	1.5
1050	113	2.3	1.7
1200	125	2.8	1.9
1350	138	3.4	2.5
1500	150	4	3
1650	163	4.4	3.4
1800	175	4.9	3.6
1950	188	5.3	4
2100	200	6.1	4.4
2250	200	7	5.1
2400	213	7.8	5.5
Concrete Strength 34.5 MPa			
2550	213	8.7	5.9
2700	225	9.9	6.4
All Permitted Reinforcing Steel Concrete Strength 34.5 MPa			
2850	238	11.9	8.9
3000	250	12.9	9.7
3150	263	13.8	10.4
3300	275	14.8	11
3600	300	16.9	12.7

4.1.1 In addition, test the pipe designs covered by Tables 706.02-1, 706.02-2, 706.02-3, and 706.02-4 and ASTM C 76 (ASTM C 76M), Tables 2 through 5, and interpolated designs by the three-edge bearing method. When the test load on the pipe reaches 115 percent of the required 0.01-inch (0.3 mm) crack D-load without developing a 0.01-inch (0.3 mm) or larger crack, accept the test specimen for strength. If any test specimen fails to pass this test, but attained the 0.01-inch (0.3 mm) crack, continue the test until the ultimate D-load is reached.

4.1.2 In addition, accept pipe 54 inches (1350 mm) and larger in diameter covered by Tables 706.02-1, 706.02-2, 706.02-3, and 706.02-4, and ASTM C 76 (ASTM C 76M), Tables 2 through 5, and interpolated designs according to Section 12 and the following requirements:

1. When pipe from a plant has been approved by the Laboratory for a specified design and pipe from the same plant has wall and steel area not less than the approved pipe.

2. When it has been established that two or more plants have complied with the above requirements for the class and size under consideration, and the plant under consideration has established compliance with the above requirements for an adjacent size, and the wall and steel area are not less than the pipe tested at the two plants.

6.1.2.1 Provide cement according to 701.

6.1.2.2 Provide fly ash according to 701.13

6.1.3 Provide aggregates conforming to the quality requirements of 703.02.

6.1.5 Provide steel according to 709.08, 709.10, 709.11, or 709.12.

6.2.4 Ensure that no more than two holes are cast, drilled, or otherwise neatly made in the shell of each piece of pipe for the purpose of handling or laying. Ensure that the holes are tapered unless drilled, and before backfilling, fill the tapered holes with portland cement mortar, or secure precast concrete plugs with portland cement mortar. Fill drilled holes with portland cement mortar.

7.1 and 7.3 In addition, perform strength tests using methods described in ASTM C 497 (ASTM C 497M).

10.1 In addition, ensure that pipe designs covered by Tables 706.02-1, 706.02-2, 706.02-3, and 706.02-4 and ASTM C 76 (ASTM C 76M) Tables 2 through 5 have the number of samples selected as shown in the "Minimum Requirements for Sampling Materials" table for each size, class, and production lot (pipe of the same size and class made from the same materials and by the same process and approximately the same production date) for test.

**TABLE 706.02-2**

0.01-inch Crack D-Load 1350 Ultimate Strength D-Load 2000								
Internal Diameter of Pipe (in)	Wall Thickness (in)	Circular Reinforcement in Circular Pipe		S-Stirrups				
		Inner Cage (in <sup>2</sup> /ft of pipe)	Outer Cage (in <sup>2</sup> /ft of pipe)	Minimum Area Per Support Element (in <sup>2</sup> )	Number of Lines <sup>[1]</sup>	Longitudinal Spacing (in)	Circumferential Spacing on Inner Cage (in)	Minimum Amplitude <sup>[2]</sup> of Stirrups (in)
<b>Reinforcing Steel 709.11 or 709.12 Only</b>								
<b>Concrete Strength 4000 psi</b>								
36	4	0.12	0.09					
42	4 1/2	0.15	0.11					
48	5	0.17	0.12					
54	5 1/2	0.21	0.16					
60	6	0.26	0.20					
66	6 1/2	0.30	0.21					
72	7	0.35	0.24					
78	7 1/2	0.40	0.27					
84	8	0.47	0.30					
<b>Concrete Strength 5000 psi</b>								
90	8	0.64	0.35					
96	8 1/2	0.80	0.40					
102	8 1/2	0.96	0.44					
108	9	1.07	0.47					
<b>All Permitted Reinforcing Steel</b>								
114	9 1/2	0.69	0.52	0.041	5	2	6 1/8	6 5/8
120	10	0.74	0.55	0.041	5	2	6 1/2	7 1/8
126	10 1/2	0.79	0.60	0.041	5	2	6 7/8	7 5/8
132	11	0.85	0.64	0.041	5	2	7 1/4	8 1/8
144	12	0.97	0.73	0.041	5	2	8	9 1/8
[1] Number of lines in the table indicates the number of longitudinal lines required in each top and bottom portion of the pipe. The area of each support element in a pipe is two times the cross-sectional area of the S-stirrups wire used. There shall be an equal number of these lines of S-stirrups on either side of the mid-point of both the top and bottom of the pipe. See Figure 1.								
[2] The amplitude is the overall width of the line of stirrups.								

TABLE 706.02-2M

0.3 mm Crack D-Load 65.0 Ultimate Strength D-Load 100.0								
Internal Diameter of Pipe (mm)	Wall Thickness (mm)	Circular Reinforcement in Circular Pipe		S-Stirrups				
		Inner Cage (cm <sup>2</sup> /m of pipe)	Outer Cage (cm <sup>2</sup> /m of pipe)	Minimum Area Per Support Element (mm <sup>2</sup> )	Number of Lines <sup>[1]</sup>	Longitudinal Spacing (mm)	Circumferential Spacing on Inner Cage (mm)	Minimum Amplitude <sup>[2]</sup> of Stirrups (mm)
Reinforcing Steel 709.11 or 709.12 Only Concrete Strength 27.6 MPa								
900	100	2.5	1.9					
1050	113	3.2	2.3					
1200	125	3.6	2.5					
1350	138	4.4	3.4					
1500	150	5.5	4.2					
1650	163	6.4	4.4					
1800	175	7.4	5.1					
1950	188	8.5	5.7					
2100	200	9.9	6.4					
Concrete Strength 34.5 MPa								
2250	200	13.5	7.4					
2400	213	16.9	8.5					
2550	213	20.3	9.3					
2700	225	22.6	9.9					
All Permitted Reinforcing Steel								
2850	238	14.6	11.0	26	5	50	156	168
3000	250	15.7	11.6	26	5	50	165	181
3150	263	16.7	12.7	26	5	50	175	194
3300	275	18.0	13.5	26	5	50	184	206
3600	300	20.5	15.5	26	5	50	203	232
[1] Number of lines in the table indicates the number of longitudinal lines required in each top and bottom portion of the pipe. The area of each support element in a pipe is two times the cross-sectional area of the S-stirrups wire used. There shall be an equal number of these lines of S-stirrups on either side of the mid-point of both the top and bottom of the pipe. See Figure 1M.								
[2] The amplitude is the overall width of the line of stirrups.								

**TABLE 706.02-3**

0.01-inch Crack D-Load 2000 Ultimate Strength D-Load 3000 Concrete Strength 5000 psi								
Internal Diameter of Pipe (in)	Wall Thickness (in)	Circular Reinforcement in Circular Pipe		S-Stirrups				
		Inner Cage (in <sup>2</sup> /ft of pipe)	Outer Cage (in <sup>2</sup> /ft of pipe)	Minimum Area Per Support Element (in <sup>2</sup> )	Number of Lines <sup>[1]</sup>	Longitudinal Spacing (in)	Circumferential Spacing on Inner Cage (in)	Minimum Amplitude <sup>[2]</sup> of Stirrups (in)
78	7 1/2	0.69	0.52	0.029	11	2	4 1/8	4 5/8
84	8	0.74	0.56	0.029	11	2	4 5/8	5 1/8
90	8	0.85	0.63	0.031	11	2	4 5/8	5 1/8
96	8 1/2	0.91	0.69	0.034	11	2	5 1/8	5 5/8
102	8 1/2	1.02	0.77	0.041	12	2	5 1/8	5 5/8
108	9	1.07	0.80	0.045	11	2	5 5/8	6 1/8
114	9 1/2	1.02	0.77	0.048	11	2	6 1/8	6 5/8
120	10	1.10	0.82	0.051	11	2	6 1/2	7 1/8
126	10 1/2	1.17	0.88	0.055	11	2	6 7/8	7 5/8
132	11	1.25	0.94	0.058	11	2	7 1/4	8 1/8
144	12	1.42	1.07	0.065	11	2	8	9 1/8

[1] Refer to Footnote for Table 706.02-2.  
[2] Refer to Footnote for Table 706.02-2.

**TABLE 706.02-3M**

0.3 mm Crack D-Load 100 Ultimate Strength D-Load 150 Concrete Strength 34.5 MPa								
Internal Diameter of Pipe (mm)	Wall Thickness (mm)	Circular Reinforcement in Circular Pipe		S-Stirrups				
		Inner Cage (cm <sup>2</sup> /m of pipe)	Outer Cage (cm <sup>2</sup> /m of pipe)	Minimum Area Per Support Element (mm <sup>2</sup> )	Number of Lines <sup>[1]</sup>	Longitudinal Spacing (mm)	Circumferential Spacing on Inner Cage (mm)	Minimum Amplitude <sup>[2]</sup> of Stirrups (mm)
1950	188	14.6	11.0	19	11	50	105	117
2100	200	15.7	11.9	19	11	50	117	130
2250	200	18.0	13.3	20	11	50	117	130
2400	213	19.3	14.6	22	11	50	130	143
2550	213	21.6	16.3	26	12	50	130	143
2700	225	22.6	16.9	29	11	50	143	156
2850	238	21.6	16.3	31	11	50	156	168
3000	250	22.3	17.4	33	11	50	165	181
3150	263	24.8	18.6	35	11	50	175	194
3300	275	26.5	19.9	37	11	50	184	206
3600	300	30.1	22.6	42	11	50	203	232

[1] Refer to Footnote for Table 706.02-2M.  
[2] Refer to Footnote for Table 706.02-2M.

TABLE 706.02-4

0.01-inch Crack D-Load 3000 Ultimate Strength D-Load 3750								
Internal Diameter of Pipe (in)	Wall Thickness (in)	Circular Reinforcement in Circular Pipe		S-Stirrups				
		Inner Cage (in <sup>2</sup> /ft of pipe)	Outer Cage (in <sup>2</sup> /ft of pipe)	Minimum Area Per Support Element (in <sup>2</sup> )	Number of Lines <sup>[1]</sup>	Longitudinal Spacing (in)	Circumferential Spacing on Inner Cage (in)	Minimum Amplitude <sup>[2]</sup> of Stirrups (in)
<b>Concrete Strength 6000 psi</b>								
6	1 3/4	0.07	--					
8	1 3/4	0.07	--					
10	1 3/4	0.07	--					
54	5 1/2	0.86	0.62					
60	6	0.95	0.68					
<b>Concrete Strength 5000 psi</b>								
54	5 1/2	0.64	0.48	0.029	15	2	2 1/8	2 5/8
60	6	0.70	0.53	0.029	14	2	2 5/8	3 1/8
66	6 1/2	0.79	0.59	0.029	13	2	3 1/8	3 5/8
72	7	0.87	0.66	0.029	12	2	3 5/8	4 1/8
78	7 1/2	0.92	0.69	0.031	11	2	4 1/8	4 5/8
84	8	0.99	0.74	0.034	11	2	4 5/8	5 1/8
90	8	1.13	0.85	0.041	11	2	4 5/8	5 1/8
96	8 1/2	1.20	0.90	0.045	11	2	5 1/8	5 5/8
102	8 1/2	1.34	1.00	0.053	11	2	5 1/8	5 5/8
108	9	1.51	1.13	0.063	11	2	5 5/8	6 1/8
114	9 1/2	1.51	1.13	0.064	11	2	6 1/8	6 5/8
120	10	1.62	1.21	0.068	11	2	6 1/2	7 1/8
126	10 1/2	1.73	1.30	0.072	11	2	6 7/8	7 5/8
132	11	1.84	1.38	0.076	11	2	7 1/4	8 1/8
144	12	2.09	1.57	0.085	11	2	8	9 1/8
[1] Refer to Footnote for Table 706.02-2.								
[2] Refer to Footnote for Table 706.02-2.								

**TABLE 706.02-4M**

0.3 mm Crack D-Load 140.0 Ultimate Strength D-Load 175.0								
Internal Diameter of Pipe mm	Wall Thickness mm	Circular Reinforcement in Circular Pipe		S-Stirrups				
		Inner Cage (cm <sup>2</sup> /m of pipe)	Outer Cage (cm <sup>2</sup> /m of pipe)	Minimum Area Per Support Element (mm <sup>2</sup> )	Number of Lines <sup>[1]</sup>	Longitudinal Spacing (mm)	Circumferential Spacing on Inner Cage (mm)	Minimum Amplitude <sup>[2]</sup> of Stirrups (mm)
<b>Concrete Strength 41.4 MPa</b>								
150	44	1.5	--					
200	44	1.5	--					
250	44	1.5	--					
1350	138	18.2	13.1					
1500	150	20.1	14.4					
<b>Concrete Strength 34.5 MPa</b>								
1350	138	13.5	10.2	19	15	50	54	67
1500	150	14.8	11.2	19	14	50	37	79
1650	163	16.7	12.5	19	13	50	79	92
1800	175	18.4	14.0	19	12	50	92	105
1950	188	19.5	14.6	20	11	50	105	117
2100	200	21.0	15.7	22	11	50	117	130
2250	200	23.9	18.0	26	11	50	117	130
2400	213	25.4	19.1	29	11	50	130	143
2550	213	28.4	21.2	34	11	50	130	143
2700	225	32.0	23.9	41	11	50	143	156
2850	238	32.0	23.9	41	11	50	156	168
3000	250	34.3	25.6	44	11	50	165	181
3150	263	36.6	27.5	46	11	50	175	194
3200	275	38.9	29.2	49	11	50	184	206
3600	300	44.2	33.2	55	11	50	203	232
[1]	Refer to Footnote for Table 706.02-2M.							
[2]	Refer to Footnote for Table 706.02-2M.							

11.1 Perform compression tests on cores according to ASTM C 497 (ASTM C 497M).

11.3 Does not apply.

12 Perform inspection at the project site. Obtain random samples from material delivered to the project site or at other locations designated by the Laboratory.

16 Furnish materials from suppliers certified according to Supplement 1074.

17 In addition, after the capital letter “D,” designate the D-load, the design wall thickness in millimeters (inches expressed as a decimal). Ensure that pipe with S-stirrups have the symbol “S”. Ensure that pipe requiring axis orientation without lift holes (i.e., stirrup pipe, quadrant reinforced pipe, elliptically reinforced pipe) has the centerline of the crown of the pipe marked inside and outside with the symbol “TB”. Mark pipe with quadrant steel with the symbol “Q”. Mark pipe

with elliptical reinforcement with the symbol “E”. Mark pipe with deformed wire reinforcement required in the design with the symbol “DF”.

**706.03 Reinforced Concrete Pipe, Epoxy Coated.** Provide Type A reinforced concrete epoxy coated pipe conforming to 706.02 and Type B conforming to 706.04, with the following modification:

In the plant, prepare the interior barrel and joint surface areas of the concrete pipe to remove all forms of oil, laitance, and other deleterious materials and then line them with a high-build, polyamide-cured, two-component coal tar epoxy coating, Military Specification DOD-P-23236A (SH). Spray the lining compound to obtain a continuous and relatively uniform and smooth lining with a minimum dry film thickness of 0.03 inch (760 µm). Ensure that all coated pipe are free of surface irregularities such as air bubbles, delamination, lumping, sagging, blistering, pinholing, or porosity, in the coating film.

**706.04 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.** Provide reinforced concrete elliptical culvert, storm drain, and sewer pipe conforming to ASTM C 507 (ASTM C 507M), with the following modifications:

4.1 Delete Class HE-A. Table 706.04-1 includes additional design requirements.

5.1 All materials, processes of manufacture, and finished pipe are subject to inspection and approval by the Department. When directed by the Laboratory, the manufacturer will cut holes in sections of the finished pipe for inspection.

6.2.1 Provide cement according to 701, except 701.07.

6.2.2 Provide fly ash according to 701.

6.3 Provide aggregates conforming to the quality requirements of 703.02.

6.5 Provide steel according 709.08, 709.10, 709.11, or 709.12.

7.2 In addition, manufacture horizontal elliptical pipe HE-II and HE-III using the design requirements of Table 706.04-1.

8.1 In addition, ensure that pipe made in accordance with 706.04-1 has three lines of reinforcement of elliptical shape. Place the outer and inner lines of reinforcement so that the nominal protective covering of the concrete over the reinforcement in the barrel of the pipe is 1 inch (25 mm) subject to the variations permitted in Section 12.5. Ensure that the third or middle line is in contact with and fastened securely to the inner line at the vertical axis of the pipe both top and bottom and to the outer line at the horizontal axis on both sides. Ensure that the length of the middle line is the average of the length of the inner and outer line. Ensure that the middle line is of an elliptical shape and runs smoothly between the specified points of contact with the inner and outer lines.

10 Ensure that no more than two holes are cast, drilled, or otherwise neatly made in the shell of each piece of pipe for the purpose of handling or laying. Taper the holes unless drilled, and before backfilling, fill the tapered holes with portland cement mortar, or secure the precast concrete plugs with portland cement mortar. Fill the drilled holes with portland cement mortar.

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11.2 Select the specified number of pipe, as noted in the “Minimum Requirements for Sampling Materials” table, for the purpose of test at the plant and at random from the lot to be shipped or at the project site from the pipe delivered and that are pipe that would not otherwise be rejected under these Specifications. Test pipe according to Section 5.1.1 except the Laboratory may accept pipe 54 inches (1350 mm) and larger in diameter according to Section 5.1.2 and the following requirements:

1. When pipe from a plant has been approved by the Laboratory for a specified design, pipe from the same plant with wall and steel area not less than the approved pipe may be approved by means of tests on cores verifying absorption, strength, wall, and steel area.

2. When it has been established that two or more plants have complied with the above requirements for the class and size under consideration and the plant under consideration has established compliance with the above requirements for an adjacent size, and the wall and steel area are not less than the pipe tested at the two plants.

11.3.1 Ensure that the load to produce a 0.01-inch (0.3 mm) crack and the ultimate load as determined by ASTM C 497 (ASTM C 497M) three-edge bearing method, is not less than shown in Tables 1, 2, and 706.04-1. The ultimate strength test may be waived when the test load on the pipe reaches 115 percent of the required 0.01-inch (0.3 mm) crack D-load without developing a 0.01-inch (0.3 mm) or larger crack.

11.4 Perform compression tests for satisfying the minimum specified concrete strength requirement from cores drilled from the wall of the pipe. Ensure that the diameter of the core is such that the capped height to diameter or L/D ratio lies between one and two. Ensure that the cores are secured, prepared for testing, and tested by methods prescribed in the appropriate sections of ASTM C 497 (ASTM C 497M). Ensure that the compressive strength of each core tested is equal to or greater than the design strength of the concrete. If a core does not meet the required strength, test another core from the same pipe. If this core does not meet the required strength, the Department may reject the pipe. Make additional tests on other pipe to determine the acceptability of the lot. When the cores cut from a section of pipe successfully meet the strength test requirement, ensure that the core holes are plugged and sealed by the manufacturer in a manner such that the pipe section will meet all of the test requirements of these Specifications.

11.9 Does not apply.

11.10 Does not apply.

14 Perform inspection at the project site. Obtain random samples from material delivered to the project site or at other locations designated by the laboratory.

Ensure manufacturers of these materials are certified according to Supplement 1074.

16 In addition, place the plant location on each pipe, and for pipe manufactured to design requirements of 706.04-1 place the letter “A” after the pipe

class. Ensure that the markings are legible and indented in the pipe section or painted on with waterproof paint.

<b>TABLE 706.04-1 DESIGN REQUIREMENTS FOR HORIZONTAL ELLIPTICAL PIPE</b>				
<b>Equivalent Round Size (in)</b>	<b>Rise (in) × Span (in)</b>	<b>Minimum Wall Thickness (in)</b>	<b>Minimum Reinforcement (in<sup>2</sup>/ft)</b>	
			<b>HE-II</b>	<b>HE-III</b>
			<b>D-Loads</b>	
			<b>0.01=1000</b>	<b>0.01 = 1350</b>
			<b>Utl. = 1500</b>	<b>Utl. = 2000</b>
78	63 × 98	8	3 lines totaling 0.87	3 lines totaling 1.23
84	68 × 106	8 1/2	3 lines totaling 0.97	3 lines totaling 1.33
90	72 × 113	9	3 lines totaling 1.03	3 lines totaling 1.43
96	77 × 121	9 1/2	3 lines totaling 1.13	3 lines totaling 1.54
102	82 × 128	9 3/4	3 lines totaling 1.23	3 lines totaling 1.70
108	87 × 136	10	3 lines totaling 1.43	3 lines totaling 1.85
The test load in lb/ft equals D-load x nominal inside span in feet. Concrete strength=5000 psi.				

<b>TABLE 706.04-1M DESIGN REQUIREMENTS FOR HORIZONTAL ELLIPTICAL PIPE</b>				
<b>Equivalent Round Size (mm)</b>	<b>Rise (mm) × Span (mm)</b>	<b>Minimum Wall Thickness (mm)</b>	<b>Minimum Reinforcement (cm<sup>2</sup>/m)</b>	
			<b>HE-II</b>	<b>HE-III</b>
			<b>D-Loads</b>	
			<b>0.03 = 50.0</b>	<b>0.03=65.0</b>
			<b>Utl. = 75.0</b>	<b>Utl.=100.0</b>
1950	1585 × 2495	200	3 lines totaling 18.4	3 lines totaling 26.0
2100	1705 × 2690	213	3 lines totaling 20.5	3 lines totaling 28.2
2250	1830 × 2880	225	3 lines totaling 21.8	3 lines totaling 30.3
2400	1950 × 3070	238	3 lines totaling 23.9	3 lines totaling 32.6
2550	2075 × 3265	244	3 lines totaling 26.0	3 lines totaling 36.0
2700	2195 × 3455	250	3 lines totaling 30.3	3 lines totaling 39.2
The test load in kN/m equals D-load x nominal inside span in mm. Concrete strength=34.5 MPa.				

**706.05 Precast Reinforced Concrete Box Sections.** Provide precast reinforced concrete box section conforming to ASTM C 1577, with the following modifications:

Ensure that manufacturers of precast concrete members are certified by the Laboratory according to Supplement 1073.

6.2.1 Provide cement according to 701, except 701.07.

6.2.2 Provide fly ash according to 701.

6.3 Provide aggregates conforming to the quality requirements of 703.02.

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6.5 Provide reinforcement according to 709.10 or 709.12. Provide longitudinal distribution reinforcement according to 709.01, 709.10 or 709.12.

7.1 Only the following sizes are permitted. The box sizes, span by rise, are 8 x 4, 5, 6, 7; 10 x 5, 6, 7, 8, 9; and 12 x 4, 6, 8, 10 feet.

9.1 Provide hardened concrete that contains a minimum of 4 percent entrained air for wet-cast sections with spans less than 14 feet (4200 mm) and for all sections with spans 14 feet (4200 mm) and greater.

9.4 Lift holes are not permitted. Use handling devices that do not require a hole through the box.

10.1 Verify concrete strength using cylinders. Do not ship items before the design strength of the concrete is reached.

11.5 A minimum cover of 1/2 inch (13 mm) over both circumferential and longitudinal reinforcement is required at the mating surfaces of joints.

15 In addition, mark the identification of the plant on each box section. For box sections 14 feet (4200 mm) or greater, mark the reinforcing steel areas for the section on each box section. Place the manufacturers' name and required product information on the inside of the box section within the top one-half of the culvert.

**706.051 Precast Reinforced Concrete Three-Sided Flat Topped Culverts.** Provide precast concrete three-sided flat topped culverts according to ASTM C 1504, with the following modifications:

Provide flat deck culvert structures with a minimum clear span (measured normal to the structure at the bottom of the haunch) of 14 feet (4200 mm) and a minimum opening rise (measured from bottom of leg to bottom of deck at the centerline of the structure) of 4 feet (1200 mm); and a maximum clear span of 34 feet (10,200 mm) and maximum opening rising of 10 feet (3000 mm). Ensure that the minimum wall and deck thicknesses is 10 inches (250 mm) and 12 inches (300 mm) respectively, measured under the haunch normal to the structure and at the centerline of the span measured perpendicular to the structure.

Ensure manufacturers of precast concrete members are certified according to Supplement 1073.

Ensure that the manufacturer submits design calculations, a structural load rating and shop drawings for review and approval by the Department. Do not produce any units until receiving approval. Submit a minimum of five copies of the drawings. Allow a minimum of four weeks for approval. Ensure that the shop drawings include the following:

1. All structural design according to section 900 of the Department's Bridge Design Manual and loading information.
2. Load rate the structure according to the requirements of section 900 of the Department's Bridge Design Manual.
3. All material specifications.
4. All plan view.
5. All elevation view.
6. All headwall and wingwall attachment requirements.
7. All dimensions.
8. All maintenance of traffic phases.
9. All section sizes.
10. All design handling strength.

The manufacturer may modify an approved shop drawing and resubmit for approval to the Department.

Ensure that the shop drawings also include the following special information as required:

1. For top mounted guardrail, show the guardrail plate and bolt locations in the plan view. Ensure that holes are a minimum of 6 inches (150 mm) from a joint.
2. For side mounted guardrail, show additional reinforcing details as per the plan details.

6.2.1 Provide cement according to 701, except 701.07.

6.2.2 Provide fly ash according to 701.13.

6.3 Provide aggregates conforming to the quality requirements of 703.02.

6.4 Use chemical admixtures according to 705.12. Use a corrosion inhibitor unless epoxy coated reinforcing steel is used. An approved list of corrosion inhibiting admixtures is on file at the Laboratory. Manufacturers should recognize that the corrosion inhibitors and admixtures may have an effect on strength, entrained air content, workability, etc. of their concrete mixes. The manufacturers choice of one of these corrosion inhibitors does not alleviate meeting all design requirements of this structure.

6.4.1 Provide air-entraining admixture according to 705.10.

6.5 Provide epoxy coated reinforcement according to 709.00, Grade 60 (Grade 420), or 709.14. In lieu of epoxy coated reinforcement, an approved corrosion inhibiting admixture may be added to the concrete at the approved dosage; and provide reinforcement according to 709.01, 709.03 or 709.05; Grade 60 (Grade 420) or 709.08, 709.10, 709.11 or 709.12. Provide epoxy or galvanized coated connections when connecting a precast structural unit into a cast-in-place structural component or between segments of adjacent precast structural units either manufactured as separate units or across construction joints when

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manufactured as one unit. Provide epoxy coated reinforcement according to 709.00 or 709.14, when these connections are designed using reinforcing steel. Provide galvanized coatings according to 711.02, when these connections are designed using connection plates, hardware or concrete inserts.

7.1 Design according to *AASHTO LRFD Bridge Design Specifications*, Section 12.14.

7.2 Ensure that the concrete cover dimension over reinforcement is a minimum of 2 inches (50 mm) in the slab and in the exterior of the leg. Ensure that the interior of the leg reinforcement cover tapers from 1 inch (25 mm) at the bottom of the leg to 2 inches (50 mm) at the bottom of the haunch.

Ensure that the ends of longitudinal reinforcement have a minimum cover of 1/2 inch (13 mm), and spacers used to position the reinforcement are plastic or epoxy coated steel regardless of whether a corrosion inhibiting admixture is used.

8 Ensure that the top slab is produced with a keyway joint. The keyway provides a void volume equivalent to that of 12 inches (300 mm) prestressed beam as per Standard Construction Drawing PSBD-2-07. Ensure that the joint in the leg sections is designed to produce a shear key or inter-locking joint. Ensure that non-adjointing outside legs are flat. Sandblast the joint surfaces to the satisfaction of the Department, or a 2000 pounds per square inch (14 MPa) water blast no more than 14 days prior to shipping. Ensure that the culvert is designed such that the sections when laid together will make a continuous line with a smooth interior free of appreciable irregularities, all compatible with the permissible variations of Section 11.

9 Application of membrane waterproofing at any location other than the final location shown on the plans is prohibited.

9.1 Ensure that the aggregate, cement, and water are manufactured in conformance with 499.06, 499.07, and 499.09.

Ensure that the temperature requirements of 511.08 and 511.15 are met.

Ensure that the proportion of portland cement is not less than 564 pounds per cubic yard ( $335 \text{ kg/m}^3$ ) of concrete.

If used, add the corrosion inhibitor as an aqueous solution. Consider the water in the solution as mixing water for the purpose of determining the w/c ratio of concrete.

9.2 Cure the three-sided sections in the forms for the length of time required to obtain the specified minimum design handling strength as defined in the shop drawings. Test a cylinder to check each section's design handling strength. Repeat this test as often as needed. Only one cylinder passing will ensure that the design handling strength has been met. If the shop drawing shows no design

handling strengths, then the minimum handling strength is assumed to be 100 percent of the design strength. Ensure that the curing then continues either in or out of the forms until the specified minimum design strength is met.

9.2.1 Steam curing is an accelerated cure by low pressure steam or radiant heat within a suitable insulated enclosure to contain the live steam or heat. The initial application of the steam or heat is from two to four hours after the final placement of concrete to allow the initial set to take place. If retarders are used, increase the waiting period to 4 to 6 hours. As an alternative, determine the actual time of initial set according to ASTM C 403. Do not start curing until the actual time to initial set has elapsed.

During the waiting period, ensure that the temperature within the curing enclosure is not less than 50 °F (10 °C).

During the initial application of live steam or radiant heat, ensure that the ambient temperature within the curing enclosure increases at an average rate not exceeding 40 °F (22 °C) per hour until the curing temperature is reached.

Ensure that the maximum curing temperature does not exceed 150 °F (65 °C). Hold the design temperature until the concrete has reached the desired design strength. Do not direct the application of live steam on the concrete forms so as to cause localized high temperatures.

9.2.2 Provide water curing according to 511.15 and 511.17, Method A.

9.2.3 Provide membrane curing according to 511.16, Method B.

9.3 Ensure that all forms are in place until the design handling strength is met.

9.4 Holes for handling or setting are not permitted. Do not move members before the design handling strength of the concrete is reached, or shipped before the design strength of the concrete is reached. Ensure that the manufacturers have equipment necessary to handle and transport the pieces without damaging them.

10 Ensure that the hardened concrete contains a minimum of 4 percent entrained air.

10.2.1 Keep the cylinders and matching culvert section together to guarantee the cylinders are matched with the corresponding culvert section; or, upon agreement by the Department, keep the cylinders at a location that will provide the same environment as the culvert sections.

10.2.2 For each section of the culvert, produce and mark at least four cylinders so that they are identifiable with the matching culvert section.

10.2.3 Conform to Supplement 1073 for acceptance.

10.2.3.1 Ensure that cylinder strengths conform to Supplement 1073.

10.3.3.2 Deleted.

10.4 Plug the core holes by using a concrete that is the same as that used in the section and cured in according to Section 9.2, or by a non-shrink grout that exceeds the concrete design strength.

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11 The design in the plan reflects the external top slab elevation of the structure. If the structure supplied has a deck thicker than the plan design, eliminate the difference between the design top slab elevation and the supplied top slab elevation by a reducing the leg length. The Department may approve alternate methods to eliminate the difference between the design top slab elevation and the supplied top slab elevation. The Department will not approve a change in the top slab elevation from that shown on the plans.

The clear span shown is the minimum for the structure. The manufacturer may provide a clear span greater than that shown. Base the exact footer locations for both the elevation and offset on the manufacturer's shop drawings. Ensure that these footer locations are such that the centerline of the leg at the bottom of the haunch matches the centerline of the footer.

All changes to the project resulting from the manufacturer's dimensional changes in the structure are at no charge to the Department.

Ensure that the sections are free of fractures spalls and chips. Ensure that all surfaces have a smooth and regular finish being defined as a 1/4-inch variation within 4 feet (6 mm variation within 1.2 m).

11.1 Ensure that the slab and walls are perpendicular with a diagonal difference of not more than 0.5 percent.

Ensure that the length of each section is within 1/2 inch (13 mm) of the design length. Consider the length is the average of the length measured at each side and at the middle of the three-sided section.

11.4 Ensure that the maximum variation in the position of the reinforcement is 3/8 inch (9 mm), except that the cover over the reinforcement for the external surface of the top slab is not less than 2 inches (50 mm). The above tolerances or cover requirements do not apply to mating surfaces at the joint.

11.5 Resubmit any change in reinforcement from the shop drawings for approval.

12 Make repairs according to the Department's requirements. The Department will not make additional payments for culvert repairs. Repairs are acceptable if, in the opinion of the Department, the repairs are sound, properly finished, and cured.

13 Perform inspection at the project site.

Furnish precast concrete components from suppliers certified according to Supplement 1073.

14 Form seams and slight surface irregularities that are expected from a wood panel forming system will not be cause for rejection. In addition, hairline cracks less than 0.01 inch (0.25 mm) are not cause for rejection.

15.1 Ensure that the location of the product marking is on the interior of the three-sided section 1 foot (300 mm) below the leg haunch.

Add the product marking upon removal of the forms.

The manufacturer may be required to repeat the product markings before the project is final.

**706.052 Precast Reinforced Concrete Arch Sections.** Provide precast reinforced concrete arch sections according to ASTM C 1504, with the following modifications:

This item shall consist of manufacturing precast reinforced concrete arch sections for culverts.

Ensure that manufacturers of precast concrete members are certified according to Supplement 1073.

5 Ensure the manufacturer submits design calculations, a structural load rating and shop drawings for review and approval by the Department. Do not produce any units until receiving approval. Submit a minimum of five copies of the drawings. Allow a minimum of 4 weeks for approval. Ensure the shop drawings include the following:

1. All structural design according to section 900 of the Department's Bridge Design Manual and loading information.
2. Load rate the structure according to the requirements of section 900 of the Department's Bridge Design Manual.
3. All material specifications.
4. All plan view.
5. All elevation view.
6. All headwall and wingwall attachment requirements.
7. All dimensions.
8. All maintenance of traffic phases.
9. All section sizes.
10. All design handling strength.

The manufacturer may modify an approved shop drawing and resubmit for approval to the Department.

Ensure that the shop drawings also include the following special information as required:

1. For top mounted guardrail, the guardrail plate and bolt locations are shown in the plan view. Holes shall be a minimum of 6 inches (150 mm) from a joint.

2. For side mounted guardrail, additional reinforcing details are shown as per the plan details.

6.2.1 Provide cement according to 701, except 701.07.

6.2.2 Provide fly ash according to 701.13.

6.3 Provide aggregates conforming to the quality requirements of 703.02.

6.4 Use chemical admixtures according to 705.12. Use a corrosion inhibitor unless epoxy coated reinforcing steel is used. An approved list of corrosion inhibiting admixtures is on file at the Laboratory. Manufacturers should recognize that the corrosion inhibitors and admixtures may have an effect on strength, entrained air content, workability, etc. of their concrete mixes. The manufacturers choice of one of these corrosion inhibitors does not alleviate meeting all design requirements of this structure.

6.4.1 Provide air-entraining admixture according to 705.10.

6.5 Provide epoxy coated reinforcement according to 709.00, Grade 60 (Grade 420), or 709.14. In lieu of epoxy coated reinforcement, an approved corrosion inhibiting admixture may be added to the concrete at the approved dosage; and provide reinforcement according to 709.01, 709.03 or 709.05; Grade 60 (Grade 420) or 709.08, 709.10, 709.11 or 709.12. Provide epoxy or galvanized coated connections when connecting a precast structural unit into a cast-in-place structural component or between segments of adjacent precast structural units either manufactured as separate units or across construction joints when manufactured as one unit. Provide epoxy coated reinforcement according to 709.00 or 709.14, when these connections are designed using reinforcing steel. Provide galvanized coatings according to 711.02, when these connections are designed using connection plates, hardware or concrete inserts.

7.1 Design according to *AASHTO LRFD Bridge Design Specifications*, Section 12.14.

7.2 Ensure that the concrete cover dimension over the outside circumferential reinforcement is a minimum of 2 inches (50 mm). Ensure that the concrete cover dimension over the inside circumferential reinforcement is a minimum of 1 1/2 inches (38 mm). The clear distance of the end circumferential wires shall not be less than 1 inch (25 mm) nor more than 2 inches (50 mm) from the ends of the sections. Reinforcement shall be assembled utilizing single or multiple layers of welded wire fabric (three-layer maximum), or utilizing a single layer of deformed billet-steel bars. The welded wire fabric shall be composed of circumferential and longitudinal wires and shall contain sufficient longitudinal wires extending through the section to maintain the shape and position of reinforcement. Longitudinal distribution reinforcement may be welded wire fabric or deformed billet-steel bars. The ends of the longitudinal distribution reinforcement shall be not more than 3 inches (75 mm) from the ends of the sections.

The outside and inside circumferential reinforcing steel for the corners of the culvert shall be bent to such an angle that it is approximately equal to the configuration of the culverts outside corner.

7.3 Tension splices in the circumferential reinforcement shall not be made. For splices other than tension splices, the overlap shall be a minimum of 12 inches (300 mm) for welded wire fabric or deformed billet steel bars. The spacing center-to-center of the circumferential wires in a wire fabric sheet shall be not less than 2 inches (50 mm) or more than 4 inches (100 mm). For the wire fabric, the spacing center-to-center of the longitudinal wire shall not be more than 8 inches (200 mm).

The spacing center-to-center of the longitudinal distribution steel for either line of reinforcing in the top slab shall be not more than 16 inches (410 mm).

8.1 Ensure the sections are produced with butt ends. The ends of the sections shall be such that when the sections are laid together they will make a continuous line of sections with a smooth interior free of appreciable irregularities, all compatible with the permissible variations in these Specifications. Provide a chamfer on the outside surface at the sections joint to form a void for a  $7/8 \times 1\ 3/8$ -inch ( $24 \times 34$  mm) flexible plastic gasket 706.14.

9 Application of membrane waterproofing on the arch section at any location other than the final location shown on the plans is prohibited.

9.1 Ensure that the aggregate, cement, and water are manufactured according to 499.06, 499.07, and 499.09.

Ensure that the temperature requirements of 511.08 and 511.15 are met.

Ensure that the proportion of portland cement is not less than 564 pounds per cubic yard ( $335\text{ kg/m}^3$ ) of concrete.

If used, add the corrosion inhibitor as an aqueous solution. Consider the water in the solution as mixing water for the purpose of determining the water-cement ratio of concrete.

9.2 Cure the arch sections in the forms for the length of time required to obtain the specified minimum design handling strength as defined in the shop drawings. Test a cylinder to check each section's design handling strength. Repeat this test as often as needed. Only one cylinder passing will ensure that the design handling strength has been met. If the shop drawing shows no design handling strengths, then the minimum handling strength is assumed to be 100 percent of the design strength. Ensure that the curing then continues either in or out of the forms until the specified minimum design strength is met.

9.2.1 Steam curing is an accelerated cure by low pressure steam or radiant heat within a suitable insulated enclosure to contain the live steam or heat. The initial application of the steam or heat is from 2 to 4 hours after the final placement of concrete to allow the initial set to take place. If retarders are used, increase the waiting period to 4 to 6 hours. As an alternative, determine the actual time of initial set according to ASTM C 403. Do not start curing until the actual time to initial set has elapsed.

During the waiting period, ensure that the temperature within the curing enclosure is not less than  $50\text{ }^\circ\text{F}$  ( $10\text{ }^\circ\text{C}$ ).

During the initial application of live steam or radiant heat, ensure that the ambient temperature within the curing enclosure increases at an average rate not exceeding  $40\text{ }^\circ\text{F}$  ( $22\text{ }^\circ\text{C}$ ) per hour until the curing temperature is reached.

Ensure that the maximum curing temperature does not exceed  $150\text{ }^\circ\text{F}$  ( $65\text{ }^\circ\text{C}$ ). Hold the design temperature until the concrete has reached the desired design strength. Do not direct the application of live steam on the concrete forms so as to cause localized high temperatures.

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9.2.2 Provide water curing according to 511.15 and 511.17, Method A.

9.2.3 Deleted.

9.3 Ensure that all forms are in place until the design handling strength is met.

Holes for handling or setting are not permitted. Do not move members before the design handling strength of the concrete is reached, or shipped before the design strength of the concrete is reached. Ensure that the manufacturers have equipment necessary to handle and transport the pieces without damaging them.

10 Ensure that the hardened concrete contains a minimum of 4 percent entrained air.

10.2.1 Keep the cylinders and matching culvert section together to guarantee the cylinders are matched with the corresponding culvert section; or, upon agreement by the Department, keep the cylinders at a location that will provide the same environment as the culvert sections.

10.2.2 For each section of the culvert, produce and mark at least four cylinders so that they are identifiable with the matching culvert section.

10.2.3 Conform to Supplement 1073 for acceptance.

10.2.3.1 Ensure that cylinder strengths conform to Supplement 1073.

10.3.3.2 Deleted

10.4 Plug the core holes by using a concrete that is the same as that used in the section and cured according to Section 9.2, or by a non-shrink grout that exceeds the concrete design strength.

11.0 The under-run in length of a section shall not be more than 1/2 inch (13 mm).

All changes to the project resulting from the manufacturer's dimensional changes in the structure are at no charge to the Department.

Ensure that the sections are free of fractures spalls and chips. Ensure that all surfaces have a smooth and regular finish being defined as a 1/4 inch variation within 4 feet (6 mm variation within 1.2 m).

11.1 The internal dimensions shall vary not more than 1 percent from the design dimensions or more than 38 mm (1 1/2 inches), whichever is less. The haunch dimensions shall vary not more than 19 mm (3/4 inch) from the design dimension.

11.4 Ensure that the maximum variation in the position of the reinforcement is 3/8 inch (9 mm), except that the cover over the reinforcement for the external surface of the top slab is not less than 2 inches (50 mm). The above tolerances or cover requirements do not apply to mating surfaces at the joint.

11.5 Resubmit any change in reinforcement from the shop drawings for approval.

12.0 Make repairs according to the Department's requirements. The Department will not make additional payments for culvert repairs. Repairs are acceptable if, in the opinion of the Department, the repairs are sound, properly finished, and cured.

13.0 Perform inspection at the project site.

Furnish precast concrete components from suppliers certified according to Supplement 1073.

14.0 Form seams and slight surface irregularities that are expected from a wood panel forming system will not be cause for rejection. In addition, hairline cracks less than 0.01 inch (0.25 mm) will not be cause for rejection.

15.1 Ensure that the location of the product marking is on the interior of the arch section 1 foot (300 mm) below the leg haunch.

Add the product marking upon removal of the forms.

The manufacturer may be required to repeat the product markings before the project is final.

**706.06 Perforated Concrete Pipe.** Provide perforated concrete pipe according to ASTM C 444 (ASTM C 444M), and 706.01 or 706.02.

Ensure manufacturers providing materials are certified according to Supplement 1074.

**706.07 Concrete Drain Tile.** Provide extra-quality concrete drain tile according to ASTM C 412 (ASTM C 412M), with the following modifications:

Ensure manufacturers providing materials are certified according to Supplement 1074.

4.0 This specification covers extra-quality concrete drain tile only.

5.1(3) Does not apply.

6.2.1 Provide cement according to 701, except 701.07.

6.2.2 Provide fly ash according to 701.13

6.3 Provide aggregate conforming to the quality requirements of 703.02.

8.1 Perform inspection at the project site. Obtain random samples from material delivered to the project site or at other locations designated by the Laboratory. Ensure manufacturers providing materials are certified according to Supplement 1074.

Testing. Ensure that the manufacturer furnishes all facilities and personnel to carry out the tests.

**706.08 Vitrified Clay Pipe.** Provide vitrified clay pipe according to ASTM C 700, with the following modifications:

Furnish materials according to the Department's Qualified Products List (QPL).

14.0 Perform all tests except hydrostatic according to ASTM C 301.

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15.0 Perform inspection at the project site. Obtain random samples from material delivered to the project site or at other locations designated by the Laboratory.

**706.09 Clay Drain Tile.** Provide extra-quality clay drain tile according to ASTM C 4, with the following modifications:

6.1 Perform inspection at the project site. Obtain random samples from material delivered to the project site or at other locations designated by the Laboratory.

11, 12, and 13 Ensure that the manufacturer furnishes all facilities and personnel to carry out the tests.

Furnish materials according to the Department’s Qualified Products List (QPL).

**706.10 Bituminous Pipe Joint Filler.** Provide cold applied, mineral filled, joint sealing compound for joints of bell and spigot, or tongue and groove sewer; or drain pipe conforming to the following:

**A. Composition.** Provide a steam-refined petroleum asphalt or a refined coal tar, dissolved in a suitable solvent, and containing an appropriate stiffener.

**B. General Requirement.** Provide a bituminous plastic cement that has a smooth, uniform mixture, not thickened or livered, and that shows a separation easily overcome by stirring. Ensure that the material is of such consistency and properties that it is readily applied with a trowel, a putty knife, or with a caulking gun without pulling or drawing. Provide a material that when applied to metal, concrete, or vitrified clay surfaces, exhibits good adhesive and cohesive properties and has only slight shrinkage after curing. Provide a material that is not damaged by exposure to below freezing temperatures.

**C. Detail Requirements.** Provide materials conforming to the following requirements:

1.	When applied in a layer 1/16 to 1/8-inch (1.6 to 3.2 mm) thick on a tinned metal panel and cured at room temperature for 24 hours, the bituminous plastic cement shall set to a tough, plastic coating, free from blisters.		
		<u>Minimum</u>	<u>Maximum</u>
2.	Grease Cone Penetration (unworked, 150 grams, 25 °C, 5 sec, ASTM D 217, mm/10)	175	250
3.	Weight, kg/L	1.17	--
4.	Non-volatile, 10 g, 105 to 110 °C, 24 hrs, %	75	--
5.	Ash, by ignition, %	25	45

Furnish materials according to the Department’s Qualified Products List (QPL).

**706.11 Resilient and Flexible Gasket Joints.** Provide resilient and flexible gasket joints for concrete pipe according to ASTM C 443 (ASTM C 443M).

Furnish materials according to the Department's Qualified Products List (QPL).

**706.12 Resilient and Flexible Joints.** Provide resilient and flexible joints for vitrified clay pipe according to ASTM C 425.

Furnish materials according to the Department's Qualified Products List (QPL).

**706.13 Precast Reinforced Concrete Manhole Riser Sections, Flat Slab Tops, Catch Basins and Inlet Tops, and Portable Barriers.** Provide precast reinforced concrete manhole riser sections, flat slab tops, catch basins and inlet tops, and portable barriers according to ASTM C 478 (ASTM C 478M), with the following modifications:

1.1 Provide precast catch basin tops where permitted by the plans.

4.1.2.1 Provide cement according to 701, except 701.07.

4.1.2.2 Provide fly ash according to 701.13.

4.1.4 Provide aggregate conforming to the quality requirements of 703.02.

4.1.6 Provide steel according to 709.01, 709.08, 709.10, or 709.12. Provide epoxy coated steel according to 709.00 for the manhole flat slab tops, catch basin tops and inlet tops only.

7.0 In addition, ensure that not more than two holes are cast, drilled, or otherwise neatly made in the shell of each piece of each riser section for the purpose of handling or laying. Taper the holes unless drilled, and before backfilling fill the tapered holes with portland cement mortar or secure the concrete plugs with portland cement mortar. Fill drilled holes with portland cement mortar.

8.2.2 Absorption test does not apply

10.0 Perform inspection at the project site.

11.0 In addition, mark the plant location on each manhole top or barrier section.

Ensure manufacturers providing materials are certified according to Supplement 1073

Ensure that the manufacturer submits design calculations to the Office of Structural Engineering for structures that have a span of 10 feet or greater and are located in the pavement. Ensure the design is based upon section 1000 of the Location and Design Manual, Volume 2. Calculations must contain signatures from two (2) Professional Engineers qualified in structural design

**706.14 Preformed Flexible Joint Sealant.** Provide preformed flexible joint sealant for concrete conduit according to ASTM C 990.

Furnish materials according to the Department's Qualified Product List (QPL).

**706.15 Precast Reinforced Concrete Outlets.** Provide precast reinforced concrete outlets composed of cement conforming to 701, except 701.07. Provide aggregate conforming to the quality requirements of 703.02. Provide epoxy coated steel reinforcement conforming to 709.00. Do not provide holes for handling or

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laying. Ensure that the outlet hole are the same size as the outlet pipe. Perform inspection at the project site.

Ensure manufacturers providing materials are certified according to Supplement 1073

### **707 STEEL, ALUMINUM, AND PLASTIC PIPE**

**707.00 Acceptance.** Corrugated metal pipe conforming to 707.01, 707.02, 707.03, 707.04, 707.05, 707.07, 707.11, 707.12, 707.13, 707.14, 707.15, 707.21, 707.22, 707.23, 707.24, and 707.25 may be accepted for shipment to and immediate use in construction projects when provided from suppliers certified according to Supplement 1019.

**707.01 Metallic Coated Corrugated Steel Conduits and Underdrains.** Provide conduits and underdrains having a corrugation depth of 1/2 or 1/4 inch (13 or 6.5 mm) and according to AASHTO M 36/M 36M, with the following modifications:

7.5 Ensure either helical lock or continuous welded seams are used.

7.7.1 Helical corrugated pipe, 12-inch (300 mm) diameter and larger, shall have at least two annular corrugations at each end of each pipe length.

8.1.2. Ensure that the minimum wall thickness (coated) of steel pipe and pipe-arches is as follows:

<b>Pipe</b>		<b>Pipe-Arch</b>	
<b>Diameter (in)</b>	<b>Wall Thickness (in)</b>	<b>Size (in)</b>	<b>Wall Thickness (in)</b>
6	0.052		
8	0.064		
10	0.064		
12	0.064		
15	0.064	17 × 13	0.064
18	0.064	21 × 15	0.064
21	0.064	24 × 18	0.064
24	0.064	28 × 20	0.064
27	0.064		
30	0.064	35 × 24	0.064
33	0.064		
36	0.064	42 × 29	0.064
42	0.064	49 × 33	0.079
48	0.064	57 × 38	0.109
54	0.109	64 × 43	0.109
60	0.109	71 × 47	0.138
66	0.138	77 × 52	0.168
72	0.138	83 × 57	0.168
78	0.168		
84	0.168		

Pipe		Pipe-Arch	
Diameter (mm)	Wall Thickness (mm)	Size (mm)	Wall Thickness (mm)
150	1.32		
200	1.63		
250	1.63		
300	1.63		
375	1.63	430 × 340	1.63
450	1.63	530 × 380	1.63
525	1.63	610 × 460	1.63
600	1.63	710 × 510	1.63
675	1.63		
750	1.63	885 × 610	1.63
825	1.63		
900	1.63	1060 × 740	1.63
1050	1.63	1240 × 840	2.01
1200	1.63	1440 × 970	2.77
1350	2.77	1620 × 1100	2.77
1500	2.77	1800 × 1200	3.51
1650	3.51	1950 × 1320	3.51
1800	3.51	2100 × 1450	4.27
1950	4.27		
2100	4.27		

Ensure that the minus tolerance conforms to AASHTO M 218, M 274, or M 289.

**TABLE 707.01-1 PIPE REQUIREMENTS**

Nominal Inside Diameter		Corrugation Depth Nominal		Minimum Width of Lap	
(in)	(mm)	(in)	(mm)	(in)	(mm)
27	675	1/2	13	2	50
33	825	1/2	13	2	50

8.3.2.1 Ensure that the minimum number of longitudinal rows of perforations is four.

9.1 Coupling bands shall have annular corrugations.

9.2 Ensure that coupling bands are not more than two nominal sheet thicknesses thinner than the thickness of the pipe to be connected. For pipes 48-inch (1200 mm) diameter and smaller, ensure that the coupling band is not thinner than the 0.052-inch (1.32 mm) nominal sheet thickness. For pipes 54-inch (1350 mm) diameter through 84-inch (2100 mm) diameter, ensure that the coupling band is not thinner than the 0.064-inch (1.63 mm) nominal sheet thickness. For pipe diameters over 36 inches (900 mm), provide coupling bands that have at least one

annular corrugation that indexes into the inboard corrugation of each pipe section joined.

**707.02 Metallic Coated Corrugated Steel Conduits [1-inch (25 mm) Corrugations].** Provide conduits according to AASHTO M 36/M 36M, with the following modifications:

7.5 Ensure either helical lock or continuous welded seams are used.

7.7.1 Helical corrugated pipe shall have at least two annual corrugations at each end of each pipe length.

8.1.2. Ensure that the minimum wall thickness (coated) of steel pipe and pipe-arches is as follows:

Pipe		Pipe-Arch	
Diameter (in)	Wall Thickness (in)	Size (in)	Wall Thickness (in)
36	0.064	40 × 31	0.109
42	0.064	46 × 36	0.109
48	0.064	53 × 41	0.109
54	0.079	60 × 46	0.109
60	0.079	66 × 51	0.109
66	0.109	73 × 55	0.109
72	0.109	81 × 59	0.109
78	0.109	87 × 63	0.109
84	0.109	95 × 67	0.109
90	0.109	103 × 71	0.109
96	0.109	112 × 75	0.109
102	0.109	117 × 79	0.109
108	0.109	128 × 83	0.138
114	0.109	137 × 87	0.138
120	0.109	142 × 91	0.169

Pipe		Pipe-Arch	
Diameter (mm)	Wall Thickness (mm)	Size (mm)	Wall Thickness (mm)
900	1.63	1010 × 790	2.77
1050	1.63	1160 × 920	2.77
1200	1.63	1340 × 1050	2.77
1350	2.01	1520 × 1170	2.77
1500	2.01	1670 × 1300	2.77
1650	2.01	1850 × 1400	2.77
1800	2.77	2050 × 1500	2.77
1950	2.77	2200 × 1620	2.77
2100	2.77	2400 × 1720	2.77
2250	2.77	2600 × 1820	2.77
2400	2.77	2840 × 1920	2.77
2550	2.77	2970 × 2020	2.77
2700	2.77	3240 × 2120	3.51
2850	2.77	3470 × 2220	3.51
3000	2.77	3600 × 2320	4.27

Ensure that the minus tolerance conforms to AASHTO M 218, M 274, or M 289.

9.1 Provide coupling bands with a minimum wall thickness (coated) of 0.064 inch (1.63 mm) and that have at least one annular corrugation that indexes into the inboard corrugations of each pipe section joined.

**707.03 Structural Plate Corrugated Steel Structures.** Provide structural plate pipe, pipe arch, and arch structures according to AASHTO M 167 (AASHTO M 167M), with the following modification:

5.4 Assembly bolts may be galvanized by an electrolytic process.

**707.04 Precoated, Galvanized Steel Culverts.** Provide conduits and coupling bands according to AASHTO M 245/M 245M, as modified by 707.01 and 707.02. Ensure that the precoated, galvanized steel sheets conform to AASHTO M 246/M 246M, Type B. Ensure that the polymeric coating is 10 mils (250 µm) on the interior and 10 mils (250 µm) on the exterior.

**707.05 Bituminous Coated Corrugated Steel Pipe and Pipe Arches with Paved Invert [1/2-inch (13 mm) Corrugations].** Provide conduits and coupling bands according to 707.01 and to AASHTO M 190. Provide either Type B half bituminous coated pipe, or pipe arches with paved invert or Type C fully coated pipe, or pipe arches with paved invert.

**707.07 Bituminous Coated Corrugated Steel Pipe and Pipe Arches with Paved Invert [1-inch (25 mm) Corrugations].** Provide conduits and coupling bands according to 707.02 and to AASHTO M 190. Provide either Type B half bituminous coated pipe, or pipe arches with paved invert or Type C fully coated pipe, or pipe arches with paved invert.

**707.10 Square and Rectangular Steel Tubing.** Provide square and rectangular steel tubing according to ASTM A 501 or ASTM A 500, Grade B, with the following modifications:

Galvanize the tubing according to 711.02.

Test the tubular steel from all heat numbers supplied for toughness according to ASTM E 436, except as modified herein. Take and test tubing test samples before delivery of the railing. Ensure that the taking of the test samples is witnessed and the testing is performed by an independent test laboratory. Submit certified test data for review and approval as specified in 501.06.

Perform testing on test specimens obtained from galvanized tubing with the same heat number as that being used. Conduct the testing at a temperature of 0 °F (-18 °C) on 2 × 9-inch (50 × 225 mm) specimens supported to provide a 7-inch (180 mm) clear span. Do not remove the galvanizing from the specimens. Cut three 2 × 9-inch (50 × 225 mm) test specimens from each of the unwelded sides for a total of nine specimens. If all three unwelded sides are not large enough to remove 2 × 9-inch (50 × 225 mm) specimens, then remove nine specimens from any unwelded side.

Disregard the three specimens from the side with the lowest average shear area when calculating the final average shear area. If specimens were not removed from three unwelded sides, then disregard the three specimens with the lowest average shear area. Calculate the final average shear area using the six remaining specimens. If the average shear area falls below 50 percent, reject material from the heat represented by these tests. However, if the average shear area is 30 percent or greater, the Department will allow one retest at a sampling frequently three times that of the first test, and with no samples excluded in calculating the average. Reject materials not having a 50 percent average shear area upon retest.

Before galvanizing, the manufacturer of the tubing shall identify the product with the steel heat number (or with some number that is traceable to the heat number) and with the manufacturer's unique identification code to facilitate acceptance or rejection of the material. Ensure that the identification method is such that identification is on only one face of the section, and is repeated at intervals no greater than 4 feet (1.2 m), and does not extend into the curved surface of the tubing at the corners.

**707.11 Mortar Lined Corrugated Steel Pipe.** Provide pipe according to 707.01 and 707.02 and having the interior coated with mortar according to ASTM A 849, Class C, with the following modifications:

These requirements apply to 24-inch to 120-inch (600 to 3000 mm) diameter conduit. Conduits 24 to 60 inches (600 to 1500 mm) in diameter shall conform to 707.01. Conduits 66 inches (1650 mm) and above in diameter shall conform to 707.01 or 707.02. Ensure that the minimum wall thickness of the 707.02 steel pipe is 0.109 inch (2.77 mm).

7.7 Before the mortar lining is applied, apply a bituminous coating according to AASHTO M 190, Type A, or an approved barrier coating, to the

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inside surface of the conduits if they are fabricated from steel sheet according to AASHTO M 274 or M 289.

7.7 The mortar lining shall have a minimum thickness of 1/4 inch (6 mm) above the crests of the corrugations. Ensure that the mortar lining is prequalified by the manufacturer by submitting to the Laboratory certified test data according to 101.03. This data will include test data for all components of the mixture, and the 7 and 28-day compressive strengths of the mixture.

14 These conduits may be accepted for shipment to and immediate use in construction projects by using the manufacturer’s certification for the steel pipe and mortar. Ensure that the certification states that the mortar is of the same design as that prequalified with the Laboratory.

**707.12 Corrugated Steel Spiral Rib Conduits.** Provide conduits that have a center-to-center rib spacing of 7 1/2 inches (190 mm). Provide conduits and fittings according to AASHTO M 36, Type IR, with the following modifications:

6.1 Fabricate pipe from aluminum coated sheet according to AASHTO M 274.

7.2.2 The ribs shall conform to AASHTO M 196, Section 7.2.2.

7.7.1 Reroll the ends of the individual pipe sections to form at least two annular corrugations on each end. Paint the rerolled end with zinc rich paint.

8.1.2 Ensure that the minimum wall thickness (coated) of steel pipe is as follows:

<b>Pipe</b>			
<b>Diameter</b>	<b>Wall Thickness</b>	<b>Diameter</b>	<b>Wall Thickness</b>
<b>(in)</b>	<b>(in)</b>	<b>(mm)</b>	<b>(mm)</b>
18	0.064	450	1.63
21	0.064	525	1.63
24	0.064	600	1.63
30	0.064	750	1.63
36	0.064	900	1.63
42	0.064	1050	1.63
48	0.064	1200	1.63
54	0.109	1350	2.77
60	0.109	1500	2.77
66	0.109	1650	2.77
72	0.109	1800	2.77
78	0.109	1950	2.77
84	0.138	2100	3.51
90	0.138	2250	3.51

9.1 Coupling bands shall have annular corrugations.

9.2 Coupling bands shall conform to 707.01.

9.3 A bell and spigot joint per ASTM A760 (A760M) may be used with the following modifications:

9.3.1 These joints may be used for conduits ranging in size from 18 (450mm) to 48 (1200mm) inches in diameter.

9.3.2 Ensure the bell and spigot has a soil tight joint by use of a shop applied gasket on the bell end and a field applied gasket on the spigot end.

9.3.3 Provide a minimum of 0.064 (1.63mm) inch nominal sheet thickness or not more than two (2) nominal sheet thickness thinner than the thickness of the pipe to be joined.

14.1 Ensure that the certification and sampling conforms to 707.01.

**707.13 Bituminous Lined Corrugated Steel Pipe [1/2-inch (13 mm) Corrugations].** Provide pipe according to 707.01 and AASHTO M 190, Type D.

**707.14 Bituminous Lined Corrugated Steel Pipe [1-inch (25 mm) Corrugations].** Provide pipe according to 707.02 and AASHTO M 190, Type D.

**707.15 Corrugated Steel Box Culverts.** Provide corrugated steel box culverts according to ASTM A 964.

Ensure that all manufacturers are pre-approved. Ensure that manufacturers not pre-approved submit a structural design criteria and analysis method to the Department before the project letting for approval. The Department maintains a list of all pre-approved manufacturers.

Ensure that the manufacturer submits shop drawings and design calculations for review and written approval before manufacture. Submit a minimum of seven copies of the drawings. Allow a minimum of four weeks for approval. Ensure that the shop drawings include the following:

- A. All structural design and loading information.
- B. All material specifications.
- C. All plan view.
- D. All elevation view.
- E. All headwall and wingwall attachment requirements.
- F. All dimensions.
- G. All maintenance of traffic phases.
- H. All plate size and dimensions.

The manufacturer may modify an approved shop drawing and resubmit for approval to the Department.

**707.17 Spiral Rib Steel Pipe Arch.** Provide conduits according to AASHTO M36, Type IIA, with the following modifications:

6.1 Fabricate pipe from aluminum coated sheet according to AASHTO M 274.

7.2.2 The ribs shall conform to AASHTO M 196, Section 7.2.2.

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9.1 Coupling bands shall have annular corrugations.

9.2 Coupling bands shall conform to 707.01.

14.1 Ensure that the certification and sampling conforms to 707.01.

Ensure that the minimum wall thickness of Spiral Rib steel pipe arches is as follows:

<b>Pipe-Arch</b>			
<b>Size (in)</b>	<b>Wall Thickness (in)</b>	<b>Size (mm)</b>	<b>Wall Thickness (mm)</b>
20 x 16	0.079	500 x 410	2.01
23 x 19	0.079	580 x 490	2.01
27 x 21	0.079	680 x 540	2.01
33 x 26	0.079	830 x 670	2.01
40 x 31	0.079	1010 x 790	2.01
46 x 36	0.079	1160 x 920	2.01
53 x 41	0.109	1340 x 1050	2.77
60 x 46	0.109	1520 x 1170	2.77
66 x 51	0.109	1670 x 1300	2.77
73 x 55	0.109	1850 x 1400	2.77
81 x 59	0.138	2050 x 1500	3.51

**707.21 Corrugated Aluminum Alloy Conduits and Underdrains.** Provide conduits and underdrains having a 1/4, 7/16, or 1/2-inch (6.5, 11, or 13 mm) corrugation depth and according to AASHTO M 196/M 196M, with the following modifications:

8.1 and 8.2 Provide helically corrugated pipe 12 inches (300 mm) in diameter and larger that have at least two circumferential corrugations at each end of each pipe length.

8.1.2 Ensure that the minimum wall thickness of aluminum pipe and pipe arches is as follows:

Pipe		Pipe-Arch	
Diameter (in)	Wall Thickness (in)	Size (in)	Wall Thickness (in)
6	0.048		
8	0.060		
10	0.060		
12	0.060		
15	0.060	17 × 13	0.060
18	0.060	21 × 15	0.060
21	0.060	24 × 18	0.060
24	0.060	28 × 20	0.075
27	0.075		
30	0.075	35 × 24	0.075
36	0.075	42 × 29	0.105
42	0.105	49 × 33	0.105
48	0.105	57 × 38	0.135
54	0.105	64 × 43	0.135
60	0.135	71 × 47	0.164
66	0.164		
72	0.164		

Pipe		Pipe-Arch	
Diameter (mm)	Wall Thickness (mm)	Size (mm)	Wall Thickness (mm)
150	1.22		
200	1.52		
250	1.52		
300	1.52		
375	1.52	430 × 330	1.52
450	1.52	530 × 380	1.52
525	1.52	610 × 460	1.52
600	1.52	710 × 510	1.91
675	1.91		
750	1.91	885 × 610	1.91
900	1.91	1060 × 740	2.67
1050	2.67	1240 × 840	2.67
1200	2.67	1440 × 970	3.43
1350	2.67	1620 × 1100	3.43
1500	3.43	1800 × 1200	4.17
1650	4.17		
1800	4.17		

Ensure that the minus tolerance conforms to AASHTO M 197/M 197M.

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9.2 Provide coupling bands with a minimum wall thickness (coated) of 0.060 inch (1.52 mm). For pipe diameters 12 inches (300 mm) and larger, provide coupling bands that have at least one circumferential corrugation that indexes into the inboard corrugations of each pipe section joined.

**707.22 Corrugated Aluminum Alloy Conduits.** Provide conduits having a 1-inch (25 mm) corrugation depth and according to AASHTO M 196/M 196M, with the following modifications:

8.1 and 8.2 Provide helically corrugated pipe that have at least two circumferential corrugations at each end of each pipe length.

8.1.2 Ensure that the minimum wall thickness of aluminum pipe is as follows:

<b>Pipe</b>			
<b>Diameter</b>	<b>Wall Thickness</b>	<b>Diameter</b>	<b>Wall Thickness</b>
<b>(in)</b>	<b>(in)</b>	<b>(mm)</b>	<b>(mm)</b>
36	0.060	900	1.63
42	0.060	1050	1.63
48	0.060	1200	1.63
54	0.075	1350	1.91
60	0.105	1500	2.67
66	0.105	1650	2.67
72	0.105	1800	2.67
78	0.105	1950	2.67
84	0.105	2100	2.67
90	0.105	2250	2.67
96	0.105	2400	2.67
102	0.135	2550	3.43
108	0.135	2700	3.43
114	0.164	2850	4.17
120	0.164	3000	4.17

Ensure that the minus tolerance conforms to AASHTO M 197/M 197M.

9.2 Provide coupling bands that are not lighter than 0.060-inch (1.52 mm) nominal sheet thickness and that have at least one circumferential corrugation that indexes into the inboard corrugations of each pipe section joined.

**707.23 Aluminum Alloy Structural Plate Conduits.** Provide aluminum alloy plates and fasteners for structural plate conduits according to AASHTO M 219/M 219M.

**707.24 Corrugated Aluminum Spiral Rib Conduits.** Provide conduits that have a center-to-center rib spacing of 7 1/2 inches (190 mm). Provide conduits and fittings according to AASHTO M 196, Type IR, with the following modifications:

7.5.1 Reroll the ends of the individual pipe sections to form at least two annular corrugations on each end.

8.1.2 Ensure that the minimum wall thickness of aluminum pipe is as follows:

<b>Pipe</b>			
<b>Diameter (in)</b>	<b>Wall Thickness (in)</b>	<b>Diameter (mm)</b>	<b>Wall Thickness (mm)</b>
18	0.060	450	1.52
21	0.060	525	1.52
24	0.060	600	1.52
30	0.060	750	1.52
36	0.075	900	1.91
42	0.105	1050	2.67
48	0.105	1200	2.67
54	0.105	1350	2.67
60	0.135	1500	3.43
66	0.135	1650	3.43

9.1 Coupling bands shall have annular corrugations.

9.2 Coupling bands shall conform to 707.21.

14.1 Ensure that the certification and sampling conforms to 707.21.

**707.25 Corrugated Aluminum Box Culverts.** Provide corrugated aluminum box culverts according to ASTM B 864/B 864M.

Ensure that all manufacturers are pre-approved. Ensure that manufacturers not pre-approved submit a structural design criteria and analysis method to the Department before the project letting for approval. The Department maintains a list of all pre-approved manufacturers.

Ensure that the manufacturer submits shop drawings and design calculations for review and written approval before manufacture. Submit a minimum of seven copies of the drawings. Allow a minimum of four weeks for approval. Ensure that the shop drawings include the following:

- A. All structural design and loading information.
- B. All material specifications.
- C. All plan view.
- D. All elevation view.
- E. All headwall and wingwall attachment requirements.
- F. All dimensions.
- G. All maintenance of traffic phases.
- H. All plate size and dimensions.

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The manufacturer may modify an approved shop drawing and resubmit for approval to the Department.

**707.31 Corrugated Polyethylene Drainage Tubing.** Provide corrugated polyethylene drainage tubing according to AASHTO M 252 Type C and CP,

Only provide materials from manufacturers certified according to Supplemental Specification 1066.

**707.32 Corrugated Polyethylene Drainage Pipe.** Provide conduits, coupling bands, and fittings according to AASHTO M 294, Type C.

Only provide materials from manufacturers certified according to Supplemental Specification 1066.

**707.33 Corrugated Polyethylene Smooth Lined Pipe.** This specification covers smooth lined corrugated polyethylene pipe, closed profile polyethylene pipe, couplings, and fittings which shall conform to AASHTO M 252 or AASHTO M 294, Type S, SP, or D, with the following modifications to AASHTO M 294:

1.1.1 Nominal size of 4 to 60 inches (100 mm to 1500 mm) are included. 4.1.2 Annular corrugated pipe (Type S or SP) or closed profile pipe (Type D) shall be provided.

6.1 Carbon black may be blended with the virgin resin by means of a carrier resin. The proportioning of the carrier resin to the carbon black shall not be greater than 3:1.

7.2.1 Nominal diameters shall be 4, 6, 8, 10, 12, 15, 18, 24, 30, 36, 42, 48, 54, and 60 inches (100, 150, 200, 250, 300, 375, 450, 600, 750, 900, 1050, 1200, 1350, and 1500 mm).

7.2.2 The inner liner of Type S and SP pipe, and both inner and outer walls of Type D pipe shall have the following minimum thicknesses, when measured in according to Section 7.2.2.

Diameter		Inner Wall Thickness	
(in)	(mm)	(in)	(mm)
4	100	0.020	0.50
6	150	0.020	0.50
8	200	0.025	0.60
10	250	0.025	0.60
12	300	0.035	0.90
15	375	0.040	1.00
18	450	0.050	1.30
24	600	0.060	1.50
30	750	0.060	1.50
36	900	0.065	1.70
42	1050	0.070	1.80
48	1200	0.070	1.80
54	1350	0.070	2.0
60	1500	0.070	2.0

7.4 When tested in accordance with Section 9.1, the pipe shall have a minimum pipe stiffness at 5 percent deflection as follows:

Diameter		Pipe Stiffness	
(in)	(mm)	(P/II)	(N/m/mm)
4	100	50	340
6	150	50	340
8	200	50	340
10	250	50	340
12	300	50	345
15	375	42	290
18	450	40	275
24	600	34	235
30	750	28	195
36	900	22	150
42	1050	20	140
48	1200	18	125
54	1350	16	110
60	1500	14	95

7.8.5 In addition, couplings for corrugated pipe shall be bell and spigot or bell-bell couplings, or clamp-on bands, for all size up to and including 36-inch (900 mm) diameter.

Couplings for Type D pipe shall be a bell-bell or bell and spigot coupling. The coupling may be welded on one end of each length of pipe by means of a full circumferential weld. Stitch welds are not permitted.

Couplings for pipe diameters 42 inches (1050 mm) and larger shall be bell-bell or bell and spigot.

9.1 Test specimens shall have a minimum length of 12 inches (300 mm) or one pipe diameter whichever is greater.

11.1.3 In addition, pipe with diameters 4 through 10 inches (100 through 200 mm) inclusive may be marked "AASHTO M252".

12.1 Only provide materials from manufacturers certified according to Supplemental Specification 1066.

**707.41 Polyvinyl Chloride Plastic Pipe.** Provide smooth wall perforated PVC plastic pipe and fittings with nominal size of 4, 6, and 8-inch (100, 150, and 200 mm) diameter according to ASTM F 758, Type PS 46 minimum, with the following modifications:

7.2.4 The pipe shall have has a minimum of four rows of perforations.

14 Furnish the manufacturer's certification and the report of test results.

**707.42 Polyvinyl Chloride Corrugated Smooth Interior Pipe.** Provide PVC profile wall pipe with a smooth interior that consists of an outer corrugated wall fused to a smooth inner wall. Nominal size of 4, 6, 8, 10, 12, 15, 18, 21, 24, 27, 30, 36, 42, & 48-inch (100, 150, 200, 250, 300, 375, 450, 525, 600, 675, 750, 900,

**707.43**

1050, & 1200 mm) diameter are included for pipe, joints, and fittings. Provide sanitary sewer pipe according to ASTM F 949, and storm sewer and drain pipe according ASTM F 949 or AASHTO M 304, with the following modifications:

**A. ASTM F 949.**

5.2.4 Perforated pipe may be specified.

10.1 The manufacturer shall furnish certified test data annually to the Laboratory or at any time when the method of manufacture is changed. Provide a letter or certification to cover each shipment of material verifying that it meets specification requirements.

**B. AASHTO M 304.**

10.5 The manufacturer shall furnish certified test data annually to the Laboratory or at any time when the method of manufacture is changed. Provide a letter or certification to cover each shipment of material verifying that it meets specification requirements.

**707.43 Polyvinyl Chloride Profile Wall Pipe.** Provide PVC profile wall, smooth flow, sewer pipe and fittings with integral bell joints. The inside diameters range from 4 through 48 inches (100 through 1200 mm).

A. Provide storm sewer pipe from 4 to 15-inch (100 to 375 mm) diameter and sanitary sewer pipe and fittings according to ASTM F 794, with the following modifications:

7.5 Ensure a minimum pipe stiffness of 46 or greater.

10.6 The manufacturer shall furnish certified test data annually to the Laboratory, or at any time when the method of manufacture is changed. A letter of certification shall be provided to cover each shipment of material verifying that it meets specification requirements.

B. Provide storm sewer pipe 18-inch (450 mm) diameter and greater according to AASHTO M 304, with the following modifications:

6.1 Internal sleeve joints are not permitted.

10.5 The manufacturer shall furnish certified test data annually to the Laboratory, or at any time when the method of manufacture is changed. Provide a letter of certification to cover each shipment of material verifying that it meets specification requirements.

**707.44 Polyvinyl Chloride Sanitary Pipe.** Provide PVC plastic pipe and fittings with nominal size of 4 through 15-inch (100 through 375 mm) diameter according to ASTM F 789, Type PS 46 minimum, with the following modification:

11.1 Furnish the manufacturer's certification and the report of the test results.

**707.45 Polyvinyl Chloride Solid Wall Pipe.** Provide PVC solid wall pipe and fittings with nominal size of 4 through 15-inch (100 through 375 mm) diameter according to ASTM D 3034, SDR 35, with the following modifications:

9.1 Perform inspection at the project site.

10.1 The retest provisions do not apply.

11.1 Furnish certified test data as defined in 101.03 to the Engineer.

**707.46 Polyvinyl Chloride Drain Waste and Vent Pipe.** Provide PVC drain, waste, and vent pipe and fittings with nominal size of 1 1/4 through 12-inch (30 through 300 mm) diameter according to ASTM D 2665, with the following modifications.

8.1 The retest provisions do not apply.

10 Furnish certified test data as defined in 101.03 to the Engineer. Perform inspection at the project site.

**707.47 ABS and Polyvinyl Chloride Composite Pipe.** Provide ABS and PVC composite pipe and fittings with nominal size of 4 through 15-inch (100 through 375 mm) diameter according to ASTM D 2680, with the following modifications.

11.1 Perform inspection at the project site.

12.1 The retest provisions do not apply.

13.1 Furnish certified test data as defined in 101.03 to the Engineer.

**707.51 ABS Drain Waste and Vent Pipe.** Provide ABS schedule 40 plastic drain waste and vent pipe and fittings with nominal size of 4 1/4 through 16-inch (30 through 150 mm) diameter according to ASTM D 2661, Type PS 46 minimum or SDR 35, with the following modifications:

6.4.1 Perform inspection at the project site.

9.1 The retest provisions do not apply.

11 Furnish certified test data as defined in 101.03 to the Engineer.

**707.52 ABS Sewer Pipe.** Provide ABS sewer pipe and fittings with nominal size of 3 through 12-inch (75 through 300 mm) diameter according to ASTM D 2751, SDR 35, with the following modifications:

9.1 Perform inspection at the project site.

10.1 The retest provisions do not apply.

11.1 Furnish certified test data as defined in 101.03 to the Engineer.

**707.70 Welded and Seamless Steel Pipe.** Provide welded and seamless steel pipe according to ASTM A 53 or ASTM A 139/A 139M, Grade B, with the following modifications:

20.1 Perform inspection at the project site. Obtain random samples from material delivered to the project site or at other locations designated by the Laboratory.

Furnish materials according to the Department's Qualified Products List (QPL).

## 708 PAINT

**708.01 Inorganic Zinc Silicate Primer Paint.** Provide inorganic zinc silicate primer paint conforming to AASHTO M 300, Type I or Type IA, and the following modification:

5.1 A green colorant approximately No. 34159 of FS 595B.

Follow the submittal requirements of Supplement 1084 to obtain approval of materials conforming to this specification.

Once the Director approves the paint, the Department will not require further performance testing by the manufacturer unless the formulation or manufacturing process has been changed, in which case the Department will require new certified test results.

Furnish materials certified according to S 1084 and listed on the Department's Qualified Products List (QPL)

**708.02 OZEU Structural Steel Paint.** This specification covers the formulation and testing of a three-coat structural steel paint system consisting of an organic zinc prime coat, an epoxy intermediate coat, and a urethane finish coat (OZEU). Material requirements for the respective coats are as follows:

**A. General.** For each lot of all coatings, furnish a coated card (Drawdown card) that shows the color, gloss, and general appearance of the material covered by the lot. Use a minimum card size of 3-inches by 5-inches. The color must match the color card furnished for the Contract or order within visual limits determined by the Engineer. In case of disagreement, provide test data according to ASTM D 2244 showing a color difference of no greater than 2.0,  $\Delta E^*$  (CIE 1976  $L^*a^*b^*$ ).

**B. Organic Zinc Prime Coat.** Provide an organic zinc prime coat consisting of a zinc dust filled, two or three-component epoxy polyamide, and selected additives as required. The coating shall also meet the following:

### 1. Physical Requirements.

a. **Total solids, % by weight of paint, ASTM D 2369.** 70 percent minimum.

b. **Pigment, % by weight of total solids, ASTM D 2371.** 83 percent minimum.

c. **Total zinc dust, % by weight of pigment. ASTM D 521.** 93 percent minimum.

d. **Total zinc, % by weight of total solids (by calculation) ASTM D 521.** 77 percent minimum.

e. **Total solids, % by volume, ASTM D 2697.** 45 percent minimum.

f. **Color.** Greenish gray, approximating **FS-595B-34159**, visual comparison.

**g. Pot life.** SSPC-Paint 22, Section 5.5 with the following exception: 6 hours minimum at 77+/-3 °F (25+/-2 °C) with no evidence of gellation. The coating will be in a free-flowing condition and easily sprayed.

**2. Qualitative Requirements.**

**a. Mixing.** Section 5.2, SSPC-Paint 20 using only a high shear (Jiffy) mixer.

**b. Storage Life.** Section 5.4, SSPC-Paint 20.

**c. Mudcracking.** Section 5.7, SSPC-Paint 20.

**3. Material Quality Assurance.** Analysis for each component.

Material Quality Assurance will conform to the requirements of Supplement 1084.

**C. Epoxy Intermediate Coat.** Provide a two-part epoxy intermediate coat composed of a base component and a curing agent suitable for application over the epoxy-polyamide zinc rich primer.

The base component shall contain an epoxy resin together with color pigments, mineral fillers, gellant, leveling agent, and volatile solvents. The curing agent component will contain a liquid polyamide resin and volatile solvent. The coating shall also meet the following:

**1. Physical Requirements.**

**a. Color.** White, meeting or exceeding, **FS-595B-37875** as per **ASTM E 1347**.

**b. Components.** Two, mixed before application.

**c. Volume solids, ASTM D 2697.** 50 percent minimum.

**d. Pot life.** SSPC-Paint 22, Section 5.5 with the following exception: 6 hours minimum at 77+/-3 °F (25+/-2 °C) with no evidence of gellation. The coating shall be in a free-flowing condition and easily sprayed

**e. Curing time.**

(1) **Set-to-touch, ASTM D 1640.** 4 hours, maximum at 77 °F (25 °C).

(2) **Dry-to-recoat, ASTM D 1640.** 24 hours, maximum at 77 °F (25 °C).

(3) **Full cure.** 7 days, maximum at 50 °F (10 °C).

No pick-up when rubbed with a cloth soaked in Methyl Ethyl Ketone.

**f. Fineness of grind, ASTM D 1210.** Hegman 3 minimum.

**g. Volatile Organic Compounds (VOC), maximum, ASTM D 3960.** 2.83 lb/gal(340 g/L), as applied.

**2. Material Quality Assurance.** Material Quality Assurance will conform to the requirements of Supplement 1084.

**D. Urethane Finish Coat.** Provide a two-component urethane finish coat composed of a polyester and/or acrylic aliphatic urethane and suitable for use as a finish coat over the white epoxy polyamide intermediate coat. The coating shall also meet the following:

**1. Physical Requirements.**

**a. Finish, Specular gloss, ASTM D 523.** Use Fed Std 595B-16440 Gray: 70 % minimum after 3000 hours weathering resistance. Color change less than 2.0 ΔE\*, (C.I.E 1976 L\*a\*b\*) ASTM D2244.

**b. Volume solids, ASTM D 2697.** 42 percent minimum.

**c. Curing time, at 77 °F (25 °C) and 50% RH.** Set-to-touch, ASTM D 1640: 30 minutes, minimum; 4 hours, maximum.

**d. Pot life.** SSPC-Paint 22, Section 5.5 with the following exception: 4 hours minimum at 77+/-3 °F (25+/-2 °C) with no evidence of gellation. The coating shall be in a free-flowing condition and easily sprayed

**e. Volatile Organic Compounds (VOC), maximum, ASTM D 3960.** 2.83 lb/gal(340 g/L), as applied.

**f. Colors.**

**(1) Specified.<sup>[2]</sup>**

Brown	FS-595B, 10324
Green	FS-595B, 14277
Blue	FS-595B, 15526

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[2] Contractor's choice unless specified on plans

**(2) Elective.** As specified on the plans.

**g. Gloss requirements, ASTM D 523.**

Full gloss	minimum 80% unless specified on the plans
Semi-gloss	30 to 45%
Lusterless (Matte)	maximum 6%

**2. Material Quality Assurance.**

Material Quality Assurance will conform to the requirements of Supplement 1084.

**Performance Requirements.** Test the coating system, which consists of the organic zinc prime coat, the epoxy intermediate coat, and the urethane topcoat, prior to use.

Prepare three panels for each of the specified tests according to ASTM D 609, except provide a minimum thickness of 1/8 inch (3 mm) and use ASTM A 36/A

36M hot rolled steel. Blast clean (using coal slag abrasive) the surface to equal, as nearly as is practical, the standard Sa 2 1/2 of ASTM D 2200 (Steel Structures Painting Council SSPC-SP10 meets this requirement). Ensure that the surface has a nominal height of profile of 1 to 3.5 mils (25 to 88  $\mu\text{m}$ ) verified by using appropriate replica tape. Coat and cure the panels according to the manufacturer's printed instructions. Provide a dry film coating thickness for the system to be tested as follows:

Organic Zinc:	3.0 to 5.0 mils (75 to 125 $\mu\text{m}$ )
Epoxy:	5.0 to 7.0 mils (125 to 175 $\mu\text{m}$ )
Urethane:	2.0 to 4.0 mils (50 to 100 $\mu\text{m}$ )

The coating system shall pass each of the following tests:

**A. Fresh Water Resistance Test (ASTM D 870).** Scribe the panels according to ASTM D 1654 to the depth of the base metal in the form of an "X" having at least 2-inch (50 mm) legs, and immerse panels in fresh tap water at  $75 \pm 5$  °F ( $25 \pm 3$  °C). After 30 days of immersion, examine the panels to verify that they show no rusting and that the coating shows no blistering, softening, or discoloration. Rate blistering according to ASTM D 714.

**B. Salt Water Resistance Test (ASTM D 870).** Scribe the panels as specified in "A" above, and immersed panels in a water solution of 5 percent sodium chloride at  $75 \pm 5$  °F ( $25 \pm 3$  °C). After 7, 14, and 30 days of immersion, examine the panels to verify that they show no rusting and that the coating shows no blistering or softening. Rate blistering according to ASTM D 714. Replace the sodium chloride solution with a fresh solution after examination at 7 and 14 days.

**C. Weathering Resistance Test.** Test the panels according ASTM D 4587, Method D, using Ultra Violet A 340 bulbs. Place the panels on test at the beginning of a wet cycle. After 3000 hours of continuous exposure, examine the panels to verify that they show no rusting and that the coating shows no blistering or loss of adhesion. Perform the 60 degree specular gloss measurements on the sprayed panels utilized for this test. Average the three initial measurements (one per panel) together. Also, average the three final measurements together.

**D. Salt Fog Resistance Test.** Scribe the panels as specified in "A" above, and test them according to ASTM B 117. After 3000 hours of continuous exposure, examine the coating to verify that it shows no loss of bond and that it shows no rusting or blistering beyond 1/16 inch (2 mm) from the center of the scribe mark. Rate blistering according to ASTM D 714.

**E. Adhesion Test, ASTM D 4541 Type IV.** Test the panels according to the following:

1. Lightly sand the coating surface and aluminum dolly, and apply a quick set adhesive.
2. Allow adhesive to cure overnight.
3. Scribe the coating and adhesive around the dolly before testing.

## 709.00

4. Make a minimum of 4 trials to failure, and report the 4 trials. Ensure that each trial is greater than 400 pounds per square inch (2.8 MPa). Reject trial if fracture at the primer-blast interface occurs.

Prequalification. Before approval, submit copies of the manufacturer's certified test data showing that the coating system complies with the performance requirements of this specification to the Laboratory. Ensure that the certified test data also states the following physical properties for each coating: Density, pounds per gallon (g/mL); Solids, percent by weight; Solids, percent by volume; Viscosity; Drying time; and VOC content, pounds per gallon (g/mL).

Use an independent testing laboratory, approved by the Laboratory, to develop the test data. Include with the test data the brand name of the paint, name of manufacturer, number of lots tested, and date of manufacture.

Once the Director approves the coating, the Department will not require further performance testing by the manufacturer unless the formulation or manufacturing process has been changed, in which case the Department will require new certified test results.

Sampling. The Laboratory will establish acceptance variances.

Furnish materials certified according to S 1084 and listed on the Department's Qualified Products List (QPL).

## 709 REINFORCING STEEL

**709.00 Epoxy Coated Reinforcing Steel.** Provide epoxy coated reinforcing steel according to ASTM A 775/A 775M, with the following modifications:

5.1 Ensure that steel reinforcing bars to be coated conform to 709.01, 709.03, or 709.05, and are free of oil, grease, or paint.

5.2 Ensure that the coating material meets the requirements listed in Annex A1 and is a color that facilitates inspection of the installed bar. The color is subject to approval of the Director.

5.3 Sample required.

8.3.1 Evaluate the adhesion of the coating by bending production coated bars around a mandrel of specified size according to the bending tables in ASTM A 615 (ASTM A 615M) or ASTM A 996 (ASTM A 996M) as applicable. Perform the bend test for adhesion of the coating at a uniform rate, and ensure that it takes up to 90 seconds to complete. Place the two longitudinal deformations in a plane perpendicular to the mandrel radius, and ensure that the test specimens are at thermal equilibrium between 68 and 86 °F (20 and 30 °C).

12.1 Perform tests, inspection, and sampling at a site specified by the Director. Sampling for testing requires three 30-inch (1 m) samples for each bar size, for each coating lot, and for each heat of steel reinforcing bars.

14.1 Report of test results required.

Where reinforcing bar cages for prestressed concrete beams are fabricated by tack welding, patch the areas damaged by the tack welding according to ASTM A

775, Section 11, permissible Amount of Damaged Coating and Repair of Damaged Coating.

**709.01 Deformed and Plain Billet Steel Bars for Concrete Reinforcement.**

Provide deformed and plain billet steel bars for concrete reinforcement according to ASTM A 615 (ASTM A 615M), with the following modification:

13.1 Where positive identification of a heat can be made, perform one tension test and one bend test from each bar designation number of each heat in the Lot. Where identification of the heat is not practical, perform one tension test and one bend test for each bar designation number in each lot of 10 tons (10 metric tons) or fraction thereof.

Furnish certified material according to Supplement 1068.

**709.03 Rail Steel Deformed and Plain Bars for Concrete Reinforcement.**

Provide rail steel deformed and plain bars for concrete reinforcement according to ASTM A 996/A 996M.

Furnish certified material according to Supplement 1068.

**709.05 Axle Steel Deformed and Plain Bars for Concrete Reinforcement.**

Provide axle steel deformed and plain bars for concrete reinforcement according to ASTM A 996/A 996M.

Furnish certified material according to Supplement 1068.

**709.08 Cold-Drawn Steel Wire for Concrete Reinforcement.**

Provide cold drawn steel wire for concrete reinforcement according to ASTM A 82, with the following modification:

7.2 Completely cover galvanized wire with a coating of pure zinc of uniform thickness, so applied that it will adhere firmly to the surface of the wire. Ensure that the minimum weight of zinc coating is 0.8 ounces per square foot (244 g/m<sup>2</sup>) of surface as determined by ASTM A 90.

Furnish certified material according to Supplement 1068.

**709.09 Fabricated Steel Bar or Rod Mats for Concrete Reinforcement.**

Provide fabricated steel bar or rod mats for concrete reinforcement according to ASTM A 184/A 184M, with the following modifications:

4 Use deformed bars.

4.1 Provide longitudinal bars conforming to Grade 60 of 709.01, 709.03, or 709.05.

4.2 Provide longitudinal bars according to 709.01, Grade 60. Provide transverse bars according to 709.01.

Furnish certified material according to Supplement 1068.

**709.10 Welded Steel Wire Fabric For Concrete Reinforcement.** Provide welded steel wire fabric for concrete reinforcement according to ASTM A 185.

Furnish certified material according to Supplement 1068.

**709.11**

**709.11 Deformed Steel Wire for Concrete Reinforcement.** Provide deformed steel wire for concrete reinforcement according to ASTM A 496.

Furnish certified material according to Supplement 1068.

**709.12 Welded Deformed Steel Wire Fabric for Concrete Reinforcement.** Provide welded deformed steel wire fabric for concrete reinforcement according to ASTM A 497.

Furnish certified material according to Supplement 1068.

**709.13 Coated Dowel Bars.** Provide coated dowel bars according to AASHTO M 254, with the following modifications:

4.1 The core material will consist of steel according to 709.01, 709.03, or 709.05.

5.2 Is waived. Ensure that the coating thickness is as approved under 2.5 and is within the manufacturer's stated tolerance.

Coat all surfaces of dowel bars. Suitably re-coat ends of dowel bars that have been cut to length after coating or have not had the uncoated ends coated during manufacturing or fabrication. Prepare surface and patch uncoated bar ends with material equivalent to the original epoxy coating.

If the Contractor elects to use basket supports for positioning of the above dowel bars as specified in 451.08.B or as shown on the plans, provide a fusion-bonded epoxy coated basket dowel bar assembly. Repair uncoated areas with surface preparation and patching material equivalent to the original epoxy coating.

Suitably repair coating on the dowel bars or baskets damaged during installation.

Do not expose coated dowels to weather or sunlight for a period exceeding 180 days.

Furnish certified material according to Supplement 1068.

**709.14 Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.** Provide epoxy coated steel wire and welded wire fabric for reinforcement according to ASTM A 884, with the following modifications:

5.1 Ensure that plain or deformed steel wire or welded wire fabric to be coated conform to 709.08, 709.10, 709.11, or 709.12, and is free of oil, grease, or paint.

8.1 Ensure that the coating thickness conforms to Type A. Provide dry film thickness of 5 to 12 mils (0.13 to 0.31 mm).

8.4 Test coated steel wire or welded wire fabric at the manufacturer's plant before shipment or at other sites as designated by the Laboratory.

Furnish certified material according to Supplement 1068.

**709.15 Plastic Supports for Reinforcing Steel.** Conform to Supplement 1125.

**709.16 Galvanized Reinforcing Steel Option for Bridge Structure Spirals.** As an option to 709.00 provide galvanized reinforcing steel for the spiral bars only

in round column and drilled shaft reinforcing steel cages. Galvanized steel will conform to ASTM A767, Class 1. The galvanized coated reinforcing steel will meet all other requirements of 509.

The galvanized coating will be applied after the reinforcing has been fabricated. If the galvanized surface becomes damaged during handling in the field, repairs will conform to ASTM A780.

Where a sample is requested, provide a replacement splice conforming to the lap length requirements for epoxy coated reinforcing.

Furnish certified material according to Supplement 1068.

## 710 FENCE AND GUARDRAIL

**710.01 Barbed Wire.** Furnish barbed wire according to ASTM A 121, Type Z, Class 3 Galvanizing, or ASTM A 585, Type I, with the following modifications:

### A. ASTM A 121, Type Z, Class 3.

6.3.1 Ensure that the weight of coating for various gages of wire composing the strands and barbs are not less than 0.80 ounces per square foot ( $244 \text{ g/m}^2$ ) of surface.

7.1 Furnish No. 12 1/2, 13 1/2 or 15 1/2 steel wire gage barbed wire. Ensure that the barbs are four point round steel wire spaced 5 inches (130 mm) center-to-center.

9.1 Select one sample, as per Section 9.2, from each 50 spools or fraction thereof.

11.1 Perform inspection at the project site.

Furnish certified material according to Supplement 1067.

### B. ASTM A 585, Type I.

12.3 Does not apply.

14.1 Perform inspection at the project site.

Furnish certified material according to Supplement 1067.

**710.02 Woven Steel Wire Fence, Type 47.** Furnish woven steel wire fence according to ASTM A 116, Type Z, Class 3 galvanizing, with the following modifications:

7.1 Ensure that the fence fabric is design number 1047-6.9.

11.1 Perform inspection at the project site.

In addition, ensure that all hardware and attachments are galvanized according to 711.02.

Furnish certified material according to Supplement 1067.

## 710.03

**710.03 Chain-Link Fence.** Furnish chain-link fence according to AASHTO M 181, with the following modifications:

3.1 Furnish posts, gate frames, post braces, and top rails made of Type I or Type III material. Furnish Type I material conforming to the requirements of Table 710.03-1. Furnish Type III material conforming to the requirements of Table 710.03-2.

Furnish top rails in lengths not less than 18 feet (5.5 m).

Fasten the fabric to the posts using either aluminum alloy or galvanized steel bands or wires. Furnish wires that have a 0.148-inch (3.7 mm) minimum diameter and a zinc coating or steel fasteners that are not less than 0.8 ounces per square foot (244 g/m<sup>2</sup>).

Furnish stretcher bars that have a  $3/4 \times 3/16$ -inch ( $19 \times 5$  mm) cross-section or an equivalent cross-section with a length equal to full height of fabric.

Furnish steel truss rods that have a steel  $3/8$ -inch (9.5 mm) diameter or equivalent cross-section and that have suitable adjustment.

**TABLE 710.03-1 STEEL POSTS, GATE FRAMES, POST BRACES, AND TOP RAILS**

Usage – nominal fence height 6 ft or less	Section Thickness	Outside Diameter or Dimensions (in)	Weight Nominal lb/ft	Tolerance (+/- %)	Minimum Yield Strength (psi)
Line posts	Grade 1 Pipe	2.375	3.65	10	30,000
	Grade 2 Pipe	2.375	3.12	10	50,000
	C-Section	2.250 × 1.700	2.78	10	50,000
	H-Section	2.250 × 1.700	3.26	10	50,000
End, corner pull posts	Grade 1 Pipe	2.875	5.79	10	30,000
	Grade 2 Pipe	2.875	4.64	10	50,000
Gate Posts, for nominal width of gate (single or one leaf of Double):					
Up to 6 ft incl.	Grade 1 Pipe	2.875	5.79	10	30,000
	Grade 2 Pipe	2.875	4.64	10	50,000
Over 6 to 13 ft incl.	Grade 1 Pipe	4.000	9.11	10	30,000
	Grade 2 Pipe	4.000	6.56	10	50,000
Over 13 to 18 feet incl.	Grade 1 Pipe	6.625	18.97	10	30,000
Over 18 feet	Round	8.625	28.58	10	30,000
Gate frames	Grade 1 Pipe	1.900	2.72	10	30,000
	Grade 2 Pipe	1.900	2.28	10	50,000
Top rails, <sup>[1]</sup> post braces	Grade 1 Pipe	1.660	2.27	10	30,000
	Grade 2 Pipe	1.660	1.84	10	50,000
	Roll-form	1.6250 × 1.250	1.35	10	50,000
	Round tubing	1.660	1.38	10	50,000
[1] When tension wire is specified, it will be of 0.177 in diameter.					

**TABLE 710.03-1M STEEL POSTS, GATE FRAMES, POST BRACES, AND TOP RAILS**

Usage – nominal fence height 1.8 m or less	Section Thickness	Outside Diameter or Dimensions (mm)	Weight Nominal (kg/m)	Minimum Tolerance (+/- %)	Yield Strength (MPa)
Line posts	Grade 1 Pipe	60	5.4	10	209
	Grade 2 Pipe	60	4.6	10	345
	C-Section	57 × 43	4.1	10	345
	H-Section	57 × 43	4.9	10	345
End, corner pull posts	Grade 1 Pipe	73	8.6	10	209
	Grade 2 Pipe	73.00	6.9	10	345
Gate Posts, for nominal width of gate (single or one leaf of Double):					
Up to 1.8 m incl	Grade 1 Pipe	73.00	8.6	10	209
	Grade 2 Pipe	73.00	6.9	10	345
Over 1.8 to 4 m incl.	Grade 1 Pipe	102.00	13.6	10	209
	Grade 2 Pipe	102.00	9.8	10	345
Over 4 to 5.5 m incl.	Grade 1 Pipe	168.00	28.2	10	209
Over 5.5 m	Round	219	42.5	10	209
Gate frames	Grade 1 Pipe	48	4.0	10	209
	Grade 2 Pipe	48	3.4	10	345
Top rails, <sup>[1]</sup> post braces	Grade 1 Pipe	42	3.4	10	209
	Grade 2 Pipe	42	2.7	10	345
	Roll-form	41 × 32	2.0	10	345
	Round tubing	42	2.1	10	345
[1] When tension wire is specified, it will be of 4.5 mm diameter.					

Furnish ornamental cap post tops made of steel, malleable iron or cast iron. Furnish them with a hole suitable for through passage of the top rail. Ensure that they fit snugly to the post, have a means of attaching securely to the post, and exclude moisture from tubular posts. Furnish swing type gates complete with latches, stops, keepers, hinges, locks, and fabric. Cover them with fabric matching the fence. Furnish hinges of adequate strength to support the gate and that do not twist or turn under action of the gate. Locate plunger bar type latches at the full gate height in a manner that will engage the gate stop. Forked latches may be used for single gates less than 10 feet (3 m) wide. Furnish lockable latches. Furnish stops that consist of a flush plate with anchor placed in concrete to engage the

plunger bar of the latch. Other approved types of stops may be used for single gates less than (10 feet) 3 m wide. Keepers are substantial devices for securing and supporting the free end of the gate in open position.

Furnish top rail couplings consisting of the outside sleeve type at least 6 inches (150 mm) long. Ensure that a minimum of 20 percent of the coupling has an internal heavy spring to take up expansion and contraction.

Furnish gate frames that are assembled by welding, using properly designed, formed sheet, or sandcast fittings. Cover the gates with fabric matching the fence.

Furnish offset type hinges. Furnish galvanized latches, stops, and keepers made of malleable iron, except for plunger bars that may be galvanized tubular or bar steel according to Section 6.2.

Furnish top rails in lengths not less than 18 feet (5.5 m).

Furnish flat stretcher bars in  $3/4 \times 1/4$ -inch ( $19 \times 6$  mm) sections.

Furnish self-centering outside rail couplings that are 6 inches (150 mm) long.

Furnish tie wire that has a 0.148-inch (3.7 mm) minimum diameter and that meets an aluminum alloy.

Furnish wrought or cast turnbuckles.

Furnish truss and brace rods with an  $3/8$ -inch (9.5 mm) outside diameter or equivalent cross-section.

Furnish beveled brace bands in  $1 \times 1/8$ -inch ( $25 \times 3$  mm) section.

Furnish bolts with an anodic coating at least 2 mil (5  $\mu$ m) in thickness, chromate sealed.

11.1. Ensure that the size of the fabric conforms to 0.148-inch (3.7 mm) nominal diameter of coated wire, 2-inch (50 mm) mesh.

14.1 Table 8. Type I Zinc-Coated Steel Chain Link Fabric will have Class D weight of coating.

15.5 Ensure that the vinyl covering is of a uniform medium green color.

19.1 Perform inspection at the project site.

32.2 Does not apply.

32.3.3.2. Increase the minimum weight of interior coating to an average of 0.9 ounces per square foot ( $275 \text{ g/m}^2$ ) and not less than 0.8 ounces per square foot ( $244 \text{ g/m}^2$ ) on an individual specimen.

**TABLE 710.03-2 DIAMETERS OR PLAIN END, SCHEDULE 40 ALUMINUM ALLOY PIPE**

The weights and dimensions are as specified in ANSI H 35.2.

		Nominal Pipe Size	
		(in)	(mm)
Material			
Brace rails and top rails		1 1/4	32
Gate frames and rail couplings		1 1/2	40
Line posts		2	50
End and corner posts		2 1/2	65
Gate posts single or one leaf of double:			
Gate opening			
(ft)	(m)	(in)	(mm)
To 6	To 1.8	2 1/2	65
Over 6 to 12	Over 1.8 to 3.7	3 1/2	90
Over 12 to 18	Over 3.7 to 5.5	6	150
Over 18 to 32	Over 5.5 to 9.8	8	200

A 8'8" line post may be substituted in lieu of the line post shown on standard drawings Chain Link Fence 1.1, 7-28-00 and Walk Gates F-3.2, 7-28-00. This will be accomplished by reducing the 4'-0" depth as necessary to accommodate the shorter posts, all other dimensions shown in the standard drawings shall remain unchanged

Furnish certified material according to Supplement 1067.

**710.06 Deep Beam Rail.** Furnish deep beam rail according to AASHTO M 180, Type II, Class A, with the following modifications:

5.1 Perform inspection at the project site.

5.2.1 When a field check of coating thickness shows insufficient coating thickness or shows insufficient coating weight, sample and test the guardrail.

9.1.2 The minimum check limits for both triple and single-spot tests apply.

Furnish certified material according to Supplement 1042.

**710.09 Wire Rope Rail.** Furnish wire rope rail according to AASHTO M 30, Class A, Type I rope, with the following modification:

9 Perform inspection at the project site.

Obtain random samples from material delivered to the project site or at other locations designated by the Laboratory.

**710.11 Fence Posts and Braces.** Furnish round wood posts conforming to 710.12 and 710.14. Furnish dimension timber, posts, and lumber for braces and stream crossings that are sound, straight, free from unsound or loose knots, splits and shakes, and that are treated according to 712.06.

Furnish steel line posts according to ASTM A 702, with the following modifications:

5.6.2 Furnish fasteners or clamps that have a 0.120-inch (3 mm) diameter and that are galvanized according to ASTM A 116, Type Z, Class 3.

5.6.1 Supply each post with a sufficient number of fasteners or clamps.

6.2 Ensure that the post lengths are as designated.

7.1 Furnish galvanized line posts and anchors according to 711.02.

7.2 Delete.

9. Perform sampling according to 712.06.

Furnish certified material according to Supplement 1067.

**710.12 Square-Sawed and Round Guardrail Posts.** Furnish pressure treated square-sawed and round guardrail posts according to 710.14 and 712.06. Cut posts from growing timbers that are free from unsound or loose knots and rot and from injurious or excessive shake, and season checks that exceed 1/4 inch (6 mm) in width.

Furnish round posts that are  $8 \pm 1$  inch ( $200 \pm 25$  mm) in diameter and have a uniform taper. Ensure that the sweep does not exceed 1 inch (25 mm) for the length of the post. Peel round posts their entire length, removing all outer and inner bark and leather fiber by shaving the surface. Trim knots even with the post, and saw both ends of the post square.

Furnish square sawed posts that are free from injurious cross grain and sapwood. They may contain a limited number of sound knots that do not exceed 2 inches (50 mm) in diameter. Ensure that they are from wane above the ground line. Ensure that the wane below the ground line is limited to two adjacent corners and does not exceed 1 1/2 inches (38 mm) measured along the wane.

Furnish certified material according to Supplement 1072.

**710.14 Pressure Treated Guardrail and Fence Posts, Braces, and Blocks.** Furnish pressure treated guardrail and fence posts, braces, and blocks according to AASHTO M 168 and 710.11, 710.12, and 712.06.

Furnish certified material according to Supplements 1042 and 1072.

**710.15 Steel Guardrail Posts.** Furnish steel guardrail posts in the sections and lengths as specified. Ensure that they are made of copper bearing steel when so specified. Furnish steel according to ASTM A 36/A 36M. Furnish galvanized posts according to 711.02.

Furnish certified material according to Supplements 1042.

**710.16 Guard Posts.** Furnish pressure treated wood posts according to 710.14. Furnish posts that are either 5 × 6-inch ( $125 \times 150$  mm) sawed square or 5 1/2-inch + 1/2-inch (138 mm) diameter round when measured 30 inches (0.75 m) from the top. Furnish posts that are 5 feet, 3 inches (1.6 m) in length and are embedded such that 30 inches (0.75 m) remains exposed. Ensure that the center-to-center spacing is spaced at 6 feet (1.8 m) intervals, unless otherwise shown on the plans.

Furnish certified material according to Supplements 1042.

## 711 STRUCTURAL STEEL AND STRUCTURE INCIDENTALS

**711.01 Structural Steel.** Furnish structural steel conforming to ASTM A 709, Grade 36 (A36), 50 (A572), 50W (A588), or 70W.

Ensure that materials designated to meet notch toughness requirements have a minimum longitudinal Charpy V-Notch (CVN) energy absorption value as listed below. Sample and test according to ASTM A 673/A 673M. Use the (H) frequency of heat testing and provide the test data as required by 501.06.

ASTM Designation	Thickness and Connection Method	Value Min CVN
A709 Gr. 36 (A36, A36M)	Up to 4 in (102 mm) mechanically fastened or welded	15 ft-lb @ 40 °F (20 J @ 4 °C)
A709 Gr. 50 (A 572/A 572M), A709 Gr. 50W (A 588/A 588M)	Up to 4 in (102 mm) mechanically fastened	15 ft-lb @ 40 °F <sup>[1]</sup> (20 J @ 4 °C)
A709 Gr. 50 (A 572/A 572M), A709 Gr. 50W (A 588/A 588M)	Over 2 to 4 in (51 to 102 mm) welded	20 ft-lb @ 40 °F <sup>[1]</sup> (20 J @ 4 °C)
A709 Gr. 50 (A 572/A 72M), A709 Gr. 50W (A 588/A 588M)	Up to 2 in (51 mm) welded	15 ft-lb @ 40 °F <sup>[1]</sup> (20 J @ 4 °C)
A709 Gr. 70W	Up to 4 in (100 mm) mechanically fastened or welded	2515 ft-lb @ -10 40 °F <sup>[1]</sup> (34 20 J @ -23 °C)
[1] If the yield point of the material exceeds 65 ksi (448 MPa), the temperature of the CVN value for acceptability should be reduced by 15 °F (8.3 °C) for each increment, or part of increment, of 10 ksi (69 MPa) above 65 ksi (448 MPa).		

**711.02 Galvanized Steel.** Furnish galvanize steel according to ASTM A 123 after cutting, bending, and welding. At the discretion of the Engineer, replace, re-galvanize, or repair damaged galvanized material. If a repair is authorized, perform work according to ASTM A 780 except the Department will not allow aerosol spray applications of paints containing zinc dust.

Furnish bolts, nuts, washers, and similar threaded fasteners that are galvanized according to ASTM A 153 or F2329. These items may be mechanically zinc coated according to ASTM B 695, Class 50. Except for ASTM A 325 (ASTM A 325M) bolts, electrogalvanizing may also be used if the coated item meets the thickness coating requirements of ASTM A 153 or F2329.

**711.03 Steel for Piling.** Furnish steel for H-piling conforming to ASTM A 572 Grade 50 / A 572M Grade 345. Furnish steel for sheet piling according to

ASTM A 328/A 328M. Furnish steel for cast-in-place reinforced concrete piles conforming to ASTM A 252, Type 2.

**711.04 Cold Rolled Steel.** Furnish cold rolled steel according to ASTM A 108, Grades 1016 through 1030 for pins, rollers, trunnions, and other similar parts.

**711.07 Steel Castings.** Furnish steel castings according to ASTM A 27/A 27M, Grade 65-35 or Grade 70-36, with the following modification:

Ensure that steel castings are free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended. No sharp, unfilleted angles or corners are allowed.

**711.08 Arc-Welding Electrodes and Fluxes.** The following applies to all steel, except for exposed bare ASTM A 242/A 242M and ASTM A709 Grade 50W (A 588/A 588M) steels. For exposed bare ASTM A 242/A 242M and A709 Grade 50W (A 588/A 588M) applications, see Table 711.08-1.

**A. Manual shielded metal-arc welding.**

1. AWS A5.1 Low Hydrogen Only
2. AWS A5.5 Low Hydrogen Only

**B. Submerged Arc Welding**

1. AWS 5.17<sup>5</sup>
2. AWS 5.23<sup>5</sup>

**C. Gas metal-arc welding, AWS A 5.18<sup>5</sup>**

**D. Flux cored arc welding, AWS A5.20<sup>5</sup>**

**TABLE 711.08-1**

Filler metal requirements for exposed bare applications of ASTM A 242/A 242M and ASTM A709 Grade 50W (A 588/A 588M) steel.

Shielded metal arc	Welding Process	
	Submerged arc <sup>[5]</sup>	Gas metal arc or Flux cored arc <sup>[2],[4],[5]</sup>
AWS A5.5	AWS A5.23	AWS A5.28 and 5.29
E8015, 8016, or 8018 electrodes that deposit weld metal meeting C1, C1L, C2, C2L, C3, or W analysis	All electrode-flux combinations that deposit weld metal with a Ni1, Ni2, Ni3, Ni4, or W analysis <sup>[2],[3]</sup>	All electrode-flux combinations that deposit weld metal with a Ni1, Ni2, Ni3, Ni4, or W analysis

[2] Deposited weld metal will have a minimum impact strength of CVN 20 ft-lb (27 J) at 0 °F (-18 °C) (only applied to bridges).

[3] The use of the same type filler metal having next higher mechanical properties as listed in AWS specification is permitted.

[4] Deposited weld metal will have a chemical composition the same as that for any one of the weld metals in this table for the shielded metal arc welding process.

[5] In conformance with those classifications allowed under AWS D1.5 *Bridge Welding Code*, Tables 4.1 and 4.2.

## 711.09

The Laboratory will issue a list of approved electrodes and combinations of shielding. The Laboratory will include electrodes in the list when certified test data submitted by the manufacturer is found in compliance with the specified requirements. The certification will cover either process qualification or quality control tests. To qualify, such tests must be made within one year before the period covered. For each submission of certified test data, include the manufacturer's statement that it will advise the Laboratory immediately of any change in materials or processing used in the manufacture of the electrodes made within one year from the date of the tests.

When electrodes to be used are not included in the Laboratory's list of approved electrodes and combinations of shielding, submit certified test data as described above for each lot showing compliance with the specified requirements.

**711.09 High-Strength Steel Bolts, Nuts, and Washers.** Furnish high-strength steel bolts, nuts, and washers according to ASTM A 325 (ASTM A 325M), with the following modification:

11 If necessary for approval, obtain samples from material delivered to the project site or at other locations designated by the Laboratory.

Furnish bolts for steel use in bare unpainted applications according to A 325 (A 325M), Type 3.

When galvanized bolts, nuts, and washers are specified, mechanical galvanizing is permitted.

Use galvanized bolts to fasten steel that has received an inorganic zinc prime coat according to 514.

Furnish high-strength steel bolts, nuts, and washers that also meet the requirements of Supplement 1080.

Provide samples to the Laboratory for acceptance.

**711.10 Machine Bolts.** Furnish machine bolts according to ASTM A 307, with the following modification:

If necessary for approval, obtain samples from material delivered to the project site or at other locations designated by the Laboratory.

Mechanical galvanizing is permitted.

**711.12 Gray Iron Castings.** Furnish gray iron casting according to ASTM A 48, Class 30B, with the following modifications:

12 Two or more test bars will accompany each lot of castings or; one pair of test bars may represent castings shipped to two or more projects provided the lot number or date cast are cast or anchored in both the bars and castings. The identifying data or castings shall not interfere with the use of the casting.

9 In addition, ensure that castings are free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended. Ensure that the castings are generously filleted at angles and the arrises are sharp and perfect.

17 Ship test bars with the lot or make test bars representing the lot available to the Laboratory at the place of manufacture or warehouse.

**711.13 Ductile Iron Castings.** Furnish ductile iron castings according to ASTM A 536, with the following modifications:

8.1 In addition, ensure that castings are free from pouring faults, sponginess, cracks, blowholes, and other defects in positions affecting their strength. Ensure that the castings are generously filleted at angles and arrises are sharp and perfect.

10.1 Send a keel block or Y-block specimen made according to ASTM A 536 with the shipment for each heat number, ladle number, and date of casting.

14.1 Submit a certification stating that the test bars shipped with the castings were prepared according to the specified requirements.

**711.14 Gray Iron and Ductile Iron Castings.** Furnish gray iron and ductile iron castings according to AASHTO M 306, Class 35B, with the following modifications:

Test bars are required as outlined in 711.12 and 711.13. In addition, submit certified test data for monthly proof load testing to the Laboratory with each inspection of castings from that month.

Design Approval. Submit designs for cast frames, grates and covers for manholes, catch basins and inlets that vary from the standard construction drawings to the Department for approval. Manufacturers will seek approval for such non-standard designs well in advance of a projects sale date.

**711.15 Sheet Copper.** Furnish sheet copper according to ASTM B 370.

**711.16 Phosphor Bronze Plate.** Furnish phosphor bronze plate according to ASTM B 100.

**711.17 Cast Bronze.** Furnish cast bronze according to ASTM B 22, Copper Alloy No. C91100, with the following modification:

Finish cast plates to plane surfaces and finish one plate of a pair at right angles to the other plate of the pair.

**711.18 Leaded Bronze.** Furnish leaded bronze according to ASTM B 584, Copper Alloy No. C93700, with the following modification:

Finish cast plates to plane surfaces and finish one plate of a pair at right angles to the other plate of the pair.

**711.19 Sheet Lead.** Furnish sheet lead according to ASTM B 29.

**711.20 Aluminum for Railings.** Furnish aluminum other than permanent mold castings that conform to the following requirements:

711.21

Portion of Railing	ASTM Designation	Alloy	Condition or Temper (B296)
Sand castings	B 26/B 26M	356.0	T6
Shims	B 209 (B 209M)	1100	0
Washers	B 209 (B 209M)	Clad 2024 6061	T4 T6
Sheet and plate	B 209 (B 209M)	6061	T6
Drawn seamless tubes	B 210	6061 or 6063	T6
Bars, rods, wire	B 211 (B 211M)	6061	T6
Bolts, set screws	B 211 (B 211M)	2024 <sup>[1]</sup> 6061	T4 T6
Nuts	B 211 (B 211M)	6061 6262	T6 T9
Extruded bars, rods, shapes	B 221 (B 221M)	6061 or 6063 6351	T6 T5
Extruded tubes	B 221(B 221M)	6061 or 6063 6351	T6 T5
Pipe	B 241/B 241M	6061 or 6063	T6
Rivets	B 316(B 316M)	6061	T6
[1] Will have an anodic coating.			

For permanent mold castings for bridge railing posts, provide aluminum according to AASHTO M 193.

**711.21 Preformed Bearing Pads.** Composition. Furnish preformed bearing pads consisting of a fabric and rubber body. Ensure that the pad is made with new, unvulcanized, natural and/or synthetic rubber, and unused cotton and/or synthetic fabric fibers in proper proportion to maintain strength and stability.

Physical Properties. The required surface hardness, expressed in standard rubber hardness figures, is 80 ± 10 Shore Durometer. The minimum ultimate break down limit of pads under compressive loading is 10,000 pounds per square inch (69 MPa). Furnish pads to specified dimensions and accurately locate and cleanly cut all bolt holes.

Furnish materials according to the Department’s Qualified Products List (QPL).

**711.22 Buried Liner Waterproofing Membrane.** Furnish buried liner waterproofing membrane according to ASTM D 7176-06, with the following modification:

Only 4.1.2 through 4.1.6 is approved.

Furnish materials according to the Department’s Qualified Products List (QPL).

**711.23 Elastomeric Bearings.** Furnish bearing pads and elastomeric bearings conforming to *AASHTO Standard Specifications for Highway Bridges*, Division II, Construction, Chapter 18, Section 18.4.5.1 Grade 3 requirements. Fabricate elastomeric bearing pads according to Sections 18.5.6.1 and 18.5.6.2. Test pads and bearings according to 18.7.1, 18.7.2.1, 18.7.2.3, 18.7.2.5, 18.7.2.6, 18.7.3,

18.7.4.5, and 18.10.3. Include testing in the price bid for the bearings. Furnish certified material according to Supplement 1081.

Furnish bearing pads and laminated bearings consisting of neoprene cast in molds under pressure and heat. A plain elastomeric bearing pad and steel load distribution plate combination is classified as a laminated elastomeric bearing. Obtain test specimens according to ASTM D 3182 or ASTM D 3183. Where test specimens are cut from the finished product, a 20 percent variation from the original physical properties is allowed. The use of compounds of nominal hardness between the values shown in Table 711.23-1 is permitted and the test requirements interpolated.

**TABLE 711.23-1**

<b>Physical Properties</b>	<b>Grade</b>		
	<b>50</b>	<b>60</b>	<b>70</b>
Hardness, Durometer A, ASTM D 2240.	50 ± 5	60 ± 5	70 ± 5
Tensile Strength, min psi (MPa), ASTM D 412	2500 (17)	2500 (17)	2500 (17)
Elongation at break, min %	400	350	300
Accelerated Tests to Determine Long-Term Aging Characteristics, Over-Aged 70 hrs at 212 °F (100 °C), ASTM D 573:			
Hardness, points change, max	15	15	15
Tensile strength, % change, max	-15	-15	-15
Elongation at break, % change, max	-40	-40	-40
<b>Physical Properties</b>	<b>Grade</b>		
	<b>50</b>	<b>60</b>	<b>70</b>
Ozone 1 ppm in air by volume 20% strain, 104 °F (40 °C) ASTM D 1149, 100 hrs (Samples to be solvent wiped before test to remove any traces of surface impurities)	No cracks	No cracks	No cracks
Compression set 22 hrs/212 °F (100 °C) ASTM D 395, Method B, % max	35	35	35
Adhesion, bond made during vulcanization ASTM D 429 Method B, lb/in (kN/m)	40 (7.0)	40 (7.0)	40 (7.0)

Furnish bearing pads that are individually molded, cut from previously molded strips or slabs, or extruded and cut to length. Mold laminated bearings together into an integral unit with all edges of internal steel laminates covered by a 1/8-inch (3 mm) minimum thickness of elastomer. Fill indentations or grooves on the exterior surface of the bearings caused by external laminate restraining devices to a 1/8 inch (3 mm) minimum cover by a revulcanized patch; or by a silicon caulk conforming to Federal Specifications TT-S-001543A; or by an approved equal. Ensure that the bearing manufacturer patches the bearings.

Ensure that the external connection or distribution plates of laminated bearings are the same material as the attached structural steel and are similarly cleaned and coated. Furnish internal plates according to ASTM A 709 grade 36 or A 570/A

**711.24**

570M, Grade 36 or Grade 40. Minimum thickness for the internal plates is 0.074 inch (1.88 mm). Debur all plates.

The bearing manufacturer will furnish certified test data for the elastomer, base plate, steel laminates, and proof load.

The bearing manufacturer will produce one sample bearing for each bridge structure in the project plans. Ensure that the sample bearing for each bridge structure is of the same design and materials as the bearings furnished for that bridge structure. The bearing manufacturer will ship the completed sample bearings to an independent testing laboratory for destructive testing for the following physical properties:

Hardness, Durometer A	ASTM D2240
Tensile Strength	ASTM D412
Elongation at Break	ASTM D412
Adhesion bond made during vulcanization	ASTM D429, Method B

Ensure that the bearing manufacturer submits to the project the certified test data for the sample bearings from the independent testing laboratory with the bearing manufacturer’s certified test data for the elastomer, base plate, steel laminates, and proof load.

**711.24 Waterproofing Fabric.** Furnish waterproofing fabric according to ASTM D 173.

Furnish materials according to the Department’s Qualified products List (QPL).

**711.25 Type 2 Membrane Waterproofing.**

Physical Properties	
Thickness ASTM D 1777	60 mils (1500 μm) min.
Width	36 inches (914 mm) min.
Pliability [180° bend over 1/4 inch (6 mm) mandrel @ -25 °F (-32 °C)] ASTM D 146	No Effect
Elongation ASTM D 412 (Die C)	300% min
Puncture Resistance-Membrane	
ASTM E 154	40 lb (18 kg) min.
Permeance (Grains/ft <sup>2</sup> /hr/in Hg)	
ASTM E 96, Method B	0.1 max.
Water Absorption (% by Weight) ASTM D 570	0.2 max.
Adhesion to concrete ASTM D 903	5.0 min.
Submit certified test data and letter of certification to the Engineer.	

Furnish materials according to the Department’s Qualified Products List (QPL).

**711.26 Structural Timber, Lumber and Piling.** Furnish structural timber, lumber and piling according to 712.06, and AASHTO M 168, with the following modification:

Air-dry or kiln-dry timber and lumber to a moisture content not to exceed 19 percent by weight. Size and grade will conform to American Lumber Standards.

Use only structural timber, lumber, and piling meeting the certification requirements of Supplement 1072.

**711.27 Prestressing Steel Strands.** Furnish prestressing steel strands according to ASTM A 416, with the following modification:

11 Sample and inspect as directed by the Laboratory.

**711.28 Cellular Polyvinyl Chloride Sponge.** Furnish cellular PVC sponge according to AASHTO M 153, Type I, and with a minimum density of 20 pounds per cubic foot (320 kg/m<sup>3</sup>).

Furnish materials according to the Department's Qualified Products List (QPL).

**711.29 Type 3 Membrane Waterproofing.** Furnish Type 3 membrane waterproofing conforming to the following requirements.

<b>Physical Properties</b>	
Thickness	0.135 inches (3.43 mm) min.
Width	36 inches (914 mm) min.
Weight	0.8 lb/ft <sup>2</sup> (3.875 kg/mm <sup>2</sup> ) min.
Tensile strength (machine direction)	
ASTM D 882	275 lb/in (48.1 N/mm)
Modified <sup>[1]</sup>	200 psi (13.8 MPa)
Tensile strength ASTM D 882 (90° machine direction)	
	150 lb/in (26.2 N/mm)
Modified <sup>[1]</sup>	1000 psi (6.9 MPa)
Elongation at break ASTM D 882	
Modified <sup>[1]</sup>	100%
Brittleness ASTM D 517	Pass
Softening point (mastic) ASTM D 36	200 °F (93 °C) min.
Peel adhesion ASTM D 413 <sup>[1]</sup>	2.0 lb/in (0.35 N/mm)
Cold flex ASTM D 146	No cracking
2 × 5 inch (50 × 125 mm) Specimen-180° bend over 2 inch (50 mm) mandrel	
Heat stability	No dripping or delamination
2 × 5 inch (50 × 125 mm) specimen vertically suspended in a mechanical convection oven 2 hr @ 190 °F (88 °C)	
[1] 12 inches (300 mm)/minute test speed and 1 inch (25 mm) initial distance between the grips.	

Submit certified test data and letter of certification to the Engineer.

Furnish materials according to the Department's Qualified Products List (QPL).

**711.30 Aluminum for Steps.** Furnish aluminum for steps according to ASTM B 221 (ASTM B 221M), Alloys 6061-T6 or 6005-T5.

## 711.31

Furnish materials according to the Department's Qualified Products List (QPL).

**711.31 Reinforced Propylene Plastic Manhole Steps.** Furnish reinforced propylene plastic manhole steps conforming to the details shown on the plans.

Furnish steel rod according to 709.01, Grade 60 that is continuous through the entire length of legs and tread. The steel may be coated according to ASTM A 934/A 934M. Ensure that the manufacturer furnishes written certification. Furnish propylene plastic according to ASTM D 4101, Table B 33430. Ensure that the manufacturer furnishes certified test data for the propylene plastic used in each lot of steps.

Furnish materials according to the Department's Qualified Products List (QPL).

## 712 MISCELLANEOUS

**712.01 Expansion Shield Anchors.** Furnish anchors conforming to the dimension requirements of the project plans and the following:

**A. Type A.** Federal Specification FF-S-325, Group II, Type 4 Class 1, and Group VIII, Type 1.

**B. Type B.** Federal Specification FF-S-325, Group III, Type 1 (a) or (c).

The supplier or producer of the anchors will provide a certification showing certified test results of the proof load required in Federal Specification FF-S-325.

Furnish materials according to the Department's Qualified Products List (QPL).

**712.02 Calcium Chloride.** Furnish calcium chloride according to ASTM D 98.

Furnish materials according to the Department's Qualified Products List (QPL).

**712.03 Sodium Chloride.** Furnish sodium chloride according to ASTM D 632, Type I, Grade 1, with the following modification:

4 Total Chlorides (NaCl, CaCl<sub>2</sub>, and MgCl<sub>2</sub> as NaCl based on dry weight) not less than 97 percent.

### **712.04 Lime and Lime Kiln Dust.**

**A.** Furnish hydrated lime for masonry purposes according to ASTM C 207, Type S.

**B.** Furnish quick lime for soil stabilization that is certified according to Supplement 1087 and listed on the Department's Qualified Products List (QPL) and according to ASTM C 977, with the following modification:

4.2.1 *Particle size of Quick Lime* – Quick lime shall all pass the No. 4 (4.75 mm) sieve.

**C.** Furnish lime kiln dust for soil stabilization that is certified according to Supplemental 1087. Lime kiln dust is a by-product of making lime. Furnish lime kiln dust that meets the following requirements. Perform chemical analysis of the lime kiln dust according to ASTM C 25.

Total calcium and magnesium oxides	50 % minimum
Total calcium oxides (nonvolatile basis)	50 % minimum
Available calcium hydroxide (rapid sugar test)	15 % minimum
Loss on ignition (carbon dioxide plus moisture, combined and free on as-received basis)	15 % maximum
Free water (as-received basis)	2 % maximum

Sieve analysis.

Sieve Size	Minimum Percent Passing
No. 4 (4.75 mm)	95
No. 30 (600 $\mu\text{m}$ )	90
No. 100 (150 $\mu\text{m}$ )	75

Submit test results for the above requirements for every 100 tons (90 metric tons) of lime kiln dust supplied to the Department. If multiple tests were performed, include the average and standard deviation with the results.

### 712.06 Preservative Treatment for Structural Timber, Lumber, Piling, Posts, Braces, and Blocks.

**A. General.** Furnish structural timber, lumber, and pilings according to 711.26, and posts, braces, and blocks according to 710.14, except that moisture may be removed from the untreated lumber at the time of preservative treatment. Ensure that structural timber, lumber, piling, posts, and braces conform to the current AWWA standards and this subsection. The minimum retention for blocks is 0.40 pounds per cubic foot (6.4 kg/m<sup>3</sup>).

**B. Materials.** Furnish timber preservatives according to AASHTO M 133.

**C. Preparation for Treatment.** Sort the material into one kind or designated group of kinds of wood and into pieces of approximately equal size and moisture and sapwood content. Separate material to ensure contact of treating medium with all surfaces.

**D. Framing.** Conduct all adzing, boring, chamfering, framing, graining, mortising, and surfacing before treatment.

**E. Incising.** Incise lumber 3 inches (75 mm) or more thick on all four sides. Incise lumber less than 3 inches (75 mm) thick on the wide faces only, except as shown on the plans.

Incise Douglas fir with a minimum dimension of 2 inches (50 mm) using a suitable power-driven machine before treatment. Do not incise Douglas fir rails and rail posts.

Use the spacing and shape of the cutting teeth and the method of incising necessary to produce a uniform penetration. The minimum required depths of the incisions are as follows:

**712.09**

<b>Size<sup>[1]</sup></b>	<b>Minimum depth of incision, inch (mm)</b>
2 × 12 (50×300)	3/8 (9)
3 × 12 (75×300)	7/16 (11)
4 × 12 (100×300)	1/2 (13)
8 × 10 (200×250)	9/16 (14)
10 × 12 (250×300)	5/8 (16)
12 × 12 (300×300)	3/4 (19)
[1] Intermediate size in proportion.	

**F. Amount of Preservative.** The required net retention in any charge is no less than 90 percent of the quantity of preservative specified, but the average retention by the material treated under any contract or order and the average retention of any five consecutive charges are required to be at least 100 percent of the quantity specified. Ensure that the minimum amounts of preservative retained conform to AASHTO M 133 and the requirements set forth in the referenced AWWA Standard. Treat all species of structural timber, lumber, piling, posts, and blocks according to the current AWWA standards.

**G. Acceptance.** Accept only structural timber, lumber, piling, posts, braces, and blocks according to Supplement 1072.

**712.09 Geotextile Fabrics.** Furnish fabric composed of strong rot-proof polymeric fibers formed into a woven or non-woven fabric. The Department will determine acceptance of Type A, B, C and D fabric according to test data obtained in the most current report from the National Transportation Product Evaluation Program (NTPEP) – Laboratory Results of Evaluations on Geotextiles and Geosynthetics.

<b>Type A: Underdrains and Slope Drains</b>	
Minimum Tensile Strength <sup>[ASTM D4632]</sup>	80 lb (355 N)
Minimum Puncture Strength <sup>[ASTM D4833]</sup>	25 lb (110 N)
Or Minimum Puncture Strength <sup>[ASTM D6241]</sup>	140 lb (625 N)
Minimum Tear Strength <sup>[ASTM D4533]</sup>	25 lb (110 N)
Apparent Opening Size <sup>[ASTM D4751]</sup>	
Soil Type-1: Soils with 50% or less passing No. 200 (75 µm) sieve	AOS ≤ 0.6 mm
Soil Type-2: Soils with 50 to 85% passing No. 200 (75 µm) sieve	AOS ≤ 0.3 mm
Minimum Permittivity <sup>[ASTM D4491]</sup>	0.5 sec <sup>-1</sup>
<b>Type B: Filter Blankets for Rock Channel Protection</b>	
Minimum Tensile Strength <sup>[ASTM D4632]</sup>	200 lb (890 N)
Minimum Puncture Strength <sup>[ASTM D4833]</sup>	80 lb (355 N)
Or Minimum Puncture Strength <sup>[ASTM D6241]</sup>	440 lb (1955 N)
Minimum Tear Strength <sup>[ASTM D4533]</sup>	50 lb (220 N)
Minimum Elongation <sup>[ASTM D4632]</sup>	15%
Apparent Opening Size <sup>[ASTM D4751]</sup>	AOS ≤ 0.6 mm
Minimum Permittivity <sup>[ASTM D4491]</sup>	0.2 sec <sup>-1</sup>
<b>Type C: Sediment Fences</b>	
Minimum Tensile Strength <sup>[ASTM D4632]</sup>	120 lb (535 N)
Maximum Elongation <sup>[ASTM D4632]</sup>	50%
Minimum Puncture Strength <sup>[ASTM D4833]</sup>	50 lb (220 N)
Or Minimum Puncture Strength <sup>[ASTM D6241]</sup>	275 lb (1225 N)
Minimum Tear Strength <sup>[ASTM D4533]</sup>	40 lb (180 N)
Apparent Opening Size <sup>[ASTM D4751]</sup>	AOS ≤ 0.84 mm.
Minimum Permittivity <sup>[ASTM D4491]</sup>	0.01 sec <sup>-1</sup>
*Ultraviolet Exposure Strength Retention <sup>[ASTM D4355]</sup>	70%
<b>Type D: Subgrade-Base Separation or Stabilization</b>	
Minimum Tensile Strength <sup>[ASTM D4632]</sup>	180 lb (800 N)
Maximum Elongation <sup>[ASTM D4632]</sup>	50%
Minimum Puncture Strength <sup>[ASTM D4833]</sup>	70 lb (310 N)
Or Minimum Puncture Strength <sup>[ASTM D6241]</sup>	385 lb (1715 N)
Minimum Tear Strength <sup>[ASTM D4533]</sup>	70 lb (310 N)
Apparent Opening Size <sup>[ASTM D4751]</sup>	Same as Type A
Permittivity <sup>[ASTM D4491]</sup>	0.05 sec <sup>-1</sup>

- [1] ASTM D6241 is now the standard puncture resistance test required by AASHTO and NTPEP. NTPEP will continue to publish product data, tested under ASTM D4833, until the product is retested under ASTM D6241.
- [2] Provide certified test data to the Department. Include strength retention data at 0, 150, 300, and 500 hours

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For Type E material, supply fabric conforming to the requirements of AASHTO M288, Section 10, Table 8. The Department will accept Type E material based on certified test data.

All minimum strengths shown are average roll minimum values in the weakest principal direction.

Ensure that the fabric is free of any treatment that might significantly alter its physical properties.

During shipment and storage, wrap the fabric in a heavy-duty protective covering to protect it from UV deterioration, direct sunlight, dirt, dust, and other debris.

Furnish materials according to the Department's Qualified Products List (QPL).

**712.10 Prefabricated Edge Underdrain.** Furnish prefabricated edge underdrain consisting of a polymeric core with a minimum thickness of 1 inch (25 mm) wrapped in fabric according to 712.09, Type A. Ensure that the underdrain is flexible, rectangular in shape, and of hollow construction. Use core material that is resistant to petroleum-based chemicals, naturally occurring soil chemicals, and road de-icing agents. The core material will have sufficient flexibility to withstand bending and handling during installation without damage. The core will provide a minimum of 100 square inches (0.064 m<sup>2</sup>) unobstructed (one side only) drainage area per 1 foot (0.3 m) of width. Side walls of the core will have at least 5 percent open area to permit unobstructed flow through the filter and wall to the core. The required minimum compressive strength of the prefabricated edge drain is 6000 pounds per square foot (290 kPa) with a maximum 20 percent compression in a parallel plate compression test (ASTM D 695). The minimum (single side) core flow capacity is 10 gallons per minute per foot of width for a 0.1 gradient at 10 pounds per square inch bladder load according to ASTM D 4716. Furnish the manufacturer's certified test results as specified 101.03.

**712.11 Temporary Erosion Control Mats Materials.** Unless specifically itemized, furnish any of the type mats listed below. Provide certified test data for each shipment of material.

**A. Type A Temporary Erosion Control Mat.** Conform to the following:

1. A machine-produced mat consisting of 100 percent agricultural straw covered on the top with a polypropylene netting having an approximate 1/4 × 1/4 inch to 1/2 × 1/2 inch (6 × 6 mm to 13 × 13 mm) mesh, and sewn together with biodegradable or photodegradable thread.
2. A consistent thickness with the straw evenly distributed over the entire area of the mat.
3. A minimum mat width of 6.5 feet (2 m).
4. An average mat weight of 0.5 pound per square yard (270 g/m<sup>2</sup>) ± 10 percent.

5. A netting weight of approximately 1 pound per 1000 square feet (5 kg/1000 m<sup>2</sup>).

**B. Type B Temporary Erosion Control Mat.** Conform to the following:

1. A machine-produced mat consisting of 100 percent agricultural straw covered on the top with a photodegradable polypropylene netting having an approximate 1/2 × 1/2 inch to 5/8 × 5/8 inch (13 × 13 mm to 16 × 16 mm) mesh and on the bottom with a photodegradable polypropylene netting having an approximate 1/4 × 1/4 inch to 1/2 × 1/2 inch (6 × 6 mm to 13 × 13 mm) mesh, sewn together with biodegradable or photodegradable thread.

2. A consistent thickness with the straw evenly distributed over the entire area of the mat.

3. A minimum mat width of 6.5 feet (2 m).

4. An average mat weight of 0.5 pound per square yard (270 g/m<sup>2</sup>) ±10 percent.

5. A top netting weight of approximately 3 pounds per 1000 square feet (15 kg/1000 m<sup>2</sup>) and a bottom netting weight of approximately 1 pound per 1000 square feet (5 kg/1000 m<sup>2</sup>).

**C. Type C Temporary Erosion Control Mat.** Conform to the following:

1. A machine-produced mat consisting of 70 percent agricultural straw and 30 percent coconut fiber covered on the top with a photodegradable polypropylene netting having an approximate 5/8 × 5/8 inch (16 × 16 mm) mesh and on the bottom with a photodegradable polypropylene netting having an approximate 1/4 × 1/4 inch (6 × 6 mm) mesh, sewn together with cotton thread.

2. A consistent thickness with the straw and coconut fiber evenly distributed over the entire area of the mat.

3. A minimum mat width of 6.5 feet (2 m).

4. An average mat weight of 0.5 pound per square yard (270 g/m<sup>2</sup>) ± 10 percent.

5. A top netting weight of approximately 3 pounds per 1000 square feet (15 kg/1000 m<sup>2</sup>) and a bottom netting weight of approximately 1 pound per 1000 square feet (5 kg/1000 m<sup>2</sup>).

**D. Type D Temporary Erosion Control Mat.** Conform to the following:

1. A machine-produced mat consisting of 70 percent agricultural straw and 30 percent coconut fiber with a biodegradable tissue upon which seeds are placed, and sewn together with cotton thread.

2. Covered on the top of the mat with a photodegradable polypropylene netting having an approximate 5/8 × 5/8 inch (16 × 16 mm) mesh.

3. Covered on the bottom of the mat with a biodegradable tissue paper upon which Kentucky 31 fescue grass seed is placed at a rate of 90 pounds per acre (10 g/m<sup>2</sup>) and Rye grass at a rate of 45 pounds per acre (5 g/m<sup>2</sup>).

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4. Covered on the bottom of the mat and tissue paper with a photodegradable polypropylene netting having an approximate  $1/4 \times 1/4$  inch ( $6 \times 6$  mm) mesh.

5. A consistent thickness with the straw and coconut fiber evenly distributed over the entire area of the mat.

6. A minimum mat width of 6.5 feet (2 m).

7. An average mat weight of 0.5 pound per square yard ( $270 \text{ g/m}^2$ )  $\pm$  10 percent.

8. A top netting weight of approximately 3 pounds per 1000 square feet ( $15 \text{ kg}/1000 \text{ m}^2$ ) and a bottom netting weight of approximately 1 pound per 1000 square feet ( $5 \text{ kg}/1000 \text{ m}^2$ ).

**E. Type E Temporary Erosion Control Mat.** Conform to the following:

1. A machine-produced mat consisting of 100 percent coconut fiber covered on the top and bottom with an ultraviolet stabilized polypropylene netting having an approximate  $5/8 \times 5/8$  inch ( $16 \times 16$  mm) mesh, and sewn together with polyester thread.

2. A consistent thickness with the coconut fiber evenly distributed over the entire area of the mat.

3. A minimum mat width of 6.5 feet (2 m).

4. An average mat weight of 0.5 pound per square yard ( $270 \text{ g/m}^2$ )  $\pm$  10 percent.

5. An ultraviolet stabilized polypropylene netting with a weight of approximately 3 pounds per 1000 square feet ( $15 \text{ kg}/1000 \text{ m}^2$ ).

**F. Type F Temporary Erosion Control Mat.** Conform to the following:

1. A uniform open plain weave of undyed and unbleached single jute yarn.

2. Loosely twisted yarn not varying in thickness by more than one-half its normal diameter.

3. Furnish mats in rolled strips with:

a. A minimum length of 50 yards (46 m).

b. A width of 48 inches  $\pm$  1 inch ( $1.2 \text{ m} \pm 25 \text{ mm}$ ).

c. Warp ends width  $81 \pm 3$ .

d. Weft ends per yard (meter)  $41 \pm 3$  ( $49 \pm 3$ ).

e. An average weight of 1.22 pounds per linear yard ( $0.6 \text{ kg/m}$ )  $\pm$  10 percent.

**G. Type G Temporary Erosion Control Mat.** Conform to the following:

1. A machine-produced mat consisting of wood excelsior, 80 percent of which is at least 8 inches (200 mm) in length.

2. Excelsior cut from wood that is properly cured to achieve adequately curled and barbed fibers.

3. A consistent thickness with the fiber evenly distributed over the entire area of the mat.

4. For use in ditches or channels, cover the top and bottom of the excelsior with lightweight netting entwined with the excelsior for maximum strength and ease of handling, or cover the top only with heavyweight netting machine sewn on maximum 2 to 4-inch (51 to 102 mm) centers along the longitudinal axis of the material. For all other applications, cover the top with lightweight netting entwined with the excelsior for maximum strength and ease of handling.

5. Regardless of application, lightweight netting consists of either netting having a maximum  $3 \times 1$  inch ( $75 \times 25$  mm) weave, twisted craft [check spelling] paper yarn having a high web strength or biodegradable plastic.

6. Mat widths of 24, 36, 48, or 78 inches (0.6, 0.9, 1.2, or 2 m) or greater,  $\pm 1$  inch ( $\pm 25$  mm).

7. Mat rolls of more than 90 feet (27.5 m) in length.

8. A mat weight of not less than 0.72 pound per square yard ( $390 \text{ g/m}^2$ ) constant weight, air dry.

**H. Type H Temporary Erosion Control Mat.** Conform to the following:

1. Layers of silt and expanded biodegradable paper fabricated into a mat sewn together with cotton thread.

2. A consistent thickness with sufficient open areas for grass growth through the mat.

3. An average mat weight of 0.55 pounds per square yard ( $300 \text{ g/m}^2$ )  $\pm 10$  percent.

4. Rolls packaged in plastic bags to prevent damage from weather conditions and handling.

**I. Type I Temporary Erosion Control Mat.** Conform to the following:

1. Extruded polymeric plastic net having a mesh opening of approximately  $3/4 \times 3/4$  inch ( $20 \times 20$  mm).

2. A netting with an average weight of 3 pounds per 1000 square feet ( $15 \text{ kg}/1000 \text{ m}^2$ )  $\pm 10$  percent and a minimum tensile strength of 15 pounds over a 3-inch width (67 N over a 77 mm width) in the weakest principal direction.

**720 DELINEATOR MATERIALS**

**720.01 Rectangular Reflectors.** Furnish rectangular reflectors that are a minimum size of 3 x 6 inches (75 x 150 mm) and that consist of reflective sheeting according to 730.192 or 730.193 adhered to a flexible post or an aluminum plate. Furnish white, yellow, or red reflectors as specified. Furnish aluminum plate for rectangular reflectors according to ASTM B 209 (B 209M), 6061-T6 with a minimum thickness of 0.060 inch (1.5 mm).

Furnish materials according to the Department’s Qualified Products List (QPL).

**720.03 Flexible Posts.** Conform to Supplement 1020.

Furnish materials according to the Department’s Qualified Products List (QPL).

**720.04 Barrier Reflectors.** Furnish concrete barrier, retaining wall and bridge parapet reflector body housings that are made of acrylic or polycarbonate plastic, or corrosion resistant metal. Ensure that the minimum reflective surface area of the reflector is 7 square inches (4400 mm<sup>2</sup>).

Furnish white reflectors that reflect the following minimum candela of light at the indicated observation angles for each 1 foot-candle (10.76 lx) of incident light at the indicated entrance angles. Furnish amber reflectors that reflect at least 60 percent of these values.

**MINIMUM SPECIFIC INTENSITY, CD/10.76 LX**

		Observation Angle (degrees)	
		0.2	2.0
Entrance angle (degrees)	-4	62	0.25
	15	52	0.18

The entrance angle is measured in the horizontal plane between the direction of incident light and normal to the face of the reflector. The observation angle is measured in the vertical plane between the observer’s line of sight and the direction of light incident to the reflector face.

Furnish guardrail blackout reflectors that are a minimum size of 4.5 x 10 x 0.125 inches (112.5 x 250 x 3.1 mm) and made of corrosion resistant metal with 1/4" (6 mm) predrilled mounting holes. One or both sides shall be covered with a minimum 4.5 x 5 inches (112.5 x 125 mm) of Type G, H or J reflective sheeting.

Furnish materials according to the Department’s Qualified Products List (QPL).

**721 RAISED PAVEMENT MARKER MATERIALS**

**721.01 Raised Pavement Marker Castings.** Ensure that the casting is nodular iron according to ASTM A 536, hardened to 51-55 RC, snow plowable in the two opposing longitudinal directions and designed to accommodate a replacement prismatic retroreflector.

Furnish materials according to the Department's Qualified Products List (QPL).

**721.02 Prismatic Retroreflector and Adhesive.** Furnish reflectors that contain one or two prismatic reflective faces to reflect incident light from a single or opposite directions. Furnish reflectors with nominal dimensions of  $4 \times 2 \times 0.48$  inch ( $100 \times 50 \times 12$  mm). Ensure that the reflector fits securely in the recessed area and does not protrude above the profile of the casting.

Furnish manufacturer recommended retroreflector adhesive to bond the prismatic retroreflectors to casting.

Furnish materials according to the Department's Qualified Products List (QPL).

**721.03 Casting Adhesive.** Furnish adhesive according to AASHTO M 237, Type IV, except that the viscosity is 200 to 900 poise at  $77 + 2$  °F ( $25 + 1$  °C) and the unit weight is 11.3 to 11.9 pounds per gallon (1.35 to 1.43 kg/L).

Furnish materials according to the Department's Qualified Products List (QPL).

## 725 HIGHWAY LIGHTING MATERIALS

**725.01 General.** Furnish luminaires, conduits, wire, switch gear and other electrical hardware that are listed with Underwriters Laboratories.

Ensure that each item of manufactured electrical apparatus as a unit has a durable nameplate identifying the manufacturer and manufacturer's product identification.

The Engineer will inspect all lighting materials at the project site.

Only provide samples when required by the Laboratory.

**725.02 Wire and Cable.** Ensure that each nonshielded wire or cable rated 0-2kV is single conductor, stranded copper with cross-linked thermosetting polyethylene insulation, nonjacketed, meets the requirements of ICEA S-95-658/NEMA WC70 and is of UL Type RHH-RHW-USE except for conductors 10 AWG and smaller for which those with insulation meeting the requirements of UL Type XHHW may also be used.

Ensure that each non-shielded wire or cable rated 5000 volts (2400 volts working under the 2005 NEC) is single conductor, stranded copper with chemically cross-linked polyethylene insulation, nonjacketed, meets the requirements of ICEA S-96-659/NEMA WC71 and of UL Type MV-90 dry.

Ensure that each cable's identification device defining its use is either a tag tied onto the cable or a band applied around the cable. Ensure that cable tags are of copper, brass or plastic (except for tags within switch and device cabinets which shall be nonconducting) 1/32 inch (0.8 mm) minimum in thickness permanently fastened to the cables by means of cable tying straps. Ensure that cable identifying bands are approximately 1/32-inch (0.8 mm) thick wrap completely around the

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cable and closed securely. Ensure that each tag or band is marked using 1/4 inch (6 mm) minimum height embossed or engraved letters.

Ensure that conductors shall be marked "CKT" followed by the circuit designation shown on the plans and that grounding conductors are marked "GND" and that neutral conductors are marked "NEU" and that hot conductors are marked "Line" followed by "1" or "2" for single phase power or "Phase" followed by "A" or "B" or "C" for three phase power.

Furnish materials according to the Department's Qualified Products List (QPL).

**725.03 Unit Type Duct-Cable Systems** Ensure that factory made cable-in-duct has conductors as specified, that the duct is high density polyethylene Type III, Class C, Category 5, Grade 34 conforming to NEMA TC-7 and that the duct has the manufacturer's name and the year of manufacture included in the marking.

Conductors and neutrals will conform to 725.02.

Furnish materials according to the Department's Qualified Products List (QPL).

**725.04 Rigid Galvanized Steel Conduit and Fittings** Ensure that rigid galvanized steel conduit complies with the requirements of ANSI C 80.1 and UL 6 Type I and that each length of conduit bears the UL label. Furnish fittings that comply with the requirements of ANSI/NEMA FB 1 AND ANSI/UL 514B.

Furnish materials according to the Department's Qualified Products List (QPL).

**725.051 Polyvinyl Chloride Conduits and Fittings.** Furnish polyvinyl chloride conduit EPC-40-PVC conforming with NEMA Standard TC 2 for normal above ground or below ground, either concrete encased or direct burial. Use fittings conforming to NEMA Standard TC-2 references.

Furnish materials according to the Department's Qualified Products List (QPL).

**725.052 Polyethylene Conduits and Fittings.** Furnish polyethylene conduit EPEC-40-HDPE conforming with NEMA Standard TC 7 for below ground only, whether concrete encased or direct burial. Use fittings conforming to ASTM D3350.

Furnish materials according to the Department's Qualified Products List (QPL).

**725.06 Polymer Concrete Pull Boxes** Ensure that the polymer concrete pull box and cover is of aggregate bound with a polymer resin. Ensure that the body of the box is of one piece construction. Ensure that all surfaces of the box and cover are smooth and that the cover has a molded slip resistant surface. Ensure that the cover is labeled in clearly legible block letters 1 inch to 2 inches (25 mm - 50 mm) in height integral to the cover with the word "TRAFFIC", "LIGHTING", "ELECTRIC" or "TELEPHONE" to designate the circuit(s) contained. Ensure that the cover closely fits the opening and is secured by stainless steel bolts and hardware and that the threaded holes into which the cover bolts fasten are of open bottom design. Ensure that the box and cover meet the structural requirements of Society of Cable Telecommunications Engineers Tier 15.

Furnish materials according to the Department's Qualified Products List (QPL).

**725.07 Plastic Pull Boxes** Ensure that the plastic pull box and cover is of high density ultraviolet stabilized molded polyethylene with a box wall thickness of at least 1/4 inch (6 mm). The box depth may be obtained through the use of extensions or stacking. Ensure that the cover is slip resistant and has in clearly legible block letters 1 inch to 2 inches (25 mm - 50 mm) in height integral to the cover the word "TRAFFIC", "LIGHTING", "ELECTRIC" or "TELEPHONE" to designate the circuit(s) contained. Ensure that the cover closely fits the opening and is secured by stainless steel bolts and hardware and that the threaded holes into which the cover bolts fasten are of open bottom design. The box shall meet the structural requirements of Western Underground Committee Guide 3.6.

Furnish materials according to the Department's Qualified Products List (QPL).

**725.08 Portland Concrete Pull Boxes.**

**A. Pull Box.** Ensure that the Portland concrete pull box is constructed of reinforced portland cement concrete. When the box is precast, provide pull boxes from suppliers certified to Supplement 1073. Ensure that the pull box cover is constructed according to 725.08B and as shown on the plans.

**B. Pull Box Covers.** Furnish metal pull box covers that conform to the following requirements:

1. Furnish 1/2-inch (13 mm) thick steel plate for the steel cover conforming to 711.01 with 1/2-inch (13 mm) minimum flange around the edge and galvanized to conform to 711.02. Display on the steel cover or on an attached brass or stainless steel plate (tag) clearly legible block letters 1 inch to 2 inches (25 mm to 50 mm) in height with the word "TRAFFIC", "LIGHTING", "ELECTRIC" or "TELEPHONE" to designate the circuit(s) contained. Ensure that the word designating the use is in raised letters that are either integral to the steel cover or integral to a brass or stainless steel plate 1/16 inch (1.6 mm) in thickness securely mechanically attached to the steel cover at the four corners of the tag and at intervals 2 inches to 3 inches (50 mm to 75 mm) along the perimeter between corners.

2. Furnish gray iron or ductile iron with a minimum thickness of 3/8 inch (9 mm) conforming to C&MS 711.14. Certification is required. Ensure that the word "TRAFFIC," "LIGHTING", "ELECTRIC," or "TELEPHONE" is cast in the top surface of the cover forming letters 1 inch to 2 inches (25 mm to 50 mm) in height.

**725.10 Junction Boxes.** Ensure that the junction boxes are iron castings hot-dip galvanized in accordance with 711.02. Ensure that the junction boxes meet the requirements of NEMA ICS-6-Type 3. When a drilled and tapped conduit entry is stipulated, ensure that the junction box has adequate wall thickness and that a boss has been cast into the box if such is necessary.

Furnish materials according to the Department's Qualified Products List (QPL).

**725.11 Luminaires.**

**A. Optical System.** Furnish a luminaire set to the photometric distribution stipulated in the plan and that the distribution along with the settings required to produce it are clearly indicated on a durable label affixed to the interior of the

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housing in a position readily apparent and easily read by a worker lamping the luminaire.

Furnish a luminaire with a borosilicate glass refractor free of striations and imperfections and embossed to clearly indicate the street side when the refractor may be installed in more than one position. Ensure the refractor is held firmly in the housing, but is easily removed without the use of special tools.

Furnish a luminaire with an aluminum reflector with a specular polished reflective surface free from scratches. Ensure the reflector is held firmly in the housing, but is easily removed without the use of special tools.

Furnish a luminaire with a socket for mogul base lamps where there is a choice of size for the application at hand.

Furnish a lamp socket with a large center contact spring providing a firm contact with the lamp base and lamp grips to prevent the lamp from loosening. Ensure that the shell is shrouded in porcelain and that the wiring terminals and contacts are identified.

Ensure that socket positions adjustments have positive indexing such as holes, lugs or notches and are not slots with infinite settings.

Ensure that socket adaptors are not necessary nor used.

**B. Lamps.** Furnish a luminaire that has been provided with a lamp of the type and wattage specified and that each lamp has a clear glass envelope, a date recording feature and does not have any ballasting or starting components.

Furnish high pressure sodium lamps that are first line, high quality lamps having heat resistant clear glass envelopes with a quartz arc tube interior with horizontal initial lumens and approximate hours of life not be less than the values shown in Table 725.11-1.

TABLE 725.11-1

ANSI	WATTS	Horizontal Lumens Initial	Economic Life Hours
S62	70	5,800	14,000
S54	100	9,500	14,000
S56	150	16,000	16,000
S66	200	22,000	16,000
S50	250	27,500	16,000
S67	310	37,000	16,000
S51	400	50,000	16,000
S52	1,000	130,000	16,000

Furnish high pressure sodium lamps that produce a minimum of 80 percent of the initial lumen output at the end of economic life.

Furnish metal halide lamps that are first line, high quality lamps having heat resistant clear glass envelopes with a quartz arc tube interior with horizontal initial lumens and approximate hours of life not less than the values shown in Table 725.11-3.

**TABLE 725. 11-3**

<b>ANSI</b>	<b>WATTS</b>	<b>Horizontal Lumens Initial</b>	<b>Economic Life Hours</b>
M57	175	14,000	4,000
M58	250	18,000	4,000
M59	400	32,000	10,000
M47	1,000	95,000	7,500

Furnish metal halide lamps that produce a minimum of 65 percent of the initial lumen output at the end of economic life.

Furnish low pressure sodium lamps that are first line, high quality lamps having heat resistant clear glass envelopes with a quartz arc tube interior with horizontal initial lumens and approximate hours of life not less than the values shown in Table 725.11-4.

**TABLE 725.11-4**

<b>WATTS</b>	<b>Lumens Initial</b>	<b>Economic Life Hours</b>
35	4,000	16,000
55	8,000	16,000
90	13,500	16,000
135	22,500	16,000
180	33,000	16,000

Furnish lamp materials according to the Department's Qualified Products List (QPL).

**C. Ballast.** Ensure that the ballast is of an integral design contained within the luminaire housing.

If the ballast is to be wired line to line or phase to phase, ensure that the ballast has an isolated primary winding. If the ballast is to be wired line to grounded neutral or phase to grounded neutral, the ballast may be either the isolated primary winding design or the auto transformer design.

Furnish a ballast (in conjunction with the starter in the case of high pressure sodium lamps) capable of starting and operating the lamp at ambient temperatures as low as -20°F (-30°C).

At circuit voltage of nominal plus or minus 10 percent or the ballast manufacturer's stated range if greater, ensure that the ballast can start (in conjunction with the starter in the case of high pressure sodium lamps) and operate the lamp within the lamp's ANSI operating parameters for the full design life of the lamp.

When required by the Engineer, furnish original copies of the luminaire manufacturer's ballast electrical data and lamp operating volt-watt traces for nominal and plus or minus ten percent rated line voltage to verify ballast performance and compliance with ANSI lamp specifications, for the rated life of the lamp.

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Furnish a ballast capable of operation with the lamp in an open or short circuit condition for six months without significant loss of ballast life.

Furnish a starter of encapsulated solid state design capable of withstanding the temperatures encountered in the ballast compartment of the luminaire.

Ensure that the starter provides a timed pulsing with sufficient follow through current to completely ionize and start all lamps that meet published ANSI standards.

Ensure that the starter ceases operation after the lamp has started and that the starter protects itself, the ballast, the capacitor, and the lamp socket against cycling, burned out, broken or missing lamps by ceasing the starting operation after the power has been applied to the luminaire for a period of not less than 3 minutes and no more than ten minutes and not beginning the starting operation again until power has been shut off and reapplied to the luminaire.

Ensure that the starter has push-on type electrical terminations and is field replaceable with no adjustment necessary for proper operation.

Ensure that there is a barrier type terminal block for connection of the incoming electrical circuit.

### **D. Housing.** Furnish a housing of cast aluminum.

Ensure that the housing has a flat area on the top side on which a level may be placed and read by a worker leveling a mounted luminaire on an erected support.

Ensure that the door(s) providing access to the optical and electrical components have hinges and latches of corrosion resistant materials that remain securely closed during operation.

Ensure that the silicone rubber, ethylene propylene terpolymer, dacron felt or other durable gaskets and seals supplied by the manufacturer either as part of the basic luminaire or as options are in good condition and properly installed at the socket entry, between the refractor and reflector and any other location where such gaskets or shields are part of the luminaire and options.

Ensure that the exterior finish of the luminaire is a light gray color unless otherwise specified.

Furnish a glare shield of aluminum or opaque plastic material when specified. Furnish a shield supplied by the manufacturer of the luminaire.

**E. Conventional Luminaries.** Ensure that the luminaire housing doors may be opened, closed, removed or installed without the use of tools.

Ensure that the clamp for the slip-fit mounting accommodates both 1 1/4" (32 mm) and 2" (50 mm) nominal pipe mounting bracket. Ensure that a stop is provided as part of the housing to prevent over insertion of the bracket into the housing. Ensure that the clamp engages at least 4 1/2"(115 mm) longitudinally along the arm of the bracket arm between the extremes of a minimum of two clamping points. Ensure that the mounting clamp provides for leveling of the luminaire to the specified transverse and longitudinal position with respect to the roadway.

Ensure that the luminaire is equipped with a device indicating the direction and amount of tilt over a range of zero to five degrees in any direction with indications at level, three degree tilt and five degree tilt all accurate to one half degree. Ensure that the indicating device is clearly readable in daylight from a distance of 50 feet (15 m) and in no way alters or reduces the amount of light from the luminaire. Ensure that the indicating device is constructed of a transparent container having one horizontal surface which is curvilinear in any vertical cross section for supporting an indicator and a damping fluid. Ensure that the damping fluid is a liquid which shall be suitable for operation at -40° F (-40° C) and that the transparent container is fabricated from clear ultraviolet-inhibited acrylic or similar material.

Ensure that the glare shield will cut off the upward component of light and that it does not reduce the total output of the luminaire more than 3 percent.

Ensure that the luminaire has a label or decal indicating the type of source and wattage rating. Ensure that, with the luminaire installed in its normal operating position, the label or decal is clearly legible in daylight at a distance of 50 feet (15 m). Ensure that the labeling is in accordance with the provisions of NEMA Publication OD-150 or EEI Publication TDJ-150.

Ensure that the complete conventional luminaire assembly including the lamp and all options including, when required, the glare shield does not weigh more than 75 pounds (34 kg).

Furnish conventional luminaire materials according to the Department's Qualified Products List (QPL).

**F. Wall Mounted Underpass Luminaires.** Ensure that the assembly is weatherproof and sealed against dust.

Ensure that a wire entry for the incoming power is provided on both of the vertical side surfaces of the housing, that each entry is drilled and tapped for 3/4 inch (19 mm) conduit and that the unused entry is properly closed with the screw type plug supplied by the manufacturer.

Ensure that the luminaire housing doors may be opened, closed, removed or installed without the use of special tools.

Ensure that the housing can be mounted onto a vertical flat surface by means of cap screws or bolts through the wall side of the housing.

Ensure that the luminaire has the option for protecting the glass refractor with a guard or shield that is integral to the luminaire and does not have to be removed to gain access to the lamp or ballast.

Furnish wall mounted underpass luminaire materials according to the Department's Qualified Products List (QPL).

**G. High Mast / Low Mast Luminaires.** Ensure that luminaires with a symmetric distribution shall have an initial intensity of no more than 100 candela per 1000 lamp lumens at nadir and no more than 325 candela per 1000 lamp lumens at angles between 55 and 65 degrees above nadir.

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Ensure that luminaires with an asymmetric distribution or a long and narrow distribution shall have an initial intensity of no more than 175 candela per 1000 lamp lumens at nadir and no more than 425 candela per 1000 lamp lumens at angles from 66 through 73 degrees above nadir.

Ensure that the output efficiency of the luminaire shall be not less than 65 percent of the bare lamp lumens. The luminaire shall emit at least 25 percent but no more than 35 percent of the bare lamp lumens at vertical angles of at least 60 degrees above nadir but no more than 90 degrees above nadir.

Ensure that no portion of the arc tube of the lamp shall be viewable at angles of 70 degrees or more above nadir.

Ensure that the photometric distribution is produced by an optical assembly consisting of a reflector alone or in combination with a refractor which redirects the output of a lamp mounted in a socket therein and that the reflector and refractor (if used) are each of a one piece design.

Ensure that the optical assembly is field rotatable to align the light distribution horizontally independent of the orientation of the arm supporting the luminaire.

Ensure that a luminaire for use with a 1000 watt lamp has an auxiliary lamp support that engages the outer end of the lamp envelope.

Ensure that the luminaire is of substantial design adequate to operate at mounting heights up to and including 150-feet(45 m) and wind velocities up to and including 90 mph (145 km/h).

Ensure that the luminaire mounts by means of a slip fit onto a horizontal 2 inch (50 mm) pipe and that the luminaire's integral mounting provides adjustment for leveling but remains secure and does not twist about the mounting pipe of the bracket when subjected to the vibration and wind loads of the installation.

Ensure that the maximum weight of the complete luminaire does not exceed 75 pounds (34 kg) and the maximum projected area does not exceed 3.5 square feet (0.3 m<sup>2</sup>).

Furnish high mast/low mast luminaire materials according to the Department's Qualified Products List (QPL).

**725.12 Polyethylene, Fiberglass Reinforced, Pull Box with Polymer Concrete Cover and Support Ring** Ensure that the pull box body is of fiberglass reinforced high density ultraviolet stabilized molded polyethylene with a polymer concrete cover support ring and polymer concrete cover. Ensure that the body of the box is of one piece construction. Ensure that the body of the box has a wall thickness of at least 1/4 inch (6 mm). Ensure that the cover support ring is permanently integrated into the box. Ensure that the cover is slip resistant and has in clearly legible block letters 1 inch to 2 inches (25 mm - 50 mm) in height integral to the cover the word "TRAFFIC", "LIGHTING", "ELECTRIC" or "TELEPHONE" to designate the circuit(s) contained. Ensure that the cover closely fits the opening and is secured by stainless steel bolts and hardware and that the threaded holes into which the cover bolts fasten are of open bottom design.

Ensure that the box and cover meet the structural requirements of Society of Cable Telecommunications Engineers Tier 5.

Furnish materials according to the Department's Qualified Products List (QPL).

**725.15 Circuit Cable Connections and Terminations.** Ensure that each connector or terminator is of the same voltage rating as the wire being connected or terminated except that 600 volt connectors may be used with 5000 volt (secondary service) cable used in 600 volt service for the highway lighting circuits.

Ensure that each connector or terminator is a compression style which fully encloses the conductor(s) and is of high strength copper alloy not a metal other than copper which has been plated. Ensure that each connector used for a "butt" splice is a sleeve type with a "stop" in the center.

**A. Termination of Oversize Wire.** Ensure that each cable terminal of each device can properly accommodate the size of the wire being terminated. If a terminal of adequate size cannot be furnished, ensure that a short length of smaller wire is connected to the oversize conductor through the use of a proper butt style crimp connector or a terminal block, that no strands have been cut back in the oversize conductor to make the connection and that the smaller wire is rated to carry the full ampacity of the circuit protection device.

**B. Fused Pull-Apart Connection.** Ensure that each fused pull-apart cable connector kit is a molded synthetic rubber housing consisting of a female line side with two ports and a male load side with one port containing a socket type fuse holder wherein the fuse also acts as the pin for the load connection which is designed to break the circuit when the two halves of the connector body are separated. Ensure that the assembled kit is rated for direct burial and exposure to sunlight. Ensure that the metal parts of connector are of copper with a conductivity of 90 percent, have individual compression connections for each wire on the line side, have a crimp connection for the wire on the load side and have annular spring on the socket for each end of the fuse. Ensure that the fuse holder is for a standard midget [13/32" x 1-1/2" (10 mm x 38 mm)]fuse. Ensure that the fuse is rated 600 VAC, 100,000 AIC and does not have a glass body. Ensure that each cable port is sized for the wire or cable entering the entering the port and that there is a closure for the second line port if it is not to be used.

**C. Unfused Pull-Apart Connection.** Ensure that each unfused pull-apart cable connector kit is a molded synthetic rubber housing consisting of a female line side with two ports and a male load side with one port containing a line side socket and load side pin making a connection which is designed to break the circuit when the two halves of the connector body are separated. Ensure that the assembled kit is rated for direct burial and exposure to sunlight. Ensure that the metal parts of connector are of copper with a conductivity of 90 percent, have an individual compression connection for each wire on the line side, have a crimp connection for the wire on the load side, and have an annular spring on the socket for the pin. Ensure that each cable port is sized for the wire or cable entering the port and that there is a closure for the second line port if it is not to be used.

**D. Unfused Bolted Connection.** Ensure that each unfused re-enterable cable connector kit is a rigid molded plastic sleeve closed on each end by a molded

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synthetic rubber female end housing having one or two ports as needed containing space in which the connection is made by crimping a lug onto each wire and then bolting all of the lugs together. Ensure that the assembled kit is rated for direct burial and exposure to sunlight. Ensure that the metal parts of connector are of copper with a conductivity of 90 percent and that each connecting bolt has a self locking nut. Ensure that each wire enters through a port sized for the wire and that there is a closure for the port if it is not to be used.

**E. Unfused Permanent Connection.** Ensure that each cable splicing kit is a rigid transparent molded body having as many as two ports on each which allows the completed splice to be completely encapsulated by filling the mold with a resin compound. Ensure that the actual conductor connections are made using one time use compression connectors and that each wire or cable enters the mold through its own port.

Furnish materials according to the Department's Qualified Products List (QPL).

**725.16 Ground Rods.** Ensure that each ground rod is 1 inch (25 mm) in diameter and 10 feet(3 m) in length with a driving point on the lower end. If of other than circular cross section, ensure that the periphery of the rod is 3.2 inches (80 mm) or more. Ensure that the rod is of solid construction and is either stainless steel jacketed steel, copper clad steel or hot dipped galvanized steel in accordance with ASTM A 153, Class B-1.

Ensure that the rod bears a label denoting that it is UL listed.

Furnish materials according to the Department's Qualified Products List (QPL).

**725.19 Power Service Components.** Furnish the materials and equipment comprising a service pole, including service equipment, that meets the following requirements.

**A. Service Entrance Conduit.** Ensure that the service entrance or riser conduit is rigid galvanized steel with a rain tight galvanized steel service entrance head (weatherhead) threaded to fit the conduit containing a composition insert for 3 conductors.

**B. Service Disconnect.** Ensure that the service disconnect is a properly rated fused switch of the ampacity specified and solid neutral. Ensure that the service fuses are cartridge fuses on the load side of the switch.

**C. Lighting Contactor.** Ensure that the lighting contactor is of the open type electromagnetically held.

Ensure that control of the contactor is through a photocell connected through a "HAND-OFF-AUTOMATIC" selector switch accessible only with the contactor enclosure open. Ensure that the control circuit is a separate circuit with its own protection.

**D. Lighting Circuit Protection.** Ensure that separate protection is provided on the load side of the lighting contactor for each lighting circuit and that such protection will open all line or phase conductors of the respective circuit should a fault occur on any one line or phase conductors.

**E. Photoelectric Cell.** Ensure that the photoelectric control is a twist-lock plug-in, utility grade, solid state, cadmium sulfide type of the proper voltage, rated for 1000 watts maximum load, with integral surge protection, a fail-safe mode in which the lighting circuits will remain energized, and a hermetically sealed case. Ensure that the nominal "turn on" level is 1 footcandle (10 lux) vertical and that the nominal "turn-off" level is 6 footcandles (65 lux) vertical with tolerances of 20 percent for the specified values. Ensure that the photocell has a time delayed response that will not respond to flashes of light from lightning, headlights of passing vehicles or emergency vehicle strobes and beacons. Ensure that the photoelectric control mounting bracket has a EEI-NEMA locking-type receptacle.

**F. Switchgear Enclosure.** Ensure that components are mounted on a removable back panel of 14 gage or heavier enameled steel rather than directly on the back wall of the enclosure and that the back panel mountings do not penetrate the walls of the enclosure.

Ensure that a neutral terminal bar of adequate ampere rating and with holes in number and of size to terminate each conductor separately is provided in each enclosure where neutral conductors are to be terminated. Ensure that an equipment grounding conductor terminal bar of adequate ampere rating and with holes in number and of size to terminate each conductor separately is provided in each enclosure where grounding conductors are to be terminated. When there is no code or utility company prohibition, a combination neutral and equipment grounding conductor bar may be furnished.

Ensure that an enclosure containing a disconnect switch with an external operating handle allows that handle to be padlocked in either the "OFF" or the "ON" position.

Ensure that the enclosure containing the service disconnect switch has an interlock to prevent the door from being opened when the switch is in the "ON" position

Ensure that the enclosure provides for padlocking the door.

Ensure that each switchgear enclosure is a NEMA ICS-1-110.15 Type 4 fabricated from No. 16 gage or heavier AISI Type 302 or 303 annealed stainless steel with fully welded seams and a brushed finish.

All fasteners used in assembly of the enclosures shall conform to ASTM A 320/A 320M (AISI-300 series).

**G. Wiring Schematic, Wiring Diagram, Placards.** Furnish both a schematic diagram and a wiring diagram of the entire power service from the power company service transformer secondary connection through the lighting branch circuit connections in triplicate with two copies delivered to the project and the third copy placed in the service disconnect enclosure. The Engineer will ensure that one of the two copies delivered to the project is filed with the project records and the other is delivered to the maintaining agency contact person.

Ensure that each placard to be attached to an apparatus enclosure is of multiple layers of plastic thermally bonded together to provide a plate of at least 1/8" (3 mm) in thickness with engraved plain block letters at least 1/2" (12 mm) in height.

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Ensure that placards designating the function of the apparatus contained in an enclosure or other such information are of white letters on a black placard. Ensure that placards warning of high voltage possibly present in an enclosure or other such warning are of white letters on a red placard.

**H. Customer Service Pole.** Furnish a wood pole that complies with Supplement 1072. Ensure that the pole and any cross arms or pole key is Southern Pine or Western Red Cedar, full length, pressure treated in compliance with specifications of the American Wood Preservers Association using either creosote or pentachlorophenol. Ensure that the retention of preservative in Southern Pine is 7.5 pounds (120 kg) of creosote by assay or 0.38 pounds (6 kg) of pentachlorophenol by lime-ignition assay per cubic foot (cubic meter) of wood. Ensure that the retention of preservative in Western Red Cedar is 16 pounds (256 kg) of creosote by assay or 0.8 pounds (13 kg) of pentachlorophenol by lime-ignition assay per cubic foot (cubic meter) of wood. Ensure that the pole is 35 feet (10.5 m) minimum in length and Class 4 or heavier and conforming to ANSI 05.1 Specifications and Dimensions for wood poles. Ensure that the pole is reasonably straight without pronounced sweep or short crooks.

Ensure that all pole hardware, including racks, braces, straps, guy anchors, guy wire, clamps, bolts, nuts, washers, screws, nails, etc. is hot dip galvanized in accordance with 711.02.

Ensure that the grounding conductor is fastened to the pole with copper clad, rolled point staples of adequate size.

Ensure that the grounding conductor molding is either wood or plastic, in sections not less than 8 feet (2.4 m) long, of sufficient width and groove depth to completely enclose the grounding conductor.

Ensure that each pole anchor is of malleable iron or galvanized steel, 6 inch (150 mm) minimum diameter, two-way or four-way expanding type. Ensure that each anchor rod is 5/8 inch (16 mm) minimum diameter, 8 feet (2.4 m) minimum length galvanized steel with thimble eye. Ensure that each guy wire is 3/8 inch (10 mm) minimum diameter, conforming to ASTM A 475, galvanized steel.

**725.20 Multiple Cell Polyvinyl Chloride Conduit and Fittings.** Ensure that the multiple cell conduit consists of inner ducts conforming to NEMA TC-8 type DB in an outer conduit conforming to NEMA TC-2 (type EPC-40 or EPC-80 as specified except that size shall be the true inside diameter) in a factory preassembled unit. Ensure that fittings are factory made couplings that couple inner ducts and the outer conduit simultaneously, maintain the continuity and indexing of the inner ducts and are of a push fit design mechanically locked in place.

Furnish materials according to the Department's Qualified Products List (QPL).

**725.21 Luminaire Supports.** Ensure that the complete luminaire support from the luminaire(s) down through the connection to the foundation or other structure to which the luminaire support is attached conforms to the requirements of AASHTO's "Standard Specifications for Structural Supports for Highway Signs,

Luminaires and Traffic Signals". Ensure that the combined stress ratio above the first field joint is greater than the combined stress ratio at the base of the pole.

The design wind speed for all areas of the State shall be 90 mph (145 km/h).

The Director may require various tests including destructive tests at either the factory or on site prior to acceptance of a support in which case the Department's representative will supervise the Contractor and/or manufacturer as the appropriate entity perform the tests on supports selected at random by the Department from the lot produced for the project. Ensure that any support damaged by the testing is replaced at no additional cost to the Department.

Ensure that the support identification labels are adhesive labels with silver white reflective characters on a reflective green background meeting the requirements of 730.18.

Furnish certified luminaire supports according to Supplement 1091

**A. Light Poles.** Ensure that the deflection of the pole from vertical when placed under the load of the bracket arm, and a weight of 75 pounds (35 kg) in place of each luminaire does not exceed an angle of 1 degree 10 minutes when tested in accordance with Supplement 1025 and that certified copies of the results obtained from the deflection tests are furnished the Laboratory.

A pole and arm constructed from either aluminum or steel but not a combination of the two may be furnished.

Ensure that each bracket arm is made from straight or tapered stock round or ovaliptic in cross section not less in size than 2 inch (50 mm) nominal pipe.

Ensure that the luminaire end of each bracket arm has an outside diameter equal to 2 inch (50 mm) pipe, is straight for a distance of eight inches (203 mm), with the longitudinal axis canted not less than 1 degree nor more than 4 degrees above horizontal.

Ensure that the bracket has an internal raceway with a minimum internal diameter of 1-3/32 inches (28 mm) free of projections and obstructions, which, when assembled to the shaft, will permit installation of luminaire supply conductors without insulation damage and which will not require bending the conductors to a radius less than 3 inches (75 mm).

Ensure that the pole does not have more than two sections, that the shorter section of a sectional is at the top and that the shorter section of a sectional pole is not less than 10 feet (3 m) in length. Ensure that the pole sections are joined by telescoping the bottom of the upper section over the top of the lower section for a minimum length of 1 1/2 times the external diameter of the bottom of the upper section, driving the joint tight, and securing by through bolting with a stainless steel hex head bolt of a minimum diameter of 5/8 inch (16 mm).

Ensure that a pole section does not have more than one longitudinal, automatically electrically welded seam and no transverse seams. Ensure that the longitudinal welded seam is neat and uniform in appearance, that the weld is not be less than the thickness of the base material and that the bead height does not exceed 1/16 inch (2 mm). Ensure that the wall thickness is uniform throughout,

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except at the weld bead. Ensure that the cross section of the pole is circular, or multi-sided with no less than eight sides and that the difference between the major and minor diameters of poles of circular cross section or the difference between the maximum and minimum distances across corners for poles of multi-sided cross section, measured at any point along the longitudinal axis, does not exceed 3/16 inch (5 mm).

Ensure that steel poles are tapered tubes with a true continuous taper not less than 0.06 inches per foot(1.5 mm per 300 mm)nor more than 0.16 inches per foot(4.0 mm per 300 mm).

Ensure that aluminum poles, either spun or cold rolled, are a true continuous taper except for the top and bottom sections which may be straight, that no more than 40 percent of the total shaft length is straight, and that the average rate of shaft taper including straight portions of the shaft is not less than 0.06 inches per foot(1.5 mm per 300 mm)nor more than 0.16 inches per foot(4.0 mm per 300 mm).

Ensure that the full design strength of the pole shaft section in bending can be transmitted through the base plate into the transformer base or the anchor bolts without permanent bending of the base plate or failure of the pole shaft to base plate connection.

Ensure that there is a "J" hook inside the pole just below the top on which to hang the pole and bracket cable support assembly.

Ensure that nonstructural castings for aluminum poles, including the pole cap are of ASTM B 26/B 26M or B 108, Alloy S 5 A, Condition F.

Ensure that steel poles and bracket arms are hot dipped galvanized after fabrication in accordance with the requirements of 711.02.

Furnish aluminum poles and bracket arms in natural aluminum with a satin brushed surface.

Ensure that each light pole is identified by a raised or engraved marking applied to the edge of the base plate which identifies the manufacturer and the year that the pole was manufactured and that such marking remains legible after the pole has been galvanized.

Ensure that bolts, nuts, washers and other fasteners used to assemble the light pole are of galvanized steel conforming to 711.02, stainless steel conforming to ASTM A 320/A 320M (AISI-300 series) or silicon bronze conforming to ASTM B 98M (B 98).

Ensure that each non-frangible steel transformer base is capable of transmitting the design dead, live, ice and wind loads of the light pole to be mounted on it to the foundation without failure or permanent deformation, has a flush door permanently attached by means of a top-mounted continuous stainless steel hinge, and is made from steel conforming to ASTM A36/A 36M hot dip galvanized after fabrication.

Ensure that each frangible aluminum transformer base is capable of transmitting the design dead, live, ice and wind loads of the light pole to be mounted on it to the foundation without failure or permanent deformation, has a flush aluminum door permanently attached by means of a top-mounted continuous stainless steel hinge,

and bears easily found and read durable labeling as to which AASHTO frangibility criteria the base meets. Ensure that the base has been tested and accepted by the FHWA as complying with the 1985 AASHTO frangibility requirements

Ensure that the bolts and nuts used to fasten the base plate of the pole to the transformer base are heavy hex conforming to ASTM A 307 and galvanized in accordance with 711.02. When either the top or the bottom of an aluminum transformer bases is to be fastened against non-galvanized steel, ensure that both the steel and the aluminum mating surfaces have been coated with a heavy film of zinc rich paint.

Ensure that the anchor bolts are steel with 55,000 psi (380 Mpa) minimum yield strength, that the threaded ends of the bolts and nuts are galvanized in accordance with 711.02 for at least 2 inches (50 mm) beyond the threads and that the nuts are capable of developing the full strength of the anchor bolt and are galvanized in accordance with 711.02.

**B. Light Towers.** Ensure that the structural design of the light tower is based on a load of six luminaires or the actual number of luminaires to be installed whichever is greater. Ensure that the structural design of the light tower is based on each luminaire weighing 75 pounds (34 kg) and having an effective projected area of 3.5 square feet (0.3 m<sup>2</sup>) or the actual weight and effective projected area of each luminaire whichever is greater. Ensure that the structural design of the light tower is based on the head frame assembly with lowering device weighing 340 pounds (154 kg) and having a projected area of 5.3 square feet (0.5 m<sup>2</sup>) or the actual weight and effective projected area of the head frame and lowering device whichever is greater.

Ensure that the luminaire lowering device (consisting of the luminaire ring, the head frame, the winch, the power cables and all miscellaneous mechanical and electrical equipment mounted in or on the pole) and the pole are compatible with each other.

**1. Luminaire Ring.** Ensure that the luminaire ring assembly is fabricated from steel which conforms to ASTM A 36/A 36M and that the ring is fitted with a separate 2 inch (50 mm) nominal steel pipe mounting arm directly attached to the ring for each luminaire.

Ensure that the luminaire ring is supported by three wire ropes equally spaced around the ring. Ensure that the three wire ropes are of the same material and construction. Ensure that the wire rope for this purpose is 3/16 inch (5 mm) minimum diameter and either galvanized steel hoisting cable or aircraft grade stainless steel control cable composed of 7 strands of 19 wires each. Ensure that each wire rope support cable is connected to the ring by a corrosion resistant device that will allow the connection to develop the full breaking strength of the wire rope while permitting ready adjustment of the length of the wire rope to level the ring. Ensure that the ring is equipped with a minimum of three spring loaded roller tipped centering arms equally spaced around the ring that are in continuous contact with the pole shaft and that the guide arm rollers are of a nonabrasive, water resistant material.

Ensure that the luminaire ring is equipped with three positive latching devices equally spaced around the ring that latch to the head frame supporting the ring in the raised position allowing tension to be removed from the lifting cables. Ensure that all moving parts of each latching device are part of the ring portion of the latch assembly and that each latch assembly incorporates a reflectorized flag that is clearly discernible from the ground when the ring is latched to the head frame. Ensure that the latching sequence shall not exert a horizontal force sufficient to cause an excess of 4 g's acceleration upon the luminaires.

Ensure that the luminaire ring is equipped with a NEMA 4 corrosion resistant junction box for the connections between the main power cord bringing power to the ring and the separate power cords for each luminaire. Ensure that each power cord has copper conductors of adequate size and insulation, that each power cord is of suitable construction, and that each power cord enters the junction box through a weather tight cord connector. Ensure that there is a cord support capable of withstanding a load of 1-1/2 times the weight of the main power cord without damage to the cord transmitting the weight of the main power cord directly to the ring. Ensure that there is a weather tight power inlet on the luminaire ring which allows the main power cord in the base of the tower to connect to the ring when the ring is in the lowered position. Ensure that the junction box is equipped with a 600 volt class terminal block for the connections between the main power cord, the luminaire power cords and the power inlet cord. Ensure that each luminaire ring is identified by a raised or engraved marking applied in a prominent location which identifies the manufacturer and the year that the ring was manufactured and that such marking remains legible after the ring has been galvanized

**2. Head Frame Assembly.** Ensure that the head frame is fabricated from steel which conforms to the requirements of ASTM A 36/A 36M. Ensure that the head frame assembly is equipped with pulleys for the wire ropes hoisting cables and rollers for the main power cord to the luminaire ring. Ensure that each hoisting cable sheave has a tread diameter of at least 20 times the cable diameter for galvanized cable and 25 times the cable diameter for stainless steel cable, that the groove for the hoisting cable has a semi-circular in cross section with a radius of one-half the cable diameter plus 1/64 inch(0.4 mm), that the sheave has an oil-impregnated bronze bushing and that the shaft on which the sheave turns is of stainless steel. Ensure that the rollers for power cord run on AISI 304 stainless steel shafts between cold-rolled steel plates. Ensure that bending radius of the power cord is not less than 7 inches (180 mm). Ensure that keeper bars have been provided over the power cord and ring support cables to keep them in their respective tracks. Ensure that a guide is provided to separate the individual cables as they pass between the head frame and the top of the pole. Ensure that the head frame mechanism is protected from the weather by a domed cover of either copper free spun aluminum or fiberglass. Ensure that each head frame is identified by a raised or engraved marking applied in a prominent location which identifies the manufacturer and the year that the head frame was manufactured and that such marking remains legible after the head frame has been galvanized.

**3. Transition Plate.** Ensure that there is a transition plate between the ring support cables and the main hoisting cable. Ensure that the luminaire ring support cables are secured to the transition plate by shop applied, swage-type fittings

designed to develop a connection strength equal to the breaking strength of the cable and prevent abrasion of the cable by the transition plate. Ensure that there is a cord support capable of withstanding a load of the weight of the main power cord plus a wind load on the cord equal that of a 30 mph (48 km/h) wind perpendicular to the full length of the cord without damage to the cord connecting the main power cord to the transition plate.

**4. Hoisting Winch.** Ensure that the winch is of cast iron and steel construction with an integral enclosed lubricant bathed worm and gear drive having a reduction great enough to be self-locking. Ensure that the winch has a pulling capacity at least five times greater than that required to lift the load. Ensure that the winch drum diameter is not less than 4 inches (100 mm), that the drum flange diameter is at least 3 inches (75 mm) greater than the diameter of the drum. Ensure that there is a cable guide or follower to prevent cable buildup at the ends of the winch drum. Ensure that the support plate for the winch bears a durable tag which identifies the manufacturer, manufacturer's model and year of manufacture for the lowering device.

**5. Winch Drive Unit (Portable Power Unit).** Ensure that the winch drive unit is powered by a heavy duty reversing drill motor, minimum 560 W (3/4 horsepower) rating, 120 volt. Ensure that there is a mechanical slip clutch torque limiter incorporated into the output shaft and that there is a placard on the portable winch drive unit giving the settings and instructions for care of the torque limiter. Ensure that there is a separately packaged dry type isolated winding transformer included to permit operation of the drill motor from the lighting circuit by plugging into the luminaire power cord outlet in the base of the tower. Ensure that the cord outlet and plug for connecting the motor to the transformer are NEMA L5-15 devices. Ensure that the hoisting rate is between 15 and 25 feet per minute (4 and 8 m/min). Ensure that the hand control switch incorporates 20 feet (6 m) of cable to allow operation of the lowering device from a position away from the pole and not beneath the ring and luminaires. Ensure that each winch drive unit frame is identified by a raised or engraved marking applied in a prominent location which identifies the manufacturer and the year that the portable power winch drive unit was manufactured and that such marking remains legible after final finish has been applied to the frame.

**6. Connection of Tower to Lighting Circuit.** Ensure that there is a separate terminal block for each conductor of the supply circuit in the base of the tower, and that there are enough spaces on the blocks to allow the incoming circuit to split into three outgoing directions in addition to the feed to the tower itself. Ensure that the terminal block has set screw style terminations, sized for 4 AWG - 1/0 AWG for the incoming and outgoing lighting circuit and 12 AWG - 10 AWG for the tower wiring. Ensure that there is a circuit breaker in a NEMA 4 enclosure located electrically after the terminal blocks for the lighting circuit and before the power cord leading up the tower to the luminaires. Ensure that the breaker enclosure is internally mounted and that the breaker is readily accessible through the tower hand hole. Ensure that the circuit breaker is a bolt on design, sized at 15 amperes with a minimum interrupting capacity of 14,000 amperes for 480 volt circuits or sized at 20 amperes with a minimum interrupting capacity of 10,000 amperes for 240 volt circuits and is of a single handle rather than a tied handle

design with one pole for each line or phase conductor. Ensure that cord connector, plug and inlet on the ring for electrical power to the luminaires are NEMA L8-20 devices for 480 volt systems or are NEMA L6-30 devices for 240 volt systems. devices

**7. Operating Manual.** Furnish a complete manual including instructions on installation, operation and maintenance for each lowering device, winch assembly and portable power winch drive unit.

**8. Shaft.** Ensure that shaft of the tower is of not more than four round or multi-sided tapered steel sections for towers up to and including 100 feet (30 m), five sections for towers over 100 feet (30 m) up to and including 120 feet (37 m), and six sections for towers over 120 feet (37 m). Ensure that the shaft is of steel having a minimum yield strength of 55,000 psi (379 MPa). Ensure that the shaft sections are joined by telescoping the bottom of the upper section over the top of the lower section for a minimum length of 1 1/2 times the external diameter of the bottom of the upper section or two feet (0.6 m) whichever is greater and driving the joint tight. Ensure that the sections have been pre-fitted and match-marked at the factory. Ensure that the inside surface of the shaft is relatively smooth and that there are no more than two longitudinal welds which shall be made by automatic electric arc welding. Ensure that the longitudinal seam welds have complete penetration, are of uniform density, are no thinner than the shaft material nor no more than 20 percent thicker than the shaft material. Ensure that the base plate is fabricated from steel which conforms to the requirements of ASTM A 36/A 36M and that the shaft is joined to the base plate using the American Welding Society prequalified joint TC-U4a-S or TC-U4c-GF. Ensure that the hand hole in the shaft is properly reinforced to avoid stress risers and that the reinforcements are welded to the shaft using a joint and techniques designed to insure total penetration plus an outside fillet equal to the thickness of the shaft material. Ensure that all welds in the shaft satisfy AWS D 1.1 Structural Welding Code Article 9.25.3 for tensile stress when tested either by the ultrasonic method or by an approved alternate method, and that certified results are furnished to the Laboratory. Ensure that the door is fabricated from the same type steel as the shaft, is attached with a continuous stainless steel hinge having non-removable stainless steel hinge pins, fits the opening closely, and is securely held shut. Ensure that there are provisions for padlocking the handhole door closed and that each tower has been furnished with a vandal resistant padlock having a bronze or brass lock body and a corrosion-protected steel shackle keyed to the key number specified by the maintaining agency. Ensure that there are two holes, tapped 1/2-13, 180 degrees apart provided at the base of the tower for the grounding conductors. Ensure that the shaft shall be hot dipped galvanized after fabrication in accordance with the requirements of 711.02. Ensure that each shaft is identified by a raised or engraved marking applied to the edge of the base plate which identifies the manufacturer and the year that the shaft was manufactured and that such marking remains legible after the pole has been galvanized.

**9. Anchor Bolts and Nuts.** Ensure that each anchor bolt is steel conforming to ASTM F1554, Grade 55, and galvanized in accordance with 711.02. at least 2 inches (50 mm) beyond the threads. In lieu of a bent end, an anchor bolt with the lower end threaded and inserted into a steel plate of approved size and thickness

which has been drilled and tapped to receive the anchor bolt may be furnished. Ensure that the nuts used with each anchor bolt are capable of developing the full strength of the anchor bolt.

**725.22 Plastic Caution Tape.** Furnish tape that is an inert material, approximately 6 inches (150 mm) wide composed of polyethylene plastic, highly resistant to alkalis, acids or other chemical components likely to be encountered in soils. Furnish tape that is bright red with identifying printing "ELECTRIC" in black letters on one side only. Furnish tape in continuous rolls with the identifying lettering repeated continuously the full length of the tape.

## 730 TRAFFIC SIGN AND SUPPORT MATERIAL

**730.01 Steel Tube and Pipe.** Furnish steel tube and pipe according to ASTM A 53, Grade B or ASTM A 501, except provide tubing for truss and end frame diagonals according to 711.01.

**730.015 U-Channel Posts.** Furnish U-channel posts fabricated from steel into a characteristic cross-section that may be used alone or paired to form a heavier post by being bolted together back to back. Furnish posts with a uniform cross section for their full length. Cut posts square to a length tolerance  $\pm 1$  inch ( $\pm 25$  mm) and ensure that posts do not have ragged or sharp edges, or cracks or other imperfections affecting strength or durability. The back of the posts may be flat or contain raised longitudinal ribs.

Furnish posts meeting the deflection criteria of Supplement 1075. Furnish posts manufactured from rail or billet steel according to ASTM A 499, Grade 60.

Provide a yield type driven post without breakaway devices conforming to NCHRP 350 requirements. Provide a copy of the approval letter from FHWA.

Other material specifications may be accepted by the Department for drive posts conforming to the dimensional requirements listed below and on ODOT standard drawings and the performance requirements of NCHRP 350.

Furnish posts with a nominal weight before punching or galvanizing as follows:

Post Size Number	Weight lb/ft (kg/m)	Tolerances %
1	1.12 (1.7)	-3.5, +10.0
2	2.00 (3)	-3.5, +10.0
3	3.00 (4.5)	-3.5, +10.0

Furnish posts with 3/8-inch (10 mm) diameter holes accurately punched on the centerline spaced at 1-inch (25 mm) centers beginning not more than 1 1/8 inches (30 mm) from the top of the post through the entire length, to allow bolting the posts back to back, without redrilling, using 5/16-inch (8 mm) diameter bolts. Furnish posts that have been galvanized after punching according to 711.02.

Furnish materials according to the Department's Qualified Products List (QPL).

**730.016 Square Posts.** Furnish square posts fabricated from steel according to ASTM A 1011 with a minimum yield strength of 60,000 pounds per square inch (415 MPa), with 7/16-inch (11 mm) diameter die-cut knockouts or open holes

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spaced on 1-inch (25 mm) on the centerline of all four sides, in true alignment and opposite each other. Furnish posts with the dimensional requirements conforming to the Department's standard drawings. Furnish posts that have been finished with one of the following methods:

A. Both inside and outside of the post are hot-dip galvanized according to ASTM A 653 G-235.

B. The outside of the post has a zinc coating of 0.80 ounce per square foot (244 g/m<sup>2</sup>) followed by chromate conversion coating and a cross-linked polyurethane acrylic coating. The inside of the post has a zinc organic coating.

C. Provide a yield type driven post without breakaway devices conforming to NCHRP 350 requirements. Provide a copy of the approval letter from FHWA.

Other material specifications may be accepted by the Department for drive posts conforming to the dimensional requirements listed below and on ODOT standard drawings and the performance requirements of NCHRP 350.

Furnish materials according to the Department's Qualified Products List (QPL).

**730.017 Wooden Box Beams.** Furnish wooden box beams fabricated from 1/10 or 1/8 inch (2.54 or 3.18 mm) thick laminated veneers with the grain oriented parallel to the length of the finished beam and the veneers glued together in a continuous process with lap or scarf joints connecting successive veneers in each layer staggered throughout the thickness of the beam. A 45 degree miter shall be used for the corner joints. The adhesive used shall be a phenol-formaldehyde which conforms to ASTM D 2559. The beams shall be pressure treated with a pentachlorophenol preservative meeting AWWA Standard C33, with a minimum preservative retention of 0.60 lb/ft<sup>3</sup> (9.6 kg/m<sup>3</sup>) of pentachlorophenol.

**730.02 Steel Anchor Bolts and Nuts.** Furnish anchor bolts made of steel conforming to ASTM F1554 Grade 105, galvanized according to 711.02 at least 2 inches (50 mm) beyond the threads, with the end either bent or with a drilled and tapped steel plate. Furnish leveling nuts and anchor nuts capable of developing the full strength of the anchor bolt.

Furnish materials according to the Department's Qualified Products List (QPL).

**730.03 Steel Poles and Arms.** Furnish poles and arms made of steel with a minimum yield strength of 52,000 pounds per square inch (359 MPa) and galvanized according to 711.02.

Furnish certified material according to Supplement 1093

**730.04 Base and Arm Plates.** Furnish support or pole anchor bases and arm attachment plates fabricated from steel plate according to ASTM A 36 (A 36M) or ASTM A 572 (A 572M), Grade 42. Weld plates to supports, poles, or arms both inside and outside with fillet or full penetration welds equal to the wall thickness, or by AWS prequalified welding joints TC U4a-S or TC U4c-GF. The Contractor may use a cast steel base of equivalent strength.

Furnish certified material according to Supplement 1093.

**730.05 Handhole Covers.** Furnish handhole covers for poles and overhead sign supports made of 0.109-inch (2.7 mm) galvanized steel or 0.125-inch (3 mm) nominal aluminum alloy.

Furnish certified material according to Supplement 1093.

**730.06 Pole Caps.** Furnish pole caps made of aluminum, galvanized ferrous metal, or zinc die casting.

Furnish certified material according to Supplement 1093.

**730.07 Arm Caps.** Furnish arm caps made of steel that cover at least 50 percent of the end area.

Furnish certified material according to Supplement 1093.

**730.08 Steel Hardware.** Furnish bolts 5/8-inch (16 mm) diameter or larger according to ASTM A 325 (A 325M). Furnish bolts and screws less than 5/8-inch (16 mm) diameter according to SAE J429, Grade 5. Furnish nuts of all size, except anchor nuts and leveling nuts according to SAE J995, Grade 2. Furnish flat washers according to ANSI B18.22.1. Furnish lock washers according to ASME B18.21.1. Furnish U-bolts according to ASTM A 307. Furnish all hardware that is hot-dipped galvanized according to ASTM A 153 or mechanically galvanized according to ASTM B 695, Class 50.

Furnish certified material according to Supplement 1092 or 1093.

**730.09 Stainless Steel.** Furnish any AISI 300 or 400 series stainless steel.

Furnish certified material according to Supplement 1093.

**730.10 Stainless Steel Hardware.** Furnish stainless steel hardware according to ASTM A 320/A 320M (AISI 300 series). Furnish bolts, screws, nuts, washers, handhole cover chains, and U-bolts that are passivated commercial grade.

Furnish certified material according to Supplement 1092 or 1093.

**730.11 Aluminum Sheet and Plate.** Furnish sheets for extrusheet panels according to ASTM B 209 (B 209M), 3003-H18, or 5052-H38. Furnish sheets for flat sheet and overlay signs, and sign post reflectors, according to ASTM B 209 (B 209M), 3004-H38, 5052-H38, or 6061-T6. Furnish plates for sign support structures according to ASTM B 209 (B 209M), 6061-T6.

Furnish certified material according to Supplement 1092 or 1093.

**730.12 Aluminum Extrusions.** Furnish extruded panels and extrusions for extrusheet panels according to ASTM B 221 (B 221M), 6063-T6. For sign support structures, provide rolled or cold finished bar, rod, and wire according to ASTM B 211 (B 211M), 6061-T6; provide extruded bars, rods, shapes, and tubes according to ASTM B 221 (B 221M), 6061-T6.

Furnish certified material according to Supplement 1092 or 1093.

**730.13 Aluminum Tube and Pipe.** Furnish seamless pipe and seamless extruded tube according to ASTM B 241/B 241M, 6061-T6. Furnish extruded structural pipe and tube according to ASTM B 429, 6061-T6.

Furnish certified material according to Supplement 1092 or 1093.

**730.14**

**730.14 Aluminum Castings.** Furnish sand castings according to ASTM B 26/B 26M, 356-T6 or T7. Furnish permanent mold castings according to ASTM B 108, 356-T6 or T7.

Furnish certified material according to Supplement 1092 or 1093.

**730.15 Aluminum Forgings.** Furnish forgings according to ASTM B 247 (B 247M), 6061-T6.

Furnish certified material according to Supplement 1092 or 1093.

**730.16 Aluminum Welding Rods.** Furnish welding rods according to AWS ER-4043.

**730.17 Aluminum Hardware.** Furnish hardware according to:

	<b>ASTM Designation</b>	<b>Alloy</b>	<b>Condition/ Temper</b>
Bolts and screws	B 211 (B 211M)	2024 6061	T4 T6
Studs-welded	B 211 (B 211M)	1100	H16
Nuts-hex	B 211 (B 211M)	6061 6262	T6 T9
Nuts-lock	B 211 (B 211M)	2017	T4
Washers-flat	B 209 (B 209M)	Clad 2024 6061	T4 T6
Lock washers	B 211 (B 211M)	7075	T6
Rivets-solid	B 316/B 316M	6053 6061	T6 T6
Rivets-blind	B 316/B 316M	2017 2117 5052	F F F

In addition, provide break-mandrel aluminum blind rivets with a stainless steel or aluminum mandrel.

Furnish certified material according to Supplement 1092.

**730.18 Reflective Sheeting Type F.** Furnish sheeting according to ASTM D 4956, Type I, including supplemental requirement S1.

**730.19 Reflective Sheeting Type G.** Furnish Type G reflective sheeting according to Supplement 1049, and according to ASTM D 4956, Type III or IV, including supplemental requirement S1.

Furnish materials according to the Department’s Qualified Products List (QPL).

**730.191 Reflective Sheeting Reboundable.** Furnish reboundable reflective sheeting according to Supplement 1049, and according to ASTM D 4956, Type III, IV, VII, VIII, IX or X, including supplemental requirements S1 and S2, with watermarks or other identification marks inconspicuously incorporated into the face of the sheeting on a repeating pattern if necessary to distinguish the sheeting from other similarly appearing sheetings.

Furnish materials according to the Department’s Qualified Products List (QPL)

**730.192 Reflective Sheeting Type H.** Furnish Type H reflective sheeting according to Supplement 1049, and according to ASTM D 4956, Type VIII including supplemental requirement S1.

Furnish materials according to the Department's Qualified Products List (QPL).

**730.193 Reflective Sheeting Type J.** Furnish Type J reflective sheeting according to Supplement 1049, and according to ASTM D 4956, Type IX, including supplemental requirements S1.

Furnish materials according to the Department's Qualified Products List (QPL).

**730.20 Nonreflective Sheeting.** Furnish non-reflective sheeting according to ASTM D 4956, except provide sheeting that does not incorporate any optical elements.

Furnish materials according to the Department's Qualified Products List (QPL).

**730.22 Silk Screen Inks.** Furnish opaque and transparent process color inks used in the silk screen process that the manufacturer of the reflective sheeting accepts and warrants according to Supplement 1049. Use inks that provide a tough, durable film of uniform thickness and appearance on the sign surface. Furnish transparent process color inks used in the reverse screen process according to the color specification limits in ASTM D 4956, Table 17.

**730.23 Transparent Electronic Cuttable Films.** Furnish transparent electronic cuttable films the manufacturer of the reflective sheeting warrants according to Supplement 1049. Use films that provide a uniform appearance on the sign surface. Furnish films according to the color specification limits in ASTM D 4956, Table 17.

## 731 SIGN LIGHTING AND ELECTRICAL SIGNS MATERIAL

### 731.03 Changeable Message Sign, Electrical Type.

**A. General.** Electrical changeable message signs consist of units or groups of units containing arrangements of pixels that use electrical circuitry to display different messages.

Place signs in weatherproof cabinets. Integrate control logic units, load switches, monitor feedback circuits, power supply, etc., within the sign cabinet or mount within a separate weatherproof enclosure as required.

**B. Message Type.** Furnish electrical changeable message signs of the limited message or unlimited message type.

Limited message signs contain pixels in an arrangement so that by the energizing of selected pixels two or more messages may be displayed.

Unlimited message signs contain pixels arranged in full matrix or alphanumeric type modules positioned side-by-side to provide line units of the specified length. Ensure that the line units are capable of displaying messages containing letters and numerals, limited only by the number of characters that can

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be accommodated. Ensure that the line units are capable of continually displaying alternating messages.

Furnish materials according to the Department's Qualified Products List (QPL).

**C. Display Type.** Furnish electrical changeable message signs consisting of lamp, light emitting diode, fiber optic, light reflecting, or hybrid types.

Lamp type changeable message signs consist of individual incandescent bulbs.

Light emitting diode changeable message signs consist of groups of individual light emitting diodes that, acting together, form individual character pixels.

Fiber optic changeable message signs consist of fiber optic bundles that transmit light from a remote source to form individual pixels.

Light reflecting changeable message signs consist of individual light reflecting panels.

Hybrid changeable message signs consist of individual light reflecting panels, each augmented by a light emitting pixel of the specified type. Ensure that the light emitting pixels are displayed when the corresponding reflecting panel is in the exposed position, and concealed or de-energized when the corresponding reflecting panel is in the unexposed position.

Furnish materials according to the Department's Qualified Products List (QPL).

**731.05 Internally Illuminated Fixed Message Sign.** Furnish internally illuminated fixed message signs of the required legend and that consist of an opaque housing with a face of translucent plastic. If specified, provide double faced signs. Illuminate signs using interior lamps located so the sign face is uniformly lighted.

Furnish signs either with the legend on the exterior surface to maintain legibility when unlighted due to power failure, or with the legend on the interior surface so as to be invisible when the sign is unlighted. Apply the legend using black silk screening or by direct applied characters to white sign faces, unless otherwise specified. Design the sign faces for quick removal for maintenance, and provide faces with a safety chain or like device. If specified, shield the sign faces with sunscreens, louvering, or visors.

Furnish housings made of corrosion-resistant material that is cast, extruded, or formed. Furnish mounting hubs that are similar to traffic signal design. Furnish weatherproof signs that have drainage weepholes.

Furnish the sign with the appropriate hardware for mounting by span wire, mast arm, pedestal top, or pole type bracket arms. Include fluorescent type lamps with ballast.

Furnish materials according to the Department's Qualified Products List (QPL).

**731.06 Sign Flasher Assembly.** Furnish beacons consisting of single traffic signal sections with 8 or 12-inch (200 or 300 mm) yellow lenses. Ensure that the flasher control unit flashes the beacons at a rate for each beacon of between 50 to

60 times per minute with the light period from one-half to two-thirds of the total cycle. Furnish flasher control units that have all solid state components and that meet NEMA TS-1, part 6. House control units within a weatherproof corrosion-resistant enclosure with a lockable door. Include the incandescent lamps.

Ensure that the manufacturer of LED beacons is listed on the Department's Qualified Products List (QPL) for LED signal lamps.

Furnish materials according to the Department's Qualified Products List (QPL).

**731.07 School Speed Limit Sign Assembly.** Furnish yellow beacons that are 8 inches (200 mm) or 12 inches (300 mm). Ensure that the flashers flash the beacons alternately at a rate for each beacon of 50 to 60 times per minute with the light period from one-half to two-thirds of the total cycle. Furnish flashers that have all solid state components and that meet NEMA TS-1, part 6. Ensure that the backing members with hardware are compatible with the method of support.

Ensure that the manufacturer of LED beacons is listed on the Department's Qualified Products List (QPL) for LED signal lamps.

Furnish materials according to the Department's Qualified Products List (QPL).

**731.08 Flexible Conduit.** Furnish galvanized steel flextube conduit with a waterproof PVC jacket according to UL 360 for wiring of lighted signs.

Furnish materials according to the Department's Qualified Products List (QPL).

**731.10 Timer with Enclosure.** Furnish a timer that allows automatic sign operation for a minimum of 8 times per day and for selected days of the week. Furnish a solid state timer with a back-up battery to maintain timekeeping and program memory for at least 48 hours. Furnish a battery with a design life of 10 years under field conditions when power failures over the 10-year period would accumulate to 100 days. If installed outdoors, house the timer within a lockable, weatherproof, corrosion-resistant enclosure. Furnish each enclosure with at least one padlock complying with 631.06.

Furnish materials according to the Department's Qualified Products List (QPL).

## 732 TRAFFIC SIGNAL MATERIAL

**732.01 Vehicular Signal Heads, Conventional.** Ensure that vehicular traffic signal heads conform to the ITE "Vehicle Traffic Control Signal Heads" standard. In conformance with the above standard, provide signal heads that are of cast nonferrous corrosion resistant metal, with plastic or glass lenses, and reflectors of either highly specular finished aluminum or silvered glass. When provided, plastic lenses are ultraviolet stabilized, weather and impact resistant, and heat resistant so that operation does not cause crazing, cracking, deformation, color change, or other changes in physical properties.

Traffic signals consist of specified assemblies of optical sections containing 8 or 12-inch (200 or 300 mm) diameter colored lenses, a housing, a door frame with stainless steel hinge pins and latching device, gasketing, visor, wiring, and

includes LED lamp in accordance with 732.04. Twelve-inch (300 mm) lenses are the standard wide angle type. All hardware used to join optical sections together shall be stainless steel.

Fit each optical section with a cutaway type visor unless other type visors or louvering is specified. Ensure that the visors for 8-inch (200 mm) lenses are at least 7 inches (175 mm) long and those for 12-inch (300 mm) lenses are at least 9 1/2 inches (240 mm) long.

Ensure that optical sections are designed for assembly with all 8-inch (200 mm), all 12-inch (300 mm), or intermixed arrangements. Assemble using suitable hardware that forms weatherproof joints with no light leakage from one section to another. Ensure that the assembly arrangements contain the specified number of optical sections, lens size, lens color, and circular or arrow configuration. Assemble from one to a maximum of five sections as specified to form a signal face.

Furnish multi-way heads with appropriate top and bottom brackets with an opening in the center of the top bracket provided for mounting purposes. Correct signal face height inequalities for multi-way heads for proper accommodation between top and bottom brackets by the use of pipe spacers.

Furnish signal heads with required mounting hardware. Furnish signal face orientation to traffic by serrated rings or other devices on housing sections and mounting hardware. Permit adjustment in increments not greater than 5 degrees of rotation and not affected by wind gusts when locked. Furnish galvanized steel or aluminum spacers and drop pipes 1 1/2 inches (38 mm) nominal pipe size (1.90 inch (48 mm) actual diameter). Ensure that disconnect hangers have at least twelve terminals unless a greater number is required.

Paint signal external surfaces with yellow enamel paint, Color 13655, Federal Standard 595 or gloss black to closely agree with Federal Standard 595, Color 13655 or Color 17038, as specified in the plans. Paint interior surfaces of visors flat black.

Furnish materials according to the Department's Qualified Products List (QPL).

### **732.02 Vehicular Signal Heads, Optically Programmed, 12-inch (300 mm)**

**Lens.** Ensure that optically programmed signal heads incorporate an optical system projecting an indication that is programmed to be visible only within boundaries of a specific area. Ensure that the optical system is capable of being veiled anywhere to within 15 degrees of the optical axis using procedures and opaquing material according to the manufacturer's instructions.

Ensure that the signal sections conform to applicable portions of the ITE standard and 732.01. Furnish and mount optical sections with a 12-inch (300 mm) lens size alone or in combination with additional sections of optically programmed or conventional optics types to form signal faces and heads. Furnish an optically programmed signal section that includes an incandescent lamp or, if specified, a LED lamp.

Balance adjusters, if specified, shall have a splined eyebolt design and splined external clamping body. All assembly hardware shall be stainless steel.

Furnish a visor with each signal section.

Cable entrance adapters shall be of the tri-stud type with stainless steel hardware. A neoprene gasket placed under the clamp washer in the top signal section shall effectively seal the entrance adapter on the signal to make a weatherproof connection and shall have a minimum thickness of 3/32 inch (2.5 mm).

Furnish materials according to the Department's Qualified Products List (QPL).

**732.03 Vehicular Signal Heads, Optically Programmed, 8-inch (200 mm) Lens.** Optically programmed signal heads with 8-inch (200 mm) lenses consist of a conventional 8-inch (200 mm) signal housing, reflector and door; and an extension portion which is attached in place of a conventional lens and which contains a lens system capable of optical programming. Furnish the conventional signal housing with reflector and wiring, and the optical programmable extension portion according to the applicable requirements of 732.01 and 732.02.

Furnish a cutaway visor with each signal section. Ensure that the signal sections include an incandescent lamp or when specified, a LED lamp.

Programming the 8-inch (200 mm) lens type head requires the use of an extender tool as recommended by the manufacturer to move the extension portion to the side to expose the optics for programming purposes.

Furnish materials according to the Department's Qualified Products List (QPL).

#### **732.04 Signal Lamps.**

**A. Optically Programmed and Pedestrian Signal Incandescent Lamps.** Ensure that optically programmed and pedestrian signal incandescent lamps conform to the ITE A Standard for Traffic Signal Lamps and Table 732.04-1.

**TABLE 732.04-1**

Lens Configuration	Lumens min. initial	Watts max. input	Light Center Length, inches (mm) <sup>[1]</sup>	Envelope Glass	Rated Life, hours
12-inch (300 mm) vehicular optically programmed	950 <sup>[2]</sup>	150		Sealed beam PAR-46	
8-inch (200 mm) vehicular optically programmed	1260	115	2 7/16 (62)	frosted	6000
Pedestrian, type A-1	1300	120	2 7/16 (62)	clear	6000
Pedestrian, type A-2	1650	150	3 (76)	clear	6000
Pedestrian, type D-2	550	70	2 7/16 (62)	clear	6000
[1] Light center length is the distance between the filament center and the base tip.					
[2] Beam intensity, integral reflector type.					

Furnish materials according to the Department's Qualified Products List (QPL).

**B. Vehicular Signal Incandescent Lamps.** Prequalify all traffic vehicular signal incandescent lamps with the Office of Traffic Engineering (OTE) according to Supplement 1046. Ensure that vehicular signal lamps conform to the ITE A Standard for Traffic Signal Lamps and Table 732.04-2.

**TABLE 732.04-2**

Lens Configuration	Lumens, min. initial	Watts, max. input	Light Center Length, inches (mm)[1]	Envelope Glass	Rated Life, hours
12-inch (300 mm) vehicular	1650	150	3 (76)	clear	8000
8-inch (200 mm) vehicular (YELLOW)	550	70	2 7/16 (62)	clear	8000
8-inch (200 mm) vehicular (GRN/RED)	1260	116	2 7/16 (62)	clear	8000
[1] Light center length is the distance between the filament center and the base tip.					

In addition to the requirements of Table 732.04-2, provide model A-19 or AT-19 lamps for 8-inch (200 mm) and model A-21 or AT-21 for 12-inch (300 mm). Supply a medium brass screw type base with reflection disk. Furnish a C-11V or C-9 filament with a minimum of five hook supports for maximum filament stability. Ensure that the lamp contains at least 85 percent Krypton gas. Ensure that the voltage is a 120V  $\pm$ 10V, 60 hertz cycle. Ensure that the lamp operates over the temperature range from -40 to 165 °F (-40 to 73.9 °C) and from 0 to 100

percent humidity. Operate the lamp in the horizontal position. Ensure that the glass envelope and base have a maximum seal temperature of 662 °F (350 °C). Ensure that the glass is free of any impurities that might allow moisture build up within the lamp. Ensure that the glass envelope of the lamp is indelibly marked to show: original manufacturer's identification, rated voltage, rated lumens, rated average life, rated wattage, date of manufacture, and batch code.

Furnish materials according to the Department's Qualified Products List (QPL).

**C. Vehicular and Pedestrian Light Emitting Diode (LED) Lamps.** Prequalify vehicular and pedestrian LED lamps according to Supplement 1097.

Furnish LED signal lamp units that meet or exceed all the requirements of the current Institute of Transportation Engineers (ITE) publications - Vehicle Traffic Control Signal Heads (VTCSH) - Light Emitting Diode (LED) Circular Signal Supplement 2005; Pedestrian Traffic Control Signal Indications (PTCSI) - Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Modules and Vehicle Traffic Control Signal Heads - Part 3: Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Modules, unless otherwise stated herein. . LED module shall be certified by the Intertek LED Traffic Signal Module Certification Program.

All LED signal lamp units shall be the latest model currently in production and new. Equipment no longer being manufactured shall not be accepted, even if it meets the following specifications.

LED signal lamp units shall conform to the following criteria:

#### 1. Physical and Mechanical Requirements

a. The LED traffic signal lamp unit shall be designed as a retrofit replacement for existing incandescent signal lamps and shall not require any special tools for installation. The 12"(300 mm) retrofit replacement LED traffic signal lamp unit shall fit into existing traffic signal housings built to ITE VTCSH standards without modifications.

b. Installation of a retrofit replacement LED traffic signal lamp unit into an existing signal housing shall only require removal of the existing lens and incandescent lamp. The new unit shall fit securely in the housing door and connect to existing electrical wiring or terminal block by means of simple connectors. Removal of the reflector is optional.

c. Each LED signal lamp unit shall be identified on the back side with the following:

- 1) Manufacturer's name and trademark
- 2) Part number
- 3) Serial number
- 4) Voltage rating
- 5) Power consumption (watts and volt-ampere)
- 6) Vertical indexing indicator (i.e., "up arrow", or the word "UP" or "TOP") if specific orientation of the module is required.
- 7) Date of manufacture (minimum information required - month &

year)

Single units shall have identification markings as to the type and color of the module. Bi-Modals shall be marked with module type.

## 732.04

Each LED signal lamp unit shall have a label placed on the unit certifying compliance to ITE standards for color and luminance.

d. The LED traffic signal lamp unit shall be a single, self-contained device, not requiring on-site assembly for installation into an existing traffic signal housing.

e. The assembly and manufacturing process for the LED traffic signal lamp unit assembly shall be such as to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.

f. The lens of the LED signal lamp unit shall be capable of withstanding ultraviolet light (direct sunlight) exposure for a minimum time period of five years without exhibiting evidence of deterioration.

g. Ensure that lenses will withstand a 3.5 foot (1.0 meter) drop test, are a minimum of 1/8 inch (3 mm) thick, and are free of bubbles and imperfections. The lenses shall be smooth on the outside with no external facets to prevent dirt and debris build up.

h. Each LED traffic signal lamp unit shall comprise a UV stabilized polymeric outer shell, multiple LED light sources, and a regulated power supply.

i. If red or yellow lenses are tinted, they shall match the wavelength (chromaticity) of the LED. Do not furnish green tinted lenses.

j. An optical assembly shall diffuse the light output and provide uniform illumination across the entire surface of the lens and eliminate the visibility of the individual LEDs to the observer. The optical assembly shall be used for all ball modules and shall be optional on arrow and pedestrian modules.

k. The LED traffic signal lamp unit shall be designed for universal installation in both span wire and standard/stationary pole mount applications.

l. The "Arrow" pattern produced by the Arrow LED traffic signal lamp units shall conform to the VTCSH standard for color, size and shape. The Arrow LED traffic signal lamp units shall not require a specific orientation or have a variance in light output, pattern or visibility for any mounting orientation.

m. LED pedestrian signal lamp units shall be designed as a retrofit replacement, modular or screw in unit for the message bearing surface of a 12" (300 mm) pedestrian traffic signal, type A-2, housing built to the PTCSI - part 2 Standard.

n. The LED pedestrian signal lamp unit shall fit into existing pedestrian signal housings without the need to modify the housing. Installation of the retrofit replacement LED pedestrian signal lamp unit into an existing 12"(300 mm) pedestrian signal housing shall only require the removal of the existing message bearing surface, existing lamp components (i.e. lens, lamp module, gaskets, and reflector) and insertion of the retrofit replacement into the area once occupied by the removed assembly.

o. The single pedestrian module shall be designed to display a full "HAND" icon and a full" Walking "Person icon that complies with PTCSI standards for this (icon) symbol for the size specified.

p. LED traffic signal lamp units shall be visible at 450 feet (137 meters) during sway conditions (extended view) until obscured by the visor.

q. The module shall be designed to detect catastrophic loss of the LED load. Upon sensing the loss of the LED load, the module shall present a resistance of at least 250K Ohms across the input power leads within 300 msec.

r. Turn-On and Turn-off time is less than 75 msec. Also, low voltage Turn-Off is less than 35 Volts.

## **2. Photometric Requirements**

a. The red, yellow and orange lamps shall be manufactured using AlInGaP (Aluminum-Indium-Gallium-Phosphide) technology or other LEDs with lower susceptibility to temperature degradation than AlGaS (Aluminum-Gallium-Arsenic). AlGaS LEDs will not be permitted. Green lamps shall be manufactured using Indium Gallium Nitride.

b. Each LED traffic signal lamp unit shall meet minimum laboratory light intensity values, color (chromaticity), and light output distribution as described in ITE VTCSH – LED Circular Signal Supplement of the specifications 4.1, and 4.2 as a minimum. Table A-1 provides the minimum maintained luminous intensity values for the VTCSH LED Circular Signal. Environmental test shall include an expanded view for the red and green ball indications with the following minimums for a period of 60 months.

TABLE A-1				
Minimum Luminous Intensity Values (In Candelas)				
Vertical Angle	Horizontal Angle (Left/Right)	RED	YELLOW	GREEN
-17.5	2.5	51	127	67
	17.5	15	36	19
-12.5	2.5	110	273	143
	17.5	37	91	48
-7.5	2.5	281	701	366
	17.5	91	228	119
-2.5	2.5	358	892	466
	17.5	117	291	152
+2.5	2.5	150	373	195
	7.5	124	309	162
	12.5	84	209	109
	17.5	47	118	62
+7.5	2.5	69	173	90
	7.5	55	137	71
	12.5	40	100	52
+12.5	2.5	37	91	48
	7.5	29	73	38
-22.5	2.5	37	91	48
	7.5	29	73	38
	12.5	22	55	29
	17.5	11	27	14
-27.5	2.5	26	64	33
	17.5	18	46	24

Notes:

Luminous intensity values for equivalent left and right horizontal angles are the same.  
 Tabulated values of luminous intensity are rounded to the nearest whole value.

**ARROW INDICATIONS (IN CANDELAS/M<sup>2</sup>)**

Yellow	Green
11,000	11,000

c. LEDs for arrow indications shall be spread evenly across the illuminated portion of the arrow area. Arrow LED traffic signal lamp units shall meet VTCSH – Part 3: LED Vehicle Arrow Traffic Signal Modules, March 2004. Arrow LED traffic signal lamp units shall be designed so that when operated over the specified ambient temperature and voltage ranges, the signal is clearly visible and attracts attention for a distance of at least 1300 feet (400 meters) under normal atmospheric conditions. Arrow LED traffic signal lamp units shall have 3 rows of LEDs only.

d. Measured chromaticity coordinates of LED traffic signal lamp units shall conform to the chromaticity requirements of the following table, for a minimum

period of 60 months, over an operating temperature range specified in section "D". Each LED traffic signal lamp unit shall meet the minimum requirements for light output for the entire range from 80 to 135 volts.

CHROMATICITY STANDARDS	
Red	Y: not Y: not greater than 0.308 or less than 0.998 - x
Yellow	Y: not Y: not less than 0.411 nor less than 0.995 - x nor less than 0.452
Green	Y: not Y: not less than 0.506 - 0.519x nor less than 0.150 + 1.068x nor more than 0.730

e. LED pedestrian signal lamp units shall be designed so that when operated over the specified ambient temperature and voltage ranges, the signal shall attract the attention of, and be readable to, a viewer (both day and night) at all distances from 10 feet (3 meters) to the full width of the area to be crossed.

f. The measured chromaticity coordinates of LED pedestrian signal lamp units shall conform to the chromaticity requirements of Section 5.3, Color and the associated Figure C of the PTCSI standard, for a minimum period of 60 months, over an operating temperature range specified in section "D". Each LED traffic signal lamp unit shall meet the minimum requirements for light output for the entire range from 80 to 135 volts.

### 3. Electrical

a. Each unit shall incorporate a regulated power supply engineered to electrically protect the LEDs and maintain a safe and reliable operation. The power supply shall provide capacitor filtered DC regulated current to the LEDs per the LED manufacturer's specification. Design of the power supply shall be such that the failure of an individual component or any combination of components cannot cause the signal to be illuminated after AC power is removed.

b. The LED traffic signal lamp unit shall operate on a 60 Hz AC line voltage ranging from 80 volts RMS to 135 volts RMS. The circuitry shall prevent flickering over this voltage range. Nominal rated voltage for all measurements shall be  $120 \pm 3$  volts RMS.

c. All unit types shall be operationally compatible with the traffic signal equipment that each type is designed and intended to interface with. This equipment includes all controllers, conflict monitors, current monitors, switch pack and flashers currently in use by the Ohio Department of Transportation. The LED traffic signal lamp unit shall be operationally compatible with all TS-1, TS-2, 170 and 2070 controllers, NEMA TS-1 conflict monitors (including so-called NEMA plus features such as dual indication detection and short yellow time detection); NEMA TS-2 Malfunction Management Units; and 170 cabinet Type 210ECL and 2010ECL conflict monitors (including red monitoring and so-called plus features such as dual indication detection and short yellow time detection) currently used by the Department. In the case of conflicts between specifications, the latest ODOT specifications will control.

d. The individual LED light sources shall be wired so that a catastrophic failure of one LED light source will not result in the loss of more than 1 LED light source in the LED signal lamp unit.

e. Two, captive, color coded, 600 V, 20 AWG minimum jacketed wires, 3 feet (0.9 m) long, conforming to the National Electric Code, rated for service at 221 °F (105 °C), are to be provided for an electrical connection.

f. The LED signal shall operate with a minimum 0.90 power factor.

g. Total harmonic distortion (current and voltage) induced into an AC power line by a signal lamp unit shall not exceed 20 percent.

h. LED signal lamp units and associated on-board circuitry shall conform to the requirements in Federal Communications Commission (FCC) Title 47, Sub Part B, Section 15 regulations concerning the emission of electronic noise.

i. The LED signal lamp units shall incorporate circuitry to ensure that they show no evidence of illumination for input voltages below 35 volts. LED signal lamp units shall be illuminated (unregulated illumination) for all input voltages higher than 45 volts AC but less than 80 volts AC. They shall have fully regulated illumination for applied voltages of 80 volts through 135 volts AC. Proof of the intended function of this circuitry shall be accomplished by connecting the lamps to a variable voltage source and slowly raising the applied voltage from zero volts up to 135 volts, and then slowly lowering the applied voltage from 135 volts to zero volts.

j. Proposed LED signal lamp units shall be less than or equal to the base wattage shown below at 77 °F (25 °C).

Retrofit	Wattage
12" R 12" Red Ball	12 or less
12" Y 12" Yellow Ball	22 or less
12" G 12" Green Ball	15 or less
12" Y 12" Yellow Arrow	10 or less
12" G 12" Green Arrow	19 or less

**4. Environmental Requirements**

a. Green and red LED traffic signal lamp units shall be rated for use in the ambient operating temperature range of -40 °F to +166 °F (-40 °C to +74 °C). Yellow signal lamps shall be rated at a range of -13 °F to +77 °F (-25 °C to +25 °C).

b. The unit shall consist of a housing that is a sealed watertight enclosure that eliminates dirt contamination and allows for safe handling in all weather conditions. The LED signal lamp unit shall be sealed against dust and moisture intrusion per the requirements of NEMA Standard 250-1991 for Type 4 enclosures to protect all internal LED and electrical components.

**5. Documentation Requirements.** Each LED traffic signal lamp unit shall be provided with the following documentation:

a. Installation instructions.

b. The manufacturer name, brand and model number of all LEDs used shall be provided, along with the LED manufacturer’s recommended drive current and degradation curves.

**6. Warranty.** The LED signal lamp unit shall be repaired or replaced by the manufacturer if it exhibits a failure due to workmanship or material defects within the first 60 months of field operation.

The LED signal lamp unit shall be repaired or replaced by the manufacturer if, when operating over the specified operating ambient temperature and voltage ranges, the unit does not meet or exceed all minimum luminous intensity requirements as defined in the ITE (Institute of Transportation Engineers) LED Purchase Specification - Vehicle Traffic Control Signal Heads (VTCSH), Part 2: Light Emitting Diode (LED) Vehicle Traffic Signal Modules dated June 2005 during the first 60 months of field operation.

The measured chromaticity coordinates of LED signal lamp units shall conform to the requirements for chromaticity in Section 4.2 and Figure 1 of the ITE VTCSH and the PTCSI over the temperature range provided in the Specifications for the duration of the warranty period.

The manufacturer shall provide a written warranty against defects in materials, workmanship and luminous intensity for LED signal lamp units for a period of 60 months after installation of LED signal lamp units. Replacement LED signal lamp units shall be provided within 10 days after receipt of failed LED signal lamp units at no cost, except the cost of shipping the failed units.

An LED pedestrian signal lamp unit shall be repaired or replaced by the manufacturer if the signal lamp unit does not attract the attention of, or is not readable to, a viewer (both day and night) at all distances from 10 feet (3 meters) to the full width of the area to be crossed when operated over the specified operating ambient temperature and voltage ranges.

Furnish materials according to the Department's Qualified Products List (QPL).

**732.05 Pedestrian Signal Heads.** Furnish pedestrian signal heads that conform to the *ITE Pedestrian Traffic Control Signal Indications*. Furnish signal heads that are complete units made up of two optical compartments with no leakage of light from one compartment to another. Ensure that the signal heads alternately display the symbol of an upraised hand in portland orange and the symbol of a walking person in white light. Do not furnish outline style symbols. Furnish material for housings that consist of cast or sheet, corrosion resistant, non-ferrous metal. Adequately reinforce the housings. Ensure that the lens frames are non-ferrous metal or polycarbonate material.

Ensure that the lenses are glass or ultraviolet and impact-resistant plastic and display the legend with translucent symbols within an opaque black background.

Seal the lens to the door frame by the use of a weatherproof seal. Furnish an elastomeric gasket between the door frame and housing to ensure a dust and weatherproof seal.

Use a signal head design that provides adequate dissipation of heat to ensure rated lamp life.

Ensure that the reflectors distribute light evenly from the source to the lens and are fastened or fitted securely in the compartment. Furnish reflectors made of highly specular finished aluminum, silvered glass, porcelainized steel, or break resistant silvered plastic. Finish reflector material to preserve the original reflective properties.

**732.05**

Fit each compartment of pedestrian signal heads with a visor that is at least 7 inches (175 mm) in length or, in lieu of visors, protect the entire face with a sunshade fastened close to the lens. Furnish a black grid sunshade fabricated of high impact resistant plastic with a nominal depth of 1 1/2 inches (38 mm) and consisting of horizontal members spaced at not more than 1/2-inch (13 mm) and vertical members spaced appropriately.

Furnish pedestrian signal heads with required mounting brackets. Furnish either pipe type brackets or, when compatible with the mounting position required by the plans, two-piece hinged type brackets that support the signal head close to the pole.

Furnish 1 1/2-inch (38 mm) galvanized steel pipe brackets with necessary fittings and adapters, and that are one-way or two-way as required. Orient the signal face to crosswalks by selective meshing of serration rings or other devices provided on housings and mounting brackets. Make adjustment in increments not greater than 5 degrees of rotation and that is not affected by wind gusts when locked.

Furnish two-piece hinged brackets of cast aluminum with stainless steel hinge pins, and when closed will be secured by a tamperproof bolt. Ensure that the mounting incorporates a terminal block for quick disconnect of field wiring. Ensure that the mounting design permits attachment to the pole by banding, bolting or by lag screws in the case of wood poles.

Paint signal exterior surfaces black with enamel paint. Paint interior surfaces of visors flat black.

Furnish pedestrian signal head types according to Table 732.05-1.

TABLE 732.05-1		
Signal Head Type	Symbol Height, Inches, (mm)	Light Source
A1	6 (152)	Clear lamp
A2	9 (229)	Incandescent, LED
D2	9 (229)	Clear lamp Incandescent, LED

If specified, furnish the types listed below:

**A. Type A1.** Furnish a signal head that utilizes the housings of two 8-inch (200 mm) lens type vehicular traffic sections connected together to form a vertical unit. Ensure that the sections have square lenses. Ensure that the upper lens displays the symbol of an upraised hand in portland orange and the lower lens will display the symbol of a walking person in white . Install a lamp in each section.

Furnish materials according to the Department’s Qualified Products List (QPL).

**B. Type A2.** Furnish a signal head that utilizes the housings of two 12-inch (300 mm) lens type vehicular traffic sections connected together to form a vertical unit. Ensure that the sections have square lenses with the same symbol position as Type A1. Install a lamp in each section.

Furnish materials according to the Department's Qualified Products List (QPL).

**C. Type D2.** Furnish a single housing signal head with a lens in one piece or in two sections, one for each message. Color and mask the lens to display in portland orange the symbol of an upraised hand from the left compartment and the symbol of a walking person in white from the right compartment. Furnish reflectors and baffle that form two light compartments. Install a clear glass incandescent lamp in each compartment. When a LED light source is specified, the upraised hand and the walking person symbols may be integral in the same compartment.

**D. Countdown.**

1. Operation.

a. Display driver shall be designed to allow individual LED failures without affecting other LEDs in the same display.

b. The countdown timer shall be of the "smart" type, which continuously samples the timing intervals presented by the pedestrian signal load switch driver(s) in order to "learn" the programmed timing being used by the controller.

c. During interval sampling time, the countdown timer numerical display shall be blank.

d. Sampling time to determine interval settings shall take a maximum of two complete signal cycles.

e. The unit shall be capable of displaying a countdown commencing at the onset of the pedestrian clearance interval and reaching zero at the end of the pedestrian clearance interval.

f. Any interruption of the flashing pedestrian clearance display, e.g., preemption, timing plan change, during a countdown display shall immediately cause blanking of the countdown numerals. The countdown timer shall "re-learn" the pedestrian clearance interval upon return to normal service after preemption or immediately following a change in walk clearance time associated with a timing plan change.

2. Type A2. The top section shall be identical to the 12 inch (300 mm) Type D2 pedestrian signal. The bottom section shall consist of a countdown display in a 12 inch (300 mm) housing. The display numeral segments shall be comprised of two rows of discrete LEDs.

3. Type D2. The left side of the signal section shall consist of an integral hand/walking person display. The right side compartment shall contain the countdown display. The display numeral segments shall be comprised of two rows of discrete LEDs.

Furnish materials according to the Department's Qualified Products List (QPL).

**732.06 Pedestrian Pushbuttons.** Furnish pushbuttons of sturdy construction that consist of a base housing and a removable cover. Furnish components that provide a pushbutton with normally open contacts and that include all electrical and mechanical parts required for operation.

## 732.07

Ensure that the design of the pushbutton and its associated contacts and housing are sturdy and resistant to mechanical shocks and abuse. Ensure that a concentrated force of 50 pounds (225 N) applied to the button or any exposed portion does not damage the unit or misadjusts the contacts. Furnish a housing with a curved back surface for mounting on poles of various diameters. Integrate the curved surface with the housing or supply an adapter with a flat back type housing. Attach the cover assembly to the housing by stainless steel machine screws, resulting in a weatherproof and shockproof assembly. Furnish a hole threaded for a 1/2-inch (13 mm) pipe in the housing for conduit attachment purposes. Paint external surfaces yellow with enamel paint of Color 13655, Federal Standard 595.

Ensure that the maximum force required to operate the pushbutton is 5 pounds per foot (22.5 N). Furnish a raised or flush pushbutton with a minimum of 2 inches (50 mm) at its smallest dimension.

Furnish pedestrian pushbutton signs that are a minimum of 0.07-inch (1.8 mm) steel or 0.10-inch (2.5 mm) aluminum. Ensure that the legends and backgrounds are baked enamel paint for steel signs and enamel paint or non-reflective sheeting for aluminum signs.

Furnish materials according to the Department's Qualified Products List (QPL).

### **732.07 Loop Detector Units.**

**A. NEMA TS-1.** Ensure that the loop detector units comply with the requirements of NEMA TS-1, section 15, with the following modifications. Furnish shelf mounted loop detector units that are powered from 120 volts. Use solid state isolated output units for all controller applications where directly connected to a solid state digital controller unit. Ensure that the conductors in the cable harness for loop input pins are twisted three to five times per 1 foot (300 mm).

Ensure that the electrical connections for four-channel shelf-mounted units either are the 19-pin MS connector, as required by the foregoing specification, or consist of four connectors of the type required for single-channel shelf-mounted detector units.

If specified, design detector unit electrical connection plugs or wiring harness such that any multi-channel shelf-mounted detector unit may be readily replaced with single-channel detector units. Accomplish this by furnishing only units with the connector type required for single-channel shelf-mounted detector units, or by wiring the controller back panel to single-channel harnesses which are, in turn, plug-connected to an adapter harness which is mated to the multi-channel connector of the detector unit.

Furnish loop detector unit with an LED or LCD display indication of call strength ( $\Delta L/L$  or equivalent). This display shall be a bar graph or numerical display with at least eight (8) discrete levels indicated.

Furnish materials according to the Department's Qualified Products List (QPL).

**B. NEMA TS-2.** Furnish loop detector units according to NEMA Standards TS-2.

Furnish loop detector unit with an LED or LCD display indication of call strength ( $\Delta L/L$  or equivalent). This display shall be a bar graph or numerical display with at least eight (8) discrete levels indicated.

Furnish materials according to the Department's Qualified Products List (QPL).

**732.08 Loop Detector Units, Delay and Extension Type.** Ensure that the loop detector units of this type comply with the requirements of NEMA TS-1, section 15. Furnish shelf-mounted loop detector units that are powered from 120 volts. Use solid state isolated output units for all controller application where directly connected to a solid state digital controller unit. When specified, apply the provisions of 732.07 for possible replacement of multi-channel units with single channel units.

Furnish loop detector unit with an LED or LCD display indication of call strength ( $\Delta L/L$  or equivalent). This display shall be a bar graph or numerical display with at least eight (8) discrete levels indicated.

Furnish materials according to the Department's Qualified Products List (QPL).

Furnish materials according to the Department's Qualified Products List (QPL).

**732.11 Signal Supports.** Furnish signal poles and mast arms that are tapered tubes of a true continuous taper. Furnish tubes that are circular or regular polygons with six or more sides. Ensure that any measurements of circular tube diameter at a specific point along the longitudinal axis do not vary by more than 3/16-inch (5 mm). Ensure that the taper is between 0.54 and 1.3 percent.

Fabricate mast arms of the true continuous taper type in two portions joined by overlapping of sections with the overlap being at least 1 1/2 diameters as determined by the largest diameter of the outer portion. Assemble the sections with a 5/8-inch (16 mm) minimum stainless steel or galvanized steel hex head through-bolt.

Ensure that there is not more than one longitudinal, automatically electrically welded seam on circular poles. Ensure that the welded seams are neat and uniform in appearance and have a thickness not less than the base material and a bead height not exceeding 1/16-inch (2 mm). Ensure that the wall thickness at each pole or arm cross-section is of uniform thickness, except at weld beads. Do not place transverse seams or welds on true continuous taper type poles or arms. Weld according to 513.17.

After fabrication, hot-dip galvanize poles and arms according to 711.02.

Do not use guy rods or truss-type arms. Furnish poles and mast arms with attachment plates and gussets. Assemble using high-strength bolts with the connection developing the full moment-resisting capability of the arm. Do not allow the butt diameter of mast arms to exceed the nominal diameter of the pole at the point of attachment.

## 732.12

Fit poles with a welded-on cast or plate steel base designed to mount on an anchor bolt foundation and ensure that each pole includes the furnishing of anchor bolts and conduit ells for installation in the foundation. Furnish at least one 2-inch (50 mm) diameter conduit ell for installation in each foundation. Furnish conduit ells made from steel complying with 725.04; however, if they connect to non-metallic conduit, ensure that they are of the same non-metallic material.

Use steel anchor bolts conforming to ASTM F1554, Grade 105 and galvanized according to 711.02. Ensure that the galvanizing extends at least 2 inches (50 mm) beyond the threads. Ensure that ends either are bent or have a drilled and tapped steel plate as shown on the plans.

Ensure that the poles include a handhole near the base oriented as required. Reinforce the handhole with a welded-on steel frame with a grounding lug and fit it with a cover plate fastened by stainless steel screws. Ensure that the poles also include a cable and wire support J-hook welded near the top and a removable pole cap. Design poles and arms so their interiors conceal wiring and their mast arms include grommeted wire outlets for the signal heads. Furnish hanger clamps with clevises on the mast arms for the signal heads as required. Ensure that arm caps are made of steel and cover at least 50 percent of the end area.

Ensure that signal poles combining provisions for roadway lighting include an additional handhole located opposite the mast arm flange with the poles' J-hook located above.

Furnish pedestrian pushbutton access holes and blind half couplings for controllers and pedestrian signal heads as required. Plug any unused holes.

Furnish certified materials according to Supplement 1094.

**732.12 Strain Poles.** Furnish signal strain poles for the attachment of span wire that are steel tapered tubes according to the requirements of 732.11. Ensure that all poles include a removable pole cap, and messenger wire clamps with clevis and shackle unless otherwise specified.

Furnish anchor bolt foundation type strain poles that include a welded-on cast or plate steel base, bolt covers, a handhole, and a J-hook, as required by 732.11, and that also include at least one 2-inch (50 mm) cable entrance with a weatherhead and a welded blind half-coupling. Ensure that the poles include the furnishing of anchor bolts and conduit ells for installation in the foundation. Furnish at least one 2-inch (50 mm) diameter conduit ell for installation in each foundation. Furnish steel conduit ells that comply with 725.04; however, if they connect to non-metallic conduit, ensure that they are of the same non-metallic material.

Furnish certified materials according to Supplement 1094.

**732.13 Wood Poles.** Furnish wood poles that conform to ANSI 05.1 "Specifications and Dimensions for Wood Poles", that are made of Southern Pine or Western Red Cedar, and that are full-length pressure treated according to 725.19.

**732.14 Down Guy Assemblies.** Furnish down guy assemblies according to 725.19. Furnish insulators and hardware that conform to 732.18. Furnish

expanding or screw type anchors capable of withstanding a guy tension of 8000 pounds (35 kN) when installed in firm moist soil.

Furnish materials according to the Department's Qualified Products List (QPL).

**732.15 Pedestals.** Fabricate pedestals for the support of traffic control equipment of 4-inch (100 mm) schedule 40 steel or aluminum pipe. Fit the steel pipe with a welded-on base of plate or cast steel, or when specified thread the steel pipe into a gray cast iron transformer type base. Furnish galvanized steel pedestals according to 711.02. Thread aluminum pipe into an aluminum cast transformer type base. Design pedestals to mount on an anchor bolt foundation and include the furnishing of anchor bolts and conduit ells for installation in the foundation.

Furnish materials according to the Department's Qualified Products List (QPL).

**732.16 Conduit Risers.** Ensure that risers have conduit and fittings according to 725.04 and the weatherhead is made of aluminum or galvanized ferrous metal and threaded.

**732.17 Cable Support Assemblies.** Ensure that the cable grip used with cable support assemblies is of the proper size and strength for the cables and is of the flexible "closed" or "split with rod" type, of stainless steel or tin coated bronze, and equipped with a single "U" eye bale. Ensure that the smallest cable grip permitted has a minimum rated breaking strength of 250 pounds (1.1 kN).

Ensure that the slings for cable supports are made from copper clad or galvanized multi-strand steel wire with an overall diameter of not less than 1/8-inch (3 mm) and a breaking strength of at least 400 pounds (1.7 N). Use thimbles to form eyes at each end of the sling with grooves to match the wire. Adjust the sling to the proper length with the wire at each thimble lapped and secured with split bolt clamps.

Furnish materials according to the Department's Qualified Products List (QPL).

**732.18 Messenger Wire.** Furnish Utilities Grade messenger wire, twisted strand galvanized steel wire according to ASTM A 475, Class B, with the exception that tags according to Section 19.2 are not required on lengths less than 1000 feet (300 m), and that 1/4-inch (6 mm) seven-strand be high-strength. Ensure that all accessories have a rated loading strength equal to or greater than the messenger wire minimum breaking strength. For breakaway tether installations, accessories shall have strength equal to or greater than 3000 pounds (13.2 kN). Furnish galvanized steel helical lashing rods in 5-foot (1.5 m) lengths.

Furnish materials according to the Department's Qualified Products List (QPL).

**732.185 Tether Wire.** Furnish Utilities Grade tether wire, 1/4-inch (6 mm), twisted strand galvanized steel according to ASTM A475, Class B, with the exception that tags according to Section 19.2 are not required on lengths less than 1000 feet (300 m). Ensure that all accessories except S-hooks have rated load strength equal to or greater than the tether wire minimum breaking strength. S-hooks shall be made of mild low-carbon galvanized steel and of the wire size indicated on the plans; larger wire sizes and higher-strength steel S-hooks shall not be substituted. Safety tie wire shall be 304 or 316 stainless steel, 1x19 stranded, 1/8-inch (3 mm) with stainless steel wire rope clips. Lead sheet to wrap tether

## 732.19

wire in breakaway anchors shall be commercially pure lead of thickness 0.030 to 0.042 inches (0.75 to 1.0 mm).

**732.19 Cable and Wire.** Furnish cable and wire meeting the requirements of Table 732.19-1 and rated at 600 volts with conductors of copper unless otherwise specified. Ensure that the cable or wire jacket is indelibly marked at intervals of not more than 6 feet (2 m) with nomenclature stating the size, the type, the organization specifying the type, and the manufacturer's name or trademark.

Furnish materials according to the Department's Qualified Products List (QPL).

**732.20 Power Service.** Furnish risers for power service that are 1 to 1 1/2-inch (25 to 38 mm) diameter conduit and fittings according to 725.04. Furnish weatherheads that are threaded and made of aluminum or galvanized ferrous metal. Include a disconnect switch with enclosure.

**732.21 Disconnect Switch with Enclosure.** Ensure that the switch enclosure is a UL listed watertight lockable stainless steel NEMA Type 4 supplied with the conduit hubs listed on the enclosure UL label. Furnish an enclosure that contains as a minimum a single-throw, 2 pole, solid neutral, fused safety disconnect switch (or circuit breaker) UL listed as suitable for a service disconnect with a minimum capacity of 30-amperes at 240 VAC. Ensure that the unit can be padlocked in both the "ON" and "OFF" positions.

Furnish materials according to the Department's Qualified Products List (QPL).

**732.22 Backplates.** Furnish backplates constructed of wrought sheet aluminum, according to ASTM B 209 (B 209M), 6061-T6, .050 inch (1.3 mm) minimum thickness. Backplate base metal shall be anodized to maximize paint adhesion according to Mil-A-8625, Type II or Type I. Furnish backplates painted on both sides with at least two coats of flat black alkyd enamel paint or polyester powder coat (no epoxy) closely matching FED-STD-595b-37038. Furnish a backplate that extends 5 inches (125 mm) beyond the outside of the signal assembly on all sides. The overall outside shape of the installed backplate shall be rectangular. The backplate shall allow no gaps between the backplate and the signal head or between signal sections. A 2-inch (50 mm) wide continuous outside border of yellow or fluorescent yellow reflective sheeting shall be applied to the front face of the backplate. Reflective sheeting shall be Type H or J listed on the Department's Qualified Products List. All assembly and mounting hardware shall be stainless steel conforming to 730.10. If used, machine nuts shall be thread-deforming or nylon locknuts. Rivets shall not be used for mounting the backplate to the signal head. A minimum of four mounting points shall be used on each signal section for attaching the backplate. Furnish all mounting hardware.

TABLE 732.19-1 CABLE AND WIRE					
Cable or Wire	Number of Conductors	Wire Gage	Specification or type	Conductor Type	Notes
Signal Cable	As specified	As specified	IMSA 19-1 IMSA 20-1	Copper, color coded, stranded	
Interconnect cable	As specified	As specified	IMSA 19-1 IMSA 20-1	Copper, color coded, stranded	
	Twisted pairs as specified	As specified	RUS PE-39 IMSA 19-2 IMSA 20-2	Copper, color coded, solid	
Interconnect cable, integral, messenger type	As specified	As specified	IMSA 19-3 IMSA 20-3	Copper, color coded, stranded	
	Twisted pairs as specified	As specified	IMSA 19-4 IMSA 20-4	Copper, color coded, solid	ANSI/ICEA Cable shall have: Solid insulations Full count color coding 8-mil shield 772 kHz attenuation compliance All other specifications are manufacturers option unless specified.
Loop detector wire	Single conductor	14 AWG	IMSA 51-5	Copper, stranded	
Loop detector lead-in cable	Two conductor	14 AWG	IMSA 50-2	Copper, twisted pair, stranded, shielded	
Power cable	Two conductor	As specified	UL: RHH/RHW/US E or XHHW, cross linked polyethylene w. an insulation thickness of 0.045 in(1.14 mm) (min.)	Copper, stranded	Three-conductor cable may be specified. Permitted substitution: 2 (or 3) single conductor cable
Service cable	Two conductor (duplex)	As specified		Aluminum, [1] twisted, stranded	
Ground Wire	Single conductor		UL: RHH/RHW/US E or XHHW, cross linked polyethylene	Copper, stranded	Minimum size is equal to the power or service cable, whichever is larger.
Loop detector lead-in cable, direct burial	As specified	12 or 14 AWG, or as specified	IMSA 19-6 IMSA 20-6	Copper, stranded	
Loop detector lead-in cable, Integral messenger type	As specified	12 or 14 AWG, or as specified	IMSA 19-4 IMSA 20-4	Copper, stranded	
[1] Copper Conductors may be substituted					

## 733 TRAFFIC SIGNAL CONTROLLER MATERIAL

### 733.01 References and Definitions.

“NEMA TS-2,” “Type TS-2/A2,” and “Type TS-2/A1” refers to equipment manufactured in conformance with the National Electrical Manufacturers Association (NEMA) Standards Publication No. TS-2.

“NEMA TS-1” and “Type TS-1” refers to equipment manufactured in conformance with the National Electrical Manufacturers Association (NEMA) Standards Publication No. TS-1.

“Type 332”, “Type 334” and “Type 336” refers to equipment manufactured in conformance with the California Department of Transportation (CalTrans) specifications titled “Traffic Signal Control Equipment Specifications” and “Transportation Electrical Equipment Specifications”, including all addenda.

“Type 170E” and “Type 2070” refers to equipment manufactured in conformance with the California Department of Transportation (CalTrans) specifications titled “Transportation Electrical Equipment Specifications”, including all addenda.

“CalTrans QPL” refers to the California Department of Transportation (CalTrans) “Qualified Product List” for traffic signal equipment.

### 733.02 Controller Units.

**A. General Requirements.** Ensure that each controller unit contains internal time based coordination and, if used in a hardwired coordination system, provide an internal communication device or transceiver for connection to interconnect cables including multi-conductor 120 volt cables, twisted pair low voltage cables or fiber optic cables as shown on the plans.

If used in a closed loop system, ensure that the local intersection controller contains all of the software features necessary to operate with the system requirements given in 733.06 and 733.07. Furnish the necessary dial-up communications capability for isolated local intersections when part of the monitoring and control system described in 733.08.

When the signal timing and phasing configuration shown on the plans requires a pre-timed operation, ensure that the controller unit meets all requirements of this section and can also be configured in a pre-timed, sequential phase, fixed interval mode.

Furnish controller memories that are nonvolatile and do not require batteries or other sources of energy to retain data while power is removed from the controller.

**B. Software.** Furnish a communication port for connection to a laptop computer for database upload/download. Furnish software for the personal computer to completely program all features of the controller unit. Unless otherwise shown on the plans, provide the controller unit with software that provides the following features even if not used by the signal phasing operation shown on the plans:

1. NEMA 8 phase, dual ring capability with four pedestrian movements, 4 overlaps, and the ability to program an exclusive pedestrian movement. Ensure that the controller is capable of being programmed for sequential phasing operation.

2. Volume density functions
3. Secondary coordination plans
4. Time of day/day of week scheduler
5. Time based coordination, minimum 3 dials, 3 offsets, 3 splits
6. Internal preemption for railroad and emergency vehicles
7. Operator selectable single or dual entry in dual ring use
8. Security access codes
9. Detector features including delay timing, carryover (extension) timing and detector switching
10. Simultaneous gap out feature
11. If operated in a system, communication capabilities to interface with hardwired masters or dial up modems
12. Data upload and download capability to a personal computer
13. Storage of detector counts utilizing phase detectors for a minimum 24 hour period in 15 minute increments
14. Detector failure monitoring and logging features for constant calls and absence of calls

Furnish 60-month warranties or for the manufacturers' standard warranty, whichever is greater for the following equipment:

1. NEMA Controller Equipment
  - a. TS-2 Controller Units
  - b. Bus Interface Units
  - c. Malfunction Management Units
  - d. TS-1 Conflict Monitors
2. CalTrans Controller Equipment
  - a. Model 2010 Conflict Monitor Units
  - b. 170E Controller Units including the following subassembly item:
    - (1) CPU Board
  - c. 2070L and 2070LC Controller Units including the following subassembly units:
    - (1) 2070-1E CPU Board
    - (2) 2070-2A Field I/O Module

## (3) 2070-3B Front Panel.

Ensure that the warranty period begins on the date of shipment to the project. Ensure that each unit has a permanent label or stamp indicating the date of shipment.

**A. Type TS 2/A1.** Furnish a controller unit that meets NEMA TS-2 specifications and is shelf or rack mounted. Ensure that controller settings are programmable through a keyboard on the front panel. Ensure that the front panel contains an 8-line by 40-character display.

Furnish materials according to the Department's Qualified Products List (QPL).

**B. Type TS-2/A2.** Furnish a controller unit that meets NEMA TS-2 specifications and is suitable for shelf mounting. Furnish a controller unit that includes all ports and input/output connectors for complete interchangeability between NEMA TS-1 and TS-2 cabinets. Ensure that controller settings are programmable through a keyboard on the front panel. Ensure that the front panel contains an eight-line by 40-character display.

Furnish materials according to the Department's Qualified Products List (QPL).

**C. Type 170E.** Furnish a controller unit that meets the specifications for "Transportation Electrical Equipment Specifications", California Department of Transportation, including all addenda. Furnish a controller unit that is listed on the CalTrans QPL and has:

1. Vertically mount all circuit boards. If ribbon cables are used, ensure that they terminate with properly rated and easily repairable connectors on each end. Ensure that ribbon cables do not terminate onto plug-in modules.
2. Furnish a power supply that is modular and easily removable from the chassis.
3. Furnish a unit that contains separate input and output modules.
4. Furnish a controller unit that includes a Model 412C Program Module with the memory configuration for the software either shown on the plans or as provided by the maintaining agency.
5. Socket mount all memory, microprocessor and ACIA devices. Furnish sockets that have machined beryllium copper contacts with gold plating.

Furnish materials according to the Department's Qualified Products List (QPL)

**D. Types 2070L, 2070LC.** Furnish controller units that meet the specifications for "Transportation Electrical Equipment Specifications", California Department of Transportation, including all addenda. Furnish a controller unit that is listed on the CalTrans QPL.

The Type 2070L version controller unit consists of the following assembled modules:

Unit Chassis

Model 2070-1E

Model 2070-2A

CPU Module, Single Board  
Field I/O for 170 Cabinet

Model 2070-3B	Front Panel, Display B (8 lines of 40 characters)
Model 2070-4A or Model 2070-4B	Power Supply
Model 2070-7A	Async Serial Communication

The Type 2070LC version controller unit consists of the following assembled modules except provide 2070-3B in lieu of Caltrans requirement for a 2070-3C:

Unit Chassis	
Model 2070-1E	CPU Module, Single Board
Model 2070-2B	Field I/O for ITS and TS-2 Cabinet
Model 2070-3B	Front Panel, Display B (8 lines of 40 characters)
Model 2070-4A or Model 2070-4B	Power Supply
Model 2070-7A	Async Serial Communication

Also, equip all versions of the Type 2070 controller unit with the following:

1. The appropriate communication port, cables, and connectors for communicating with a laptop computer.
2. Modems, ports, and cables for system communication, if the controller is to operate as part of an interconnected signal system or has a telephone drop shown on the plans.
3. Furnish a serial communication cable to be used to establish periodic automatic time sync between the 2070 controller software and the conflict monitor. The cable shall consist of six feet (2 m) of unshielded 4- conductor cable, minimum 24 gauge stranded conductors with protective jacket. End connectors shall be 9-pin D-subminiature with backshell, male and female, with pin assignments shown in the table below.

9-pin Male	9-pin Female
3	3
5	5
2	2
1	4
8	4

Furnish materials according to the Department's Qualified Products List (QPL)

**733.03 Cabinet.** Ensure that all cabinets comply with the requirements of this Section. Equip all NEMA specified cabinets as follows:

Supply two through four phase controller operation with a minimum eight position backpanel, configured for two pedestrian movements and two overlaps, with a six channel NEMA TS-1 conflict monitor or NEMA TS-2 malfunction management unit.

Supply five through eight phase controller operation with a minimum 12 position backpanel, configured for four pedestrian movements and no overlaps,

with a 12 channel NEMA TS-1 conflict monitor or NEMA TS-2 malfunction management unit.

For signal phasing configurations that require a larger capacity backpanel or conflict monitor, supply a 16 position backpanel with a 16 channel NEMA TS-1 conflict monitor or NEMA TS-2 malfunction management unit.

Furnish each cabinet main door with a sturdy, permanently lubricated lock that is covered with a weatherproof tab. Key the project locks to the master key used by the agency that will maintain the equipment. Supply two keys with each lock. Also, equip the small door-in-door with a lock that is keyed to the maintaining agency's master key.

#### **A. Type TS-1.**

**1. Cabinets.** Furnish a cabinet size that provides ample space for housing the controller unit and all associated electrical devices furnished with it, together with any other auxiliary devices that are specified. Furnish a cabinet with sufficient shelf space to accommodate all existing, proposed, and designated future equipment. Ensure that the space provided accommodates the appropriate controller unit frame as designated in NEMA TS-1, Section 14.

Construct the cabinets of cast aluminum or sheet aluminum, drawn or formed, with aluminum support and stiffening of members provided as necessary. Ensure that the exterior is smooth with no sharp edges. Weld all joints. Ensure that the cabinet is rigid and is designed to support all components. Ensure that the application of the following loads do not result in breakage, deformation, or loss of weatherproof qualities: a 100-pound (445 N) load applied to any 1-inch (25 mm) square surface of the cabinet or door (open or closed), in any direction; or a 300-pound (1.3 kN) load applied vertically downward to any 4-inch (100 mm) square of the top surface or to the top edge of the closed and latched door.

Provide cabinet exterior surfaces of bare aluminum. When the plans specify a cabinet color, prime and finish all cabinet exteriors with two coats of high-grade enamel paint of the specified color. Ensure that the cabinet interior surfaces are the same as the exterior, or may be painted flat white.

Ensure that the cabinet contains at least one rain-tight louvered vent equipped with a replaceable filter. Install vents to allow for the release of excessive heat and any explosive gases that might enter the cabinet.

Ensure that the cabinets are functional in design and have a door in the front providing access to substantially the full interior area. Attach a gasket of elastomeric material to the cabinet or door to form a weatherproof seal. Furnish door hinge pins of stainless steel or equivalent corrosion resistant material. Furnish a door stop to retain the door in at least a 90 degree open position.

Include a small, hinged, and gasketed door-in-door (police door) on the outside of the main controller door. Ensure that the door-in-door does not allow entrance to the controller mechanism nor to exposed electrical terminals, but provides access to a small switch panel and compartment (police panel).

Fit the cabinet with the necessary provisions for mounting, with a bottom conduit connection provided for pole-mounted cabinets. Furnish suitable

hardware and equipment for each cabinet mounting method, including bolts for drilled and tapped holes on metal supports, pole attachment clamps, pedestal slipfitter, and anchor bolts and conduit ells for installation in concrete foundations. Furnish steel anchor bolts that are galvanized at least 1 inch (25 mm) beyond the threads. Certified cabinet anchor bolts are not required.

Directly place all equipment designed for shelf mounting on a shelf except for loop detector units (amplifiers) and similar devices designed for stacking on each other. Arrange components on shelves and devices on the door so that a 1-inch (25 mm) minimum space separates them when the door is shut. Ensure that plugs, wires, controls, or similar items do not compromise this space.

Reserve a minimum 4-inch (100 mm) clear area on the bottom of the cabinet for the routing of cables. Do not locate panel mounted equipment in the bottom 6 inches (150 mm) of the cabinet. Do not locate shelves or components within 6 inches (150 mm) of the bottom of foundation mounted cabinets.

Arrange all equipment for easy withdrawal and replacement, without the necessity of disturbing adjacent equipment. Permanently locate devices within the cabinet to allow free circulation of air and that do not restrict air flow from fan ducts or vents.

Ensure that the auxiliary equipment operates within a weatherproof cabinet at ambient temperatures between -30 and 165 °F (-34 and 74 °C).

When terminals and panel mounted devices with exposed electrical contact points are located next to shelf mounted equipment, provide spacers, shelf lips, or other means to assure that component units cannot be accidentally moved into contact with any exposed electrical terminal points.

Ensure that load switches, relays, flashers, fuses, switches, terminal blocks, and other equipment mounted or plugged into the back or side panels are readily accessible. Ensure that switches, controls, and indicator lights are visible and easily operable without moving the components from their normal shelf positions.

Furnish materials according to the Department's Qualified Products List (QPL).

## 2. Accessory Equipment

**a. Ventilating Fan.** Equip all cabinets with a forced air ventilating fan. Furnish a fan that provides a capacity of at least 100 cubic feet (2.8 m<sup>3</sup>) per minute. Furnish a fan that is thermostatically controlled and adjusted to start at cabinet temperatures above 120 °F (49 °C) and to stop when the temperature has dropped below 100 °F (38 °C).

**b. Load Switches.** Furnish all cabinets with solid state, triple-signal load switches complying with NEMA TS-1, Section 5. Additionally, ensure that all load switches have both input and output indicators.

**c. Conflict Monitor.** Furnish all cabinets with a separate solid-state conflict monitor device. Ensure that the cabinet wiring, in the event of monitor disconnection, transfers the signals to a flashing condition. Furnish conflict

monitors that comply with NEMA TS-1, Section 6. Additionally, ensure that all conflict monitors are capable of causing the signals to flash as a result of the following events:

- (1) All red lamps associated with a load switch are burned out;
- (2) Within one second when red and green, or yellow and green color pairings are displayed on the same phase;
- (3) The absence of a minimum yellow interval.

Ensure that the monitor indicates the exact load switch output channel upon which the failure event occurred. Furnish conflict monitors that are capable of storing a minimum of nine fault events (event logging feature). Furnish a monitor that utilizes a LCD display and has a RS-232 port for connection to a laptop computer. Furnish software and connector cables to diagnose the conflict monitor.

**d. Flashers.** Furnish solid-state flashers that comply with NEMA TS-1, Section 8. When signals have a normal stop-and-go sequence that includes flashing, either ensure that the controller unit generates that flashing display or provide flashers. For this purpose, provide separate flashers from those provided for emergency back-up. Furnish flashers that are designed with two circuits of at least 10 amperes each.

Equip each controller cabinet with terminals that are wired so that, by an interchange of jumpers, the flashing operation is arranged to display either flashing yellow or flashing red on the vehicular signals.

**e. Relays.** Ensure that the relays required for proper operation of the specified equipment are furnished and completely wired. Furnish relays that are enclosed, readily replaceable, and designed for one-million operations without failure or need for adjustment.

**f. Surge Protection Devices.** Furnish surge protection on incoming power lines, interconnect lines, and detector leads.

The primary surge protection device (SPD) shall be an EDCO SHA-1250 or approved equal. A plug-in base shall be used to hold the device. All wiring connections shall be made to the base, and appropriate cabinet clearances maintained, to allow the SPD module to be relaced by hand without the use of tools.

Furnish loop detector lead-in cable protection that consists of devices installed in each detector circuit where the lead-in connects to the terminal block. House each device in a case that consists of two stages; a 3-electrode gas tube arrester and a semiconductor circuit. Ensure that the arrester shunts to ground a common mode transient with a 1,000 ampere peak and an 8/20 microsecond wave-shape, ionizing at 400 volts within 100 nanoseconds when subjected to a 1,000 volt per microsecond transient. Furnish a semiconductor circuit that clamps a differential transient to 30 volts within 40 nanoseconds of the appearance of the transient, and a common mode transient to 30 volts within 500 nanoseconds of the ionization of the gas tube arrester. Ensure that the second stage is able to

withstand a peak current of 13 amperes. Furnish a device that has impedance characteristics compatible with the detector unit so as not to cause false calls or increase the loop impedance above the sensitivity of the detector unit.

Furnish pedestrian pushbutton inputs with the same protection as specified for the loop detector lead-in cables.

Protect interconnect cable against transients by devices across each conductor of the cable and ground. The devices may be either 2 or 3-terminal devices. If 3-terminal devices are used, connect two conductors and ground to the same device. Furnish a protection device that consists of a gas tube arrester with a maximum ionization voltage of 1000 volts on a 10,000 volt per microsecond transient or a maximum ionization voltage of 950 volts on a 3000 volt per microsecond transient. Ensure that the maximum time from beginning of the transient to ionization is 1.1 microseconds on a 10,000 volt per microsecond transient. Ensure that the device is not ionized by normal voltage variations on a 120-volt AC line. Furnish a device that is able to withstand a 10,000 ampere peak with an 8/20 microsecond waveshape.

**g. Main Power Breaker.** Furnish an incoming AC+ power line that is controlled by a main circuit breaker rated at 240 volts and an auxiliary breaker, with capacity and wiring as specified in NEMA TS-1, Section 10.3.2.2 and Figure 10-4.

If a power service disconnect switch is located before the controller cabinet, the neutral (AC-) and the grounding bar in the controller cabinet shall not be connected together as shown in NEMA TS-1, Figure 10-4.

**h. Radio Interference Filter.** Furnish an incoming AC+ power line that contains a radio frequency interference (RFI) filter installed between the main circuit breaker and the solid state equipment. Also, provide RFI filtering for the load switches and flasher, unless the equipment furnished provides signal and flasher circuits switching at the zero voltage point of the power line sinusoid wave form.

**i. Convenience Outlet and Light.** Wire a convenience outlet into the cabinet for use by electrical maintenance equipment. Ensure that the outlet contains at least one standard duplex three-wire plug receptacle of the ground-fault circuit-interrupting type. Furnish and mount a standard incandescent lamp and socket in the upper portion of the cabinet. Furnish a door switch to control the convenience light.

**j. Manual Control and Pushbutton.** When required by the plans, provide intersection controller units with means for substituting manual operation of interval timing for automatic interval timing. Ensure that manual operation provides the same interval sequence as when the controller unit is operating automatically.

Obtain manual interval timing by a momentary pushbutton contact switch mounted on a 5-foot (1.5 m) minimum flexible weatherproof extension cord. Store that switch and cord behind the small door-in-door.

**k. Switches.** Furnish completely wired switches that are required for proper operation of specified equipment. Clearly and permanently label switches as to function and setting position, and ensure that they are accessible without the necessity of moving components.

(1) **Signal Shutdown Switch.** Furnish a cabinet with a signal shutdown switch for turning off the power to the signals at the intersection. Ensure that this switch only affects the power to the signals, and allows the controller to continue in operation. Locate the switch in the panel behind the small door-in-door (police door).

(2) **Auto/Flash Switch.** Furnish a cabinet with a flash control switch for activating the flashing of vehicular signals in a preselected emergency flash display. Ensure that the operation of the flash control switch causes a flashing display even under conditions of controller unit malfunction or of its removal from the cabinet. Ensure that the operation of the switch overrides any operation commands from a local or remote time switch. Locate the switch in the panel behind the small door-in-door (police door).

Program the transfer to and from flashing operation, when called remotely or by a local time switch, to occur only at points in the cycle allowed by the OMUTCD.

(3) **Automatic/Manual Transfer Switch.** Furnish a cabinet with an automatic/manual transfer switch. In the automatic position, ensure that the controller unit automatically sequences the signal head displays. In the manual position, ensure that the signal phase or interval sequencing occurs only upon manual activation of the manual control pushbutton. Locate the switch in the door-in-door (police door). Ensure that it is unnecessary, when switching from manual to automatic operation, or vice versa, to do so at any certain time or to make any time adjustments.

(4) **Run/Stop-Time Switch.** Furnish a cabinet with a run/stop-time switch that activates the controller stop-time feature when in the “stop-time” position. Locate the run/stop-time switch on a switch panel in the cabinet.

(5) **Controller Shutdown Switch.** Furnish a cabinet with a controller shutdown switch that cuts off power to the controller unit, conflict monitor, and detector units. Ensure that power is not cut off to those components required to maintain flashing operation. Locate the controller shutdown switch on a switch panel in the cabinet.

(6) **Coordinated/Free Switch.** Furnish controllers operated in a coordinated system with a coordinated/free switch. Ensure that this switch allows the choice of operating the controller under the supervision of a coordination device or operating the controller independently of coordination control. Locate the coordinated/free switch on a switch panel in the cabinet.

(7) **Detector Test Switches.** Furnish momentary contact switches that will enter a vehicular or pedestrian call for any actuated phase. Furnish a switch for each actuated phase vehicular and pedestrian detection input. Conveniently group and label the switches.

**l. Terminal Blocks.** Furnish cabinets that include terminal blocks mounted on panels on the walls of the cabinet. Ensure that the blocks are not obstructed by shelf-mounted devices. Furnish sufficient terminal sets for each individual harness wire as well as for contacts of signal load switches, flasher transfer relays, flasher, and other components. Also, provide separate terminal sets for field wiring connections, including power, signal, interconnection, and detector lead-in cables. Group terminal sets to separate higher voltage (120 VAC) from lower voltage, and arrange them into logical groups. Protect terminal blocks from accidental contact during the installation and removal of shelf-mounted equipment. Locate the blocks no closer than 4 inches (100 mm) from the bottom of pole and pedestal mounted cabinets, and no closer than 6 inches (150 mm) from the bottom of foundation mounted cabinets.

Ensure that the terminal points are UL listed as suitable to carry the rated loading. Ensure that the capacity and size of the terminals are as specified in NEMA TS-1, Section 10.2.5. Ensure that the terminal points for signal field wiring for each circuit accommodates at least four 12 AWG conductors with spade type terminals.

Furnish terminal points for incoming power wiring that accepts either spade terminals or bare stranded wire and are suitable for either aluminum or copper conductors.

Space terminal sets for easy wiring. Furnish at least six reserve terminal sets for controllers. Harnesses may terminate on the back of terminal blocks using through-panel terminals. Clearly mark terminal sets for ready identification including through-panel terminals that are identified on both sides. Ensure that the contact between adjacent terminal points are made by bus bar, or by wire jumpers having spade type terminals securely attached to each end.

**m. Terminal Buses.** Furnish a cabinet with supply terminal buses fed from the line side of the incoming 120 VAC power line, after the phase wire has passed through the main power switch. Ensure that the requirements for use of radio interference filters are according to Item 8 of this Section, with the buses supplying load switches and with flashers being filtered when required. Ensure that a signal bus relay controls power to the bus supplying power for the signal load switches. . The following overrides NEMA requirements for signal bus relays. A solid-state relay shall be used for the signal bus relay. The signal bus relay shall maintain output equal to or above the rating of the cabinet main overcurrent protection device over the NEMA TS-2 Environmental Operating Range of -50 to +185 degrees F (-45 to +85 degrees C).

Furnish a common terminal bus for the connection of the neutral wire of the incoming 120 VAC power line. Ensure that the common bus has sufficient terminal points to accommodate all potential cabinet wiring as well as field wiring. Use a separate common terminal, insulated from the panel, for the interconnect common.

Furnish bus terminal points that comply with Item 12 of this Section for conductor accommodation, attachment and identification.

**n. Grounding System/Bus Bars.** Furnish a cabinet that includes a grounding system as specified in NEMA TS-1, Section 10.3.2.1 with an adequate number (minimum of three) of ground terminal points.

**o. Wiring.** Neatly organize and route the harnesses and wiring bundles to individual terminals. Ensure that the harness provides a wire for each pin or contact of the device. Connect each wire to a marked terminal position. Use labeled spade type terminals or plug connections on all harness wiring. Group and lash or restrain wire bundles in such a manner that they will not interfere with the access to components, terminal blocks or buses, or the legibility of terminal identification. Ensure that the harnesses are of sufficient length to reach any point within the cabinet. Ensure that the cables and harness bundles are easily traced through the cabinet to their terminations.

Wire the cabinet so that controller pin connections associated with a given phase number matches the phase number assigned to the specified traffic movement as shown on the plans.

Furnish all wiring with stranded conductors. Ensure that the wiring is adequate for the voltage and load that represents the ultimate load of the devices connected. Ensure that the ampacity rating of the wires are as specified in NEMA TS-1, Section 10.3.3.1. Ensure that the wiring is color coded as follows:

- (1) Solid white, AC common.
- (2) Solid green or green with yellow stripes, equipment ground.
- (3) Solid black, AC line side power (AC+).

**p. Loop Detector Units.** Furnish loop detector units that comply with the requirements of NEMA TS-1, Section 15, with the following modifications:

(1) Furnish loop detector units that are shelf mounted and powered from 120 volts.

(2) Ensure that the unit uses solid-state isolated output devices.

(3) Furnish conductors in the cable harness for loop input pins that are twisted three to five times per foot (300 mm).

(4) Furnish detector unit electrical connection plugs or wiring harness that are designed such that any multi-channel shelf mounted detector unit is readily replaced with single channel detector units. Furnish only units with the connector type required for single channel shelf mounted detector units, or by wiring the controller back panel to single channel wiring harnesses which are, in turn, plug connected to an adapter harness that is mated to the multi-channel connector of the detector unit.

(5) When shown on the plans, supply delay and extension timing capability on the detector unit; otherwise, the controller unit software requirements of 733.02 will provide these features.

(6) Ensure that the harness provides a wire for each pin or contact of the device.

(7) Furnish loop detector unit with an LED or LCD display indication of call strength ( $\Delta L/L$  or equivalent). This display shall be a bar graph or numerical display with at least eight (8) discrete levels indicated.

If vehicle detector types other than “loop” detectors are required by the plans, provide these detectors by separate bid item.

Furnish TS-1 cabinets according to the Department’s Qualified Products List (QPL).

## **B. Type TS-2.**

1. Furnish TS-2 cabinets that utilize a high speed data channel to connect the controller unit, malfunction management unit, rear panel (terminals and facilities), detectors and bus interface units and also comply with the general requirements of 733.03. Furnish a prewired cabinet with malfunction management unit, loop detector units, and all accessory equipment as specified in NEMA TS-2, except as follows:

a. Section 5.3.4, use detector racks for both Type 1 (A1) and Type 2 (A2) controller units.

b. Section 5.4.2.1, if a power service disconnect switch is located before the controller cabinet, the neutral (AC-) and the grounding bar in the controller cabinet shall be connected together.

c. Section 5.4.2.7, provide an incandescent type light.

d. Section 5.4.2.7.2, provide the incandescent lamp.

e. Section 5.4.2.7.3, provide the door actuated light switch.

f. Section 6.5.2.2.1, provide 2-channel detector units, without delay/extension features (Type A).

g. Section 7.2, construct cabinets of cast or sheet aluminum.

h. Section 7.3, provide a Size 5 cabinet for four phase or less pole mounted cabinets, Size 5 for four phase or less ground mounted cabinets, and Size 6 for 5 phase or more ground mounted cabinets. Supply larger cabinets if required to house the equipment to meet the plan requirements; such as master controllers, preemption devices, 16 position backpanels or special detection units.

i. Section 7.5.7, ensure that the police panel contains switches for AUTO/FLASH, SIGNALS ON/OFF and AUTO/MANUAL in the police panel. Furnish a pushbutton with a 5-foot (1.5 m) cord.

j. Section 7.7.3, supply unpainted cabinets.

2. Furnish loop detector and pedestrian inputs that have lightning/surge protection as specified in 733.03.A.2.f.

3. Include loop detector racks with the necessary number of two-channel loop detector units with the cabinet. When shown on the plans, supply delay and extension timing capability on the detector unit; otherwise, provide the controller unit software with these features. If vehicle detector types other than “loop” detectors are required by the plans, provide these detector units by separate bid

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item. If the special bid detector units use standard TS-2 detector racks, furnish the racks as part of the pre-wired cabinet.

Furnish loop detector unit with an LED or LCD display indication of call strength ( $\Delta L/L$  or equivalent). This display shall be a bar graph or numerical display with at least eight (8) discrete levels indicated.

4. Furnish switches to control the controller unit and cabinet functions as specified in 733.03.A.2.k.

5. Furnish load switches that have both input and output indicators.

6. The primary surge protection device (SPD) shall be an EDCO SHA-1250 or approved equal. A plug-in base shall be used to hold the device. All wiring connections shall be made to the base, and appropriate cabinet clearances maintained, to allow the SPD module to be relaced by hand without the use of tools.

Furnish TS-2 cabinet according to the Department's Qualified Products List (QPL).

#### C. Type 332.

**1. General.** Furnish Model 332A cabinets that meet the specifications "Traffic Signal Control Equipment Specifications" and "Transportation Electrical Equipment Specifications", California Department of Transportation. Ensure that the manufacturer of the cabinets is listed on the CalTrans QPL at the time of the project award.

#### 2. Cabinets.

a. Ensure that the cabinets are constructed of aluminum and are supplied unpainted. An anodic coating is not required. Supply galvanized anchor bolts with nuts and washers with each cabinet. Furnish 3/4-inch (19 mm) diameter by 16 inches (0.4 m) minimum length anchor bolts with an "L" bend on the unthreaded end.

b. Fit the cabinets with a PDA-2 power distribution assembly.

c. When shown on the plans, provide the cabinet with door hinges that are "right" or "left" mounted when facing the front of the cabinet.

#### 3. Terminals and Wiring.

a. "Hardwire" output files. Do not use printed circuit wiring in the output file except for the red monitor board.

b. Ensure that the vehicle and pedestrian detector field wiring inputs connect to side mounted terminal blocks. Install terminal blocks and associated wiring to the input file. Label the field wiring terminals of the side mounted terminal block by a permanent screening process to identify the input panel (I or J), the input file slot number (1 through 14) and the channel terminal (D, E, J, or K). An example is "I4-E". Ensure that all terminals on these detector blocks are accessible without removing equipment from the EIA mounting rack.

c. Install red monitor cabling in the cabinets. Install a program board to enable/disable red monitoring. Ship the cabinets with the red monitor jumpers set in the “enable” position.

d. Do not connect the pedestrian yellow load switch outputs to the conflict monitor card-edge connector.

e. Supply each cabinet with a cable approximately 5 feet (1.5 m) long to connect a laptop computer with the controller. Ensure that the cable has a DB-9 connector on one end, and a connector on the other end to mate with the C2 on the back of the controller. The cable will allow a laptop computer to upload/download data to the controller.

f. On the output file, wire pin No. 11 of each switchpack connector to AC- so that the output indicators on dual indicator switchpacks will display properly.

#### **4. Accessories.**

a. Fully equip the cabinets with two channel loop detector sensors, flashers, flash transfer relays, power supply, AC and DC isolators, conflict monitor, switchpacks (with both input and output indicators), and a DC isolator in slot 14 for flash sense/stop time. Do not switch the input file channels from the standard layout in order to minimize the number of two-channel detector units utilized. If vehicle detector types other than “loop” detectors are required by the plans, provide these detectors under a separate bid item.

Furnish loop detector sensors according to the Department’s Qualified Products List (QPL).

b. Furnish a rack mounted detector test panel with test switches for all vehicle and pedestrian phases. Furnish switches with three position “on/off/momentary on” switches.

c. Furnish a police panel in each cabinet that includes a pushbutton with 5 feet (1.5 m) cord and three switches labeled AUTO/FLASH, SIGNALS ON/OFF and AUTO/MANUAL. Wire the pushbutton cord to the controller harness wiring by a molex plug connection and not through an AC isolator. When placed in the manual position, apply “manual control enable” to the controller and apply “recall” to all phases. Ensure that activation of the push button “advances” the controller, except prohibit the manual advancement during the minimum green, yellow, and red timing intervals.

d. Furnish an aluminum shelf with integral storage compartment in the rack below the controller. Ensure that the storage compartment has telescoping drawer guides for full extension. Ensure that the compartment top has a non-slip plastic laminate attached.

e. Ensure that each cabinet has two fluorescent lights installed at the top of the cabinet, one near each door. Wire the lights to the door switches such that opening either door will turn on both lights.

## 5. Surge Protection.

a. Furnish surge protection on pedestrian and detector inputs. Furnish three terminal surrestors equivalent to EDCO models SRA-6LCA, SRA-6LCB, or SRA-6LC.

b. Protect the cabinet's incoming power lines with an EDCO SHA1250 or approved equal surge protector in lieu of the CalTrans specified surge protection. A plug-in base shall be used to hold the device. All wiring connections shall be made to the base, and appropriate cabinet clearances maintained, to allow the SPD module to be relaced by hand without the use of tools.

**6. Conflict Monitor.** Ensure that the conflict monitor unit was tested and accepted according to Supplement 1076.

**a. Materials and Warranties.** Furnish electrical parts, switches, and other elements of the installation that are of ample capacity to carry the required current without excessive heating or drop of potential.

Use standard industrial quality components (integrated circuit chips, transistors, diodes, resistors, capacitors, etc.) wherever possible. Clearly identify these components with the original identification. Designate the other vital information such as voltage polarity, emitter or collector terminals, pin locations, etc., by an approved industrial procedure. Ensure that the major items or assemblies of equipment bear a nameplate, indelible marking, or brand that identifies it as to type, model, catalog number, and manufacturer.

Transfer that manufacturers' guarantees or warranties to the Department upon delivery and acceptance of the equipment. Ensure that all conflict monitors are warranted for a period of 24 months or for the manufacturer's standard warranty period, whichever is greater, for parts and labor from date of shipment to the project or the ODOT Signal Shop. Ensure that each unit has a permanent label or stamp indicating the date of shipment.

## b. General Requirements.

**(1) Minimum Standards.** This specification establishes minimum standards for Conflict Monitoring Devices designed for use in Model 332 and 336 Traffic Signal Controller Cabinets supplied to the Department.

**(2) Indicator Lights.** Furnish indicator lights that are water-clear (not colored or diffused lenses), ultra- bright light emitting diodes (LED), whose states are clearly readable in direct sunlight. Ensure that each conflict monitor channel provides separate red, yellow, and green LEDs.

(a) Furnish a GREEN AC POWER indicator light.

(b) Arrange indicator lights in a vertical pattern with FAULT status lights as the upper indications and the output channel lights as the lower indications [See 733.03.C.6.c.(1) and 733.03.C.6.c.(9)]. An acceptable alternative is to provide a single fault indication and a supplemental display that clearly indicates the fault type.

(c) Ensure that a failure causes its respective indicator light to display.

**(3) Monitor Power.** Ensure that the Monitor does not use the 24VDC power supply being sensed to run any of its internal circuitry. Ensure that the watchdog, stop time, external reset, and 24VDC monitor input circuits are optically isolated from the Monitor internal power supply and are conditioned to provide proper sense circuit operation throughout the operating range.

**(4) Power Fail.** Consider a line voltage less than 85 V ac  $\pm 2$  V ac as a power failure. Ensure that a power failure does not result in resetting the Monitor. Ensure that once the Monitor is triggered by detection of a fault that it remains in that state until a Reset Command is issued. Reset is issued only by the Front Panel Control Switch or by the External Test Reset input.

**(5) Power Up.** Furnish a Monitor that is compatible with the Model 170E controller as well as the Model 2070 controller unit that requires several seconds to power-up. When power is established,  $> 103 \pm 2$  Vac, the 2010 will power up in the FAULT RELAY RECOVERY mode:

When power is established, initiate FAULT RELAY RECOVERY. For an interval of  $6.0 \pm 0.5$  seconds, the following will take place:

- (a) The Output Relay contacts remain closed, and the Stop Time output remains active.
- (b) All fault monitoring functions remain suspended.
- (c) The AC POWER indicator light flashes at a 2 hertz rate.

At the end of this time interval, the Monitor begins counting Watchdog transitions from the controller and prepares to resume normal fault monitoring.

Ensure that the resumption of normal Fault monitoring occurs when either:

- (a) The Monitor has counted 5 transitions between the True and False state from the controller Watchdog; or
- (b)  $10 \pm 0.5$  seconds has elapsed from the time of LINE RECOVERY.

If the controller Watchdog output does not become active, ensure that the Monitor goes into a Latched Fault condition.

**(6) Cabinet Signals Monitored.** Furnish a Monitor designed to monitor Green, Yellow, and Red AC circuits at the field output terminals of traffic signal cabinets. In addition, monitor the cabinet 24VDC supply, and the Model 170E/2070 controller Watchdog Timer output. These signals are processed by the Monitor circuitry, and if a failure is determined to have occurred, ensure that a relay output contact closure (FAILED state) places the cabinet and intersection into flashing operation.

**(7) Failed State Output Circuits.**

(a) Use an electro-mechanical relay to provide the FAILED STATE output circuit. Ensure that the relay contacts are normally closed (FAILED STATE). In a NON-FAILED state (relay coil energized), ensure that the contacts are open. The function of this output circuit is to initiate flash operation within the cabinet and transfer field circuits from the switch pack outputs to the flash bus during a FAILED STATE.

(b) Furnish relay contacts that are rated for a minimum of 3 amperes at 120 V ac and 100,000 operations. Ensure that the contact opening/closing time is 30 ms or less. Furnish contacts that present a minimum impedance of 50,000 ohms in the open state.

(c) Ensure that the Stop Time output is active whenever the output relay contacts are in the FAILED STATE (closed). Ensure that it is inactive whenever the output relay contacts are in the NON-FAILED (open) STATE.

**(8) Monitor Unit Reset.** Furnish a front panel momentary SPST pushbutton switch labeled “RESET” to reset the Monitor to a Non-FAILED state and restores normal monitoring operation. Position the switch on the front panel so that the switch can be operated while gripping the front panel handle.

Ensure that the External Test Reset input line resets the Monitor circuitry to a Non-FAILED state and restores normal monitoring operation. Optically isolate it from the internal circuitry. Ensure that a reset issuance by either source (Unit Reset) is triggered by only the leading edge of the input signal (this will prevent a constant reset due to either a switch failure or a constant external input). Ensure that a constant reset input is ignored within 5 seconds of issuance.

**(9) Input Impedance.** Ensure that the input impedance for all monitored AC inputs are 200 kilohms  $\pm$  100 kilohms.

**(10) Connectors.** Furnish PCB 28/56P Type Monitor and Conflict Program Card Connectors. Ensure that all edge connectors use the “bifurcated bellow” type contact or equivalent.

**(11) Door Ajar Circuit.** Connect pin 24 to pin 25 on the Monitor PCB at the edge connector and ensure that it is capable of carrying one ampere per CalTrans specifications.

**(12) Handle.** Ensure that the handle placement and design is such that no interference between the handle and a closed cabinet door exists.

**(13) Fuse Holder.** Furnish low profile fuse holders on the front panel.

**c. Functional Requirements.**

**(1) General.** The Monitor monitors the cabinet for conflicts and unsafe operation. If an unsafe condition exists, the Monitor will enter into a FAILED state. This places the cabinet into flash operation and applies STOP TIME to the controller unit. Ensure that the Monitor is designed to monitor red

circuits, yellow timing, multiple outputs, and lack of outputs on a switch selectable, per channel basis. Specific conditions for failure follow:

(a) **24VDC FAIL.** The cabinet +24 volts DC does not meet the specified thresholds.

(b) **CONFLICT.** When the green or yellow input to one or more channels is ON and they are not programmed as permissive on the Conflict Program Card.

(c) **WATCHDOG TIMER (WDT) ERROR.** When the 170E/2070 controller unit watchdog output has ceased.

(d) **CONFLICT PROGRAM CARD AJAR.** Illuminates, if the Conflict Program Card is removed or if it is not properly seated in the connector. When it is not inserted into the monitor, ensure that the warning indicator light is displayed.

(e) **MONITOR FAILURE.** A fault is detected within the operation of the 2010 Monitor itself.

(f) **MULTIPLE OUTPUTS.** Simultaneous indications of Green, Yellow, or Red field outputs on a single channel.

(g) **RED FAIL.** No active field outputs on a single channel (green/yellow/red).

(h) **YELLOW ERROR.** The absence of a minimum yellow field output during a green to red sequence. Minimum yellow shall be 2.7 seconds  $\pm$  100 ms.

(2) **Operating Range.** Furnish a Monitor Unit that is fully operational using an 85 to 135 V ac power source. Ensure that the Monitor suspends Fault monitoring below 85 V ac  $\pm$  2 V ac, closes the output relay, and de-energizes the AC POWER indicator light.

(3) **Watchdog Timing.** Furnish WATCHDOG Timing Circuitry to monitor the controller unit WATCHDOG output. Ensure that the WDT Circuitry senses state changes and the time between the last change. Ensure that an absence of change for 1.5 $\pm$ 0.1 seconds places the Monitor in a FAILED state.

(4) **Channels Monitored.** Furnish a Monitor that senses and responds to conflicts and 24 VDC failures whenever the AC line voltage is within the 85 to 135 V ac operating range of the Monitor, except during FAULT RELAY OPERATION.

(5) **Yellow Inhibit.** Furnish means to selectively inhibit the monitoring of a Yellow channel input.

(6) **Power Fail after Fault.** In the event that the Monitor senses a fault, followed by a loss of operating voltage, ensure that the initial Failure Status is retained in memory and is redisplayed after restoration of power.

(a) Once the Monitor is LATCHED in a fault condition for any reason, including the removal of the Conflict Program Card, ensure that it

REMAINS LATCHED, even through a power fail/recovery, until a RESET is issued by the front panel reset switch, or by the external test reset line.

(b) Display the status of the Green, Yellow, and Red inputs of all channels, at the time the fault was latched. Ensure that a power loss does not affect the retention of this data. An acceptable alternative is to save status of all channels in memory and only display the latched fault.

(7) **Insertion/Removal of Unit.** Ensure that it is possible to insert and remove the Monitor while the cabinet is energized without placing the cabinet into Flash operation provided that: The cabinet door remains open and the reset switch is held depressed while the unit is being inserted or removed. Any momentary disruption of field signal indications is less than 500 ms.

(8) **Microprocessor Use.** If a microprocessor is used in the Monitor design, ensure that its program is written so that:

(a) Integrity tests are performed periodically on each memory cell of each memory device, relevant to each device type.

(b) Hardware external to the microprocessor circuits is employed to constantly sense proper microprocessor operation.

(c) The Monitor reverts to a FAILED state if a fault is detected with the microprocessor or during integrity tests.

(9) **Front Panel Indicators.** Ensure that the Monitor has red/yellow/green indicators for channel inputs and indicators to provide status and failure detection information. Furnish a GREEN AC POWER indicator. Ensure that all indicators are clearly readable in direct sunlight. Arrange and label the indicators as shown below:

(a) **AC POWER.** Illuminates when the incoming AC Line Voltage exceeds  $103 \pm 2V$  ac, and FLASHES during FAULT RELAY OPERATION.

(b) **VDC FAIL.** Illuminates when the Monitor has detected a 24VDC failure.

(c) **CONFLICT.** Illuminates when a conflicting signal condition is detected.

(d) **WDT ERROR.** Illuminates when a Watchdog error is detected. Do not provide a switch or similar device to disable WDT monitoring.

(e) **PC AJAR.** Illuminates when the Conflict Program Card is removed or is not properly seated in its connector.

(f) **MON FAIL.** Illuminates to indicate an internal Monitor failure.

(g) **RED FAIL.** Illuminates when the Monitor detects that there is no active output on any of the field outputs that comprise a monitored channel. Ensure that the failed channels are displayed on the corresponding channel indicators. If for any reason red fail is not enabled, ensure that the red fail indicator light flashes at approximately 2hertz.

(h) **MULT IND.** Illuminates when the Monitor detects simultaneous outputs on more than one of the field outputs that comprise a monitored channel (green/yellow/red). Ensure that the failed channels are displayed on the corresponding channel indicators.

(i) **YELLOW.** Illuminates when the Monitor detects the absence of a minimum period of active yellow field output during a green to red sequence. Ensure that the failed channel is displayed on the corresponding channel indicator.

(j) **1, 2, 3, 48.** Furnish channel indicators that illuminate a FAILED state in conformance with 733.03.C.6.c.(6).

**(10) Monitor Board Edge Connector.** Furnish monitor board edge connectors that conform to CalTrans specifications.

**(11) Monitoring of Conflicting Voltages.** Ensure that inputs to any channel that exceed the specified conflict threshold (see Section 6) are sensed as “ON” and illuminate their respective channel indicators. Ensure that the number of active channels in no way affects the conflict threshold.

Ensure that the following voltage levels and times apply: A conflict has occurred and will cause a FAILED state only when voltages appear at the field output terminals.

$> 20 \pm 5.0 \text{ V rms}$  for a duration  $> 350 \pm 150 \text{ ms}$ .

**(12) Conflict Program Card.** Furnish conflict program cards that comply with CalTrans specifications.

**d. Fault Relay Operation.**

**(1) Line Drop Out.** Furnish a Monitor that determines that a LINE DROP OUT has occurred when:

The AC Line Voltage is:

$< 98 \pm 2 \text{ VAC}$  for  $> 400 \pm 100 \text{ ms}$ .

Within this time frame, ensure that the Monitor suspends all fault monitoring functions, closes the output relay contacts, enables Stop Time output, and the AC POWER indicator on the front panel flashes at a rate of 2 hertz  $\pm 20$  percent to indicate LINE DROP OUT status. Ensure that the Monitor remains in the FAULT RELAY mode until a LINE RECOVERY has occurred.

**(2) Line Recovery.** Ensure that the Monitor that determines that a LINE RECOVERY has occurred when:

The AC Line Voltage is:

$> 103 \pm 2 \text{ VAC}$  for  $> 400 \pm 100 \text{ ms}$ .

**(3) Fault Relay Recovery.** When LINE RECOVERY is established, initiate the FAULT RELAY RECOVERY. For an interval of  $6.0 \pm 0.5$  seconds, the following will take place:

(a) The Output Relay contacts remain closed, and the Stop Time output remains active.

- (b) All fault monitoring functions remain suspended.
- (c) The AC POWER indicator light flashes at a rate of 2

hertz ± 20 percent.

At the end of this time interval the Monitor begins counting Watchdog transitions from the controller and prepares to resume normal fault monitoring.

**(4) Resumption of Normal Monitoring.** Ensure that the resumption of normal Fault Monitoring occurs when either:

- (a) the Monitor has counted five transitions between the True and False state from the controller Watchdog; or
- (b) 10 ± 0.5 seconds has elapsed from the time of LINE RECOVERY.

If the controller Watchdog output does not become active, the Monitor shall go into a Latched Fault condition.

**e. Red Monitoring Connector.**

**(1) Connector.** Mount a connector, 3M-3428-5302, with two 3518 polarizing keys, or equivalent, on the Monitor front panel. The pin assignments of the P20 connector and terminal assembly are defined in this specification.

Ensure that it is possible to plug and unplug the Red Monitoring Connector P20 without placing the cabinet into Flash operation.

**P20 CONNECTOR PIN ASSIGNMENTS**

Pin	Function	Pin	Function
1	CHANNEL 15 RED	2	CHANNEL 16 RED
3	CHANNEL 14 RED	4	UNDEFINED
5	CHANNEL 13 RED	6	SPECIAL FUNCTION 2
7	CHANNEL 12 RED	8	SPECIAL FUNCTION 1
9	CHANNEL 10 RED	10	CHANNEL 11 RED
11	CHANNEL 9 RED	12	CHANNEL 8 RED
13	CHANNEL 7 RED	14	CHANNEL 6 RED
15	CHANNEL 5 RED	16	CHANNEL 4 RED
17	CHANNEL 3 RED	18	CHANNEL 2 RED
19	CHANNEL 1 RED	20	RED ENABLE

Ensure that keying is between pins 3/5, and 17/19. The odd numbered pins are on one side, and the even pins are on the other. Key the P20 connector and the CMU connector physically alike (to prevent the Red Monitoring cable from being inserted into the P20 180 degrees out of alignment).

**(2) Red Enable Input.** Ensure that pin 20 of the Red Monitoring Connector provides the Red Enable input to the Monitor. When the Red Monitoring Connector is disconnected, or Red Enable is not present, ensure that the Monitor checks for conflicting combinations of Greens and Yellows,

Watchdog Timer, 24VDC, Conflict Program Card Ajar, and Monitor Fail. When enabled, ensure that the extended Monitor functions become active including: Red Fail, Multiple Output, and Yellow Fail.

**(3) Special Function 1 and 2 Inputs.**

(a) PIN 8, Special Function 1: Furnish an AC input to the Monitor, which will DISABLE only the RED FAIL monitoring functions while it is active (e.g. during Railroad Preempt).

(b) PIN 6, Special Function 2: Reserved for future use.

Furnish a means to select either a PRESENCE of, or LACK of AC+ to enable these inputs.

**f. Electrical Requirements.**

**(1) Operation Range.** Furnish a Monitor that is fully operational from an 85 to 135 V ac power source.

**(2) Isolation.** Isolate the Chassis Ground and AC - from one another.

**(3) Monitored AC Inputs.** The following voltage and time thresholds apply to all monitored AC inputs.

**(a) Green and Yellow Inputs.**

Any inputs < 15.0 V rms are considered OFF.

Any inputs > 25.0 V rms are considered ON.

Both sinusoidal and half-wave inputs of the specified RMS values are to meet these thresholds.

**(b) Red, Red Enable, and Special Function Inputs.**

Any inputs < 50.0 V rms are considered OFF.

Any inputs > 70.0 V rms are considered ON.

Red inputs, both sinusoidal, and half-wave, of the specified RMS values, are to meet these thresholds.

Red enable and special function inputs are to meet these thresholds for sinusoidal waveforms only.

**(c) Timing of Conflicting Inputs or Multiple Inputs.**

Inputs ON < 200 ms are NOT considered a FAULT.

Inputs ON > 500 ms are considered a FAULT.

**(d) Timing of Red Fail.**

Lack of output < 1200 ms is NOT considered a FAULT.

Lack of output > 1500 ms is considered a FAULT.

**(4) Monitored DC Inputs.**

**(a) 24VDC Input.**

Input < 18.0 VDC is considered Low VDC input.

Input > 22.0 VDC is **NOT** considered Low VDC input.

**(b) 24VDC Timing.**

Low VDC input < 200 ms is **NOT** considered a FAULT.

Low VDC input > 500 ms is considered a FAULT.

**(c) Watchdog Monitor Input.**

Input < 4.0 VDC is considered a LOW STATE.

Input > 12.0 VDC (or OPEN) is considered a HIGH STATE.

**(d) Watchdog Error Timing.**

Lack of valid input state changes for < 1400 ms is **NOT** a FAULT.

Lack of valid input state changes for > 1600 ms is a FAULT.

**g. Communications and Software.**

(1) Install an RS232 port for laptop communications on the front panel of the Monitor.

(2) Furnish a Monitor with compatible communications software for installation on a laptop computer, capable of interfacing with the Monitor via the RS232 port on the front panel. Furnish the software on a 3 1/2-inch (85 mm) floppy disk with each Monitor. Label each disk with revision number and date.

(3) Furnish a Monitor that is capable of being programmed and set-up for intersection operation without the use of a laptop computer and communication software; consider programming the Monitor via the laptop computer a secondary method of set-up.

(4) Furnish a Monitor communications software that is capable of showing and/or programming the status of all programmable set-up parameters of the unit. Furnish a communications software that is capable of displaying the following data:

- (a) Fault type
- (b) Field status (must update status continuously)
- (c) AC line voltage (must update status continuously)
- (d) Status of Red Enable
- (e) Previous fault data
- (f) Program card matrix
- (g) Yellow disable jumpers (if applicable)
- (h) Switch settings per channel (as applicable)
- (i) Option switches
- (j) Current time
- (k) Temperature (must update status continuously)

## (l) Event logs

(5) Furnish a Monitor that is capable of storing events into memory. Typical events are fault events, AC line events, reset events, etc. When a fault event is stored into memory, the Monitor will store the fault condition (type), channel status, date, time, temperature, and line voltage. Ensure that the log history stores a minimum of 100 total events.

**h. Diode Matrix and Software.** Furnish a Monitor that loads the diode matrix programming into a non-volatile memory device. When the diode matrix is loaded into memory, the memory will regularly compare with diode card and fault condition will occur if memory does not match the diode card matrix.

Furnish 332 cabinet according to the Department's Qualified Products List (QPL).

**D. Type 334.**

**1. General.** Furnish Model 334C cabinets that meet the specifications "Traffic Signal Control Equipment Specifications" and "Transportation Electrical Equipment Specifications", California Department of Transportation. Ensure that the manufacturer of the cabinets is listed on the CalTrans QPL at the time of the project award.

**2. Cabinets.** Furnish cabinets that are constructed of aluminum and are supplied unpainted. An anodic coating is not required. Supply galvanized anchor bolts with nuts and washers with each cabinet. Furnish 3/4-inch (19 mm) diameter by 16 inches (0.4 m) minimum length anchor bolts with an "L" bend on the unthreaded end.

**3. Terminals and Wiring.** Ensure that the vehicle detector field wiring inputs connect to side mounted terminal blocks. Install terminal blocks and associated wiring to the input file. Label the field wiring terminals of the side mounted terminal block by a permanent screening process to identify the input panel (I), the input file slot number (1 through 14) and the channel terminal (D, E, J, or K). An example is "I4-E". Ensure that all terminals on these detector blocks are accessible without removing equipment from the EIA mounting rack.

**4. Accessories.**

a. Fully equip the cabinets with two channel loop detector sensors, transfer relay, power supply, conflict monitor and switchpacks. When ramp meter warning signs with flashers are used, include a NEMA or Caltrans type flasher wired for control from the controller.

b. Furnish a police panel in each cabinet with the Caltrans required switches. No pushbutton with cord is provided.

c. Furnish an aluminum shelf with integral storage compartment in the rack below the controller. Ensure that the storage compartment has telescoping drawer guides for full extension. Ensure that the compartment top has a non-slip plastic laminate attached.

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d. Ensure that each cabinet has two fluorescent lights installed at the top of the cabinet, one near each door. Wire the lights to the door switches such that opening either door will turn on both lights.

**5. Lightning/Surge Protection.** Comply with the requirements of 733.03.C.5.

**6. Conflict Monitor.** Furnish a Model 208 conflict monitor unit.

Furnish 334 cabinet according to the Department's Qualified Products List (QPL).

### E. Type 336.

**1. General.** Furnish Model 336 cabinets that meet the basic cabinet specifications "Traffic Signal Control Equipment Specifications", California Department of Transportation, latest edition. Ensure that the manufacturer of these Model 336 cabinets is listed on the CalTrans QPL for the Model 332A cabinets at the time of the project award.

#### 2. Cabinets.

a. Furnish cabinets that are constructed of aluminum and are supplied unpainted. An anodic coating is not required.

b. The CalTrans Model 336 cabinet specification is only modified so that the cabinet supplied is the "stretch" type that provides approximately 10 inches of (250 mm) additional cabinet height.

c. Supply galvanized anchor bolts with nuts and washers with each base mounted cabinet. Furnish 3/4-inch (19 mm) diameter by 16 inches (0.4 m) minimum length anchor bolts with an "L" bend on the unthreaded end.

d. Furnish pole mounted cabinets with two pole mounting brackets attached and bottom plates installed. Ensure that both of the cabinet sidewalls are reinforced for pole brackets; however, also ensure that the cabinet is shipped with the brackets installed on the door hinge side of the cabinet. When a pole mounted cabinet is ordered, ensure that the door hinges are specified as "right" or "left" mounted as looking into the front of the cabinet. Ensure that the brackets are designed for banding to a pole.

e. Fit cabinets with a PDA-2 power distribution assembly.

**3. Terminals and Wiring.** Comply with the requirements of 733.03.C.3.

**4. Accessories.** Comply with the requirements of 733.03.C.4.

**5. Lightning/Surge Protection.** Comply with the requirements of 733.03.C.5.

**6. Conflict Monitor.** Comply with the requirements of 733.03.C.6.

Furnish 336 cabinet materials according to the Department's Qualified Products List (QPL).

**733.04 Cabinet Risers.** Furnish the type (size and shape) of cabinet riser that is compatible with the type of controller cabinets specified for the project.

**A. Cabinet Riser for NEMA Cabinet.** Furnish an aluminum riser that will raise the NEMA cabinet approximately 12 inches (0.3 m) above the concrete foundation. Ensure that the bottom of the riser bolts to the standard cabinet foundation anchor bolts (not included with the riser) and the top of the riser bolts to the bottom of the cabinet. Furnish attachment hardware for connecting the riser to the cabinet.

Construct the riser in a minimum of two pieces such that an existing cabinet can be raised off the foundation without disconnecting the field wiring and the riser can be inserted below the cabinet. Furnish hardware for rigidly connecting the riser sections together.

Fabricate the riser from 0.125-inch (3 mm) sheet aluminum with flanges on the top and bottom to provide rigidity. Furnish mounting flanges as necessary to connect with the controller cabinet and foundation anchor bolts. Ensure that the outside surface of the riser has a smooth, uniform, natural finish unless controller cabinet painting is shown on the plans. If painting is required, prepare and paint the riser to match the cabinet.

**B. Cabinet Riser for Type 332, 334 or Type 336 Cabinet.** Furnish an aluminum riser that will raise the Model 332, 334 or 336 cabinet approximately 8 inches (0.2 m) above the concrete foundation. Ensure that the bottom of the riser bolts to the standard cabinet foundation anchor bolts (not included with the riser) and the top of the riser bolts to the bottom of the cabinet. Furnish attachment hardware for connecting the riser to the cabinet. Manufacture the unit to CalTrans specifications. Ensure that the outside surface of the riser has a smooth, uniform, natural finish unless controller cabinet painting is shown on the plans. If painting is required, prepare and paint the riser to match the cabinet.

Furnish materials according to the Department's Qualified Products List (QPL).

**733.05 Flasher Controller.** Furnish solid-state flasher that complies with NEMA TS-1, Section 8, and have two circuits, each rated at 10 amperes. Furnish a cabinet that conforms to applicable requirements of 733.03.A, except that the following items are not required: a small door-in-door (police door), shelves, and a fan. Ensure that the cabinet size is not less than 12 inches (300 mm) high by 10 inches (250 mm) wide by 6 inches (150 mm) deep. Furnish cabinets that are designed for pole mounting with a 1-1/2 inch (38 mm) or larger conduit opening in the bottom. Ensure that the auxiliary equipment includes: on-off power switch with integral 20-ampere circuit breaker, lightning protection devices on incoming power lines, interference filters, terminal blocks, and a ground bus bar.

Furnish materials according to the Department's Qualified Products List (QPL).

### **733.06 Controller, Master, Traffic Responsive.**

**A. Description.** The traffic responsive master controller is one component of a distributive processing, traffic responsive, control, and monitoring "closed loop" system. The master controller's principal operational task is to select and implement traffic signal timing plans in response to both actual traffic conditions or time based events. The master controller monitors, in real time, local intersection activity, and overall system performance, reporting failures and status conditions to the Remote Monitoring Station.

The master controller is typically located in a local intersection cabinet; however, in special circumstances it may be located at a Remote Monitoring Station site. The master controller is capable of uploading/downloading information to local intersection controllers and the Remote Monitoring Station.

## **B. Functional Requirements.**

**1. Design.** Furnish a solid state, digital microprocessor master controller design. Furnish a controller that uses menu driven prompts, unless of Type 170 design. If the master controller is used with Type 170E or Type 2070 controllers, provide software unless otherwise shown on the plans.

Furnish a master controller that has a RS-232 port for connection to a laptop computer or printer. Furnish software and connector cables for communication with a laptop.

**2. Local Controllers.** Ensure that each master controller is able to supervise and communicate with at least 24 local intersection controllers.

**3. System Detectors.** Ensure that each master controller is able to analyze traffic sensor data from at least 32 system detectors. Distribute system detectors up to eight per intersection, but do not exceed the total system sensor capacity.

Ensure that the detectors are assignable to each of the computational channels in each group, with the channels representing cycle selection, directionality (offset), non-arterial flow (split), and special congestion indicators of queue or occupancy.

Furnish a master controller that is capable of monitoring and detecting system detector failure and removing failed detectors from volume and occupancy calculations. Upon resumption of satisfactory sensor operation, sensors shall automatically resume input to volume and occupancy calculations.

**4. Timing Patterns.** Ensure that each master controller provides a minimum of 16 selectable patterns. Ensure that each pattern shall consist of a combination of cycle, offset, and split numbers for each intersection in the system.

Furnish a master controller that is capable of implementing a “free” mode whereby all intersection controllers will operate without system coordination and a “flash” mode whereby all intersection controllers will operate in a flashing operation.

**5. Operational Modes.** Ensure that each master controller is able to operate in the following modes of operational control:

a. Traffic responsive mode whereby pattern selection is based on dynamic traffic conditions as measured by system sensors located in the control area. As a minimum, base the pattern selection on the quantitative traffic flow parameters of volume, occupancy, and directionality of the arterial traffic.

Base transfer of patterns on programmable threshold values. Furnish system sensors that are capable of selective weighting.

b. Time of day/day of week (time base) mode whereby pattern selection is based on a preprogrammed event scheduler with automatic adjustments for seasonal daylight savings time changes. Ensure that this mode of operation is able to call or override traffic responsive mode.

c. Manual override mode whereby pattern selection is made by operator control at the Remote Monitoring Station or master controller site.

Ensure that the system coordination control for each master controller is selected on a priority basis. The priority from highest to lowest is as follows:

- a. Manual control entry or remote command
- b. Time base control
- c. Traffic responsive control

**6. Reports.** Ensure that each master controller monitors and formats intersection and system information for immediate output to the Remote Monitoring Station or for storage for a minimum period of 48 hours. As a minimum, ensure that the following types of reports are generated:

- a. A local intersection activity log showing the time, date and activity of all monitored local intersection failure conditions.
- b. A system sensor failure log that includes time, sensor location, and type of failure.
- c. A system log with pattern changes.
- d. A system sensor data log that includes volume and occupancy for all system sensors.

**7. Alarms.** Ensure that each master controller continuously monitors intersection and system information for various systems and user defined critical conditions. Upon detection of an alarm condition, ensure that the master controller attempts to transmit alarm information to the Remote Monitoring Station or a preprogrammed telephone number. In case of failure to connect to the central software, the master will continue to periodically retry reporting to the Remote Monitoring Station.

**8. Communications.** Furnish a master controller that supports two-way dial-up communications to a Remote Monitoring Station computer for control, monitoring, data collection, and for timing pattern updating purposes. Through continuous, 7 days/week, 24 hours/day system monitoring, ensure that the master controller is able to automatically dial-up the Remote Monitoring Station computer upon detection of user defined critical alarm conditions.

Furnish a master controller that includes any communication devices or modems necessary to interface with the local intersection controllers within its control area.

**9. Security.** Furnish a master controller that provides for a user specified security code before any data is altered. In order to view any parameter, ensure that a security code entry is not required. Furnish a master controller that has the

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ability to disable security code requirements, allowing for perpetual access without requiring hardware changes.

### **733.07 Remote Monitoring Station.**

**A. Description.** The Remote Monitoring Station describes a distributive processing, traffic responsive, control and monitoring “closed loop” system. The system monitors, in real time, local intersection activities, and overall system performance, reporting failures and status conditions both automatically and by operator request. In order to meet current and future traffic control needs, the system also provides extensive control monitoring, data collection, reporting, and analysis functions.

For complete user flexibility, the system provides full access of each local system intersection controller from the Remote Monitoring Station site. Full access includes the capability to upload all time settings, operation parameters, and status information, as well as the capability to download all time settings and operation parameters.

**B. System Architecture.** The system consists of four principal elements:

1. Local intersection controller (see 733.02)
2. Communication links
3. Traffic responsive master controller (see 733.06)
4. A Remote Monitoring Station consisting of computer equipment and software

**C. Local Intersection Controllers.** Furnish controller units conforming to 733.02 for the type of controller shown on the plans. Furnish a controller that has internal communication capability compatible with the type of interconnect cable shown on the plans. Furnish a local system controller that is capable of processing controller and detector data and provide all necessary intersection control functions.

**D. Communications.** Ensure that communication between the Remote Monitoring Station and the master controller is through an auto-answer/auto-dial external modem on standard dial-up telephone service. Furnish telephone service at the Remote Monitoring Station site by the maintaining agency, unless otherwise shown on the plans. Furnish telephone service at the master controller or the isolated local intersection location by separate bid item as specified for “Telephone Service”.

Include error checking in the software to assure transmission and reception of valid data between the local controller, master controller, and the Remote Monitoring Station.

**E. Equipment.** Ensure that the Equipment provided at each Remote Monitoring Station location is as shown on the plans and, as a minimum, consists of the following items:

1. Microcomputer with monitor
2. Software

3. Modem
4. Printer
5. Accessory Items

**F. System Functional Requirements.** The system software provides a simplified user friendly, color menu format at the Remote Monitoring Station. Ensure that no special computer programming skills are required for the user to fully access and operate this control and monitoring system.

**1. Graphical Representation.** Furnish system software that enables the operator to display in color, the vehicular signals, pedestrian signals, and detector actuations in a real time mode. Ensure that the user is able to construct an intersection layout graphically by using predetermined intersection shapes.

**2. System Capacity.** Furnish a Remote Monitoring Station software that has the capacity to monitor and control at least 24 traffic responsive masters. Ensure that the central software is also capable of monitoring and controlling isolated system controllers.

Furnish a system software that has the capability to manually select any timing plan, free mode or flash mode.

Ensure that the system software has the capability of accepting, formatting, and processing data from at least 32 system detectors from each master controller.

**3. Data Transfer.** Ensure that it is possible to upload/download the signal timing database, including coordination, and preemption settings, between the Remote Monitoring Station and the master controller or local intersection.

Furnish a Remote Monitoring Station that provides a means to compare a currently uploaded timing database with a previously developed database stored in the Remote Monitoring Station memory. Ensure that it reports differences in the databases.

During either uploading or downloading operations, ensure that the normal traffic control operations are not suspended.

**4. Security.** Furnish a Remote Monitoring Station that provides for a user specified security code before any data is altered. Maintain controller access procedures from the Remote Monitoring Station allowing the user full security control of all system components from a remote location.

**5. Isolated Intersection Management.** Furnish a Remote Monitoring Station software that includes the capability of accessing system controllers at remote intersection locations. Ensure that this capability includes total access to controller timing parameters, alarm conditions, detector data, and intersection status conditions in real time without the use of a master controller. Ensure that this feature utilizes the local intersection controller with a dial-up modem and telephone service.

**733.08 Telephone Service.** Ensure that the telephone service is a standard dial-up service capable of supporting 2400 baud data transmission. Ensure that the

external modem provided is a Hayes compatible, auto-answer/auto-dial unit with all connections, cables, and lightning protection on the incoming wires provided.

### 733.09 Uninterruptible Power Supply(UPS).

**A. Operation.** Furnish a UPS with a minimum two and one half (2.5) hours of full run-time operation for an “LED-only” intersection with 1000 watts of active output power.

Furnish a UPS compatible with all of the following traffic signal equipment; NEMA TS-1 and TS-2 controllers and cabinets, Model 332 & 336 cabinets, Type 170 & 2070 controllers and electrical service pedestals.

The maximum transfer time allowed, from disruption of normal utility line voltage to stabilized inverter line voltage from batteries, shall be 65 milliseconds or less. The same maximum allowable transfer time shall also apply when switching from inverter line voltage to utility line voltage.

Include a means to switch the intersection from full-operation to flashing operation after 2-hours of run-time. This is to conserve battery operation during an extended utility power outage.

Include standard form C relay contacts to trigger an alarm within the controller assembly, informing a technician the system is operating on battery backup.

Operating temperature for both the inverter/charger, power transfer relay and manual bypass switch shall be -35 °F to +165 °F (-37 °C to +74 °C).

Both the power transfer relay and manual bypass switch shall be rated at 240VAC/30 amps, minimum.

The UPS shall bypass the utility line power whenever the utility line voltage is outside the following voltage range: 100VAC to 130 VAC, + 2 VAC.

When utilizing battery power, the UPS output voltage shall be between 110 VAC and 125 VAC, pure sine wave output, 60Hz ± 3Hz.

When the utility line power has been restored between 100 VAC and 130 VAC for more than 30 seconds, the UPS shall dropout of battery backup mode and return to utility line mode.

In the event of inverter/charger failure, battery failure or complete battery discharge, the power transfer relay shall revert to the NC (and energized) state, where utility line power is connected to the cabinet.

Recharge time for the battery, from “protective low-cutoff” to 80% or more of full battery charge capacity, shall not exceed 10 hours.

Include all necessary wiring and hardware for mounting (shelf angles, rack, etc).

**B. Maintenance,** Displays, Controls and Diagnostics. Furnish a UPS with a backlit LCD display that includes an event counter, hour meter, line and battery voltages/percentages and fault status. The LCD display shall have touch keys for changing display statuses and to reset counters, hour meter date and time.

Furnish a UPS with lightning surge protection compliant with IEEE/ANSI C.62.41, that has remote access via a RS-232 serial interface for laptop communication through Windows system software or hyperterminal to monitor and make setting changes, and that has status, alarm and event logging that is time and date stamped for up to 50 events. The logs shall be printable.

Furnish two (2) sets of equipment lists, operation and maintenance manuals, and board-level schematic and wiring diagrams of the UPS, and the battery data sheets. Manual shall conform to TEES 1999, Chapter 1 Section 1.2.4.2.

C. Battery System. Supply a minimum of four (4) batteries with the UPS system. Each battery shall be 12VDC and be rated at 105 Ahrs to achieve the 2.5 hour run time requirement. Furnish batteries easily replaced and commercially available off the shelf.

Furnish deep cycle, sealed prismatic lead-calcium based AGM/VRLA (Absorbed Glass Mat/ Valve Regulated Lead Acid) batteries.

Furnish batteries certified by the manufacturer to operate over a temperature range of -13 °F to +165 °F (- 25 °C to +74 °C).

Place all batteries on battery heater mats in the enclosure. The battery heater mats are designed to extend the life of the batteries.

An integral system shall prevent the battery from destructive discharge and overcharge. Batteries shall not be recharged when battery temperature exceeds 122°F+5°F(50°C±3°C).

**D. Enclosure.** Furnish an enclosure mountable to a standard Model 332, NEMA TS-1 or TS-2 traffic signal cabinet and be constructed of natural unpainted aluminum. Furnish cabinet size adequate to house "all" the UPS equipment including the controller unit, manual bypass switch and the (4) batteries. Key the enclosure to the State master #2 lock and include 2 keys.

Furnish a base seal for use between the enclosure to the concrete foundation or riser of continuous tape gasket material, minimum 1/8-inch (3 mm) thickness. Completely seal the interface to the adjacent controller cabinet with silicone caulk. Furnish an enclosure with a vent, fan and thermostat as per TEES Chapter 7, Section 2-Housings.

E. Warranty. Provide a two (2) year factory-repair warranty for parts and labor on the UPS from date of acceptance by the State. Warrant batteries for full replacement for two (2) years from date of purchase.

Furnish materials according to the Department's Qualified Products List (QPL).

## 740 PAVEMENT MARKING MATERIAL

**740.01 General.** Permanent pavement marking materials that meet the requirements of this specification and that have passed the service test required by Supplement 1047 are included on the Approved List maintained by the Office of Materials Management (OMM). OMM may retest pavement marking materials pre-qualified by a service test to determine formulation compliance to pre-qualified material and compliance with physical properties specified herein. Certified test data and samples will be furnished by the manufacturer to OMM. Failure of testing or certified test data to show formulation conforming to pre-qualified material or compliance with specified physical properties may be cause for removal of the material from the Approved List.

Ensure that the marking material is delivered in containers that are clearly marked to indicate the number of gallons (liters), weight or size of material, material density (weight per unit volume), material color, batch number or other

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similar manufacturer’s identification, date of production, and the company name and address.

**740.02 Traffic Paint.** Furnish white and yellow ready-mixed traffic paint suitable for marking various types of pavement. Prequalify materials according to Supplement 1047. Use materials certified according to Supplement 1089. Furnish paint that is a suitable binder for glass beads, 740.09 Type A, on pavement exposed to traffic. Furnish paint that will not deteriorate in storage, within one year after date of receipt, to the extent that it cannot be readily broken up with a paddle to a smooth uniform paint capable of easy application by spray.

Furnish paint that does not bleed or discolor when sprayed on asphalt concrete surfaces.

Type 1 paint is the fast dry, water-based, 100 percent acrylic type.

Type 1A paint is fast dry, water-based, 100 percent acrylic type, used for cold weather applications.

Ensure that Type 1A paint conforms to the following requirements:

Property	Test Method	Requirements (Applies to both White and Yellow, unless noted))
Total Solids	ASTM D2369	70% minimum by weight
		58% minimum by volume
Titanium Dioxide, rutile type II	ASTM D1394	1 lb/gal (120 g/l) minimum, White 0.2 lb/gal (24 g/l) minimum, Yellow
Pigment % by Weight	ASTM D3723	+/- 2% of qualifying sample
Weight per Gallon	ASTM D1475	+/- 0.3 lb/gal (36 g/L) of qualifying sample
Color	SS 1047	Appendix A
Viscosity (krebs units)	ASTM D562	70 minimum and 95 maximum @ 77°F (25°C)
Lab Drying Time	ASTM D711	10 minutes max. @ 77°F (25°C), 50% RH
		12 minutes max. @ 50°F (10°C), 50% RH
		14 minutes max. @ 35°F (1.7°C), 50% RH

Prequalify materials according to Supplement 1047. Use materials certified according to Supplement 1089.

**740.03 Polyester Pavement Marking.** Ensure that the polyester pavement marking material supplied is a two part polyester system capable of being applied at ambient temperature down to 50 °F (10 °C). Ensure that the material is capable of retaining reflective glass beads, 740.09 Type B, after application.

Ensure that the catalytic component of the system is the commercially available type recommended by the manufacturer of the polyester.

Ensure that the ratio of the catalyst to resin is specified by the manufacturer.

Ensure that the polyester conforms to the following requirements:

		Minimum	Maximum
1.	Consistency, Krebs units ASTM D 562, Procedure A:	70	90
2.	Field Dry Time (No Track), minutes:	--	45
Furnish pavement marking material that will be in "no tracking condition" in 45 minutes. The "no tracking condition" will be determined by applying the markings and beads at the specification requirements to dry pavements at a low temperature of 50 (10 C) and high temperature of 120 F (49 C). Run tests at the manufacturer's highest and lowest recommended application humidity. The marking materials will be applied at the manufacturer's recommended application temperature. The "no tracking" time will be determined by passing over the line with a passenger car at a speed of 25 to 35 mph (44 to 55 kmph) in a simulated passing maneuver. A line showing no visual deposition of the material to the pavement surface when viewed at a distance of 50 ft (15 m) will be considered as showing "no tracking" and conforming to this requirement for time to "no track".			
3.	Prime Pigment Content, percent by weight of paint:		
	White ASTM D 1394	13.9	--
	Yellow ASTM D 126 or Department approved lab method	13.8	--
4.	Pigment Content, percent by weight of paint ASTM D 2698:		
	white	--	40
	yellow	--	41
5.	Nonvolatile Vehicle Solids Content, percent by weight of paint FED STD 141C, Method 4053.1:		
	White	31	--
	Yellow	29	--
6.	Fineness of Dispersion, ASTM D 1210 micrometers,	50	--
7.	Bleeding Ratio, Fed. Std. TT-P-115F, Section 4.3.2:		
	white	0.93	--
	yellow	0.92	--
8.	Color:		
	a. White, Daylight Directional Reflectance, ASTM E 1347:	85	--
	b. Yellow	50	--
	1. Refer to Highway Yellow Color Tolerance Chart PR Color No. 1, June, 1965 U.S. Dept. of Transportation, FHWA: Yellow, Color Difference 595-33538, ASTM D 2244		
	i. Measure E, L, a, b as Cielab, Source "C"		
	L	+0.75	+1.0
	a	+0.9	+1.7
	b	+4.4	+5.1
9.	Dry Opacity, ASTM D 2805 at 0.005 wet: Fed Std 141 No 4121 Process B, Method A, white and yellow	0.97	--
10.	Condition in container Fed Std 141 No 3011.2, hand stirring by spatula, minutes		5

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Prequalify materials according to Supplement 1047. Use materials certified according to Supplement 1089.

**740.04 Thermoplastic Pavement Marking.** Furnish thermoplastic pavement marking material formulated expressly for use as retroreflective pavement markings on asphalt concrete or portland cement concrete pavement. Furnish material that includes a mixture of resins, at least one of which is solid at room temperature, and contains premixed glass beads, 740.09, with a 1.50 minimum index of refraction. Ensure that the ingredients are well mixed so that all parts are evenly dispersed throughout. Ensure that there are no foreign objects, skins, dirt, or such ingredients that would cause staining, discoloration, or bleeding. Furnish suitable materials for application in molten form by extrusion method. Ensure that the material is capable of retaining reflective glass beads, 740.09 Type C, after application.

**A. Specific Gravity.** Ensure that the thermoplastic compound has a specific gravity of 1.6 to 2.3 at 77 °F (25 °C) ASTM D 792.

**B. Flowability.** Meet percent residue requirements according to

1. AASHTO M 249, Section 4.3.6 and
2. AASHTO M 249, Section 4.3.8

**C. Drying Time.** AASHTO M249, section 4.3.2.

**D. Field Placement Stability.** After proper application and drying time, ensure that the material is not tacky and does not have an appreciable deformation or discoloration when subjected to typical vehicular traffic, and in air or road temperatures between -30 and 140 °F (-34 and 60 °C). Ensure that when the material is properly applied that it forms markings of a constant cross-section with a uniform density and character. Ensure that the markings maintain their original shape and pavement position.

**E. Ring and ball Softening Point.** Furnish a material that has a softening point of not less than 190 °F (88 °C) when tested according to ASTM E 28.

**F. Impact Resistance.** AASHTO M 249, section 4.3.4

**G. Pigment Content.** Furnish yellow material containing a minimum of 5 percent by weight of primary yellow (lead chromate) pigment (measured as per ASTM D 126 or Department approved lab method). Furnish white material containing a minimum of 10 percent by weight of white pigment ASTM D 1394.

**H. Color.**

	<b>Minimum</b>	<b>Maximum</b>
a. White, Daylight Directional Reflectance, ASTM E 1347	75	--
b. Yellow 1. Refer to Highway Yellow Color Tolerance Chart PR Color No. 1, June, 1965 U.S. Dept. of transportation, FHWA: Yellow, Color Difference 595-13538, ASTM D 2244	50	--
Measure E, L, a, b as Cielab, Source "C"		
L	+0.75	+1.0
a	+0.9	+1.7
b	+4.4	+5.1

**I. Yellowness Index, AASHTO M 249, section 4.3.7**

Prequalify materials according to Supplement 1047. Use materials certified according to Supplement 1089.

**740.05 Preformed Pavement Marking.** Furnish the preformed material suitable for retroreflective pavement markings on asphalt concrete or portland cement concrete pavement. Furnish material that is free of cracks and that has edges that are straight, true, and unbroken. Ensure that the material is flexible, formable, and suitable for application with an adhesive without heating. Furnish material containing glass beads uniformly distributed throughout with a 1.50 minimum index of refraction. Ensure that the material has a uniform surface layer of firmly bonded glass beads to provide the initial minimum specific luminance values specified for the various types of material.

Furnish material that resists deterioration by contact with highway deicing chemicals or because of the oil content of asphalt concrete pavement, or from oil droppings and other effects of traffic.

**A. Type A1 Material.** Furnish Type A1 material conforming to ASTM D 4505, Level 1, Classes 2 or 3, and that have a thickness of not less than 0.090 inch (2.28 mm), including any pre-coated adhesive layer.

**B. Type A2 Material.** Furnish Type A2 material conforming to ASTM D 4505, Level 1, Classes 2 or 3, , and that have a thickness of not less than 0.060 inch (1.52 mm), including any pre-coated adhesive layer.

**C. Type A3 Material.** Furnish Type A3 material conforming to ASTM D 4505, Level 1, Classes 2 or 3, skid resistance level A, and that have a minimum thickness at the thinnest portion of the cross-section of not less than 0.020 inch (0.50 mm), including any pre-coated adhesive layer.

Prequalify materials according to Supplement 1047. Use materials certified according to Supplement 1089.

**740.06 Work Zone Pavement Marking.** Furnish work zone pavement marking material conforming to ASTM D 4592, Type I (removable) or Type II (non-removable) with the following modifications:

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- A. Type I (removable): 0.030-inch (0.76 mm) minimum thickness.
- B. Type II (non-removable): 0.015-inch (0.38 mm) minimum thickness.

Provide materials conforming to this specification. Receive approval from the Engineer.

**740.07 Epoxy Pavement Marking Material.** Ensure that the material supplied is a 100% solids two-part epoxy system capable of being applied at ambient temperature down to 50 °F (10 °C). Furnish a slow cure material capable of retaining reflective glass beads 740.09 type D, after application.

Furnish epoxy conforming to the following requirements:

- A. Formulation.** Furnish epoxy formulated as a Long Life Pavement Marking System, capable of providing a minimum of 4 years of performance, free of any peroxides and any Tri-methylpropane Tri-acrylate) TMPTA and other multi-functional monomers. Ensure that the epoxy is designed to provide simple volumetric mixing ratio of its components (such as 2:1).
- B. Epoxide Number.** Ensure that the epoxide number of the epoxy resin is the manufacturer's target value  $\pm 0.05$  as determined by ASTM D 1652 for both white and yellow Part A on a pigment free basis.
- C. Amine Number.** Ensure that the amine number of the curing agent (Part B) is the manufacturer's target value  $\pm 50$  as per ASTM D 2074 on a pigment free basis.
- D. Laboratory Drying Time.** Ensure that the pavement marking material, when mixed in the proper ratio and applied at the properly prescribed wet film thickness at  $75 \pm 2$  °F ( $24 \pm 0.5$  °C) and with the proper saturation of glass beads, exhibit a no tracking time of no greater than 40 to 45 minutes when tested according to ASTM D 711.
- E. Field Time to No-Track.** Furnish pavement marking material that will be in "no tracking condition" between 15 to 45 minutes. The "no tracking condition" will be determined by applying the markings and beads at the specification requirements to dry pavements at a low temperature of 45°F(7°C) and high temperature of 120°F (49°C). Run tests at the manufacturer's highest and lowest recommended application humidity. The marking materials will be applied at the manufacturer's recommended application temperature. The "no tracking" time will be determined by passing over the line with a passenger car at a speed of 25 to 35 mph (44 to 55 kmph) in a simulated passing maneuver. A line showing no visual deposition of the material to the pavement surface when viewed at a distance of 50 ft (15 m) will be considered as showing "no tracking" and conforming to this requirement for time to "no track". Protect the line from tracking during the setting period by coning off or as shown on the plans.
- F. Field Curing.** Furnish epoxy pavement marking material capable of fully curing at a constant surface temperature of 45 °F (7 °C) or above.
- G. Hardness.** Furnish epoxy pavement marking materials, when tested according to ASTM D 2240, that have a Shore D Hardness of between 70 and 90.

Allow samples to cure at room temperature  $75 \pm 2$  °F ( $24 \pm 0.5$  °C) for a minimum of 24 hours and a maximum of 72 hours before performing the indicated test.

**H. Certified test data.** Provide a material manufacturer's certified test data showing the material complies with the provisions of this specification. The provisions of a certification of compliance do not waive a state inspection, sampling, or testing.

**I. Infrared Spectra.** Supply a copy of the infrared spectra of each component on each lot number

**J. Material Performance Qualifications.** Ensure that the manufacturer has expertise and performance history including: completed and passed service tests according to Supplement 1047. ; verifiable installations; ample production capacity; proper facility; compliance with EPA regulations; verifiable quality control program; and has passed a minimum of 4 years of performance (durability and retroreflectivity) on concrete or asphalt surface in the State.

**K. Condition in Container.** Fed Std 141 No. 3011.2 Hand stirring by spatula. 5 minutes maximum

Prequalify materials according to Supplement 1047. Use materials certified according to Supplement 1089.

**740.08 Heat-Fused Preformed Plastic Pavement Marking Material.** Furnish heat-fused preformed plastic pavement marking materials pre-qualified according to Supplement 1047, and conforming to the following Type A, Pre-heated Pavement tape and Type B, Post-heated tape:

Type A90 and B90 - 90 mil thickness (2.29 mm)

Type A125 - 125 mil thickness (3.18 mm)

Type B125 - 125 mil thickness (3.18 mm)

Glass beads.....740.09

The Department will field service test the pavement marking material and glass beads as a system. The Department will consider those systems performing satisfactorily for addition to the approved List. The Department reserves the right to perform random performance check sampling of materials.

Use materials certified according to Supplement 1089.

**740.09 Glass Beads.**

**A. Type A.** Furnish Type A glass beads for traffic paint conforming to Supplement 1008 and to AASHTO M 247, Type 1 without flotation properties but dual coated (for moisture resistance and adhesion), with the following exception: 4.6 Flotation Test.

Ensure that the glass beads for traffic paint are packaged in bags designated "740.02". Use materials certified according to Supplement 1089.

**B. Type B.** Furnish Type B glass beads for polyester marking material conforming to AASHTO M 247, Type 1 with  $50 \pm 5$  percent flotation coating and ensure that a  $50 \pm 5$  percent moisture resistant coating is retained on each sieve,

**740.09**

with the following exception: 4.6 Flotation Test. Ensure that the minimum percent floating equals 90 of flotation coated beads or 40.5 percent of total mixture.

Ensure that the glass beads for polyester marking material are packaged in bags designated “POLY”.

Use materials certified according to Supplement 1089.

**C. Type C.** Furnish Type C glass beads for thermoplastic material. Ensure that glass beads dropped on thermoplastic pavement marking material meet the following specification:

Sieve Size	Percent Retained
No. 16 (1.18 mm)	3 max
No. 20 (850 μm)	5 to 20
No. 40 (425 μm)	65 to 95
No. 50 (300 μm)	0 to 5
Refractive Index	1.50 to 1.60
Roundness	80 min
Coating	Moisture Resistant

Ensure the glass bead packaging is clearly marked “THERMO”

Use materials certified according to Supplement 1089.

**D. Type D.** Glass beads for Epoxy Pavement Marking.

Ensure that the glass bead packaging clearly indicates EPOXY - SIZE I or EPOXY SIZE II.

Ensure that the glass beads have the following gradation when tested according to Supplement 1089.

SIZE I		SIZE II	
Sieve Size	Percent Retained	Sieve Size	Percent Retained
No. 10 (2.00 mm)	0	No. 20 (850 μm)	0 to 5
No. 12 (1.70 mm)	0 to 5	No. 30 (600 μm)	5 to 20
No. 14 (1.40 mm)	5 to 20	No. 50 (300 μm)	30 to 75
No. 16 (1.18 mm)	40 to 80	No. 80 (180 μm)	9 to 32
No. 18 (1.00 mm)	10 to 40	No. 100 (150 μm)	0 to 5
No. 20 (850 μm)	0 to 5	pan	0 to 2
Pan	0 to 2		

**Reflective Media:** Ensure that the glass beads are smooth, clear, free from any air inclusions, and scratches that might affect their functions as a retro-reflective media, and that have the characteristics listed below.

**Roundness (Percent by Weight):** Ensure that not more than 20 percent of the glass beads are irregular or fused spheroids and that at least 80 percent of the beads are true beads.

**Index of Refraction:** Ensure that the refractive index of the beads is a minimum of 1.50 as determined by the liquid immersion method at 77 °F (25 °C). Ensure that the silica content of glass beads is not less than 60 percent.

**Coating:** Furnish Size I glass beads that are coated with a silane-type adherence coating to enhance its embedment in, and adherence to the applied binder film. Ensure that the coated beads emit a yellow-green fluorescence when tested by the Dansyl Chloride test procedure. Furnish Size II glass beads that are treated with a moisture-proof coating. Ensure that both types of glass beads show no tendency to absorb moisture in storage and remain free of clusters and lumps. Ensure that they flow freely from the dispensing equipment at any time when surface and atmosphere conditions are satisfactory for marking operations.

Determine the moisture-resistance of the glass beads on the basis of the following test:

Place 2.2 pounds (1 kg) of beads in a washed cotton bag, having a thread count of 50 per square inch (8/cm<sup>2</sup>) (warp and woof) and immerse the bag in a container of water for 30 seconds. Remove the bag and force the excess water from the sample by squeezing the bag. Suspend and allow them to drain for two hours at room temperature 70 to 72 °F (21 to 22 °C). After draining, mix the sample in the bag by shaking thoroughly. Transfer a sample slowly to a clean, dry glass funnel having a stem 4 inches (100 mm) in length, with a 3/8-inch (10 mm) inside diameter stem entrance opening, and a minimum exit opening of 1/4 inches (6 mm). Ensure that the entire sample flows freely through the funnel without stoppage. When first introduced to the funnel, if the beads clog, it is permissible to tap the funnel to initiate flow.

Use materials certified according to Supplement 1089.

## **748 WATER MAIN AND SERVICE BRANCH MATERIAL**

**748.00 Acceptance.** Follow the requirements listed in each 748 section.

**748.01 Ductile Iron Pipe, Joints, and Fittings.** Furnish ductile iron pipe conforming to ANSI/AWWA C151/A21.51 and to ANSI/AWWA C150/A21.50 for thickness design. Furnish pipe with a cement mortar lining conforming to ANSI/AWWA C104/A21.4. Furnish gaskets conforming to ANSI/AWWA for each length of pipe and suitable for the type of joint of the pipe. Ship gaskets in a separate container.

Furnish push-on joints, mechanical joints, and boltless restrained joints conforming to ANSI/AWWA C111/A21.11. For restrained joints, ensure that the restraint is an approved design that provides a positive lock against joint separation. Steel locking segments molded into a gasket to grip the pipe do not meet the requirements for this joint.

## 748.02

Ball and socket joints are suited for underwater installations. The Contractor may use ball and socket joints for other types of installations where an appreciable amount of joint deflection and a positive lock against joint separation are required.

Manufacture fittings for ductile iron pipe according to ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53, and ANSI/AWWA C111/A21.11. For fittings 16 inches (406 mm) or larger, use ductile iron only. Ensure that fittings are cement mortar lined according to ANSI/AWWA C104/A21.4.

Furnish materials according to the Department's Qualified Products List (QPL).

**748.02 Polyvinyl Chloride (PVC) Pipe, Joints, and Fittings.** Furnish PVC pipe conforming to AWWA C 900, AWWA C 905, AWWA C909, or ASTM D 2241. Furnish push-on type pipe joints conforming to ASTM D 3139 with a thickened bell and with a rubber gasket conforming to ASTM F 477.

Use PVC, PE, or PB pipe and couplings, and solvent cements made from compounds that are tested and certified as suitable for potable water distribution products by the National Sanitation Foundation (NSF) Testing Laboratory or the Canadian Standards Association Testing Laboratory, or any other similarly accredited testing agency acceptable to the Laboratory. Do not use PVC, PE, or PB pipe and couplings, or solvent cements containing any ingredient in an amount that has been demonstrated to migrate into water in quantities considered to be toxic, as tested according to Sections 3 and 4 of NSF Standard Number 14.

Furnish materials according to the Department's Qualified Products List (QPL).

**748.03 Polyethylene (PE) Service Branches and Fittings.** Furnish PE service branches and fittings conforming to AWWA C901. Furnish material with plain ends conforming to the potable waterline requirements specified in 748.02.

Furnish materials according to the Department's Qualified Products List (QPL).

**748.05 Copper Service Branches and Fittings.** Furnish copper service branches conforming to ASTM B 88 (ASTM B 88M), Type K. Assemble branches using flare-type compression fittings conforming to AWWA C800. Ensure a minimum working pressure for the branches of 150 pounds per square inch (1.0 MPa). Use either coil type (temper 060 annealed) or drawn type (temper H) material.

Furnish high-quality copper brass fittings with AWWA C800 dimensions.

Furnish materials according to the Department's Qualified Products List (QPL).

**748.06 Steel Pipe Encasement.** Furnish steel casing pipe conforming to ASTM A 139/A 139M, Grade B or ASTM A 53, Grade B, that is galvanized on exterior and interior surfaces as specified in Section 711.02. Furnish the manufacturer's certification. Steel casing pipe shall have a minimum wall thickness as shown below:

Pipe Diameter		Wall Thickness	Wall Thickness	
(in)	(mm)	Designation	(in)	(mm)
4 to 10	100 to 260	Standard	0.237 to 0.365	6.02 to 9.27
12 to 22	300 to 560	Standard	0.375	9.53
24 and larger	600 and larger	Extra-strong	0.500	12.7

For steel casing pipe specified to be bored or jacked, provide ungalvanized pipe with the largest wall thickness.

**748.07 Polyethylene Encasement.** Furnish 8-mil (200  $\mu\text{m}$ ) thick polyethylene encasement material conforming to ANSI/AWWA C105/A21.5.

**748.08 Gate Valve and Valve Box.** Furnish ductile iron gate valves conforming to AWWA C509 resilient seated.

Gate valves shall open counter-clockwise. Use valves suitable for push-on and mechanical joints for ductile iron pipe and for push-on joints for PVC pipe.

Furnish cast iron valve boxes consisting of adjustable two or three-piece with cover and with a base corresponding to the size of the valve. Use heavy-duty type valve boxes for locations within existing or proposed pavement, driveway, or other traveled areas. Ensure that valve boxes are coated with an asphaltic coating by the manufacturer. The cover shall have the word "WATER" cast in it.

Furnish materials according to the Department's Qualified Products List (QPL).

**748.09 Inserting Valve and Valve Box.** Furnish inserting valves that operated like ordinary gate valves, with the same gate and seating assembly as AWWA C509 gate valves. Furnish material that consist of a two-piece sleeve for assembly around the main the valve, and a valve box conforming to 748.08. Furnish the equipment necessary to drill the main wall and insert the valve according to the manufacturer's recommendations.

Furnish materials according to the Department's Qualified Products List (QPL).

**748.10 Cutting-in Sleeve, Valve, and Valve Box.** Furnish cutting-in valves with the same gate and seating assembly as AWWA C509 gate valves. Furnish material that consists of a cutting-in sleeve and valve suitable for assembling over the ends of a cutout length of existing pipe, according to the manufacturer's recommendations, and a valve box conforming to 748.08. Furnish sleeves and valve joints of the mechanical joint type.

Furnish materials according to the Department's Qualified Products List (QPL).

**748.11 Tapping Sleeve, Valve, and Valve Box.** Furnish tapping valves with the same gate and seating assembly as AWWA C509 gate valves. Furnish material that consists of a two-piece sleeve for assembly around the main, the valve, and a valve box conforming to 748.08. Furnish cast iron, epoxy-coated steel, or stainless steel tapping sleeves. Furnish the equipment necessary to drill the main wall through the valve according to the manufacturer's recommendations.

Furnish materials according to the Department's Qualified Products List (QPL)

**748.12 Tapping Saddle and Corporation Stop.** Furnish iron, bronze, brass, or, AWWA C223, stainless steel tapping saddles. Furnish band type or double-

## 748.13

strap type tapping saddles, with International Pipe Standard (IPS) tapping or AWWA tapered thread inlet.

For use with saddles, provide bronze alloy corporation stops with IPS inlet thread of AWWA tapered thread and with outlet thread compatible with connecting pipe, without special adapters. For direct tapping, provide bronze alloy corporation stops with AWWA tapered inlet thread and with outlet thread compatible with connecting pipe, without special adapters.

Furnish materials according to the Department's Qualified Products List (QPL).

**748.13 Service Stop and Service Box.** Furnish bronze service stops with coupling threads conforming to AWWA C800. Use service stops designed so that water pressure from the inlet side of the body provides additional sealing action. Furnish service stops that open counter-clockwise.

Use Buffalo type service boxes. Furnish covers that have the word "WATER" cast in raised letters. Securely fasten covers with a bronze or brass bolt.

Furnish materials according to the Department's Qualified Products List (QPL).

**748.14 Meter, Setting, Stop, and Chamber.** Furnish meter setting yokes that allow the meter to be readily installed without disturbing piping. Furnish angle pattern meter stops with lock wings for the street side of the meter piping. Furnish check valves for the customer side of the meter piping. Furnish chambers composed of concrete, vitrified clay, PVC, or PE. Furnish double walled, tightly fitting lids.

**748.15 Fire Hydrant.** Furnish cast iron, dry-barrel post type fire hydrants conforming to AWWA C502, with the following modifications:

Furnish hydrants incorporating an approved groundline breakable flange and valve stem coupling.

Furnish compression type hydrants with the valve opening against the pressure. Ensure that the valve end of the valve stem is designed to eliminate contact of dissimilar metals. Ensure that the valve stem is at least 1-inch (25 mm) diameter or 1-inch (25mm) square steel between the hydrant operating nut and the valve, except for the valve stem coupling located at the point corresponding to the breakable flange.

Furnish a main valve port that is at least 4 1/4-inch (108 mm) diameter. Furnish a rubber faced valve.

Ensure that the hydrant is designed so the nozzles may be oriented to point in any direction. Ensure that the hydrant connection to the pipe has at least a 6 inches (150 mm) inside diameter. Furnish push-on or mechanical type joints conforming to ANSI/AWWA C111/A21.11.

Ensure that the hydrant has one center-front pumper nozzle of 4-inch (100 mm) internal diameter with male threads to match the fire apparatus of the maintaining agency. Furnish two hose or streamer nozzles of 2 1/2-inch (63 mm) internal diameter with male threads to match apparatus of the maintaining agency. Ensure that nozzle sections are designed to lock into the hydrant body using locking lugs

or threads. Furnish nozzles with threaded cast iron caps having an integral nut of the same design as the hydrant operating nut.

Contact the maintaining agency to determine the desired color and number of coats of enamel for the hydrants.

Furnish materials according to the Department's Qualified Products List (QPL).

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