

PART 02000 - MATERIALS
Concrete Materials and Additives
Section 02001 - Concrete

Description

02001.00 Scope - This Section includes the requirements for portland cement concrete (concrete) for structural, precast prestressed, or paving applications.

02001.01 General - Produce concrete according to these Specifications and referenced Sections of ASTM C94, Standard Specification for Ready-Mixed Concrete. Provide quality control according to Section 00165.

02001.02 Abbreviations and Definitions:

- ASTV** - Actual Strength Test Value - average of test cylinder compressive strengths
- ~~**cm** - Cementitious Materials~~
- f'_c - Minimum Specified Compressive Strength at 28 days
- f'_{cr} - Average Compressive Strength Over-design. The average strength required to assure that, with normal variations, the concrete will meet f'_c
- GGBFS** - Ground Granulated Blast Furnace Slag
- HES** - High Early Strength Concrete
- HPC** - High Performance Concrete
- HRWRA** - High-Range Water-Reducing Admixture (super-plasticizer)
- PPCM** - Precast prestressed concrete member
- SCM** - Supplementary Cementitious Materials
- SSD** - Saturated Surface-Dry
- w/cm Ratio** - Water Cementitious Material Ratio
- ~~**w** - Water~~
- WRA** - Water Reducing Admixture

~~**Cementitious Materials** - Portland cement and supplementary cementitious materials. Included, but not limited to, portland cement, fly ash, silica fume, ground granulated blast furnace slag, and metakaolin.~~

High Performance Concrete - Concrete designed for enhanced durability and performance characteristics. High performance concrete is identified on the Plans by the letters "HPC" in front of the concrete class designation (for example, HPC4500 - 1 1/2 3/4).

Moderate Exposure - Elevations below 1,000 feet.

~~**Modifiers** - Pozzolans, ground granulated blast furnace slag, and latex.~~

Pozzolans - Fly ash, silica fume, and metakaolin.

Severe Exposure - Elevations 1,000 feet and above.

Supplementary Cementitious Materials - Fly Ash, silica fume, metakaolin, and ground granulated blast furnace slag.

02001.10 Materials - Furnish Materials meeting the requirements of the following:

Admixtures	02040
Aggregates	02690
Cement	02010
<u>Chemical Admixtures</u>	<u>02040</u>
<u>Concrete Modifiers</u>	<u>02035</u>
Supplementary Cementitious Materials	02030
Synthetic Fiber Reinforcing	02045
Water	02020

02001.20 Concrete Properties, Tolerances, and Limits - Provide concrete that is a workable mixture, uniform in composition and consistency, and having the following properties;

(a) Strength - Provide concrete meeting the required Classes shown in the Contract Documents. The class of concrete designates the minimum required compressive strength, f'_c at 28 days, and the nominal maximum size of Aggregate to be used in the concrete (for example, Class 3300 - 3/4" - f'_c is 3,300 psi with a nominal maximum size Aggregate of 3/4 inch).

Table 02001-1

Concrete Strength and Water/Cementitious Material (w/cm) Ratio		
Type of Concrete	Strength (PSI)	Maximum w/cm Ratio
Structural	3300	0.50
	3300 (Seal)	0.45
	4000	0.48
	4000 (Deck)	0.40
	HPC4500	0.40
	5000 and above	0.40 ¹
	HPC5000 and above	0.40
Drilled Shaft	4000	0.48
Paving	4000	0.44
¹ PPCM's with cast-in-place decks and no entrained air may have w/cm as follows: 5000 psi - 0.48; 5500 psi - 0.44; 6000 psi and up - 0.42		

(b) Air Entrainment - Provide all concrete, except PPCM with cast-in-place decks, seal concrete, and drilled shaft concrete with entrained air in the amounts shown in Table 02001-2. Field measured entrained air content shall be within ± 1.5 percent of target air entrainment values.

Table 02001-2

Air Entrainment		
Nominal Maximum Size Aggregate	Severe Exposure (Percent)	Moderate Exposure (Percent)
3/8"	7.0	6.0
1/2"	6.5	5.5
3/4"	6.0	5.0
1"	5.5	4.5
1 1/2"	5.0	4.5

(c) Slump - Provide concrete at the appropriate slump shown in Table 02001-3. Take corrective action to maintain a consistent slump at the point of discharge from the delivery vehicle.

Table 02001-3

Concrete Slump	
Condition	Slump
Concrete without WRA	4" max.
Concrete with WRA	5" max.
Concrete with HRWRA	5 1/2" ± 2 1/2"
Precast Prestressed Concrete with HRWRA	10" max.
Seal Concrete	8" ± 2"
Drilled Shaft Concrete	8 1/2" ± 1 1/2"

For drilled shaft concrete, maintain a minimum slump of 4 inches throughout the drilled shaft placement, including temporary casing extraction.

(d) Temperature - Provide concrete, at time of placement, at a temperature between a minimum of 50 °F and a maximum of 90 °F, except the maximum bridge deck concrete temperature shall be 80 °F.

Concrete Mix Designs

02001.30 Concrete Mix Design - Submit new or current mix designs, prepared by a CCT, for each required class of structural or paving concrete to the Engineer for review. Allow 21 Calendar Days for the review. Design mixes by the volumetric method in ACI 211.1 to achieve the properties of 02001.20. Do not proceed with concrete placement until the Engineer has determined that the mix design complies with the Specifications. Review of concrete mix designs does not relieve the Contractor of the responsibility to provide concrete meeting the Specification requirements.

High performance concrete (HPC) mix designs shall contain any of the following:

- Cementitious material with 66 percent portland cement, 30 percent fly ash, and 4 percent silica fume.
- ~~Cementitious material with modifiers~~ Cement with SCM proportioned according to 02001.31 ~~(be)~~ and with trial batches performed to demonstrate that the proposed alternate mix design provides a maximum of 1,000 coulombs at 90 days when tested according to AASHTO T 277.
- Cementitious material with modifiers and with trial batches performed to demonstrate that the proposed alternate mix design provides a maximum of 1,000 coulombs at 90 days when tested according to AASHTO T 277.

02001.31 Concrete Constituents:

(a) Portland Cement - Use AASHTO M 85 or ASTM C150, Type I or II cement for structural or paving concrete. Use AASHTO M 85 or ASTM C150, Type III cement for precast prestressed concrete. Provide all cement from the QPL.

(b) Supplementary Cementitious Materials - SCM may be used separately or in combinations up to the specified maximum percentage by mass according to the following:

Separate SCM	Maximum
Fly Ash + Other Pozzolans	25%
GGBFS	50%
Silica Fume	5%
Combined SCM	Maximum
Fly Ash + Other Pozzolans + GGBFS + Silica Fume	50%*
Fly Ash + Other Pozzolans + Silica Fume	30%*

* Fly ash + other pozzolans shall constitute no more than 25% and silica fume shall constitute no more than 5% of the total weight of cementitious materials.

When silica fume is added to truck mixed concrete, mix the batch a minimum of 100 revolutions at the mixing speed specified by the manufacturer before leaving the batch plant.

~~Pozzolans~~ - Pozzolans or GGBFS may be used separately or in combinations up to 30 percent of the total cementitious materials content.

~~(c) Modifiers~~ - Modifiers may be used separately or in combinations as approved by the Engineer. Alternate HPC proportions may be:

Fly Ash	12%	18%
GGBFS	20%	35%
Silica Fume	3%	5%

~~For alternate HPC mix designs do not replace more than 50 percent of total cementitious material with modifiers.~~

~~When silica fume is added to truck mixed concrete, mix the batch a minimum of 100 revolutions at the mixing speed specified by the manufacturer before leaving the batch plant.~~

~~(cd) Blended Hydraulic Cement~~ - Blended hydraulic cement may be used subject to the limits of 02001.31(b) and 02010.20.

~~(de) Chemical Admixtures~~ - Use chemical admixtures according to the manufacturer's recommendations. Use WRA in all seal concrete and in Class 5000 concrete or greater. Use HRWRA in all HPC.

Use a superset extender from the QPL in all concrete for bridge decks. Use an appropriate amount to extend the initial set time of the concrete by 90 minutes.

~~(ef) Aggregate~~ - If the nominal maximum size of the coarse Aggregate is not included as a part of the class of concrete, or shown on the Plans, any size from 1 1/2-inch to 3/8-inch nominal maximum size Aggregate may be used according to ACI guidelines except:

- Use 1 1/2 inch nominal maximum size ~~or larger~~ Aggregates in bridge deck concrete.
- Use 1 1/2 inch nominal maximum size Aggregates in paving concrete unless otherwise indicated.
- Use 3/8 inch nominal maximum size Aggregates in drilled shafts unless otherwise indicated.

Proportion all HPC for a minimum coarse Aggregate absolute solid volume according to Table 02001-4:

Table 02001-4

Absolute Solid Volume	
Maximum Nominal Aggregate Size	Cu. Yd. (Aggregate) / Cu. Yd. (concrete)
3/8"	0.36
1/2"	0.38
3/4"	0.40
1"	0.42
1 1/2"	0.446

Two or more Aggregate products or sources meeting Specifications may be blended to improve concrete properties. Blending non-specification Aggregate materials, except for gradation, with specification materials is not allowed.

(g) Synthetic Fiber Reinforcing for Concrete – Use synthetic fiber reinforcing from the QPL and according to Section 02045 in all bridge deck and silica fume overlay concrete. Use synthetic fiber reinforcing according to the manufacturer's recommendations at the rate designated on the QPL. Fiber packaging is not allowed in the mixed concrete.

02001.32 New Mix Designs - Prepare new mix designs for submittal according to the following:

(a) Trial Batch - Make at least one trial batch for each concrete mix design. Prepare and test trial batches using the same materials and having the same plastic properties of concrete that will be used in the Project. Simulate haul time and mixing conditions to ensure proper workability at the jobsite. Notify the Engineer at least 48 hours before making each trial batch. The Engineer may witness the preparation and testing.

Furnish all materials, Equipment and Work required for designing the mixes, testing Materials, and making trial batches to verify the final design for final use at no additional cost to the Agency.

(b) Plastic Concrete - For each trial batch, test the temperature, slump, density, and air content and compute the w/cm ratio and yield according to the following test methods:

Test	Test Method
Sampling Fresh Concrete	WAQTC TM 2
Slump	AASHTO T 119
Density	AASHTO T 121
Yield	AASHTO T 121
Air Content	AASHTO T 152
Concrete Temperature	AASHTO T 309
Molding Concrete Specimens	AASHTO T 23 or R 39 ¹
Water-Cement Ratio	²

¹ Cast cylinders in single-use plastic molds

² Use ODOT's Field Operating Procedure for AASHTO T 121 in the MFTP

(c) Strength Tests - For each trial batch, cast at least three test cylinders in 6 inch x 12 inch or 4 inch x 8 inch single-use plastic molds. Cast and cure all cylinders according to AASHTO T 23 or AASHTO R 39, and test at 28 Days according to AASHTO T 22.

Cast three flexural beams for paving concrete trial batches according to AASHTO T 23 or AASHTO R 39. Test flexural beams at 28 Days according to AASHTO T 97.

(d) Length Change Tests - For all HPC and Silica Fume Concrete (SFC) mix designs, except for precast bridge rail elements, make at least three specimens from the trial batch for length change testing. Test samples according to ASTM C157. Sample prisms shall have a square, 4 by 4 inch Cross Section. Wet cure the samples until they have reached an age of 28 Days, including the period in the molds. Store and measure samples according to ASTM C157, section 11.1.2. Report length change results at 28 Days.

Test	Test Method	Acceptance Value
Length Change	ASTM C157	-0.045% max. at 28 Days

(e) Permeability Tests - For alternate HPC mix designs, make at least three specimens for permeability testing. Prepare, cure, dry and test according to AASHTO T 277. Report permeability in coulombs at 90 Days.

Test	Test Method	Acceptance Value
Permeability	AASHTO T 277	1,000 coulombs max. at 90 Days

Permeability tests are not required when HPC and SFC mix designs contain cementitious material with 66 percent portland cement, 30 percent fly ash, and 4 percent silica fume.

02001.33 Required Over Design Strength (f'_{cr}) for New Mix Designs - Provide test data and calculations demonstrating compliance of the trial batch cylinder's ASTV with the requirements of either (a) or (b) below.

- (a) $f'_{cr} = f'_c \times 1.20$ Up to Class 6000 $f'_{cr} = f'_c \times 1.15$ Class 6000 and higher
- (b) $f'_{cr} = f'_c + 1.34 \times S$ Up to Class 6000 $f'_{cr} = f'_c + 1.28 \times S$ Class 6000 and higher

Where: S is the standard deviation of 28-Day cylinder strengths from a similar class (\pm 1,000 psi) mix design produced at the same plant. There shall be at least 15 sets of 28-Day cylinders from this similar class mix design to use option (b).

(c) Flexural Beams - Flexural beams for paving concrete mix designs shall achieve 600 psi at 28 Days.

02001.34 Current Mix Designs - Mix designs that meet the requirements for the specified class of concrete and are currently being used or have been used within the past 12 months on any project, public or private may be submitted for review.

(a) Length Change Tests - For all HPC and SFC mix designs, except for precast bridge rail elements, make at least three specimens for length change testing. Test samples according to ASTM C157. Wet cure the samples until they have reached an age of 28 Days, including the period in the molds. Store and measure samples according to ASTM C157, section 11.1.2. Report length change results at 28 Days.

Test	Test Method	Acceptance Value
Length Change	ASTM C157	-0.045% max. at 28 Days

(b) Permeability Tests - For alternate HPC mix designs make at least three specimens for permeability testing. Prepare, cure, dry and test according to AASHTO T 277. Report permeability in coulombs at 90 Days.

Test	Test Method	Acceptance Value
Permeability	AASHTO T 277	1,000 coulombs max. at 90 Days

Permeability tests are not required when HPC and SFC mix designs contain cementitious material with 66 percent portland cement, 30 percent fly ash, and 4 percent silica fume.

02001.35 Required Submittals for Mix Designs - Submit the following information for each concrete mix design:

(a) Supplier's Information: ~~Unique Mix Design Identification Number~~ Provide the supplier's unique mix design identification number and batch plant location.

(b) Mix Design Constituent Proportions:

- Weight per cubic yard (pounds per cubic yard) of ~~cementitious material, SCM, modifiers,~~ fine Aggregates and coarse Aggregates (SSD), and mix water, concrete modifiers and chemical admixtures.

- Absolute volumes of cementitious material, SCM modifiers, fine Aggregates and coarse Aggregates (SSD), and mix water, air content concrete modifiers and chemical admixtures.
- Dosage rates for chemical admixtures (ounces per cubic yard).
- w/cm ratio including all chemical admixtures

(c) Aggregates - Identify the Aggregate source by the ODOT source number. Report current values of the following:

- Bulk specific gravities (SSD)
- Fine Aggregate absorptions
- Coarse Aggregate absorptions
- Dry-rodded density of coarse Aggregates
- Average stockpile gradations
- Fineness modulus of sand used in the mix design calculations

(d) Cementitious Material - For each cementitious material used, identify provide the following:

- Manufacturer
- Brand name
- Type
- Relevant Specification Source or location plant
- QPL Product Number

(e) SCM Modifiers - For each SCM modifier used, identify provide the following:

- Manufacturer
- Brand name
- Source
- Relevant specification Class
- QPL Product Number

(f) Concrete Modifier - For each concrete modifier used, provide the following:

- Manufacturer
- Brand name
- QPL Product Number

(g) Admixtures - For each admixture used, identify the following:

- Manufacturer
- Brand name
- Design dosage rate
- QPL Product Number

(h) Synthetic Fiber Reinforcing - For each synthetic fiber reinforcing used, provide:

- Manufacturer
- Brand name
- Design dosage rate
- QPL product number

(i) Water - Identify the source of water to be used and provide a certificate of compliance certifying that the water meets the requirements of 02020.10.

(j) Plastic Concrete Tests - Report the temperature, slump, density, air content, yield, and w/cm ratio of the trial batch or the average of these values for the cylinder sets presented for evaluation of a current mix design.

For drilled shaft concrete, report the following additional information:

- The total time estimate from initial batching through drilled shaft placement, including haul time, placing concrete, and temporary casing extraction.
- Initial slump test results and subsequent results at 15-minute intervals, verifying a minimum slump of 4 inches is maintained for the total time estimated for drilled shaft placement, including temporary casing extraction. Report data in a table or graph format.

(ki) Compressive Strength Test Results - Report the individual test results and the ASTV of cylinders from the trial batch for new designs. For current designs, provide the individual tests and the average for the cylinder sets presented for evaluation of a current mix design.

(lj) Strength Analysis - Provide an analysis, showing all calculations, demonstrating that the mix design meets the requirements of 02001.33.

(mk) Quality Control Personnel - Provide the name and certification number of the CCT who prepared the mix design, the QCT who performed the plastic concrete tests and cast the test cylinders, the laboratory where the cylinders were tested, and the CSTT who tested the cylinders, and the ODOT certification number of the laboratory where the cylinders were tested.

02001.36 Adjusting Concrete Proportions - After a mix design has been reviewed and accepted, submit any proposed adjustments to concrete proportions for review. Significant changes to the mix design (such as decreases in cementitious material content, increases in pozzolans that replaces cement, or the use of Aggregates from a different source) may require verification of compressive strength performance by trial batch, according to 02001.32, or test results from field tests according to 02001.33. Aggregates from new sources shall meet Aggregate source quality requirements according to Section 02690.

02001.37 Trial Batch Costs - Furnish all materials, Equipment and Work required for designing the mixes, testing materials, and making trial batches to verify the design for final use at no additional cost to the Agency.

02001.40 Concrete Production - Produce concrete according to the following sections of ASTM C94, Standard Specification for Ready-Mixed Concrete:

ASTM Section	ASTM Title
9.	Measuring Materials
10.	Batching Plant
11.	Mixers and Agitators
12.	Mixing and Delivery

02001.50 Quality Control Personnel - Provide the following certified technicians:

(a) Certified Aggregate Technician (CAgT):

- **Duties:**
 - Sample and test Aggregates.
 - Sample and test each stockpiled size according to the test procedures and at the frequencies shown in the Field Tested Materials Guide section of the MFTP.
 - Record and evaluate test results according to Section 00165.
 - Provide Stat-Spec results to the Engineer.

(b) Quality Control Technician (QCT):

- **Duties:**
 - Attend pre-placement meetings for bridge deck pours and paving.
 - Be at the concrete placement site when concrete placement is in progress.
 - Have a copy of the mix design on-site and available during concrete placement.
 - Obtain and check each batch ticket upon arrival of the concrete at the jobsite for the correct mix design.

- Sample the concrete and test for ambient air temperature, plastic concrete temperature, slump, air content, density, w/cm ratio and yield at the frequencies required by and according to the tests listed in the MFTP, after concrete mixture proportions are adjusted in the field, and at such times as requested by the Engineer.
- Notify the Contractor and the Engineer immediately when the concrete is not in compliance with the Specifications.
- Be in direct contact with the CCT by telephone, radio or other means to convey information.
- Notify the CCT of loads rejected and the reason for rejection.
- Notify the CCT immediately whenever the density of the plastic concrete varies from the mix design target by more than ± 3 pounds per cubic foot.
- Notify the CCT immediately whenever the w/cm ratio varies from the mix design target by more than ± 0.03 .

(c) Concrete Control Technician (CCT):

• **Duties**

- Prepare new concrete mix designs.
- Adjust current mix designs.
- Control production of the concrete.
- Test the fine and coarse Aggregates for total moisture content according to AASHTO T 255 before batching is started and when there is a significant change in the slump of the concrete. Moisture testing may be by an alternate method if approved by the Engineer. Provide moisture content test results to the Engineer upon request.
- Visually inspect the coarse Aggregate for changes in moisture content throughout the Day. Perform necessary testing for total moisture, and make mixture adjustments if necessary.
- Monitor concrete properties and compressive strength tests throughout the duration of the Project.
- Make adjustments to maintain a satisfactory over-design f'_{cr} .
- Perform an analysis and make necessary adjustments whenever the unit weight of the plastic concrete varies from the mix design by more than ± 3 pounds per cubic foot. Submit a written analysis along with any recommendations to the Engineer by the middle of the following work shift.
- Submit to the Engineer, in writing, adjustments made to the mix design.
- Perform an analysis and verify the accuracy of coarse and fine Aggregate moistures whenever the water-cementitious material ratio varies from the mix design target by more than ± 0.03 and submit to the Engineer by noon of the following workday.

(d) Concrete Strength Testing Technician (CSTT):

• **Duties:**

- Receive concrete test cylinders
- Record data
- Strip cylinders
- Store cylinders
- Test Cylinders

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- Record test data
- Report test data

02001.60 Delivery Tickets - Send a concrete delivery ticket with each load of concrete supplied to the Project. Each delivery ticket shall include the following information:

- Concrete Supplier's name, address and telephone number
- Address and telephone number of batch plant if different from above
- Date and time the concrete batch was produced
- ~~ODOT~~ Mix design number
- Size of load batched
- Weights or volumes of constituents batched in the load
- Amount of water that can be added at the job site

Record the amount of water added at the job site on the delivery ticket.

Section 02010 - Portland Cement**Description**

02010.00 Scope - This Section includes the requirements for portland cement and blended hydraulic cement.

Materials**02010.10 Portland Cement:**

(a) Types - Furnish one or another of the following types as elected:

- Type I
- Type II
- Type III

Do not mix or alternately use differing brands or types of cement, or the same brand or type of cement from different mills without prior written approval.

(b) Specifications - Portland cement shall conform to the requirements of AASHTO M 85 or ASTM C150 for low alkali cement except as follows:

- Cement shall have a total alkali content (sodium and potassium oxide calculated as $\text{Na}_2\text{O} + 0.658 \text{K}_2\text{O}$) not exceeding 0.60 percent.
- All cement types shall contain a maximum of 8 percent tricalcium aluminate (C_3A).
- The time-of-setting tests will be by either the Gillmore test or the Vicat test.
- Types I and II maximum fineness (specific surface) as determined by AASHTO T 153 air permeability test shall be 430 m^2/kg . If $\text{C}_3\text{S} + 4.75 \text{C}_3\text{A}$ is less than or equal to 90, the fineness criteria does not apply.

(c) Acceptance - Portland cement shall be from the QPL.

02010.20 Blended Hydraulic Cement - Blended hydraulic cement shall be either Type IS-portland blast-furnace slag cement, Type IP-portland-pozzolan cement, Type IL-portland-limestone cement, or Type IT-ternary blended cement according to AASHTO M 240.

Furnish blended hydraulic cement from the QPL.

Section 02015 - Portland Cement Concrete Repair Material

Description

02015.00 Scope - This Section includes the requirements for portland cement concrete repair materials.

Materials

02015.10 Materials - All PCC repair materials are acceptable for structural applications when used according to the manufacturer's recommendations.

02015.20 Portland Cement Concrete Repair - Furnish PCC repair Material from the QPL.

02015.30 Portland Cement Concrete Repair, Polymer Modified - Furnish polymer modified PCC repair Material from the QPL.

02015.40 Portland Cement Concrete Repair, High Performance - Furnish High Performance PCC repair Material from the QPL.

02015.50 Portland Cement Concrete Repair, Surface - Furnish Surface PCC repair Material from the QPL.

Section 02020 - Water

Description

02020.00 Scope - This Section includes the requirements for water used in mixing concrete, mortar, grout, and other applications when specified or directed.

Materials

02020.10 Water:

(a) General - Water used in mixing or curing concrete, mortar, grout, and in mixing cement-treated Base shall be reasonably clean, and free of oil, sugar, organic matter, or other substances injurious to the finished product.

(b) Potable - Potable water may be used without testing if the Contractor provides a quality compliance certificate verifying that the water has met the limits and ranges of ASTM C1602, according to tests made within the last 2 years.

Water approved for public use by the Oregon Health Division may be accepted for use without testing.

(c) Non-Potable, Unknown Quality, or Suspected Quality - Non-potable, unknown quality, or suspected quality water shall be tested at no additional cost to the Agency . Test according to ASTM C114 and ASTM C1603. Water from concrete production operations is considered unknown quality. Results of testing shall comply with the limits and ranges of ASTM C1602 and shall be available for review upon request.

Section 02030 - Supplementary Cementitious Materials**Description**

02030.00 Scope - This Section includes the requirements for fly ash, silica fume, and ground granulated blast furnace slag used in portland cement concrete.

02030.01 Abbreviations:

SCM - Supplementary Cementitious Materials

Materials

02030.10 Fly Ash - Furnish Class C, Class F, or Class N fly ash from the QPL and conforming to AASHTO M 295 (ASTM C618).

02030.20 Silica Fume - Furnish silica fume from the QPL and according to the following:

(a) Types - Provide the silica fume as a slurry containing silica fume, water, and a high range water reducer, or as a densified powder. The silica fume portion shall conform to AASHTO M 307. Total alkalis, as equivalent Sodium Oxide (Na_2O), shall be 1.5 percent maximum.

(b) Acceptance - Silica fume will be accepted for immediate use if accompanied by a test results certificate according to 00165.35. If the silica fume is supplied as a slurry, the certificate shall indicate the silica fume content of the slurry as a percent by weight. If the silica fume is supplied as a densified powder, do not allow the packaging to enter the concrete mixture.

02030.40 Ground Granulated Blast Furnace Slag (GGBFS) - Furnish GGBFS from the QPL and conforming to AASHTO M 302.

02030.50 Metakaolin - Furnish metakaolin from the QPL and conforming to AASHTO M 295 (ASTM C618) Class N.

02030.60 Blended - Furnish blended GGBFS and Fly Ash from the QPL.

Section 02035 - Concrete Modifiers

Description

02035.00 Scope - This Section includes the requirements for concrete modifiers used in portland cement concrete.

Materials

02035.10 Styrene-Butadiene Latex - Furnish latex concrete modifiers from the QPL that are a nontoxic, film-forming, polymeric emulsion in water to which all stabilizers have been added at the point of manufacture. Latex modifiers shall be homogeneous and uniform in composition, and shall meet the following requirements:

Polymer Type Stabilizers	Styrene Butadiene
Latex	Nonionic Surfactants
Portland Cement Composition	Polydimethyl Siloxane
Solids, % by weight, min.	46.0
Volume Density, lb/gal, min.	8.4 at 77 °F
pH	9.0 to 11.0
Color	White

Latex that has not been stored according to the manufacturer's recommendations will not be accepted.

Section 02040 - Chemical Admixtures

Description

02040.00 Scope - This Section includes the requirements for air-entraining, water-reducing, retarding, and accelerating admixtures.

Materials

02040.10 Materials - Furnish admixtures from the QPL, ~~except as follows:~~

~~An admixture that does not appear on the QPL may be used if, prior to use, the Contractor provides a test results certificate demonstrating the admixture has been tested and conforms to these Specifications. The Agency may sample and test admixtures according to 00165.35.~~

~~Chloride content of any admixture used in portland cement concrete in contact with embedded metals shall not exceed 0.5 percent by weight of the admixture when tested according to ODOT TM 505.~~

~~Admixtures shall conform to the following requirements:~~

~~— Admixture — Specification~~

- ~~— Air-entraining AASHTO M 154 (ASTM C260)~~
- ~~— Type A - Water-reducing AASHTO M 194 (ASTM C494)~~
- ~~— Type B - Retarding AASHTO M 194 (ASTM C494)~~
- ~~— Type C - Accelerating AASHTO M 194 (ASTM C494)~~
- ~~— Type D - Water-reducing and Retarding AASHTO M 194 (ASTM C494)~~
- ~~— Type E - Water-reducing and Accelerating AASHTO M 194 (ASTM C494)~~
- ~~— Type F - Water-reducing, High Range AASHTO M 194 (ASTM C494)~~
- ~~— Type G - Water-reducing, High Range and Retarding AASHTO M 194 (ASTM C494)~~
- ~~— Type S - Specific Performance AASHTO M 194 (ASTM C494)~~

Section 02045 - Synthetic Fiber Reinforcing for Concrete**Description**

02045.00 Scope - This Section includes the requirements for synthetic fiber reinforcing used in high performance concrete (HPC) bridge decks, silica fume concrete (SFC) overlays, and PCC.

Materials

02045.10 Synthetic Micro Fiber Reinforcing - Furnish synthetic polyolefin micro fiber reinforcing from the QPL and conforming to ASTM C1116 Type III.

02045.20 Synthetic Macro Fiber Reinforcing - Furnish synthetic polyolefin macro fiber reinforcing from the QPL and conforming to ASTM C1116 Type III.

02045.30 Synthetic Blended Fiber Reinforcing - Furnish synthetic polyolefin blended fiber reinforcing from the QPL and conforming to ASTM C1116 Type III.

02045.80 Acceptance - Acceptance of synthetic fiber reinforcing will be according to 00165.35(b) when accompanied by a quality compliance certificate.

Section 02050 - Curing Materials**Description**

02050.00 Scope - This Section includes the requirements for liquid compounds, polyethylene films, and curing blankets used to cover concrete and other surfaces to retain moisture and to cure.

Materials

02050.10 Liquid Compounds - Furnish liquid membrane-forming curing compounds from the QPL and meeting the requirements of ASTM C309, ~~except that testing will be done according to ODOT TM 724.~~

All compounds shall be Type 1-D, Type 2, Class A or B.

Only Type 2, Class B resins will be allowed for the following concrete Pavement applications:

- Plain concrete Pavement.
- Continuously reinforced concrete Pavement.
- Plain concrete Pavement repair.
- Reinforced concrete Pavement repair.

~~Before using liquid compounds, submit one quart samples of each lot for testing except samples are not required for Commercial Grade Concrete.~~

02050.20 Polyethylene Films - Furnish clear or white polyethylene films for curing concrete meeting the requirements of AASHTO M C171.

02050.30 Curing Blankets - Furnish curing blankets from the QPL.

Section 02055 - Concrete Surface Retarders**Description**

02055.00 Scope - This Section includes the requirements for concrete surface retarders.

Materials

02055.10 Concrete Surface Retarders - Furnish concrete surface retarders from the QPL.

Section 02060 - Concrete and Crack Sealers

Description

02060.00 Scope - This Section includes the requirements for concrete and crack sealers.

Materials

02060.10 Low Modulus Concrete and Crack Sealer - Furnish low modulus concrete and crack sealer from the QPL.

02060.20 High Modulus Concrete and Crack Sealer - Furnish high modulus concrete and crack sealer from the QPL.

02060.30 Water Repellent Concrete Sealer - Furnish water repellent concrete sealer from the QPL.

Section 02070 - Bonding Agents**Description**

02070.00 Scope - This Section includes the requirements for epoxy and non-epoxy bonding agents.

Materials

02070.10 Epoxy Bonding Agents - Furnish epoxy bonding agents from the QPL.

02070.20 Non-Epoxy Bonding Agents - Furnish non-epoxy bonding agents from the QPL.

Section 02080 - Grout**Description**

02080.00 Scope - This Section includes the requirements for epoxy, non-epoxy, keyway, and portland cement grout.

Materials

02080.10 Epoxy Grout - Furnish epoxy grout from the QPL.

02080.20 Non-Epoxy Grout - Furnish non-epoxy grout from the QPL.

02080.30 Keyway Grout - Furnish grout used in the keyways of precast prestressed concrete members that is non-shrink, nonferrous, non-epoxy grout with a minimum design strength of 5,000 psi in 28 Calendar Days. Furnish keyway grout from the QPL and use according to the manufacturer's recommendations.

02080.40 Portland Cement Grout - Furnish portland cement grout consisting of one part portland cement and three parts sand by weight, thoroughly mixed with a minimum amount of water to produce a thick, creamy consistency. Sand shall meet the requirements of 02690.30 and cement shall meet the requirements of Section 02010.

02080.50 Tendon Grout - Furnish tendon grout from the QPL that meets vertical rise requirements.

02080.60 Structural Grout - Furnish structural grout from the QPL and use according to the manufacturer's recommendations. Grout shall be non-shrink, nonferrous, non-epoxy grout with a minimum design strength of 5,000 psi at 28 Calendar Days.

Section 02090 - Lime

Description

02090.00 Scope - This Section includes the requirements for granular quicklime and hydrated lime.

Materials

02090.10 Granular Quicklime - Furnish granular quicklime (CaO) that has a minimum calcium hydroxide content of 113 percent and meeting the following grading requirements:

Grading Requirements

Sieve Size	Percent Passing (by Weight)
3/8"	100
No. 100	25 maximum

Determine grading and hydroxide content by testing according to AASHTO T 27 and AASHTO T 219.

02090.20 Hydrated Lime - Furnish hydrated lime meeting the requirements of ASTM C1097.

02090.30 Acceptance - Provide a quality compliance certificate for lime according to 00165.35.

Wood Products

Section 02110 - Posts, Blocks, and Braces

Description

02110.00 Scope - This Section includes the requirements for wood posts and blocks for guardrail, median barrier, signs, fence posts, and braces for fencing.

Materials

02110.10 Guardrail Posts:

(a) General - Furnish posts for guardrail and median barrier of the size shown, manufactured from Douglas fir, Hem-fir, or Southern Yellow Pine. Wood for posts shall have a minimum extreme fiber bending stress (F_b) of 1,200 psi. Only treated posts from approved Suppliers that are listed in the "Nonfield-Tested Materials Acceptance Guide" will be allowed.

(b) Grading - Grading of posts shall conform to the following:

- **Douglas Fir** - Conform to the requirements for No. 1 posts and timbers as specified in either paragraph 80.11 of the current WWPA Grading Rules, or paragraph 131-b of the current WCLIB Grading Rules.
- **Hem-fir** - Conform to the requirements for select structural posts and timbers as specified in either paragraph 80.10 of the current WWPA Grading Rules, or paragraph 131-a of the current WCLIB Grading Rules.
- **Southern Yellow Pine** - Conform to the requirements for No. 1 timbers as specified in section 402 of the current Southern Pine Inspection Bureau (SPIB) Grading Rules.

(c) Certificates - Furnish certificates of lumber inspection by a recognized inspection agency.

(d) Fabrication - Before preservative treatment, bore all holes and make all necessary cuts as shown.

(e) Preservative Treatment - Treat posts according to Section 02190.

(f) Seasoning and Checking - Each preservative treated post shall show evidence of reasonable amount of seasoning and/or conditioning having occurred prior to treatment, so that further shrinkage of treated posts will not create checking which would expose untreated wood.

At the time of inspection at the plant and at the time of installation each treated post will be subject to inspection for evidence of seasoning having occurred. The presence of checking on the surface of the post will not be cause for rejection unless the width of the widest check, shake, or split exceeds 1/2 inch (surface measurement).

If an otherwise acceptable treated post has a through check, shake, or end split in the same slope of grain or plane as the bolt hole and extending from the top of the post to within 3 inches of the bolt hole, the post will be rejected unless it is provided with a tight fastening across the separation, centered on the post, and 2 inches below the top. Fasten with a 1/2 inch diameter galvanized bolt and nut with a galvanized washer under the bolt head and under the nut after final curing of post is achieved. Treat holes for fastenings according to 00570.40.

(g) Inspection, Rejection and Marking at Plant - Posts shall be subject to inspection at the treating plant at any time before, during or after treatment. Normally, inspection of treated posts will be made by the Agency's Inspector not later than 10 Calendar Days after treatment, provided the Inspector is notified of the time that treating is to be done.

Inspection of treated posts for compliance with the requirements of 02110.10(e) will be according to applicable AWP standards, except as follows:

- The Inspector will choose the number of treated posts from any one charge of the treating cylinder for determining penetration of treatment.
- Each post selected for testing shall be representative as a basis of acceptance or rejection of a pro rata number of posts in the charge.
- If 20 percent of the posts randomly selected for testing fail to conform to requirements, all of the posts in the entire charge from which they are selected may be classed as unacceptable.

At the Inspector's discretion, each treated post or a representative random selection of treated posts may be inspected for compliance with the requirements of 02110.10(f) "Seasoning and Checking".

Posts which fail to conform to requirements of this subsection will be subject to rejection at the treating plant singly, by partial lots, or by whole lots. (A "lot" comprises the posts in any charge of the treating cylinder.)

Each treated post shall bear a permanent mark or metal tag which identifies the Supplier and year of treatment, placed by the Supplier either:

- On the top of the post, or
- On the back of the post, 8 inches to 10 inches below the bolt hole.

(h) Field Inspection, Acceptance and Rejection - At the time of installation inspect each post for:

- Width of widest check, shake, or split.
- Damage to treated wood affecting soundness.
- Visible exposure of untreated wood.
- Conformance to the requirements of 02110.10(b) through 02110.10(f).
- Preservative visibly leaching from the post.

Posts that show a check, shake, or split exceeding 1/2 inch in width (surface measurement) on any surface will be rejected.

Posts that show surface damage may be repaired by field treating with preservatives according to AWP Standard M 4. Repair posts that have splits or checks, or where shakes have opened or deepened sufficiently to expose untreated wood, by treating with a field preservative from the QPL applied to all opened or deepened wood separations and completely filling the separations to the surface of the post.

Remove treated wood posts that have been rejected for any one or more of the above deficiencies or faults and not repaired as stated above.

Acceptance of Material will be according to 00165.35, 02110.10(g), and these Specifications.

02110.20 Guardrail Blocks:

(a) General - Furnish wood guardrail blocks of the dimensions shown. Blocks shall be either Douglas fir or Hem-fir meeting the requirements of 02110.10, or pine or Southern Yellow Pine meeting the requirements of 02110.20(b) and 02110.10 except for 02110.10(b). The requirements of marking and branding the treated blocks, according to the last paragraph of 02110.10(g), will be waived provided that the Supplier of the treated blocks furnishes certification with each shipment stating that the blocks conform to Specifications and that the preservative treating was done under the inspection and with the approval of the Engineer.

(b) Grading - Pine guardrail blocks shall conform to the requirements of paragraph 80.11 of the current WWPA Grading Rules. Southern Yellow Pine guardrail blocks shall conform to the requirements for No. 1 timber as specified in section 402 of the current SPIB Grading Rules.

(c) Recycled Plastic - Recycled plastic guardrail blocks from the QPL may be used.

(d) Acceptance - Acceptance of Material will be according to 00165.35 and this Section.

02110.30 Fence Posts and Braces - Fence posts and brace rails shall be of the sizes and dimensions shown and shall be of sound Douglas fir, western hemlock, or western pine free from decay, end splits, and multiple crooks. Seasoning checks of not more than 5/16 inch width (surface measurement) will be allowed. Allowable crooks may be in one plane only. A line drawn between the centers of the butt and tip of each post and brace rail shall not fall outside of the actual longitudinal centerline of the post or rail by more than 1.67 percent of its length, with an allowable maximum of 2 inches.

Posts and brace rails may be square, rough, or dressed lumber, or may be peeled round posts, as the Contractor elects. Round members shall be free from bark, protruding knots and irregularities detrimental to a pleasing appearance.

Fabricate posts and brace rails before pressure treatment. Where field boring or field cutting of a treated member is required, field-treat the exposed untreated surface of the member according to 00570.40. The size of holes after treatment shall not exceed the size of the dowels or bolts to be inserted by more than 1/16 inch.

Posts intended to be driven may be machine-pointed on either the small end or the large end, before pressure treatment.

Pressure treat the posts and brace rails according to Section 02190.

Acceptance of Material will be according to 00165.35 and these Specifications.

02110.40 Wood Sign Posts - Fabricate wood sign posts from Douglas fir, surfaced four sides (S4S) and free of heart center (FOHC).

(a) Grading - Grading requirements for wood sign posts shall conform to the applicable paragraphs of either the current WCLIB Grading Rules or the current WWPA Grading Rules, as follows:

Species	4" x 4"	4" x 6"	6" x 6" and Larger
Douglas Fir	No. 1 124-b WCLIB 42.11 WWPA	No. 1 123-b WCLIB 62.11 WWPA	No.1 131-b WCLIB 80.11 WWPA

(b) Posts - Construct wood sign posts according to the applicable portions of Section 00570, modified or supplemented as follows:

(1) Length - The length of the posts shall be shown or, where not shown, each post shall be of sufficient length to provide proper sign mounting, a proper mounting height and the required foundation depth.

(2) Framing and Boring - Cut, frame and bore timber before pressure treating, to the extent practicable.

(3) Preservative Treatment - Pressure-treat wood sign posts after fabrication according to Section 02190.

(4) Cuts and Abrasions - Treat cuts, abrasions and bolt-holes, prior to shipping, with the same preservative as originally used to treat the post, except that if the post was originally treated with pentachlorophenol - volatile petroleum solvent (LPG) solution, cuts, abrasions and bolt-holes shall be treated with pentachlorophenol - mineral spirits solvent solution according to AWPA Standard M4.

(5) Field Repair - Field treat damaged or drilled pressure-treated posts according to 00570.40.

(c) Acceptance - Acceptance of Material will be according to 00165.35 and this Section.

Section 02120 - Poles and Piling**Description**

02120.00 Scope - This Section includes the requirements for wood poles for use in illumination and signal installations, and timber piling for Structures.

Materials

02120.10 Wood Poles - Furnish all wood poles meeting the current edition of ANSI O5.1, Specifications and Dimensions (for Wood Poles), for Class 4 machine shaved Douglas fir, and treated meeting the requirements of Section 02190. All poles shall be round, sound, well-proportioned from butt to tip, and without short kinks or crooks.

02120.20 Timber Piling - Furnish timber piling meeting the requirements of ASTM D25.

The butt or tip size, or whether the piling are to be friction or bearing piles, will be identified in the Special Provisions. All foundation piles shall be Douglas fir.

Treat timber piling according to Section 02190.

02120.30 Timber Pile Straps - Straps shall be approximately 1 1/4 inch wide and 0.03 inch thick, manufactured from cold-rolled, heat-treated steel having a minimum ultimate tensile strength of 150,000 psi. The strap shall encircle the pile once and be fastened with a clip that is crimped so that the joint will have a minimum tensile strength of 80 percent of the tensile strength of the strap. Install the strap after pressure treating of the pile.

02120.40 Acceptance - Acceptance of poles and piling will be according to 00165.35 and this Section.

Section 02130 - Timber and Lumber**Description**

02130.00 Scope - This Section includes the requirements for timber and lumber.

Materials

02130.10 Timber and Lumber - Unless otherwise shown or specified, all lumber and timber shall be S4S Douglas fir. Grading requirements shall be according to the Special Provisions.

All lumber shall be grade-stamped or have a mill certification by an American Lumber Standards certified inspection agency.

02130.20 Acceptance - Acceptance of Material will be according to 00165.35 and this Section.

Section 02140 - Glued Laminated Timber Members**Description**

02140.00 Scope - This Section includes the requirements for glued laminated timber members.

Materials

02140.10 General - Furnish all structural glued laminated lumber as shown and specified.

Manufacture of structural glued laminated work shall conform to the manufacturing requirements of the current ANSI/AITC A190.1 American National Standard, Structural Glued Laminated Timber.

Provide quality control according to the AITC 200 "Inspection Manual for Glued Laminated Timber".

Lumber shall be Douglas fir, southern pine, western larch, or other species, as shown or specified. Lumber used shall be of a stress grade to provide glued laminated members with the minimum stress values in bending and tension shown or specified.

Adhesives shall meet the requirements of the glued laminated lumber standards, and be waterproof.

Unless otherwise specified, appearance of members shall be architectural grade as defined in AITC 110 Standard Appearance Grades for Structural Glued Laminated Timber.

Seal surfaces of members with penetrating sealer and apply a coat of end sealer to the ends of all members as soon as practicable after end trimming, according to AITC Standard for Preservative Treatment of Structural Glued Laminated Timber. Use a clear sealer compatible with the preservative treatment used according to Section 02210.

Bundle wrap members according to AITC Recommended Practice for Protection of Structural Glued Laminated Timber During Transit, Storage and Erection.

Furnish shop details from the fabricator and obtain approval before commencing the Work. Details shall conform to the current AITC Typical Construction Details.

02140.20 Acceptance - Glued laminated timber members will be accepted according to 00165.35 and this Section.

Section 02150 - Lumber and Timber Connectors

Description

02150.00 Scope - This Section includes the requirements for connectors, bolts, nuts, washers, nails, and miscellaneous hardware for joining lumber and timber.

Materials

02150.10 Lumber and Timber Connectors:

(a) General - Galvanize connectors for treated Structures, except those of malleable iron or lightweight connectors, according to AASHTO M 111 (ASTM A123).

For all connectors and hardware that contact lumber or timber treated with Alkaline Copper Quaternary (ACQ) or Copper Azole (CA), except those used with fence posts, sign posts, guardrail post, or guardrail blocks, furnish connectors according to one of the following:

- Fabricate connectors and all associated hardware, including fasteners, with Type 304 or Type 316 stainless steel according to ASTM A480.
- Coat all connectors and associated hardware, including fasteners, according to ASTM F2833, Grade 1 or ASTM F1136, Grade 3, or approved equal.

Contact between stainless steel and non stainless steel will not be allowed.

(b) Split Ring Connectors - Provide 2 5/8 inch and 4 inch inside diameter split rings manufactured from steel conforming to ASTM A830, Grade Number 1010 (AISI C1010, SAE 1010). Each ring shall form a closed true circle with the principal axis of the Cross Section of the ring metal parallel to the geometric axis of the ring. Bevel the metal section from the central portion toward the edges to a thickness less than the mid-section. Cut through the ring in one place in its circumference to form a tongue and slot.

Cut connector grooves in timber concentric with the bolt hole and conforming to the cross-sectional shape of the rings, to provide a snug fit. The inside diameter of the groove shall be larger than nominal ring diameter so that the ring can expand slightly during installation.

(c) Shear Plate Connectors:

(1) Pressed Steel Type - Provide 2 5/8 inch diameter pressed steel shear plates manufactured from steel conforming to ASTM A830, Grade Number 1010 (AISI C1010, SAE 1010). Each plate shall be a true circle with a flange around the edge, extending from one face of the plate only and at right angles to the face. The plate portion shall have a central bolt hole and two small perforations on opposite sides of the hole and midway between the center and circumference.

(2) Malleable Iron Type - Provide 4 inch diameter malleable iron shear plates manufactured according to ASTM A47, Grade No. 32510, for malleable iron castings. Each casting shall consist of a perforated round plate with a flange around the edge projecting from one face of the plate only and at right angles to the face. The plate portion shall have a central bolt hole reamed to size with an integral hub concentric with the bolt hole and extending from the same face as the flange. Galvanize malleable iron type connectors according to AASHTO M 232 (ASTM A153).

(d) Bolts, Nuts, Nails, and Miscellaneous Hardware - Provide machine bolts and drift bolts according to ASTM A307 or ASTM A36. Washers may be cast ogee or malleable castings, or cut from steel plate.

Galvanize bolts, nuts, washers, lag screws, and wood screws, according to ASTM F2329. Provide bolts, nuts, washers, lag screws, and wood screws in standard type and make, unless otherwise shown.

(e) Lightweight Metal Connectors - Lightweight metal connectors are mass produced plate or sheet steel connectors with a maximum thickness of 1/4 inch, used to connect wood members to wood, concrete or masonry. Provide lightweight metal connectors as shown with the required minimum capacities as specified in 00570.15 of the Special Provisions. Provide copies of the test reports from the International Code Council (ICC-ES) showing that the supplied connectors meet the minimum capacities listed in the Special Provisions. All lightweight metal connectors shall be Type 304 or Type 316 stainless steel according to ASTM A480, or galvanized according to ASTM A23 or ASTM A653, coating designation G185.

(f) Nails and Miscellaneous Hardware - Provide dowels according to ASTM A307 or ASTM A36.

Galvanize rough hardware, drift pins, dowels, clamps, anchors, joist hangers, and nails according to AASHTO M 232 (ASTM A153).

Provide rough hardware, drift pins, dowels, clamps, anchors, joist hangers, and nails in standard type and make, unless otherwise shown.

02150.20 Acceptance - Lumber and timber connectors will be accepted according to 00165.35 and this Section.

Section 02190 - Preservative Treatment of Timber

Description

02190.00 Scope - This Section includes the requirements for preservative treatment of lumber, timber, round timber piling, guardrail posts and blocks, sign posts, fence posts, and other items as specified.

Materials

02190.10 General - All preservative treatment shall be according to AASHTO M 133 and its referenced AWPA Standards, except use the following according to the AWPA Standard:

- Category UC4C, Commodity Specification Section E for round timber piling in fresh water and on land.
- Category UC5A, Commodity Specification Section G for round timber piling exposed to salt or brackish water.
- Category UC4B, Commodity Specification Section A for fence and sign posts.
- Category UC4B, Commodity Specification Section A for guardrail posts and blocks.

02190.20 Drying After Treatment - When using waterborne preservatives, ~~as defined in AWPA P5,~~ dry items according to AWPA T1, Section 7.

During the drying period and until the treated items are installed on the Project, separate each layer of treated items using spacers that are at least 1/2 inch thick.

The maximum moisture content shall be 19 percent prior to installation.

Collect all spacers and other treated wood waste from the construction site and dispose of them according to 00290.20.

02190.30 Field Treatment - Field-treat damaged or drilled wood surfaces or other damaged wood surfaces according to AWPA M4, Section 6 with a preservative listed in the QPL.

Coatings

Section 02210 - Coating Materials for Timber and Concrete

Description

02210.00 Scope - This Section includes the requirements for coating Materials used on timber and concrete.

Materials

02210.10 General:

(a) Manufacturing - Furnish coating Material meeting the following requirements:

- All coats in the coating system shall be from the same manufacturer.
- Multi-component coating materials shall be proportioned by the manufacturer with each component in its correct proportion and furnished in separate containers ready for field mixing.
- Be homogeneous, free of contamination, and of a consistency suitable for the specified use.
- Not vary in composition without prior notice by the manufacturer and approval of the Engineer.
- The coating material is not reformulated.

Use the coating material before expiration of the manufacturer's recommended shelf life.

(b) Packaging - Package the material in containers meeting the following requirements:

- Be new steel or plastic of not more than 6 gallon capacity.
- Meet U.S. Department of Transportation's Hazardous Material Shipping Regulations.
- Be original and unopened.
- Be labeled with the following:
 - Manufacturer's name
 - Exact title of coating material
 - Manufacturer's batch number
 - Date of manufacture

02210.20 Coating Materials for Timber - Furnish coatings for timber from the QPL under the category "Timber Coatings".

02210.21 Sealer for Timber - Furnish clear sealers for timber from the QPL under the category "Timber Sealers".

02210.30 Coating Materials for Concrete - Furnish coatings for concrete from the QPL under the category "Latex Emulsion Paint".

Geosynthetics and Slope Protection

Section 02320 - Geosynthetics

Description

02320.00 Scope - This Section includes the requirements for geosynthetics used in various applications.

02320.01 Definitions - Geosynthetic terms are defined in 00350.01.

Materials

02320.10 Acceptance:

(a) General Requirements - Furnish all geosynthetics meeting the following requirements:

- Free of defects, cuts or tears.
- Resistant to ambient temperatures, acid and alkaline conditions, micro-organisms and insects.
- For the intended purpose and have dimensional stability.

(1) Geotextiles - Furnish woven or nonwoven geotextiles meeting the following requirements:

- Fibers used in manufacture of geotextiles, and threads used in joining geotextiles by sewing, shall consist of long-chain synthetic polymers, composed of at least 95 percent by weight of polyolefins or polyesters. They shall be formed into a stable network such that the filaments or yarns retain their dimensional stability to each other, including selvages.
- Meet or exceed the properties specified in 02320.20.
- Be free of any chemical treatment or coating that might significantly reduce permeability.

(2) Geogrids - Furnish geogrids meeting the following requirements:

- Geogrid reinforcements approved as Type 1 MSEW Geogrid on the QPL.
- Geogrid for Subgrade reinforcement approved as Subgrade Reinforcement Geogrid on the QPL.

(b) Acceptance Requirements - The actual minimum average roll values furnished by the manufacturer shall be based on representative test results from the manufacturing plant which produced the geosynthetic, and shall meet or exceed each of the specified minimum values. All geosynthetics shall be clearly labeled as being part of the same production run certified as meeting all applicable requirements.

(c) Manufacturer's Test Certification - Furnish test result certificates according to 00165.35 from the geosynthetic manufacturer, and the following:

(1) Geotextiles - For geotextiles, include the following:

- Manufacturer's name, lot number, roll number, production facility address, and full product information (style, brand, name, etc.).
- Chemical composition of filaments and yarns, including polymer(s) used.

- Minimum average roll values for each of the specified properties from the same lot of geotextiles as the delivered material.

(2) Geogrids - For mechanically stabilized earth retaining wall geogrid, include the following:

- Average roll values for each of the specified properties from the same production run as the delivered material.
- Production run number, production plant name, and location.
- Manufacturer's name and address.
- Full product name and information.
- QPL Product Category and the Standard Specification subsection number.
- Retaining wall location referencing the drawing name, detail, and structure number.
- Polymer types for geogrid and coating, if present.
- Primary resin type, class, grade, and category for HDPE (ASTM D1248) and PP (ASTM D4101).

For subgrade reinforcement geogrid, include the following:

- Minimum average roll values and average roll values for each of the specified properties from the same production run as the delivered material.
- Production run number, production plant name and location.

(d) Manufacturer's Sampling/Testing - The manufacturer's reported property values shall be based on the following sampling and testing requirements:

(1) Sampling - Sample all geosynthetics according to ASTM D4354. The production unit used for sampling shall be a roll or sheet.

(2) Geotextile Testing - Perform the specified tests to determine geotextile properties for the intended applications. The tensile strength requirements shall be tested in both machine and cross-machine directions.

(3) Geogrid Testing - For mechanically stabilized earth retaining wall geogrid, provide laboratory test results that demonstrate the average roll value for each geogrid product is greater than or equal to the geogrid ultimate wide width tensile strength reported for the initial geogrid product evaluation and approval on the QPL. Determine the ultimate wide width tensile strength (T_{ult}) according to ASTM D6637. If the average roll value for each geogrid reinforcement product is less than the geogrid ultimate wide width tensile strength identified on the QPL, the entire production run will be rejected.

(e) Agency Check Tests - The Agency reserves the right to sample and test products for compliance with pertinent requirements, according to 00165.02.

When the Agency performs check tests, the entire production run will be accepted or rejected according to 00150.25, if any of the average roll values of tested rolls are less than the specified minimum values.

02320.11 Seam Testing and Acceptance:

(a) Factory Seams - Where factory seams are made, the sheets of geotextile shall:

- Be sewn together using a lock type stitch Type 301 or 401 as shown.

- Be sewn with polymeric thread that is at least 95 percent, by weight, polyolefin or polyester, and as resistant to deterioration as the geotextile being sewn.
- Have test results showing that the seams meet or exceed 90 percent of the specified tensile strength minimum values for the intended application.
- Nylon thread will not be allowed.

(b) Field Seams - Where field sewn seams will be used, furnish:

- The manufacturer's test result certificate, according to 00165.35, that includes wide strip, tensile strength test results and verifies that seam tensile strength and seam grab tensile strength meet or exceed 90 percent of the minimum specified tensile strength values for the geotextile.
- A field-stitched seam test sample.

02320.20 Geotextile Property Values:

Table 02320-1 Geotextile Property Values for Drainage Geotextile^{1, 2}

Geotextile Property	ASTM Test Method	Unit	Geotextile Property Requirements			
			Type 1		Type 2	
			Woven	Nonwoven	Woven	Nonwoven
Grab Tensile Strength (minimum) Machine and Cross Machine Directions	D 4632	lb	180	115	250	160
Grab Failure Strain (minimum) Machine and Cross Machine Directions	D 4632	%	< 50	≥ 50	< 50	≥ 50
Tear Strength (minimum)	D 4533	lb	67	40	90	56
Puncture Strength (minimum)	D 6241	lb	370	220	495	310
Apparent Opening Size (AOS) (maximum) U.S. Standard Sieve	D 4751	—	40	40	40	40
Permittivity (minimum)	D 4491	sec ⁻¹	0.5	0.5	0.5	0.5
Ultraviolet Stability Retained Strength (minimum)	D 4355 (at 500 hours)	%	50	50	50	50

¹ All geotextile properties are Minimum Average Roll Values (MARV). The test results for any sampled roll in a lot shall meet or exceed the values shown in the table.

² Woven slit film geotextiles (geotextiles that are made from yarns of a flat, tape-like character) are not acceptable.

Table 02320-2 Geotextile Property Values for Riprap Geotextile ^{1, 2}

Geotextile Property	ASTM Test Method	Unit	Geotextile Property Requirements			
			Type 1		Type 2	
			Woven	Nonwoven	Woven	Nonwoven
Grab Tensile Strength (minimum) Machine and Cross Machine Directions	D 4632	lb	250	160	315	200
Grab Failure Strain (minimum) Machine and Cross Machine Directions	D 4632	%	< 50	≥ 50	< 50	≥ 50
Tear Strength (minimum)	D 4533	lb	90	56	110	80
Puncture Strength (minimum)	D 6241	lb	495	310	620	430
Apparent Opening Size (AOS) (maximum) U.S. Standard Sieve	D 4751	—	40	40	40	40
Permittivity (minimum)	D 4491	sec ⁻¹	0.5	0.5	0.5	0.5
Ultraviolet Stability Retained Strength (minimum)	D 4355 (at 500 hours)	%	70	70	70	70

¹ All geotextile properties are Minimum Average Roll Values (MARV). The test results for any sampled roll in a lot shall meet or exceed the values shown in the table.

² Woven slit film geotextiles (geotextiles that are made from yarns of a flat, tape-like character) are not acceptable.

Table 02320-3 Geotextile Property Values for Sediment Fence ¹

Geotextile Property	ASTM Test Method	Unit	Geotextile Property Requirements		
			Supported	Unsupported	
			—	Elongation ² ≥ 50%	Elongation ² ≤ 50%
Grab Tensile Strength (minimum) Machine and Cross Machine Directions	D 4632	lb	90 90	120 100	120 100
Apparent Opening Size (AOS) (maximum) U.S. Standard Sieve	D 4751	—	30	30	30
Permittivity (minimum)	D 4491	sec ⁻¹	0.05	0.05	0.05
Ultraviolet Stability Retained Strength (minimum)	D 4355 (at 500 hours)	%	70	70	70

¹ All geotextile properties are Minimum Average Roll Values (MARV). The test results for any sampled roll in a lot shall meet or exceed the values shown in the table.

² Measured according to ASTM D4632.

Table 02320-4 Geotextile Property Values for Subgrade Geotextile (Separation) ¹

Geotextile Property	ASTM Test Method	Unit	Geotextile Property Requirements	
			Woven	Nonwoven
Grab Tensile Strength (minimum) Machine and Cross Machine Directions	D 4632	lb	180	113
Grab Failure Strain (minimum) Machine and Cross Machine Directions	D 4632	%	< 50	≥ 50
Tear Strength (minimum)	D 4533	lb	68	41
Puncture Strength (minimum)	D 6241	lb	371	223
Apparent Opening Size (AOS) (maximum) U.S. Standard Sieve	D 4751	—	30	30
Permittivity (minimum)	D 4491	sec ⁻¹	0.05	0.05
Ultraviolet Stability Retained Strength (minimum)	D 4355 (at 500 hours)	%	50	50

¹ All geotextile properties are Minimum Average Roll Values (MARV). The test results for any sampled roll in a lot shall meet or exceed the values shown in the table.

Table 02320-5 Geotextile Property Values for Embankment Geotextile ¹

Geotextile Property	ASTM Test Method	Unit	Geotextile Property Requirements	
			Woven	Nonwoven
Grab Tensile Strength (minimum) Machine and Cross Machine Directions	D 4632	lb	315	200
Grab Failure Strain (minimum) Machine and Cross Machine Directions	D 4632	%	< 50	≥ 50
Tear Strength (minimum)	D 4533	lb	110	80
Puncture Strength (minimum)	D 6241	lb	620	430
Apparent Opening Size (AOS) (maximum) U.S. Standard Sieve	D 4751	—	30	30
Permittivity (minimum)	D 4491	sec ⁻¹	0.02	0.02
Ultraviolet Stability Retained Strength (minimum)	D 4355 (at 500 hours)	%	50	50

¹ All geotextile properties are Minimum Average Roll Values (MARV). The test results for any sampled roll in a lot shall meet or exceed the values shown in the table.

Table 02320-6 Geotextile Property Values for Pavement Overlay Geotextile ¹

Geotextile Property	ASTM Test Method	Unit	Geotextile Property Requirements
			Nonwoven
Grab Tensile Strength (minimum) Machine and Cross Machine Directions	D 4632	lb	100
Grab Failure Strain (minimum) Machine and Cross Machine Directions	D 4632	%	≥ 50
Asphalt Retention (minimum)	D 6140	oz./sq.ft.	2.8
Melting Point (minimum)	D 276	°F	300
¹ All geotextile properties are Minimum Average Roll Values (MARV). The test results for any sampled roll in a lot shall meet or exceed the values shown in the table.			

Section 02340 - Rock Gabion Baskets

Description

02340.00 Scope - This Section includes the requirements for Rock gabion baskets of twisted or welded wire mesh.

Materials

02340.10 General - Provide wire mesh Material free of breaks in the wire, breaks at weld points or other deficiencies. Individual wires of either style mesh shall meet the following minimum requirements:

Galvanizing	0.80 oz. per sq. ft. minimum
Tensile strength *	60,000 psi minimum
Wire diameter tolerance limit	± 0.004"

* Tensile area includes galvanizing

Welded wire shall also conform to AASHTO M 55 (ASTM A185) except that the weld shears shall be 600 pounds for 11 gauge, and 800 pounds for 9 gauge wires. All wire sizes are after galvanizing.

Tie wires and internal connecting wires shall be galvanized and no smaller than 13 1/2 gauge. Spiral binders may be used as an alternate to tie wire for basket assembly and basket-to-basket connections. Spiral binders shall be 9 gauge, galvanized, and have a 3 inch pitch. High tensile fasteners of the locking spring steel clip or clamp-on ring type may be used as alternates to tie wire for basket assembly only. High tensile fasteners shall be fabricated from 11 gauge steel wire with a minimum tensile strength of 240,000 psi. Provide a Class 3 zinc coating according to ASTM A764. High tensile fasteners shall provide a closed position tensile strength of 600 pounds.

All wire shall be galvanized according to ASTM A641.

02340.12 Twisted Wire Mesh Gabion Baskets - Furnish gabion panels of the twisted mesh style manufactured from 11 gauge with 9 gauge selvage wires. The mesh shall form a uniform hexagonal pattern and shall be formed with a non-raveling twist. The major axis (maximum line dimensions) of any hexagonal opening shall not exceed 4.75 inches. The area of the hexagonal opening, approximately 3.2 inches by 4.5 inches, shall not exceed 9.5 square inches.

02340.20 Welded Wire Mesh Gabion Baskets - Furnish gabion panels of the welded mesh style manufactured from 11 gauge or 9 gauge wire. The mesh shall form a nominal 3 inch by 3 inch grid pattern and conform to AASHTO M 55 (ASTM A185). The maximum line dimension of any opening shall not exceed 4.75 inches. The 12 inch and 18 inch high mattresses shall be made from 11 gauge panels. Gabions of square Cross Section (cubical-celled units) may be made with either 9 gauge or 11 gauge panels, except that within the same unit, panels of dissimilar wire sizes may not be mixed.

Galvanized 9 gauge stiffeners, placed diagonally in the baskets at the vertical one-third points, as shown on the Plans or as recommended by the manufacturer, may be used instead of perpendicular cross ties.

02340.30 PVC Coated Wire Mesh Gabion Baskets - The wire type used for PVC coated wire mesh gabions shall be either twisted wire mesh or welded wire mesh and shall conform to 02340.00 and 02340.12 or 02340.20.

The PVC coating for twisted wire mesh gabions shall be extruded onto the wire core before weaving the coated wire into a double twisted hexagonal mesh. The use and minimum diameter of the various wires is as follows:

- Gabion Panel wire core shall be manufactured from galvanized 12 gauge wire core. The overall minimum diameter of the galvanized wire core plus PVC coating shall be 0.136 inch.
- Selvage and reinforcing wire shall be of heavily galvanized 10 gauge wire core coated with PVC and having an overall minimum diameter (galvanized wire core plus PVC coating) of 0.165 inch.
- Lacing and connecting wire shall be of heavily galvanized 13 1/2 gauge wire core coated with PVC and having an overall minimum diameter (galvanized wire core plus PVC coating) of 0.120 inch.

02340.40 Fabrication - Fabricate gabions so that the sides, ends, lid and diaphragms can be assembled at the construction site into rectangular baskets of the specified sizes. Dimensions for heights, lengths and widths of gabion baskets shall be as indicated on the Plans with a tolerance of plus or minus 3 percent. Gabions shall be of single unit construction. Either connect the base, lid, ends and sides into a single unit or connect one edge of these members to the base section of the gabion in such a manner that strength and flexibility at the point of connection are at least equal to those of the mesh.

If the length of the gabion exceeds its horizontal width, equally divide the gabion by diaphragms into cells whose length does not exceed the horizontal width. The diaphragm material shall be of the same mesh and size as the body of the gabions. Furnish the gabion with the necessary diaphragms secured in proper position on the base in such manner that no additional tying at this juncture will be necessary.

Assemble the wire mesh panels (base, ends, sides, diaphragms and lid) so strength and flexibility at connections are at least equal to those of a single panel.

02340.50 Acceptance - Provide a quality compliance certificate for gabion baskets according to 00165.35.

Section 02350 - Metal Bin Retaining Walls

Description

02350.00 Scope - This Section includes the requirements for galvanized steel sheets and hardware for the assembly of metal bin retaining walls.

Materials

02350.10 Base Metal, Galvanizing, and Thickness - Design all members, fittings and appurtenances as integral units or parts of the whole assembly. The galvanized sheets used in fabricating the members shall conform to the requirements of AASHTO M 218. Bolts, nuts and miscellaneous hardware shall be galvanized or otherwise protected with approved coatings and shall be of sizes and shapes suitable for use with the members furnished.

Fabricate the members from the specified base metal of the thickness shown. In the absence of given thickness or dimensions for any member, fitting or appurtenance, the thickness of metal or dimensions of the member shall be as required to fully develop the strength of the members whose thickness and dimensions are given, and which are used in structural combination.

02350.20 Fabrication - Fabricate all members so members of the same nominal size are fully interchangeable. Fabricate and punch the members so no drilling, punching or drifting to correct defects in manufacture will be required during field assembly. Any members having improperly punched holes will be rejected. Replace with a member with properly punched holes.

Drainage and Water Distribution Materials

Section 02410 - Concrete Pipe

Description

02410.00 Scope - This Section includes the requirements for nonreinforced and reinforced concrete pipe and concrete drain pipe and tile.

Materials

02410.10 Concrete Pipe - Furnish concrete pipe meeting the following requirements:

(a) End Designs - Where rubber gasket joints are used, modify the design of the ends of the pipe sections according to AASHTO M 198 to accommodate rubber gaskets.

(b) Sloped or Skewed Ends - If the ends of pipe require sloped ends, skewed ends or both, fabricate the ends in a manner that provides good workmanship and a smooth finish, and protection to otherwise exposed reinforcement where applicable.

(c) Markings - Indent the markings required by AASHTO M 86 (ASTM C14) in the outside surface of each section of pipe.

(d) Concrete Pipe Field Permeability Tests - The Engineer may require field permeability tests on a maximum of 5 percent of each lot, class, or size of pipe according to ASTM C497 on pipe 24 inches in diameter and smaller.

Provide all the necessary labor, Equipment, water and Materials at the site for performing field permeability tests.

At the option of the pipe Supplier, and with the approval of the Engineer, individual field permeability tests may be performed at the point of manufacture.

(e) Concrete Pipe Plant Air Test - The Engineer may require that each length of concrete pipe 12 inches in diameter and smaller be given an individual air test at the point of manufacture. Use test Equipment approved by the Engineer and a test pressure of at least of 10 psi. Each length shall show no appreciable loss of air after 5 seconds.

When individual air testing is performed, no field or shop permeability tests will be required.

(f) Nonreinforced Concrete Pipe - Provide nonreinforced or plain circular concrete pipe and special sections conforming to the requirements of AASHTO M 86 (ASTM C14) or ASTM C985 and this Section.

(g) Reinforced Concrete Pipe - Provide reinforced concrete pipe and special sections conforming to the requirements of AASHTO M 170 (ASTM C76) and this Section, except as follows.

(1) Special Sections - Furnish special sections such as elbows, wyes, tees, crosses, bends and reducers as shown, specified or directed. In the absence of any design or Specifications, the special sections shall be of the design recommended by the manufacturer for the intended use. Generally the special sections shall conform to the requirements specified for the pipe with which it is to be used.

Fabricate special sections with components from tested and approved lots. Maintain production dates of components.

(2) Load Strength - Reinforced concrete pipe having the same D-load strengths as those specified to be furnished under AASHTO M 170 (ASTM C76) may be furnished according to AASHTO M 242 (ASTM C655).

(3) Acceptance - The basis of acceptance for reinforced concrete pipe manufactured according to AASHTO M 170 (ASTM C76), and AASHTO M 242 (ASTM C655) will be Paragraph 5.1.1 of AASHTO M 170.

(h) Concrete Drain Pipe - Use circular, nonreinforced perforated concrete pipe and special sections for subsurface drainage conforming to the requirements of AASHTO M 175 (ASTM C444), Type 1, all applicable requirements of AASHTO M 86 (ASTM C14), except indent the markings required by AASHTO M 86 (ASTM C14) in the outside surface of each section of pipe.

(i) Concrete Drain Tile - Provide concrete drain tile conforming to the requirements of AASHTO M 178 (ASTM C412).

02410.80 Acceptance - Except as provided in 02410.10(g)(3), acceptance of nonreinforced concrete pipe, reinforced concrete pipe, concrete drain pipe, concrete drain tile, and hardware will be according to 00165.35 and this Section.

Section 02415 - Plastic Pipe

Description

02415.00 Scope - This Section includes the requirements for polyethylene pipe, polypropylene pipe and polyvinyl chloride pipe.

02415.01 Definitions:

Corrugated Polyethylene Pipe - Pipe that is extruded to form a smooth inner wall and a corrugated external wall. The corrugations are hollow.

Polyethylene Pipe - Pipe using high density polyethylene (HDPE) resins are included in three specific sub-categories; corrugated, solid-wall, and steel-reinforced.

Solid-Wall Polyethylene Pipe - Pipe that is extruded to form a solid pipe wall. The joint may be either butt fused or bell and spigot.

Steel Reinforced Polyethylene Pipe - Pipe that is extruded to form a smooth inner wall and a corrugated external wall. The corrugations are solid and contain a continuous steel reinforcement band.

Materials

02415.10 Corrugated Polyethylene Pipe - Furnish corrugated polyethylene pipe meeting the following requirements and listed in the QPL:

Corrugated polyethylene drain pipe	AASHTO M 252
Corrugated polyethylene culvert pipe	AASHTO M 294, Type S or D
Corrugated polyethylene storm sewer pipe	AASHTO M 294, Type S or D

The allowable nominal inside diameter of corrugated polyethylene pipe is as follows:

Corrugated polyethylene drain pipe	Up to 10"
Corrugated polyethylene culvert pipe	12" - 60"
Corrugated polyethylene storm sewer pipe	12" - 60"

Furnish watertight joints for corrugated polyethylene pipe meeting the requirements of ASTM D3212 and be listed in the QPL.

02415.20 Solid-Wall Polyethylene Pipe - Furnish solid-wall polyethylene pipe and fittings from the QPL or that meet the following requirements:

- Resin that has a hydrostatic design basis (HDB) of 1,600 psi when tested and analyzed according to ASTM D2837 and has a material designation code of PE3608 or PE4710 as listed by the Plastic Pipe Institute.
- Resin meeting the requirements of ASTM D3350 and has a minimum cell classification of PE345464C (Code D or E may also be used for pipe bursting and lining pipe and for slip lining pipe).
- The pipe does not contain recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw material pipe. Do not recycle pipe, excluding black colored pipe, that is stored outside.
- Pipe and fittings meeting the requirements of ASTM F714 and ASTM D3261 as modified for the specified material.

- With legible markings, by the pipe manufacturer, with the following information:
 - ASTM designation number
 - The letters PE followed by the material designation code
 - Nominal pipe size
 - Dimension ratio
 - Name and trademark of manufacturer
 - Production code from which the date and place of manufacture can be determined

02415.30 Steel Reinforced Polyethylene Pipe - Furnish steel reinforced polyethylene pipe meeting the following requirements and be listed on the QPL:

Steel reinforced polyethylene culvert pipe.....ASTM F2562
 Steel reinforced polyethylene storm sewer pipe.....ASTM F2562

The allowable nominal inside diameter of steel reinforced polyethylene pipe is as follows:

Steel reinforced polyethylene culvert pipe..... 24" - 72"
 Steel reinforced polyethylene storm sewer pipe..... 24" - 72"

Furnish steel reinforced polyethylene pipe joints and gaskets meeting the following requirements:

Bell and spigot couplings..... ASTM D3212
 Elastomeric gasketsASTM F447

For steel reinforced polyethylene pipe, provide either factory installed gaskets on the couplings or manufacturer installed gaskets on the pipes. Provide at least silt tight joints for culvert pipe and water tight joints for storm sewer pipe. Provide watertight joints meeting the requirements of ASTM D3212 and be listed in the QPL.

02415.40 Polypropylene Pipe - Furnish polypropylene pipe and fittings meeting the following requirements and listed in the QPL:

Dual wall polypropylene pipe and fittingsASTM F2736
 Triple wall polypropylene pipe and fittings.....ASTM F2764
 Watertight joints ASTM D3212

The allowable nominal inside diameter of polypropylene pipe is as follows:

Dual wall polypropylene pipe..... 12" - 30"
 Triple wall polypropylene pipe 30" - 60"

02415.50 Polyvinyl Chloride Pipe - Furnish polyvinyl chloride pipe (PVC) subsurface drain pipe and fittings meeting the requirements of ASTM D2729.

Furnish PVC sanitary, storm, culvert, siphon, and irrigation pipe and fittings with 2 feet or more cover that have a minimum pipe stiffness of 46 psi or a ~~minimum~~ SDR of 35 or less and meet the requirements of sewer pipe ASTM D3034, ASTM F679, or ASTM F794.

Furnish PVC sanitary, storm, culvert, siphon, and irrigation pipe and fittings with less than 2 feet but at least 1 foot cover meeting the requirements of AWWA C 900 or AWWA C 905.

02415.80 Acceptance - Acceptance of polyethylene pipe, polypropylene pipe, polyvinyl chloride pipe and hardware will be according to 00165.35 and this Section.

Section 02420 - Metal Pipe

Description

02420.00 Scope - This Section includes the requirements for corrugated steel pipe, helical rib pipe, arch type pipe, aluminum pipe, ductile iron pipe, and special sections intended for use for storm drainage, underdrains and culverts, and not intended for the conveyance of sanitary or industrial waste.

Materials

02420.10 Corrugated Steel Pipe and Pipe Arches - Furnish corrugated steel pipe, helical rib pipe, pipe arches and special sections meeting the requirements of AASHTO M 36 (ASTM A760) Types I, IA, and II, except as follows:

(a) Shapes - Provide either full-circle or elliptical pipe, as the Contractor may elect, unless otherwise shown or specified. The shapes of pipe fabricated and furnished may include any of the following:

- **Full-Circle Pipe** - Fabricate helical rib pipe in full-circle Cross Section only.
- **Arch-Type Pipe**
- **Elliptical Pipe** - Full-circle pipe distorted 5 percent out-of-round by shop fabrication to form an elliptical Cross Section with the major axis vertical.
- **Half-Circle Pipe** - Fabricate as half sections of full-circle pipe of the same diameter.
- **Nestable Pipe** - Fabricate in two separate half sections designed to fit and fasten together to form a full-circle Cross Section of specified diameter. Fasten the two half sections together by approved means which shall provide at least 90 percent of the strength of a standard riveted longitudinal seam.

(b) Connecting Bands - Use connecting bands conforming to the details shown on the Plans to make field joints for pipes and pipe arches not requiring watertight joints.

(c) Special Sections - Furnish special sections such as elbows, wyes, tees, crosses, bends, reducers and flared inlets as shown or as directed.

Generally, special sections shall conform to the requirements specified for the pipe with which they are used, and shall be connected to the pipe or to each other with connecting bands specified for use with the pipe to which they are connected.

For elbows of 30° or greater total angle, use three-piece sections of approximately equal length and equal-angle segments or pieces.

Weld joints according to recognized standard practice and repair any damaged zinc or aluminum coating according to 02420.10(d).

(d) Repair of Damaged Coating - In addition to the methods given in AASHTO M 36 (ASTM A760) the Contractor may repair damaged zinc or aluminum coating by removing all loose or cracked coating, removing all welding flux, wire brushing the damaged area, and applying two coats (minimum 2 mils total thickness) of a high zinc dust content paint conforming to the general requirements of ASTM A780.

Damaged zinc or aluminum coating within 3/8 inch of the ends of pipe sections caused by production cut-off of pipe need not be repaired. Coating damage on edges of connecting bands need not be repaired.

(e) Irrigation Pipe - In irrigation pipe installations, where Type D coating (AASHTO M 190) is not specified, the Contractor will be allowed to furnish pipe with Type D coating.

(1) Riveted Seams - If pipes are not furnished with Type D coating, do the following:

- Place a bead or strip of approved caulking compound, 1/8 inch minimum diameter or thickness, between the laps of all riveted seams.
- Rivet the annular seams of riveted pipe at spacings not greater than 3 inches. Rivet in a single row the longitudinal seams of pipes less than 42 inches in diameter. Place one rivet in each valley and one on each crest of the corrugations.
- Double rivet the longitudinal seams of pipes 42 inches and larger in diameter in each valley of the corrugations and place a single rivet on each crest of the corrugations.
- At the intersection of longitudinal and circumferential seams, close the gap caused by the three-sheet lap by special fabrication. Fabricate a special longitudinal seam at the ends of pipe sections for a sufficient distance to clear the coupling bands.

Spot welding of the seams of corrugated metal pipe used in irrigation pipe installations will not be allowed.

(2) Field Joints - Use connecting bands conforming to the details shown, and make the field joints watertight.

(f) Siphon Pipe - Fabricate corrugated steel pipe used in siphons with watertight seams.

Field joints shall provide circumferential and longitudinal strength to preserve the pipe alignment, prevent separation of pipe sections and provide a watertight joint. Attach the connecting bands so they lap a nearly equal portion of each pipe section to be connected.

(g) Sloped or Skewed Ends - If the ends of pipe culverts require sloped ends, skewed ends or both, fabricate the ends in a manner that provides good workmanship and a smooth finish. Restore zinc or aluminum coating as directed according to 02420.10(d), and bituminous protective coatings and linings when specified.

02420.11 Ductile Iron - Furnish ductile iron pipe conforming to the requirements of AWWA C151. Use Pressure Class 150 - 350 or Special Thickness Class 50 - 56, as directed.

02420.20 Protective Coatings - If specified or shown, furnish corrugated metal pipes with protective coatings as follows:

(a) Bituminous Protective Coatings - Provide corrugated metal pipe and connecting bands with bituminous coatings conforming to the requirements of AASHTO M 190 and the following:

- Before immersion, the metal shall be free of grease, dirt, dust, moisture or other contaminants.
- Apply the initial bituminous coating by one of the processes under 02420.20(a)(1) or 02420.20(a)(2).
- If a second dip is required to meet the coating thickness requirements of AASHTO M 190, the time and temperature requirements of 02420.20(a)(1) or 02420.20(a)(2) need not be followed for the second dip.

- The paved invert for both Type B and Type C coatings on either circular or arch type pipe shall fill the corrugations for at least 40 percent of the circumference of the pipe.

(1) Pipe Not Preheated - The temperature of the asphalt at the time of pipe immersion shall be $400\text{ }^{\circ}\text{F} \pm 5\text{ }^{\circ}\text{F}$ and the duration of the immersion shall conform to the following schedule:

Metal Thickness (Inch)		Minimum Immersion Time (Minutes)
Steel	Aluminum	
0.064	0.060	2.5
0.079	0.075	3.0
0.109	0.105	5.0
0.138	0.135	6.5
0.168	0.164	8.0

(2) Pipe Preheated - At the time of pipe immersion the asphalt shall have a temperature of $380\text{ }^{\circ}\text{F} \pm 5\text{ }^{\circ}\text{F}$ and the pipe shall be preheated to a temperature $300\text{ }^{\circ}\text{F}$ to $350\text{ }^{\circ}\text{F}$.

(b) Type D, Fully-Bituminous Coated, Fully-Lined - The interior lining shall be smooth, uniform and free from sags and runs. Slight residual corrugations due to cooling and shrinkage of the lining will not be cause for rejection. At the three-sheet lap an interior nonuniformity equal to the thickness of the sheet will be allowed. Maintain the thickness of the lining to the ends of the pipe.

(c) Optional Paved Invert - If an asphalt coated pipe with a paved invert (Type C coating) is shown or specified, a centrifugally-applied interior lining conforming to Type D coating may be furnished as an alternate, providing the minimum thickness of bituminous coating over the crests of the corrugations is not less than 1/4 inch.

(d) Polymeric Coatings - If polymeric coating is shown on the pipe data sheet, use a coating from section 02420.20 of the QPL.

02420.30 Corrugated Steel Pipe for Underdrains - Furnish corrugated steel pipe for underdrains conforming to the requirements of AASHTO M 36 (ASTM A760) Type III - Underdrain Pipes, except as modified in 02420.10(c) and 02420.10(d), and as follows:

(a) Class IV - Semicircular pipe may be used only as an alternate with the 6 inch size of perforated full-circle drain pipe.

(b) Connecting Bands - Connecting bands for underdrain pipe field joints shall conform to the designs shown.

02420.40 Corrugated Aluminum Alloy Pipe - Furnish corrugated aluminum alloy pipe, helical rib pipe, pipe arches and special sections conforming to the requirements of AASHTO M 196 (ASTM B745), Types I, II and III, except as follows:

(a) Shapes - The shapes of the pipes to be furnished may include any of the shapes described in 02420.10(a).

(b) Connecting Bands - Use connecting bands conforming to the requirements of AASHTO M 196 (ASTM B745) and the details shown to make field joints for pipes and pipe arches not requiring watertight joints.

(c) Special Sections - Furnish special sections such as elbows, wyes, tees, crosses, bends, reducers and flared inlets as shown or as directed.

Generally, special sections shall conform to the requirements specified for the pipe with which they are used, and shall be connected to the pipe or to each other with connecting bands specified for use with the pipe to which they are connected.

For elbows of 30° or greater total angle, use a three-piece section of approximately equal length and equal-angle segments or pieces.

(d) Irrigation Pipe - In irrigation pipe installations where Type D coating is not shown or specified, the Contractor will be allowed to furnish pipe with Type D coating.

If pipes are not furnished with Type D coating, all riveted seams shall conform to the applicable provisions of 02420.10(e)(1).

Use connecting bands conforming to AASHTO M 196 (ASTM B745) and the details shown, and make the field joints watertight for pipe installations used in irrigation.

(e) Siphon Pipe - Fabricate corrugated aluminum alloy pipe used in siphons with watertight seams.

Field joints shall provide circumferential and longitudinal strength to preserve the pipe alignment, prevent separation of pipe sections and provide a watertight joint. Fabricate the connecting bands from aluminum alloy conforming to AASHTO M 196 (ASTM B745). Attach the connecting bands so they lap a nearly equal portion of each pipe section to be connected.

(f) Sloped or Skewed Ends - If the ends of pipe culverts require sloped ends, skewed ends or both, fabricate the ends in a manner that provides good workmanship and a smooth finish. Repair bituminous protective coatings and linings when specified.

02420.50 Corrugated Aluminum Alloy Pipe for Underdrains - Furnish corrugated aluminum alloy pipe for underdrains conforming to the requirements of AASHTO M 196 (ASTM B745) Type III, except as follows:

(a) Special Sections - The provisions of 02420.40(c) apply.

(b) Connecting Bands - Connecting bands for field joints shall conform to the requirements of AASHTO M 196 (ASTM B745) and the details shown.

02420.60 Acceptance - Acceptance of pipes, underdrains, and protective coatings will be according to 00165.35 and this Section.

Section 02430 - Structural Plate Pipe

Description

02430.00 Scope - This Section includes the requirements for steel and aluminum alloy plates and hardware for structural plate pipe.

Materials

02430.10 Galvanized Steel Plates:

(a) General - Furnish galvanized steel plates for structural plate pipe conforming to the requirements of AASHTO M 167 (ASTM A761).

(b) Plates for Pipe Arches - The top plates shall form an arc between 180 and 155 degrees. The bottom plates shall form an arc between 50 and 10 degrees. Join the top plates at each end to the bottom plates with corner plates to form an arc with a radius between 16 inches and 21 inches or between 29 inches and 34 inches, as applicable, and forming an arc between 87.5 and 75 degrees.

(c) Forming and Punching Plates - Form plates to provide lap joints. Punch the bolt holes so that all plates with the same dimensions, curvature, thickness, and number of bolts per foot of seam are interchangeable. Curve each plate to the proper radius so that the cross-sectional dimensions of the finished Structure will be as shown or as specified.

Fabricate bolt holes according to AASHTO M 167. Provide additional bolt holes for special conditions of installation when specified or shown.

(d) Sloped and Skewed Ends - Cut plates for forming sloped ends, skewed ends or both, to give the angle of Slope or skew shown. Burnt edges shall be free from oxide and burrs. Legibly identify each cut plate to designate its proper position in the finished Structure.

02430.20 Aluminum Alloy Plates - Furnish aluminum alloy plates for structural plate pipe conforming to the requirements of AASHTO M 219 (ASTM B746). Fabricate according to 02430.10(b) through 02430.10(d).

02430.90 Bolts, Nuts, and Washers - Furnish bolts, nuts, and washers for use with galvanized steel structural plate pipe conforming to the requirements of AASHTO M 167 (ASTM A761) and galvanized according to AASHTO M 232 (ASTM A153).

Furnish bolts, nuts, and washers for use with aluminum alloy structural plate pipe conforming to the requirements of AASHTO M 219 (ASTM B746) and galvanized according to AASHTO M 232 (ASTM A153).

02430.95 Acceptance - Acceptance of structural plate pipe and hardware will be according to 00165.35 and this Section.

Section 02440 - Joint Materials

Description

02440.00 Scope - This Section includes the requirements for joint fillers, seals, gaskets and water stop for concrete pipe joints, manhole section joints, bridge joints, and miscellaneous concrete applications.

Materials

02440.10 Preformed Joint Fillers for Concrete - Furnish preformed joint fillers for concrete from the QPL conforming to the requirements of AASHTO M 153 or AASHTO M 213.

02440.11 Poured Joint Sealant - Furnish a two-component, low modulus, rapid-cure joint sealant from the QPL.

02440.14 Backer Rod - Furnish a closed-cell, non-gassing foam material backer rod from the QPL.

02440.15 Lubricant/Adhesive - Furnish a lubricant/adhesive conforming to ASTM D4070 and according to the recommendations of the seal manufacturer.

02440.19 Steel Bridging Plate - Furnish a hot-dip galvanized, conforming to AASHTO M 111 (ASTM A123), merchant quality steel bridging plate with a minimum thickness of 1/4 inch and a width of 8 inches, cut in lengths of 4 feet or more. Drill spike holes at 12 inch centers along the centerline of the plate before galvanizing. Repair galvanization according to ASTM A780.

02440.20 Preformed Joint Seals - Furnish compression joint seals conforming to the requirements of AASHTO M 297. Use strip seals conforming to ASTM D5973.

02440.21 Elastomeric Concrete - Furnish elastomeric concrete from the QPL.

02440.30 Hot Poured Applied Joint Sealer/Filler - Furnish hot poured applied joint sealer/filler from the QPL and conforming to the requirements of AASHTO M 324, Type II (ASTM D6690, Type II).

02440.40 Gaskets for Concrete Pipe and Precast Manhole Section Joints:

(a) Preformed Flexible Joint Sealant - Furnish Materials for tongue and groove or key lock manhole joints conforming to the requirements of AASHTO M 198 (ASTM C990).

(b) Rubber Gaskets - Furnish Materials for O-ring manhole and concrete pipe joints conforming to AASHTO M 315 (ASTM C443).

02440.50 Joint Materials for Concrete Precast Manhole Section Joints:

(a) Mortar - Furnish mortar conforming to the requirements of ASTM C387, or proportioned one part Type II portland cement to two parts clean, well-graded sand passing a No. 6 screen. Admixtures may be used not exceeding the following percentages by weight of cement:

Hydrated lime	10%
Diatomaceous earth or other inert materials	5%

The consistency of the mortar shall be such that it will readily adhere to the precast concrete if using the standard tongue-and-groove type joint.

(b) Non-Epoxy (Non-Shrink) Grout - Furnish a non-epoxy (non-shrink) grout according to 02080.230. Place or pack non-epoxy (non-shrink) grouts only with the use of a non-epoxy bonding agent according to 02070.20, applied to all cured concrete surfaces being grouted. Use a bonding agent compatible with the grout used.

02440.60 Plastic Compound for Precast Manhole Section Joints - Furnish a plastic compound that is specifically manufactured for the intended use and:

- Has a putty-like, preformed homogeneous blend of hydrocarbon resins and rubber or plasticizing materials with not more than 50 percent by weight of inert mineral filler.
- Is pliable at temperatures between 32 °F and 135 °F. A specimen at 77 °F and 1/2 inch square in Cross Section shall stretch at least 1 1/2 inches before rupture when tested with the apparatus described in ASTM D113.
- Adheres firmly and cohesively to the precast manhole sections when the compound-sealed joint is flexed to its maximum extent.
- Includes a primer solution recommended by the compound manufacturer.
- Conforms with Federal Specification SS-S-00210 (GSA-FSS).

02440.70 Water Stop - Furnish either plastic or rubber water stop, as the Contractor elects, manufactured to the dimensions shown and meeting the following requirements:

(a) Plastic - Polyvinyl chloride water stop shall be manufactured from virgin polyvinyl chloride (PVC) compound. No reclaimed PVC will be allowed. The water stop shall have the following properties:

Test	ASTM Test Method	Specification (Minimum)
Tensile Strength, psi	D 412	1,800
Elongation, %	D 412	350
100% Modulus, psi	D 412	760
Low Brittle Temperature	D 746	- 50 °F
Cold Bend Test ¹		No Failures

¹ Samples maintained at -70 °F for 2 hours, then bent quickly around a 1/4 inch mandrel to 180 degrees.

(b) Rubber - Manufacture rubber water stop to the dimensions shown, in such a manner that the finished product has an integral Cross Section which will be dense, homogeneous, and free from porosity and other imperfections. The water stop shall have the following properties:

- **Hardness** - The Shore A Durometer hardness of 60 to 70 when tested according to ASTM D2240.
- **Elongation** - Minimum of 450 percent.
- **Tensile Strength** - Minimum of 3,000 psi.
- **Water Absorption** - Maximum of 5 percent by weight after immersion in water for 2 days at 158 °F.
- **Tensile Strength after Aging** - The test specimen, after accelerated aging of 7 days at 158 °F, shall retain not less than 80 percent of the original tensile strength. The tensile

strength of the test specimen, after accelerated aging of 48 hours in oxygen at 158 °F and tensile stress of 300 psi, shall be not less than 80 percent of the original tensile strength.

- **Compression Set** - Not more than 30 percent when tested according to ASTM D395, method B after 22 hours at 158 °F.
- **Specific Gravity** - 1.17 ± 0.03 .
- **Defects** - Minor surface defects such as surface peel covering less than 1 square inch, surface cavities or bumps less than 1/4 inch in longest lateral dimensions and less than 1/16 inch deep will be acceptable.

02440.80 Acceptance - Acceptance of joint Materials will be according to 00165.35 and this Section.

Section 02450 - Manhole and Inlet Materials

Descriptions

02450.00 Scope - This Section includes the requirements for precast manhole sump sections, metal frames, covers, grates, and ladders.

Materials

02450.10 Precast Concrete Manhole Sections - Furnish precast risers, cones, and cover slabs for precast concrete manholes conforming to the requirements of AASHTO M 199 (ASTM C478).

02450.15 Precast Concrete Catch Basins and Inlets - Furnish precast concrete catch basins and inlet conforming to the requirements of ASTM C913.

02450.20 Precast Concrete Sump Sections - Furnish precast rings and lids for precast concrete sumps of portland cement concrete conforming to AASHTO M 199 (ASTM C478).

02450.30 Metal Frames, Covers, Grates, and Ladders - Comply with the following:

~~Projects on State Highways~~

Item	AASHTO (ASTM) Designation	Grade
Manhole frames and covers	M 306	Class 35 B
Inlet frames and grates	M 306	Class 35 B
	M 227 (A 663)	65
	M 270 (A 709) (A 36)	36
	M 103 (A 27)	65 - 35
Manhole ladder rails	M 270 (A 709) (A 36)	36
	M 227 (A 663)	65

~~All Other Projects~~

Item	AASHTO (ASTM) Designation	Grade
Manhole frames and covers	M 105	Class 30 B
Inlet frames and grates	M 227 (A 663)	65
	M 270 (A 709) (A 36)	36
	M 103 (A 27)	65 - 35
Manhole ladder rails	M 270 (A 709) (A 36)	36
	M 227 (A 663)	65

Fabricate steps for manholes and rungs for manhole ladders from structural steel having a minimum yield strength of 28,000 psi and galvanized according to AASHTO M 111 (ASTM A123).

As an alternate, steps for manholes may be steel-reinforced plastic conforming to AASHTO M 199 (ASTM C478) and AASHTO T 280 (ASTM C497). The steel shall be deformed reinforcing bar conforming to AASHTO M 31 (ASTM A615) Grade 60, No. 4 minimum. The plastic material surrounding the reinforcing steel bar shall be injection molded, with a textured, non-slip surface and a minimum thickness over the steel of 1/16 inch. Voids in the plastic will be cause for rejection of the step.

Welding shall conform to AWS D1.1. Frames, covers and grates for use one with another shall have even and uniform bearings. Miscellaneous metal items and hardware shall conform to the appropriate requirements of Section 00560.

Provide domestic steel frames and covers from D&L Foundry and Supply or EJ (East Jordan Iron Works).

02450.40 Damaged Zinc or Aluminum Coating - Repair damaged zinc or aluminum coating according to 02420.10(d).

02450.50 Acceptance - Acceptance of manholes and inlets will be according to 00165.35 and this Section.

Section 02470 - Potable Water Pipe Materials

Description

02470.00 Scope - This Section includes the requirements for ductile iron, steel, and polyvinyl chloride (PVC) pipe 16 inches in diameter and smaller, for potable water systems.

Materials

02470.10 General - Clearly mark all pipe with the type, class, thickness, and manufacturer's name, as applicable. Lettering shall be legible and permanent under normal conditions of handling and storage. All materials in contact with potable water shall conform to ANSI/NSF Standard 61, Drinking Water System Components - Health Effects, or equivalent, and ANSI/NSF Standard 372, Drinking Water System Components - Lead Content.

02470.20 Ductile Iron Pipe:

(a) General - Use centrifugally cast ductile iron pipe meeting the requirements of AWWA C151. Ductile iron pipe shall have a cement-mortar lining and seal coating meeting the requirements of AWWA C104. Ductile iron pipe to be joined using bolted flanged joints shall be Special Thickness Class 53. All other ductile iron pipe shall be Special Thickness Class 50, unless otherwise shown or specified.

(b) Nonrestrained Joints - Nonrestrained joints shall be rubber gasket, push-on type, or mechanical type meeting the requirements of AWWA C111. Restrained joints shall conform to 02475.50.

02470.31 High Density Polyethylene (HDPE) Pipe - Use HDPE pipe meeting the requirements of ANSI/AWWA C906, Standard Code Designation of PE3408. Furnish all pipe with a minimum dimension ratio (DR) of 17. Join pipe using thermal butt fusion method that meets the requirements of ASTM D3261.

02470.40 Polyvinyl Chloride (PVC) Pipe 4 Inches and Larger:

(a) PVC Pipe Smaller Than 14 inch Diameter - PVC pipe 4 inches in diameter up to but not including 14 inches in diameter shall meet the requirements of AWWA C900, have the same outside dimensions as ductile iron pipe, and have a minimum dimension ratio (DR) of 18 or as specified or indicated.

(b) Large Diameter PVC Pipe - PVC pipe 14 inches in diameter to 16 inches in diameter shall meet the requirements of AWWA C905, have the same outside dimensions as ductile iron pipe, and have a minimum dimension ratio (DR) of 18 or as specified or indicated.

(c) Joints - Joints shall meet the requirements of ASTM D3139 using a restrained rubber gasket conforming to ASTM F477. Solvent-welded pipe joints are not allowed.

02470.45 Polyvinyl Chloride (PVC) Pipe Under 4 Inches - Polyvinyl chloride (PVC) under 4 inches in diameter shall meet the requirements of ASTM D2241. Pipe material shall be PVC 1120, PVC 1220, or PVC 2120, and shall have minimum wall thickness equal to or greater than a standard dimension ratio (SDR) of 21, or as specified or indicated. Joints shall meet the requirements of ASTM D3139 using a restrained rubber gasket meeting the requirements of ASTM F477. Solvent welded pipe joints will only be allowed when specified or indicated.

02470.50 Polyethylene Encasement - Polyethylene encasement shall conform to AWWA C105.

02470.60 Marking Tape and Wire:

(a) Marking Tape - Marking tape shall consist of inert polyethylene plastic impervious to all known alkalis, acids, chemical reagents and solvents likely to be encountered in the Soil. The width of the tape shall be as recommended by the manufacturer for the depth of installation. The tape shall be blue and imprinted continuously over its entire length in permanent black ink with the words "Caution - Water".

(b) Detectable Marking Wire - Furnish detectable marking wire with blue colored insulation and according to 00445.11. Furnish splice kits according to 00445.48.

02470.70 Acceptance - Ductile iron, HDPE, and PVC pipe will be accepted according to 00165.35 and this Section.

Section 02475 - Potable Water Fitting Materials

Description

02475.00 Scope - This Section includes the requirements for fittings, restrained joints, and couplings for ductile iron pipe, high density polyethylene (HDPE) pipe, and polyvinyl chloride (PVC) pipe for potable water systems.

Materials

02475.10 General - Bolts, nuts and washers used for securing fittings shall be of similar materials. Steel bolts shall meet the requirements of ASTM A307 for carbon steel, or ASTM F593 for stainless steel. Nuts shall meet the requirements of ASTM A563 for carbon steel and ASTM F594 for stainless steel. Iron bolts and nuts shall meet the requirements of ASTM A536, grade 65-45-12. Galvanize carbon steel bolts, nuts and washers according to 02560.40.

All materials in contact with potable water shall conform to ANSI/NSF Standard 61, Drinking Water System Components - Health Effects or equivalent, and ANSI/NSF Standard 372, Drinking Water System Components - Lead Content.

02475.20 Ductile Iron Pipe Fittings - Fittings for ductile iron pipe shall meet the requirements of AWWA C110 or AWWA C153, and shall have a minimum working pressure rating of 250 psi. Joints shall meet the requirements of AWWA C111. Fittings shall be cement mortar lined and seal coated, meeting the requirements of AWWA C104. Provide gaskets for ductile iron flanged joints that are composed of synthetic rubber, full faced, 1/8-inch thick, and conform to ANSI/AWWA C111/A21.1. Ring gaskets will be permitted only where specified or shown. The type, material and identification mark for bolts and nuts shall be provided.

02475.31 High Density Polyethylene (HDPE) Pipe Fittings - Use HDPE pipe fittings meeting the requirements of ANSI/AWWA C906, Standard Code Designation of PE3408. Furnish all pipe fittings with a minimum dimension ratio (DR) of 17. Join pipe and fittings using a thermal butt fusion method that meets the requirements of ASTM D3261. Fittings shall be of the same class as the HDPE pipe.

02475.40 Fittings for Polyvinyl Chloride Pipe 4 Inches and Larger - Fittings for PVC pipe 4 inches in diameter and larger shall be the same as specified for ductile iron pipe.

02475.45 Fittings for Polyvinyl Chloride Pipe Under 4 Inches - Fittings for PVC pipe under 4 inches in diameter shall meet the requirements of ASTM D2466.

02475.50 Restrained Joints - Restrain pipe, fittings, and valves by using an approved bolted or boltless system. Design the restraint system to operate at a working pressure that is greater than the hydrostatic test pressure identified in 01140.51(a), unless otherwise shown. No device utilizing round point set screws will be allowed. Restraint systems provided for pipe bells shall be certified for use by the pipe manufacturer.

02475.60 Bolted, Sleeve-Type Couplings for Plain-End Pipe - Bolted, sleeve type couplings, reducing or transition couplings, and flanged coupling adapters used to join plain end pipe shall meet the requirements of AWWA C219. Buried couplings used for connecting ductile iron, gray cast iron, or PVC pipe shall be ductile iron.

02475.70 Acceptance - Acceptance of fittings, restrained joints and couplings will be according to 00165.35 and this Section.

Section 02480 - Potable Water Valve Materials

Description

02480.00 Scope - This Section includes the requirements for gate valves, butterfly valves, valve boxes, valve stem extensions, tapping sleeve and valve assemblies, check valves, combination air release/air vacuum valves, and backflow prevention devices for potable water systems.

Materials

02480.10 General - Provide valves with operating nuts or hand wheels as specified or shown. Furnish a standard 2 inch operating nut. All materials in contact with potable water shall conform to ANSI/NSF Standard 61, Drinking Water System Components - Health Effects, or equivalent. When indicated, coat all interior and exterior ferrous surfaces of valves with a protective epoxy coating meeting the requirements of AWWA C550.

02480.20 Gate Valves:

(a) Minimum Pressure - Provide gate valves that meet the requirements of AWWA C500, AWWA C509, or AWWA C515. The minimum design working pressure shall be 200 psi for pipe 2 inches to 12 inches in diameter, and 150 psi for pipe 14 inches to 16 inches in diameter.

(b) Arrangement - For 16 inch diameter pipe, arrange gate valves for operation with gear case in the horizontal position. Equip valves with bypasses and gate valves of the sizes adopted in the AWWA Standards. Equip bypass gate valves with standard 2 inch operating nuts.

(c) Valves - Provide gate valves that are resilient seat, non-rising stem type, open counterclockwise, and are equipped with an O-ring stuffing box.

02480.22 Butterfly Valves:

(a) Seats and Seals - Provide butterfly valves that are rubber seated and meet the requirements of AWWA C504, Class 150B. Shaft seals shall be standard O-ring seals, designed for replacement under line pressure.

(b) Valve Operators - Provide valve operators of the traveling nut or worm gear type and that are sealed, gasketed, and permanently lubricated for buried service. Construct valve operators to the standard of the valve manufacturer to withstand all anticipated operating torques, and design to resist submergence in groundwater.

(c) Valves - Provide butterfly valves that are resilient seat, open counterclockwise, and are equipped with an O ring stuffing box.

02480.25 Valve Boxes - Install valve boxes on all buried valves. Boxes shall be of cast iron, two-piece, slip type standard design, with a base corresponding to the size of the valve. The cover shall have the word "WATER" cast in it.

02480.26 Valve Stem Extensions - Valve stem extensions shall have a 2 inch square operating nut and self-centering rockplate support. Valves with an operating nut more than 3 feet below grade shall have a valve stem extension to raise the operating nut to within 3 feet of the ground surface.

02480.30 Tapping Sleeve and Valve Assemblies:

(a) Valve Assemblies - Furnish tapping valves with flanged inlet end connections. The outlet ends shall conform in dimensions to the AWWA Standards for mechanical joint connections or

flange connections, except that the outside of the end connection shall have a large flange for attaching a drilling machine. The seat opening of the valve shall permit a diameter cut no less than 1/2 inch smaller than the valve size. Valves specifically designed for tapping meeting the requirements of AWWA C500, and valves meeting the requirements of AWWA C509, will be allowed. Tapping valves shall be of the same type as other valves on the Project.

(b) Sleeves - Tapping sleeves shall be cast iron, ductile iron, stainless steel, epoxy coated steel or other approved Material.

02480.40 Check Valves - Check valves shall conform to the following:

(a) Swing Check Valve - Swing check valves shall meet the requirements of AWWA C508, with rubber seat materials mating with metal seating surfaces. The minimum design working pressure shall be 175 psi for check valves with diameters of 12 inches and smaller, and 150 psi for check valves with diameters of 14 inches and 16 inches. Check valves shall be non-assisted, unless otherwise indicated.

(b) Spring-Loaded Plug or Disc Check Valves - Spring-loaded plug or disc check valves shall be bronze mounted with bronze, cast or ductile iron body, bronze plug or disc, stainless steel spring, and resilient seating suitable for potable water service. The valves shall provide drop-tight sealing. The plugs or discs shall be easily replaceable. The minimum design working pressure of the valves shall be 150 psi.

02480.60 Combination Air Release/Air Vacuum Valves - Furnish combination air release/air vacuum valves that meet the requirements of AWWA C512. The valve body shall have a minimum design working pressure of 300 psi. The body and cover shall be cast iron conforming to ASTM A48, Class 30. Floats shall be stainless steel conforming to ASTM A240 and designed to withstand 1,000 psi. Seats shall be Buna-N rubber. Internal parts shall be stainless steel or bronze.

02480.70 Backflow Prevention Devices - Backflow prevention devices shall be capable of withstanding a minimum design working pressure of 150 psi, and shall conform to the following:

(a) Reduced Pressure Backflow Prevention Assembly - Reduced pressure backflow prevention assemblies shall consist of a mechanical, independently operating, hydraulically dependent relief valve located between two independently operating, spring loaded check valves that are located between two tightly closing resilient seated shutoff valves, with four resilient seated test cocks, all meeting the requirements of AWWA C511 and the Oregon State Health Division.

(b) Double Detector Check Valve Backflow Prevention Assembly - Double detector check valve backflow prevention assemblies shall consist of two spring loaded, independently operating check valves, located between two tightly closing resilient seated shutoff valves, with four resilient seated test cocks, all meeting the requirements of AWWA C510 and the Oregon State Health Division.

02480.80 Acceptance - Valves and appurtenances will be accepted according to 00165.35 and this Section.

Section 02485 - Hydrant and Appurtenance Materials

Description

02485.00 Scope - This Section includes the requirements for hydrants and hydrant appurtenances for potable water systems.

Materials

02485.10 Hydrants - Furnish hydrants that are dry-barrel conforming to AWWA C502, of standard manufacture and of a pattern approved by the Agency. Hydrants shall be designed for a minimum working pressure of 150 psi.

All materials in contact with potable water shall conform to ANSI/NSF Standard 61, Drinking Water System Components - Health Effects, or equivalent.

02485.20 End Connections - The end connections shall be mechanical joint or flanged, meeting the requirements of AWWA C110 and AWWA C111.

02485.30 Hydrant Dimensions and Nozzle Features:

(a) Hydrant Dimensions - Barrels shall have a 7 inch minimum inside diameter. Hydrant length, measured from the bottom of the hydrant to the sidewalk ring, shall provide proper cover at each installed location. Valve openings shall have a minimum diameter of 5 1/4 inches.

(b) Nozzle Features - Hydrants shall have two 2 1/2 inch diameter hose nozzles and one pumper nozzle to match the Agency's connection requirements.

Fit nozzles with cast iron threaded caps with operating nuts of the same design and proportions as the hydrant stem nuts. Thread caps to fit the corresponding nozzles and fit with suitable neoprene gaskets of positive water tightness under test pressures. The direction of opening shall be counterclockwise and shall be clearly marked on the operating nut or hydrant top. Hydrants shall have O-ring stem seals. Interior and exterior painting of the hydrant shall conform to AWWA C502.

02485.40 Hydrant Extensions - Hydrant extensions shall be gray cast iron or ductile iron with an inside diameter of at least 6 inches, and shall conform to the AWWA Standards for such castings. The drillings of the connecting flanges on the extensions shall match the drillings of the flanges on the hydrant.

Hydrant extensions shall also include the necessary hydrant operating stem extensions.

02485.50 Traffic Flange - Provide hydrants with a traffic flange. Hydrants shall be equipped with breaking devices at the traffic flange which will allow the hydrant barrel to separate at this point with a minimum breakage of hydrant parts in case of damage. Also provide, at this point, a safety stem coupling on the operating stem that will shear upon impact.

02485.60 Tie Rods - Tie rods shall be 3/4 inch diameter with threaded ends, galvanized according to 02560.40 and conforming to 02560.30.

02485.80 Acceptance - Acceptance of hydrants and hydrant appurtenances will be according to 00165.35 and this Section.

Section 02490 - Potable Water Service Connection Materials, 2 Inch and Smaller**Description**

02490.00 Scope - This Section includes the requirements for potable water service connections 2 inches in diameter and smaller, and sampling stations.

Materials

02490.10 General - Service line materials shall conform to AWWA C800 and these Specifications. Provide service line materials that are designed for a working pressure of 100 psi. Where high pressure service materials are specified or shown, provide materials that are designed for a working pressure of 150 psi. Use high pressure service materials when service line is hydrostatically tested concurrent with the water main. All materials in contact with potable water shall conform to ANSI/NSF Standard 61, Drinking Water System Components - Health Effects, or equivalent.

02490.20 Saddles - Saddles shall be ductile iron, bronze or stainless steel. Saddles used for 3/4 inch and 1 inch services shall be single strap saddles and have either AWWA tapered thread or female iron pipe thread outlet. Saddles used for 1 1/2 inch and 2 inch services shall be double strap saddles with female iron pipe thread outlet. Saddles used on asbestos cement or on PVC pipe shall be formed for the pipe and have flat, stainless steel straps.

02490.30 Service Connection Valves:

(a) Corporation Stops - Corporation stops shall be constructed of bronze alloy. Corporation stops for direct tapping shall have AWWA tapered thread inlet and outlet connections compatible with either copper or polyethylene tubing.

(1) Less Than or Equal to 1 Inch - Corporation stops used with 3/4 inch and 1 inch outlet saddles shall have either AWWA tapered thread or male iron pipe thread inlets and outlet connections compatible with either copper or polyethylene tubing. Thread patterns for the saddle outlet and corporation stop inlet shall be the same.

(2) Greater Than 1 Inch - Corporation stops used with 1 1/2 inch and 2 inch outlet saddles shall have male iron pipe thread inlets and outlet connections compatible with connecting service pipes, or have male iron pipe thread outlets.

(b) Angle Meter Valves - Angle meter valves shall meet the requirements of ASTM B62. All angle meter valves shall have a lock wing.

(c) Customer Service Valves - Customer service valves shall be bronze straight gate valves or angled gate valves on all services smaller than 2 inch and shall be non-rising stem, solid disc type with screwed or union bonnet, threaded ends, and a have brass handle. Body, bonnet, operating handle, and disc shall be ASTM B62 bronze. Stems shall be copper silicon alloy, nickel plated steel, or other approved corrosion resistant materials with equal characteristics of strength and durability. The disc shall clear the port area completely in the fully opened position. Threaded ends shall meet the requirements of ANSI B2.1.

02490.40 Service Pipe and Fittings:

(a) Copper Tubing Service Pipe - Copper tubing service pipe shall be annealed, seamless tubing conforming to the requirements of ASTM B88, Type K.

(b) Polyethylene Tubing Service Pipe - Polyethylene tubing service pipe shall meet the requirements of AWWA C901. Tubing shall be high molecular mass with a 200 psi rating.

Tubing used for 3/4 inch and 1 inch shall be either SDR 7 (iron pipe size) or SDR 9 (copper tube size). Tubing used for 1 1/2 inch and 2 inch shall be SDR 9 (copper tube size).

(c) Service Fittings - Make fittings used for service connections of bronze alloy. Fittings used for copper tubing shall be either compression or flare type, insulated or noninsulated.

Fittings used for polyethylene tubing shall be either compression or stab type. Stab type fittings shall utilize an internal grip ring and O-ring seal. Use stainless steel liners when utilizing compression fittings on polyethylene tubing.

02490.50 Meter Setters - Meter setters shall be manufactured and tested according to all applicable parts of AWWA C800. Meter setters shall be 12 inches in height and shall have an angle meter stop with drilled padlock wing, an angle check valve, and inlet and outlet threads compatible with fittings connecting to service pipes.

Meter setters for 5/8 inch by 3/4 inch, 3/4 inch, and 1 inch services shall have meter saddle nuts for installation and removal of the meter. Meter setters for 1 1/2 inch and 2 inch services shall be equipped with a locking bypass.

02490.60 Bronze Nipples and Fittings - Bronze threaded nipples and fittings shall meet the requirements of ANSI B16.15, ASA 125 pound class.

02490.70 Meter Boxes:

(a) Nontraffic Areas - Construct meter boxes and covers located in the nontraffic areas of either reinforced concrete or high density polyethylene. High density polyethylene meter boxes and covers shall have a tensile strength conforming to ASTM D638. Meter box covers shall include a reading lid.

(b) Traffic Areas - Construct meter boxes located in traffic areas of either reinforced concrete, cast iron or ductile iron. Construct traffic covers of aluminum, steel, cast iron or ductile iron. Meter boxes and covers shall be designed for continuous H-20 traffic loading.

02490.80 Sampling Stations - Sampling stations shall have a 3/4 inch inlet with the depth of bury indicated, and a 3/4 inch unthreaded nozzle. Enclose the sampling station in a lockable, non-removable, cast aluminum housing. When opened, the station shall require no key for operation, and the water shall flow in an all-brass waterway. All working parts shall also be of brass and be removable from above ground with no digging. Exterior piping shall be brass. Include at each station a copper vent tube with a ball valve to enable the station to be pumped free of standing water to prevent freezing.

02490.90 Acceptance - Materials for potable water service connections will be accepted according to 00165.35 and this Section.

Structures

Section 02510 - Reinforcement

Description

02510.00 Scope - This Section includes the requirements for bars, dowels, and strand reinforcement and tendon ducts.

Materials

02510.10 Deformed Bar Reinforcement - Furnish deformed bar reinforcement from the QPL and conforming to the requirements of ASTM A706, AASHTO M 31 (ASTM A615), or AASHTO M 18M334 (ASTM A1035 CS). Unless otherwise specified or shown, all reinforcing bars shall be Grade 60.

For pre-cast manholes and bases, the steel reinforcement may be replaced with Fibermesh 1 as manufactured by the Fibermesh Company or approved equal. The minimum length of the fibers shall be two (2) inches with a minimum of one pound of fiber per cubic yard of concrete.

02510.11 Epoxy Coated Reinforcement:

(a) Plant Certification - Epoxy coating shall be applied in a coating plant certified by the Concrete Reinforcing Steel Institute (CRSI).

(b) Handling - All systems for handling coated bars shall have padded contact areas for the bars wherever feasible. Pad all bundling bands. Lift all bundles with strong-backs, multiple supports, or platform bridges so as to prevent bar-to-bar abrasion from sags in the bar bundle.

(c) Coated Reinforcement Ties and Supports - Ties for coated reinforcement, including ties for coated-to-uncoated reinforcement connections, shall be nonmetallic coated.

(d) Epoxy Coating Repair - Repair damaged areas and visible voids according to 00530.45.

02510.20 Mechanical Splices - Mechanical splices for reinforcing bars are systems which connect the bars without raising their temperature above 1,300 °F.

- Provide mechanical splices from the QPL that develop at least the specified tensile strength or 135 percent of the specified minimum yield strength of the reinforcing bars in tension, whichever is less. Where bars of different sizes or strengths are connected, the governing strength shall be the strength of the smaller or weaker bar.
- The total slip of reinforcing bars within a splice sleeve shall not exceed 0.040 inch, measured between gauge points clear of the splice sleeve, when the reinforcing bars are loaded in tension to 67 percent of the specified minimum yield strength of the reinforcing bar.

02510.25 Headed Bar Reinforcement - Furnish Class HA headed steel bar from the QPL for concrete reinforcement. The headed steel bar shall develop the specified minimum tensile strength of the reinforcing bars, according to ASTM A970. Ferrous-filler coupling sleeves, forged headed steel bars, and welded headed steel bars are not allowed for concrete reinforcement.

02510.30 Galvanized Reinforcement:

(a) General - Galvanized reinforcement shall conform to the requirements of ASTM A767, Class II, including Supplementary Requirement S3, and ASTM A143.

(b) Fabrication - The bars may be fabricated before or after galvanizing. If the bars are fabricated after galvanizing, Supplementary Requirements S1 and S2 of ASTM A767 shall apply.

(c) Handling - All systems for handling galvanized bars shall be according to 02510.11(c).

(d) Ties and Supports - Tie all mats of galvanized steel bars with galvanized ties. Precast concrete blocks that support galvanized reinforcement shall have galvanized ties.

02510.40 Welded Wire Reinforcement - Welded wire reinforcement and deformed welded wire reinforcement shall conform to the requirements of ASTM A1064.

For pre-cast manholes and bases, the welded wire reinforcement may be replaced with Fibermesh 1 as manufactured by the Fibermesh Company or approved equal. The minimum length of the fibers shall be two (2) inches with a minimum of one pound of fiber per cubic yard of concrete.

02510.50 Dowels - Dowels shall conform to the requirements of AASHTO M 31 (ASTM A615), for Grades 40 and 60, or AASHTO M 227 (ASTM A663) for Grades 70, 75, and 80.

02510.60 Wire Reinforcement - Wire reinforcement and deformed wire reinforcement shall conform to the requirements of ASTM A1064.

02510.70 Acceptance - Acceptance of reinforcement will be according to 00165.35 and this Section.

Section 02515 - Prestressing Reinforcement

Description

02515.00 Scope - This Section includes the requirements for seven-wire strand, high tensile strength wire, high tensile strength steel alloy bars, tendon duct and couplings.

Materials

02515.10 Seven-Wire Strand - Seven-wire strand (bright wire) shall conform to the requirements of AASHTO M 203 (ASTM A416), Grade 270, supplement 1 (low relaxation strand), minimum ultimate strength, 270,000 psi.

02515.20 Wire, High Tensile Strength - High tensile strength wire shall conform to the requirements of AASHTO M 204 (ASTM A421).

02515.30 Bars, High Tensile Strength - High strength steel bars shall conform to the requirements of AASHTO M 275 (ASTM A722).

02515.40 Seven-Wire Strand Epoxy Coated Reinforcement - Epoxy coated reinforcement shall conform to the requirements of ASTM A882.

02515.50 Tendon Duct - Provide rigid galvanized steel ducts conforming to the requirements of ASTM A653 with a coating weight of G90 for post-tensioned Structures. Transition couplings connecting rigid ducts in anchoring devices need not be galvanized.

Rigid ducts may be fabricated with either welded or interlocking seams. Galvanizing of the welded seam is not required. Provide ducts with sufficient strength to maintain their correct alignment during placing of concrete and resist denting during construction.

Minimum wall thickness of ducts shall be 26 gauge for 2 5/8 inch diameter and smaller ducts, and 24 gauge for ducts that are larger than 2 5/8 inch diameter.

02515.60 Couplings - Provide couplings that develop at least 95 percent of the minimum specified ultimate strength of the prestressing steel without exceeding anticipated set. The coupling of tendons shall not reduce the elongation at rupture below the requirements of the tendon itself.

02515.70 Shipping Protection - Package prestressing steel to protect the steel against physical damage and corrosion. Place a corrosion inhibitor that prevents rust or other results of corrosion in the package, or use a corrosion inhibitor type packaging material, or when allowed, apply directly to the steel. Provide a corrosion inhibitor that has no deleterious effect on the steel or concrete or bond strength of steel to concrete. Immediately replace or restore damaged packaging.

Mark the shipping package with the type of corrosion inhibitor used, and the date packaged.

02515.80 Acceptance - Acceptance of pre-stressing reinforcement will be according to 00165.35 and this Section.

Section 02520 - Steel and Concrete Piles

Description

02520.00 Scope - This Section includes the requirements for steel pipe, steel H-beams, steel sheets, and pre-stressed concrete used for piling.

Materials

02520.10 Steel Piles:

(a) General - All steel piles, except steel pipe piles, shall meet the requirements for Camber and sweep specified in AASHTO M 160 (ASTM A6).

(b) Steel Pipe Piles - Steel pipe piles shall be either spirally welded or longitudinally welded, constant in section, and conforming to ASTM A252, Grade 2 or 3, or API 5L X42 or X52. Seal tips with a 1 inch thick steel plate or an approved cast steel point welded in place, when specified. Concrete used to fill steel pipe pile shall be Class 3300 - 1 1/2, 1, or 3/4.

(c) Steel H-Piles - Steel H-piles shall be rolled steel pile sections of the size and weight shown. Steel shall conform to the requirements of ASTM A36 or ASTM A572, Grade 50. The manufacturer's name, brand or trademark may be shown by die stamping in the web at intervals not exceeding 20 feet along the length of the pile.

(d) Steel Sheet Piles - Steel sheet piles shall conform to AASHTO M 202 (ASTM A328).

(e) Reinforced Pile Tips - Steel pile tip reinforcement includes H-pile points, pipe pile shoes or points or any other proprietary steel pile tip reinforcement. Legibly mark or tag each cast steel point or shoe delivered to the Project Site with the heat or lot number. Submit certified mill test reports showing the physical and chemical properties of each heat or lot number. If the heat or lot number cannot be read on the point or if the mark or tag is missing, the point or shoe will be rejected.

Provide reinforced tips for steel H-piles from the QPL. In addition, all cast steel points or shoes shall conform to the following:

ASTM A27, Grade 65 - 35
 ASTM A27, Grade 70 - 36
 ASTM A27, Grade 70 - 40
 ASTM A148, all grades

For steel H-piles provide no less than a 5/16 inch fillet weld full width of each flange.

(f) Sampling and Field Testing Pile Tips - The Engineer may randomly sample from each heat or lot number, at least one pile tip or up to 10 percent of the tips for larger projects, of the pile tips delivered for incorporation into the Project.

The selected tips shall be tested as follows:

- Grind five smooth spots on each randomly selected tip. The Engineer will test each smooth spot on each tip with a portable hardness tester or in a laboratory. If three or more of the five spots tested have a reading below 74 on the "B" scale, the tested tip and the entire lot shall be rejected.

- For steel H-piles, determine the weight of the tips. Each cast steel H-pile point shall have a weight not less than 30 percent of the weight of a 1 foot section of the H-pile to which it will be attached. If any of the tested tips fail to pass the minimum weight criteria the entire lot shall be rejected.

Pile tips that are supplied unattached to the pile may be selected for nondestructive testing as described above. Pile tips passing the field test may be incorporated into the Project. Pile tips selected for testing that are supplied already attached to the pile will be destructively tested as determined by the Engineer. Provide replacement tips for the tips that are destructively tested at no cost to the Agency. Replace rejected tips with new tips and rejected lots with new lots at no additional cost to the Agency. No time extension or other compensation will be granted for materials or Work required in testing pile tips, replacing rejected pile tips or for replacing tips that are destructively tested. New tips and new lots may also be tested according to the requirements above.

02520.20 Prestressed Concrete Piles:

(a) General - Prestressed concrete piles shall be manufactured according to Section 00550 and as shown.

(b) Concrete - Concrete in precast, prestressed piles shall be Class 5000 - 1 or 3/4. Minimum concrete strength at transfer of prestressing force shall be 4,000 psi. Concrete in pile extensions or "build-ups" shall be Class 3300 - 1 1/2, 1, or 3/4.

(c) Prestressing Reinforcement - Prestressing reinforcement steel shall consist of seven-wire, low-relaxation strands conforming to 02515.10.

(d) Mild Steel Reinforcement - Spiral reinforcement shall be plain reinforcing steel meeting the requirements of 02510.10 or cold-drawn wire meeting the requirements of 02510.60. All other mild reinforcing steel shall meet the requirements of AASHTO M 31 (ASTM A615), Grade 60.

(e) Forms - The use of steel forms on concrete founded casting beds is required. Forms shall enclose all except the top horizontal surface, and shall be mortar-tight. Forms for piles shall not cause the formation of fins at the intersection of surfaces.

(f) Tolerances - The maximum sweep (deviation of straightness measured along two perpendicular faces of the pile, while not subject to bending forces) shall not exceed 1/8 inch in any 10 feet of length, 3/8 inch in 40 feet, or 3/16 inch x total length in feet per 20 feet.

(g) Finish - The tops of concrete castings shall be given a uniformly smooth finish to match the finish surface of the formed sides.

02520.30 Acceptance - Material for piles will be accepted according to 00165.35 and this Section.

Section 02530 - Structural Steel

Description

02530.00 Scope - This Section includes the requirements for structural steel used in the fabrication of Bridges and non-Bridge Structures.

Materials

02530.10 Structural Steel for Bridges - Structural steel for Bridges shall conform to the following, as shown or specified:

- AASHTO M 270, Grade 36 (ASTM A709, Grade 36)
- AASHTO M 270, Grade 50 (ASTM A709, Grade 50)
- AASHTO M 270, Grade 50W (ASTM A709, Grade 50W)
- AASHTO M 270, Grade HPS 70 (ASTM A709 Grade HPS 70)
- AASHTO M 270, Grade HPS 70W (ASTM A709 Grade HPS 70W)

Supplementary Requirement S4 (AASHTO M 270 (ASTM A709)) Fracture-Critical, *F*, Material; Toughness Testing and Marking, is mandatory for all fracture critical steel. Toughness requirements for all areas of Oregon shall be according to Zone 2 requirements.

Supplementary Requirement S6, Limitation on Weld Repair, is mandatory for all fracture critical steel.

Supplementary Requirement S2, Product Analysis, of AASHTO M 160 (ASTM A6) is mandatory for all steel plate that will be welded. The product analysis shall be on a heat frequency. It shall include all elements listed in Table A of AASHTO M 160 (ASTM A6), regardless of the material specification, except that nitrogen need not be reported unless specified in the product specification. The product analysis shall be submitted to the Engineer immediately upon receipt of the steel.

02530.20 Structural Steel for Non-Bridge Structures - Structural steel for metal sign Structures and other non-Bridge Structures shall conform to the following, or as shown or specified:

- AASHTO M 270, Grade 36 (ASTM A709, Grade 36)
- ASTM A36
- AASHTO M 270, Grade 50 (ASTM A709, Grade 50)
- ASTM A572

Notch toughness of all structural steel members and plates greater than 1/2 inch thick in load carrying members of sign Bridges and cantilever sign supports shall conform to Zone 2 requirements of AASHTO M 270.

02530.40 Ultrasonic Inspection of Plate - Ultrasonically inspect flanges 2 inches and thicker for welded plate girders before fabrication according to ASTM A578 except as follows:

- Section 7, Acceptance Standard - Level A, and Section 8, Acceptance Standard - Level B, do not apply. Use Supplementary Requirement S2.1 for acceptance standard.
- Inspection of flanges of rolled shapes with flanges thicker than 1 3/4 inches.

02530.50 Universal Mill Plate - Universal mill plate shall not be used.

02530.60 Rolled Shapes - With the approval of the Engineer, rolled shapes having equal or greater section properties and meeting minimum flange and web thickness requirements may be substituted for members specified on the Plans, at no additional cost to the Agency.

02530.70 Galvanizing - Galvanizing shall be by the hot-dip process according to the following, as applicable:

- AASHTO M 111 (ASTM A123)
- AASHTO M 232 (ASTM A153)

Steel that will be finished by hot-dip galvanizing for use as sign Bridges, illumination poles, traffic signal poles, sign supports, bridge rail and items designated on the Plans as "Galvanize - Control Silicon" shall have controlled silicon content. The silicon content shall be in either of the ranges 0 - 0.04 percent or 0.15 percent - 0.25 percent. Before galvanizing, submit mill test certificates verifying silicon content to the Engineer and the galvanizer.

02530.71 Repair of Hot-Dip Galvanizing - Repair damaged hot-dip galvanizing according to ASTM A780 and ASTM A123. Furnish galvanizing repair Material from the QPL. Minimum dry film thickness is 3 mils. Minimum zinc content for Method A2 is 92 percent on the dry film.

02530.80 Acceptance - Acceptance of structural steel will be according to 00165.35 and this Section.

Section 02540 - Forgings, Shafting, Castings, and Nonferrous Materials

Description

02540.00 Scope - This Section includes the requirements for forgings, shafting, castings, and nonferrous materials except those used in potable water systems. For potable water system requirements, see Sections 02470, 02475, 02480, and 02490.

Materials

02540.10 Steel Forgings - Steel forgings shall conform to the following:

Carbon steel forgings AASHTO M 102 (ASTM A668), Class C
Alloy steel forgings AASHTO M 102 (ASTM A668), Class G

02540.20 Steel Shafting - Steel shafting shall be cold-finished and shall conform to AASHTO M 169 (ASTM A108), Grades 1016 - 1030, inclusive.

02540.30 Steel Castings - Steel castings shall conform to the following:

Carbon steel castings AASHTO M 103 (ASTM A27), Grade 70-36
Alloy steel castings AASHTO M 163 (ASTM A743), Grade CA-15

Castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes and other defects in positions affecting their strength and value for the service intended. Allowance will be made in dimensions for reasonable pattern draft.

Castings shall be boldly filleted at angles and the arises shall be sharp and perfect.

Sandblast castings or otherwise effectively clean of scale and sand to present a smooth, clean and uniform surface.

02540.40 Iron Castings - Iron castings shall conform to the following:

- **Gray Iron Castings** - AASHTO M 306.
- **Ductile Iron Castings** - AASHTO M 306. In addition to the specified test coupons, test specimens from parts integral with the castings, such as risers, shall be tested for castings weighing over 1,000 pounds.
- **Malleable Iron Castings** - ASTM A47, Grade 32510.

Finish iron castings according to 02540.30.

Clean iron castings according to 02540.30.

02540.50 Nonferrous Materials - Nonferrous Materials shall conform to the following:

Bronze castings AASHTO M 107 (ASTM B22) Copper Alloy UNS No. C91100
Copper alloy plates AASHTO M 108 (ASTM B100) Copper Alloy UNS No. C51000

02540.60 Acceptance - Acceptance of forgings, shafting, castings, and nonferrous Materials will be according to 00165.35 and this Section.

Section 02560 - Fasteners

Description

02560.00 Scope - This Section includes the requirements for fasteners.

Materials

02560.10 Carbon Steel Fasteners:

(a) Bolts - Carbon steel bolts shall conform to ASTM A307, Grade A or B.

(b) Nuts - Nuts for carbon steel bolts shall conform to the requirements of the following, or equivalent:

Plain (Noncoated) Bolts:

- 1/4" - 1 1/2" - ~~AASHTO M 291~~ (ASTM A563), Grade A, hex
- Over 1 1/2" - 4" - ~~AASHTO M 291~~ (ASTM A563), Grade A, heavy hex

Galvanized Bolts:

- All - ~~AASHTO M 291~~ (ASTM A563), Grade A, C, D, or DH, heavy hex

(c) Washers - Washers for carbon steel bolts shall conform to ASTM F436.

02560.20 High-Strength Fasteners:

(a) Bolts - High-strength bolts shall conform to AASHTO M 164 (ASTM A325). High-strength bolts used in noncoated weathering steel connections shall be Type 3.

(b) Nuts - Nuts for high-strength bolts shall conform to the requirements of the following, or equivalent:

Type 1 Plain (Noncoated) Bolts:

- All - Heavy Hex ~~AASHTO M 291~~ (ASTM A563), Grade C, D, or DH

Type 1 Galvanized Bolts:

- All - Heavy Hex ~~AASHTO M 291~~ (ASTM A563), Grade DH

Type 3 Bolts:

- All - Heavy Hex ~~AASHTO M 291~~ (ASTM A563), Grade C3 or DH3

(c) Washers - Washers for high-strength bolts shall conform to ASTM F436. Use Type 3 washers with Type 3 bolts.

(d) Direct Tension Indicators - Direct tension indicators shall be the compressible-washer type, mechanically galvanized, conforming to ASTM F959. Adjust bolt lengths to accommodate both direct tension indicators and hardened washers.

(e) Markings - All bolts, nuts, washers and direct tension indicators shall be marked according to the appropriate AASHTO/ASTM specifications and with a symbol identifying the manufacturer.

(f) Lock Pin and Collar Fasteners – ~~The shank and head of high strength steel lock pin and collar fasteners shall meet the requirements of 02560.20(a) and the chemical composition and mechanical property requirements of AASHTO M 164 (ASTM A325) types, as specified. Each fastener shall have the following:~~

- ~~• A solid shank body of sufficient diameter to provide tensile and shear strength equivalent to or greater than the bolt specified.~~
- ~~• A cold-forged round head on one end, of type and dimensions as approved.~~
- ~~• A shank length suitable for the thickness of the material fastened.~~
- ~~• Annular locking grooves.~~
- ~~• A breakneck groove (annular).~~
- ~~• Annular pull grooves (all annular grooves) on the opposite end.~~
- ~~• A steel locking flange type collar, of proper size for the shank diameter used. The collar shall be cold-swaged into the locking grooves by means of suitable installation tools, approved by the fastener manufacturer, to form a head for the grooved end of the fastener after the pull groove section has been removed. The steel locking collars shall be equipped with tab locks to prevent slippage during installation and shall be a standard product of an approved, established manufacturer of lock pin and collar fasteners.~~

~~Where lock pin and flange type collar fasteners are used, flat washers will not be required.~~

~~Clean the exposed end of the pin, where the pintail breaks away from the pin, with a wire brush and solvent. After cleaning, coat the exposed end with a zinc and micaceous iron oxide-filled single component moisture-cured urethane primer, followed by micaceous iron oxide-filled single component top coat colored to match the work. On galvanized fasteners, the exposed end of the pin may also be repaired according to ASTM A780.~~

~~Type 3 fasteners do not require coating.~~

02560.30 Tie Rods, Anchor Bolts, and Anchor Rods:

(a) Steel Tie Rods, Anchor Bolts, and Anchor Rods - Steel tie rods, anchor bolts, and anchor rods shall conform to: AASHTO M 314, Grade 36 or 55; ASTM F1554, Grade 36 or 55.

(b) High-Strength Tie Rods, Anchor Bolts, and Anchor Rods - High-strength tie rods, anchor bolts, and anchor rods shall conform to: AASHTO M 314, Grade 105; ASTM F1554, Grade 105; or ASTM A449, Type 1.

(c) Nuts - Nuts for tie rods, anchor bolts, and anchor rods shall conform to the requirements of the following, or equivalent:

Plain Steel Tie Rods, Anchor Bolts, and Anchor Rods:

- All - Heavy Hex AASHTO M 291 (ASTM A563), Grade A

Galvanized Steel Tie Rods, Anchor Bolts, and Anchor Rods:

- All - Heavy Hex AASHTO M 291 (ASTM A563), Grade A, C, D, or DH

Plain Or Galvanized High-Strength Tie Rods, Anchor Bolts, or Anchor Rods:

- All - Heavy Hex AASHTO M 291 (ASTM A563), Grade DH

(d) Washers - Washers for anchor bolts shall conform to ASTM F436, Type 1.

02560.40 Galvanizing and Coating:

(a) High Strength Fasteners - When specified, hot-dip galvanize Grade A325 fasteners or mechanically deposit zinc to Grade F1852 fasteners according to ASTM F3125.

(ba) Galvanizing of Fasteners, Tie Rods, Anchor Bolts, and Carbon Fasteners Anchor Rods - Hot-dip galvanize fasteners, tie rods, anchor bolts, anchor rods, nuts and washers according to AASHTO M 111 (ASTM A123) or AASHTO M 232 (ASTM A153), ASTM F2329 or as appropriate to the product.

~~When specified, mechanically galvanize fasteners according to ASTM B695, Class 50, Type 1. Match galvanized bolts, tie rods, anchor bolts, and anchor rods with appropriate galvanized nuts for assembly. Ship nuts in the same container consisting of bolts, tie rods, anchor bolts, or anchor rods.~~

Overlap nuts for galvanized fasteners, galvanized tie rods, galvanized anchor bolts, and galvanized anchor rods according to ~~AASHTO M 291~~ (ASTM A563).

Measure the zinc thickness on the wrench flats or top of bolt head of galvanized bolts and on the wrench flats of galvanized nuts.

~~**(cb) Galvanizing of Direct Tension Indicators** - All galvanized compressible washer type direct tension indicators shall be mechanically galvanized according to ASTM B695, Class 50, Type 1, by the manufacturer. When specified, apply mechanically deposited zinc according to ASTM F959.~~

(de) Repair of Hot-Dip Galvanizing - Repair damaged hot-dip galvanizing according to ASTM A780. Minimum zinc content for Method A2 is 94 percent on the dry film.

Testing

02560.60 Testing:

(a) Rotational Capacity Test - Test all high-strength fasteners, except tie rods, anchor bolts, and anchor rods, according to Method 1 or 2 below, as applicable. Perform the test on coated or galvanized fasteners after coating, galvanizing, oversize tapping and lubricating. Use nuts from those supplied with the bolts for the job. Use washers for this testing. Repeat the rotational capacity test at the job site prior to installation to verify the effectiveness of the lubricant. The rotational capacity test is not required for lock-pin and collar fasteners. Use Method 1 for long bolts and Method 2 for short bolts.

Test each combination of bolt production lot, nut lot and washer lot as an assembly. Assign a rotational capacity lot number to each combination of lots tested. The minimum frequency of testing shall be two assemblies per rotational capacity lot. The test shall meet one of the following requirements:

(1) Method 1 - Place the lubricated fastener, including a washer, in a device capable of indicating direct bolt tension. Use spacers and/or washers with the hole size the same nominal diameter as the hole in the washer for the fastener to be tested. Allow three to five full threads of the bolt to be exposed between the bearing surfaces of the bolt head and the nut. Tighten the nut to a snug-tight condition to produce an initial load in the bolt equal to 10 percent of the tension required in Table 00560-1 of Section 00560. Mark the nut's position relative to the fixed bolt for this snug-tight position. Tighten the nut using a calibrated torque wrench and record the measured torque with the nut in motion to reach the tension required by Table 00560-1.

The above measured torque to produce the required bolt tensions shall not exceed the torque value calculated by the following equation:

$$T = 0.25 PD$$

Where: T = Torque in foot pounds
 P = Measured Bolt Tension in pounds
 D = Nominal Bolt Diameter in feet

Reject assemblies with torque values exceeding the calculated value.

Continue to tighten the nut until the nut has turned twice the rotation shown in Table 00560-3 of Section 00560 from its snug-tight position mark. Record the measured bolt tension. The tension shall not be less than 1.15 times the tension shown in Table 00560-1. Reject assemblies not meeting this tension.

Loosen and remove the nut. Examine the threads on the nut and bolt. Reject assemblies showing evidence of thread shear failure, stripping or torsional failure of the bolt.

(2) Method 2 - Bolts that are too short to be tested in a direct bolt tension indicating device shall be tested in a steel joint.

Place the lubricated fastener including a washer in one or more flat structural steel plates. The total thickness including the washer shall be such that three to five full threads of the bolt are located between the bearing surfaces of the bolt head and the nut. The hole in the joint shall have the same nominal diameter as the hole in the washer. Using a calibrated torque wrench, tighten the nut to a snug-tight condition to produce an initial torque in the bolt equal to approximately 10 percent of the torque calculated using the equation given in Method 1 above where P shall be the minimum tension in the bolt according to Table 00560-1 of Section 00560. Mark the nut's position relative to the fixed bolt for this snug tight position.

Using the calibrated torque wrench, further tighten the nut until the nut has turned the rotation shown in Table 00560-3 of Section 00560 from its snug-tight position mark. Prevent the bolt head from turning during the tightening process. Record the measured torque with the nut in motion. The measured torque shall not exceed 1.15 times the torque value calculated in the preceding step of Method 2. Reject assemblies with torque values exceeding the calculated value.

Tighten the nut further until the nut has turned twice the rotation shown in Table 00560-3 from its snug-tight position mark. Reject assemblies which fail this rotation either by stripping or fracture.

Loosen and remove the nut. Examine the threads on the nut and bolt. Reject assemblies showing evidence of thread shear failure, stripping or torsional failure of the bolt.

(3) Shipping - Ship bolts, nuts and washers from each rotational capacity test lot in the same container. If there is only one rotational capacity test lot for each size of bolt, the bolts, nuts and washers may be shipped in separate containers. Permanently mark each container with the rotational capacity test lot number to enable identification at any stage before installation.

(b) Other Test Requirements - Proof load testing on all high-strength bolts and nuts is mandatory. Test bolts according to ASTM F606, Method 1, and nuts according to ASTM F606, paragraph 4.2, with frequency of tests according to paragraph 9.3 of ASTM A563. Test galvanized bolts, rods, and nuts after galvanizing, overtapping and lubricating. Coated bolts, rods, and nuts may be tested before coating.

Wedge test all bolts according to ASTM F606, paragraph 3.5, with frequency of testing according to AASHTO M 164 (ASTM A325). Test galvanized bolts after galvanizing. Coated bolts may be tested before coating.

Perform other tests called for on the Plans.

Provide certified test results for all tests required by these Specifications or the individual product specifications.

Provide three high-strength bolt assemblies per size per lot for check testing.

Provide one high-strength tie rod, one high-strength anchor bolt, and one high-strength anchor rod assembly per size per lot for check testing.

02560.70 Lubricating Fasteners - Furnish all galvanized and coated fasteners with a factory applied commercial water-soluble wax that contains a visible dye of a color that contrasts with the color of galvanizing or coating. Black fasteners shall be "oily" to the touch when installed.

Field lubricate galvanized bolts in tapped holes, galvanized anchor rods, and galvanized tie rods with a lubricant from the QPL. Apply lubricant to threads and to bearing surfaces that will turn during installation.

Protect fasteners from dirt and moisture at the job site. ~~Clean, relubricate with a lubricant from the QPL, and retest fasteners that do not pass the field rotational capacity test. Clean and relubricate heavy hex head fasteners with a lubricant from the QPL prior to retesting. Obtain the Manufacturer's approval before relubricating tension control fasteners that are designed to automatically provide the tension.~~

~~Coat the outer surface of the collar in lock pin and collar fasteners with an approved Manufacturer lubricant.~~

Relubrication of Twist-Off fasteners is not permitted.

02560.80 Acceptance - Acceptance of fasteners will be according to 00165.35 and this Section.

Section 02570 - Composite Bearings

Description

02570.00 Scope - This Section includes the requirements for composite bearings.

Materials

02570.10 Materials - Provide Materials meeting the following requirements:

Structural Steel	02530.20
Stainless Steel Sliding Surfaces	ASTM A240, Type 304 or Type 316
Flat Brass Rings for Pot Bearings	ASTM B36, half hard
Cap Screws	ASTM A574 or ASTM F835
Bolts and Nuts	AASHTO M 164 (ASTM A325) and Section 02560
Galvanized Bolts, Nuts, Washers, Cap screws,	
Sole Plates and Base Plates	02530.70 and 02560.40
Woven Polytetrafluoroethylene (PTFE)	section 18 of the current AASHTO
.....	LRFD Bridge Construction Specifications

Welded Stainless Steel Overlay - Produce welded stainless steel overlay for the convex rotational surface of spherical bearings using Type 309L electrodes.

Elastomer - Elastomer for elastomeric discs of pot bearings shall be 100 percent virgin natural polyisoprene (natural rubber) or 100 percent virgin chloroprene (neoprene) meeting the following requirements:

NATURAL POLYISOPRENE (Natural Rubber):

Physical Properties	ASTM Test Method	Value
Hardness, Durometer D	D 2240	50 ± 5
Tensile strength, minimum, psi	D 412	2,250
Ultimate elongation, minimum, %	D 412	450
Heat Resistance		
Change in durometer hardness, maximum points	D 573 70 hour	+ 10
Change in tensile strength, maximum, %	at 158 °F	- 25
Change in ultimate elongation, maximum, %		- 25
Compression Set		
22 hours at 158 °F, maximum, %	D 395, Method B	25
Ozone		
25 pphm ozone in air by volume, 20% strain, 100 °F ± 2 °F 48 hours mounting Procedure D518, Procedure A	D 1149	No Cracks

Adhesion

Bond made during vulcanization, lb/in	D 429 Method B	40
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Low Temperature Test

Brittleness at -40 °F	D 746 Procedure B	No Failure
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VIRGIN CHLOROPRENE (Neoprene):**Physical Properties**

Physical Properties	ASTM Test Method	Value
Hardness, Durometer D	D 2240	50 ± 5
Tensile strength, minimum, psi	D 412	2,250
Ultimate elongation, minimum, %	D 412	400

Heat Resistance

Change in durometer hardness, maximum points	D 573 70 hour at 212 °F	+ 15
Change in tensile strength, maximum, %		- 15
Change in ultimate elongation, maximum, %		- 40

Compression Set

22 hours at 212 °F, maximum, %	D 395, Method B	35
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Ozone

100 pphm ozone in air by volume, 20% strain, 100 °F ± 2 °F 100 hours mounting Procedure D518, Procedure A	D 1149	No Cracks
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Adhesion

Bond made during vulcanization, lb/in	D 429 Method B	40
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Low Temperature Test

Brittleness at -40 °F	D 746, Procedure B	No Failure
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When test specimens are cut from the finished product a 10 percent variation in physical properties will be allowed.

Polyether Urethane - The properties of polyether urethane for polyether urethane discs of disc bearings shall meet the values of the following tests:

Property	Test Method	Range of Values
Hardness, Durometer D	ASTM D2240	65 ± 5
Tensile stress, psi at 100% elongation	ASTM D412	2,300 min.
at 200% elongation	ASTM D412	4,000 min.
Tensile strength	ASTM D412	6,000 min.
Ultimate elongation %	ASTM D412	220 min.
Compression set, 22 hrs. at 158 °F	ASTM D395	40 max.

Fabric Pads - Make preformed fabric pads for fabric pad bearings of multiple layers of duck, impregnated and bound with high quality oil resistant synthetic rubber compressed into resilient pads of uniform thickness according to the following:

- Cotton duck reinforcement shall be either a two-ply cotton yarn or a single-ply 50-50 blend cotton polyester with a minimum of 8 ounces per square yard.
- The fabric shall have a minimum tensile strength of 150 pounds per inch width when tested by the grab method.
- The filling count of the duck shall be 40 ± 2 threads per inch.
- The warp count of the duck shall be 50 ± 1 threads per inch.
- The number of plies shall produce the specified thickness after compression and vulcanizing.
- The finished pads shall withstand compression loads perpendicular to the plane of the laminations of not less than 10,000 psi without any sign of distress after the load is removed. The tested pad shall have a shape factor greater than 2.5. The preformed fabric pad shall have a Shore A hardness of 90 ± 5.

02570.20 Testing - Test all bearings except where lot testing is permitted. A lot is defined as 25 bearings per type and size. Where lot testing is required, previous test results on a typical bearing of equal or greater capacity is acceptable provided the data is no more than 2 years old. Test typical bearings either by an independent testing laboratory, or have the testing witnessed and attested to by an independent testing laboratory, for compliance with specified performance requirements as listed below. Provide a test results certificate according to 00165.35 with the submittal of shop drawings. Perform the following tests:

(a) Clearance Test - Move the components of the bearing through their design displacements or rotations to verify that the required clearances exist. If the test is conducted on a rotational component which is not under simultaneous full vertical load, make allowance for the displacements which would be caused by that load.

(b) Long-Term Deterioration Test - Conduct test on one full scale bearing per lot. Load the bearing in compression to a stress corresponding to 100 percent of the maximum dead plus live service load while subjected to plus and minus the design rotational displacement amplitude for 5,000 cycles. Flat sliding systems shall be displaced through at least 1,000 cycles with an amplitude of at least ± 1.0 inch (2.0 inch peak to peak). The sliding may take place at up to 10.0 inch per minute, except when readings of the coefficient of friction are taken, at which time the sliding speed shall be 2.5 inches per minute.

Bearings will be rejected when:

- There are visible cracks, splits, or excessive wear on disassembly of the bearing.
- The coefficient of friction exceeds two-thirds the value used in design.

(c) Friction Test - Conduct test on one full scale bearing per lot. The coefficient of friction between the sliding surfaces shall not be greater than 0.06 when the maximum working stress for the polytetrafluoroethylene (PTFE) surface is 2,000 psi. It shall not be greater than 0.045 when the maximum working stress for the PTFE surface is above 3,000 psi. Determine the coefficient of friction at 68 °F according to the requirements of section 18.3.4.3.2 of the AASHTO LRFD Bridge Construction Specifications.

(d) Proof Load Test:

(1) Vertical Proof Load Test - Apply a vertical load equal to 150 percent of the vertical design capacity of the tested bearing for 5 minutes, unload, then reapply for an additional 5 minutes. Place the bearing in a rotated position during the test. Rotation shall be 0.015 radians or the design rotation, whichever is greater. The test bearing shall show no indication of failure or other defects such as weld cracking, plate distortion, extrusion of the elastomer or bearing material, or displacement of the elastomer seal while under load or subsequently upon disassembly and inspection.

The successful test of a bearing with a vertical design capacity of 50 tons or less will be accepted as qualification for all bearings of a similar design with a lesser design capacity.

(2) Horizontal Proof Load Test - A horizontal proof load test is required when the design horizontal capacity exceeds 10 percent of the design vertical capacity and no engineer's calculations are submitted. Apply a horizontal load equal to 100 percent of the horizontal design capacity while also applying a vertical load equal to 100 percent of the dead load for a period of 2 minutes. The bearing does not need to be in the rotated position. The bearing shall show no indication of failure or other defects such as weld cracking, plate distortion, extrusion of the elastomer or bearing material, or displacement of the elastomer seal while under load or subsequently upon disassembly and inspection.

The bearing tested for horizontal proof load may be either a bearing specified for use on the Project or a similar type bearing with both a vertical design capacity and a horizontal design capacity within 10 percent of the design capacities of bearings specified for use on the Project.

02570.30 Acceptance - For each composite bearing used in the Structure, provide the manufacturer's quality compliance certificate according to 00165.35 that verifies the bearing has been manufactured according to the design of the tested bearing.

Section 02571 - Elastomeric Bearing Pads

Description

02571.00 Scope - This Section includes the requirements for plain and laminated elastomeric bearing pads.

Materials

02571.10 Elastomeric Compound - The elastomer portion of the elastomeric compound shall be 100 percent virgin polychloroprene (Neoprene) or natural rubber (polyisoprene) meeting the requirements of section 18 of the AASHTO LRFD Bridge Construction Specifications including the properties from the following table:

Table 02571-1

Properties	ASTM Test Method	Requirements
Hardness, Durometer D	D 2240	60 ± 5
Tensile strength, min., psi	D 412	2,250
Ultimate elongation, min., %	D 412	350
Heat Resistance:		
Change in durometer hardness max. points after 70 hr. at 212 °F	D 2240	+ 15
Change in tensile strength, max. % after 70 hr. at 212 °F	D 573	- 15
Change in ultimate elongation, max. % after 70 hr. at 212 °F	D 573	- 40
Compressive set, max. % after 22 hr. at 212 °F	D 395 Method B	35
Adhesion: Bond made during vulcanization, lb/in	D 429 Method B	40
Tear Resistance, (psi)	D 624 Die C	180

02571.15 Metal Reinforcement - Metal reinforcement shall be rolled, mild steel sheets 14 gauge thick and conforming to ASTM A1011, Grade 36 Type 1, or ASTM A1008, Grade 40.

02571.20 Manufacturing Requirements:

(a) Pads - Pads 1/2 inch thick shall be all elastomer. Pads over 1/2 inch thick shall consist of alternate laminations of elastomer and metal.

In metal reinforced pads, the top and bottom layers shall be elastomer 1/4 inch thick, and interior elastomer layers shall be 1/2 inch thick. The nominal thickness of the bearing shown reflects the thickness of the elastomer only. It does not include the steel laminates.

(b) Laminations - Laminations of elastomer shall be of uniform thickness and in no case shall the thickness of an individual lamination exceed 5/8 inch. Variations in thickness of an individual elastomer lamination shall not exceed 1/8 inch and the variation in thickness of all elastomer

laminations within a pad shall be such that each metal lamination shall not vary by more than 1/8 inch from a plane parallel to the top or bottom surface of the pad.

(c) Laminated Pads - Laminated pads shall be molded individually to the sizes required. No shearing to size or drilling of holes will be allowed. Cover all edges of metal laminations with a minimum of 1/8 inch, and a maximum of 1/4 inch, of elastomer except at laminate restraining devices and around holes that will be entirely closed when the pad is in place on the Structure.

Clean the exposed edge voids in the pads caused by the steel laminate restraining devices with a solvent. Shop seal with an appropriate caulking material before shipment.

Sandblast and clean the steel laminates of all surface coatings such as grease, oil, rust and mill scale before bonding. Free the laminates of sharp edges and burrs.

Pads 1/2 inch in thickness may be sheared. The shearing shall not heat the material and shall produce a smooth finish to 250 microinches with no tears or jagged areas.

(d) Dimensional Tolerances and Finishes - See section 18 of the AASHTO LRFD Bridge Construction Specifications for fabrication tolerances.

Fabricate pads to meet flash tolerance, finish and appearance requirements given in the current edition of the Rubber Handbook, published by the Rubber Manufacturers Association, Inc., RMA F3 and T.063 for molded bearings and RMA F2 for extruded bearings.

02571.30 Laminated Bearing Pad Tests and Acceptance Criteria:

(a) General - Comply with additional test requirements of this subsection. Non-laminated bearing pads do not require these tests.

Independently test all completed bearings by compressive visual inspection according to 02571.30(b). Failure of individual bearings to pass the compressive visual inspection will be cause for rejection of those individual bearings.

Independently test five standard test specimens of laminated pads according to 02571.30(c). Failure of any individual specimen to meet the peel strength test requirements will be cause for rejection of the entire bearing production lot. A lot is defined as 50 or less bearings which are manufactured in a reasonably continuous manner from the same batch of elastomer, cured under the same conditions, and are all the same size and type.

Replace rejected bearings with new acceptable bearings at no additional cost to the Agency. Provide the sample pad and perform all testing at no additional cost to the Agency.

Mark all bearings in indelible ink or flexible paint with the Contract number, lot number, date of manufacturer, and bearing identification number. Place the marking on a side face visible after erection of the Bridge.

Clean and free the bearings of any foreign substances such as dust, grit and moisture before testing.

(b) Short-Duration Compression Test - Bring all bearings to a temperature of $73\text{ }^{\circ}\text{F} \pm 10\text{ }^{\circ}\text{F}$ and proof load for a compressive loaded to 1.5 times the maximum design load. The load shall be held for 5 minutes, removed, then reapplied for a second period of 5 minutes. Maintain the load constant while the bearing is inspected for visual faults. The following will be cause for rejection:

- A bulging pattern or patterns implying lack of bond between the elastomer and the laminate or bulging patterns that imply improper laminate placement.

- Three separate surface cracks which are greater than 5/64 inch wide and 5/64 inch deep, or a single crack 3/16 inch deep or wider than 1/4 inch.

(c) Peel Strength Test - Perform a peel strength test according to ASTM D429 Method B, with the exception that the specimens shall be taken randomly and cut from a production bearing submitted for the Project. The bond between the elastomer and steel laminate in each specimen shall be not less than 40 pounds per inch.

(d) Long Duration Compression Test - Perform long term duration compression tests according to the requirements of AASHTO LRFD Construction Specifications when steel reinforced elastomeric bearings are designed using Method B, or when using Grade 4 elastomer.

02571.31 Acceptance - Provide a quality compliance certification according to 00165.35 that the bearing pads conform to the requirements for materials, fabrication and testing. Provide a test result certificate according to 00165.35 that includes the manufacturer's and independent test results according to 02571.30(a).

Aggregates

Section 02610 - Special Filter Material

Description

02610.00 Scope - This Section includes the requirements for special filter material for backfilling or filling trenches for perforated drains and other subsurface drains.

Materials

02610.10 Special Filter Materials - Furnish a specially graded filter Material of coarse sand, and crushed or uncrushed Rock that meets the following requirements:

(a) Grading - Sieve analysis shall be determined according to AASHTO T 27. The Material shall meet the following gradation requirements:

Sieve Size	Percent Passing (by Weight)
3/8"	100
No. 4	54 - 82
No. 10	34 - 56
No. 40	9 - 17
No. 100	0 - 3

(b) Sand Equivalent - Special filter material shall be tested according to AASHTO T 176 and shall have a sand equivalent of not less than 25.

Section 02630 - Base Aggregate

Description

02630.00 Scope - This Section includes the requirements for Aggregates in Base.

Materials

02630.10 Dense-Graded Aggregate:

(a) Grading - Dense-graded base Aggregate shall be crushed Rock, including sand. Uniformly grade the Aggregates from coarse to fine. Sieve analysis shall be determined according to AASHTO T 27. The Aggregates shall conform to one of the grading requirements of Table 02630-1 as identified in the Special Provisions or indicated by the Pay Items in the Contract Schedule of Items.

Table 02630-1
Grading Requirements for Dense-Graded Aggregate
Separated Sizes

Sieve Size	2 1/2" - 0	2" - 0	1 1/2" - 0	1" - 0	3/4" - 0
	Percent Passing (by Weight)				
3"	100				
2 1/2"	95 - 100	100			
2"	-	95 - 100	100		
1 1/2"	-	-	95 - 100	100	
1 1/4"	55 - 75	-	-	-	
1"	-	55 - 75	-	90 - 100	100
3/4"	-	-	55 - 75	-	90 - 100
1/2"	-	-	-	55 - 75	-
3/8"	-	-	-	-	55 - 75
1/4"	30 - 45	30 - 45	35 - 50	40 - 55	40 - 60
No. 4 ¹	-	-	-	-	-
No. 10	2	2	2	2	2

¹ Report percent passing sieve when no grading requirements are listed

² Of the fraction passing the 1/4 inch sieve, 40 percent to 60 percent shall pass the No. 10 sieve

Not more than 9% by weight of the dense-graded base aggregate material shall pass the No. 200 sieve when tested in according to ASTM C 117 (wet sieve test).

(b) Fracture Of Rounded Rock - Fracture of rounded Rock shall be determined according to AASHTO T 335. Provide at least one fractured face based on the following percentage of particles retained on the 1/4 inch sieve for the designated size:

Minimum Percent of Fractured Particles (by Weight of Material)

Designated Size	Retained on 1/4 inch Sieve
1 1/2" - 0 and larger	50
Smaller than 1 1/2" - 0	70

(c) Durability - Dense-graded Aggregate shall meet the following durability requirements:

Test	Test Method	Requirements
Abrasion	AASHTO T 96	35.0% maximum
Degradation (coarse Aggregate)		
Passing No. 20 sieve	ODOT TM 208	30.0% maximum
Sediment Height	ODOT TM 208	3.0" maximum

(d) Sand Equivalent - Dense-graded Aggregate shall be tested according to AASHTO T 176, and shall have a sand equivalent of not less than 30.

02630.11 Open-Graded Aggregate:

(a) Grading - Open-graded Aggregate shall conform to the following grading requirements:

**Table 02630-2
Aggregate Gradation for Open-Graded Aggregate**

Sieve Size	Percent Passing (by Weight)
1"	100
3/4"	80 - 98
1/2"	60 - 85
3/8"	30 - 65
No. 10	5 - 20
No. 40	0 - 6
No. 100	0 - 3 (Dry Sieve)

(b) Fracture of Rounded Rock - Fracture of rounded Rock shall be determined according to AASHTO T 335. Open-graded Aggregate fracture requirements shall conform to the following:

Percentage of Fracture (by Weight)

Material Retained on 3/4", 1/2", and 1/4" Sieves (two fractured faces)	90
Material Retained on No. 10 Sieve (one fractured face)	75

(c) Durability - Open-graded Aggregate shall meet the durability requirements of 02630.10(c).

Section 02640 - Shoulder Aggregate

Description

02640.00 Scope - This Section includes the requirements for shoulder Aggregate.

Materials

02640.10 Aggregate:

(a) Grading - Shoulder Aggregate shall be crushed Rock, including sand. Sieve analysis shall be determined according to AASHTO T 27. Uniformly grade the Aggregates from coarse to fine. The Aggregates shall conform to one of the grading requirements of Table 02640-1 as identified in the Special Provisions or indicated by the Pay Item in the Contract Schedule of Items.

Table 02640-1
Grading Requirements - Shoulder Aggregates

Sieve Size	Separated Sizes	
	1" - 0	3/4" - 0
	Percent Passing (by Weight)	
1 1/2"	100	
1"	90 - 100	100
3/4"	-	90 - 100
1/4"	40 - 55	40 - 60

(b) Fracture of Rounded Rock - Fracture of rounded Rock shall be determined according to AASHTO T 335. Provide at least one fractured face based on the following percentage of particles retained on the 1/4 inch sieve for the designated size:

**Minimum Percent of Fractured Particles
(by Weight of Material)**

Designated Size	Retained on 1/4" Sieve
1 1/2" - 0 and larger	50
Smaller than 1 1/2" - 0	50

(c) Durability - The produced Aggregates shall meet the following requirements:

Test	Test Method	Requirements
Abrasion	AASHTO T 96	35.0% maximum
Degradation (Coarse Aggregate)		
Passing No. 20 sieve	ODOT TM 208	30.0% maximum
Sediment Height	ODOT TM 208	3.0" maximum

(d) Sand Equivalent - Shoulder Aggregate shall be tested according to AASHTO T 176, and shall have a sand equivalent of not less than 25.

The original Section 02690 of the Standard Specifications has been replaced with the following Section 02690 released as ODOT Boilerplate:

SECTION 02690 - PCC AGGREGATES

Description

02690.00 Scope - This Section includes the requirements for coarse and fine aggregates for portland cement concrete.

02690.01 Definitions:

Coating - Foreign or deleterious substances found adhering to the aggregate particles.

Detrimental Materials - Materials that adversely affect concrete, including but not limited to clay, shale, mica, silt, bark, alkali, sticks, organic matter, soft and flaky particles.

Nominal Maximum Size Of Aggregate - One sieve larger than the first sieve that retains more than 10 percent of the material using an agency specified set of sieves based on cumulative percent retained. Where large gaps in specification sieves exist, intermediate sieves may be inserted to determine nominal maximum size.

Materials

02690.10 Materials - PCC Aggregates shall consist of natural or crushed rock that is hard, strong, durable and free from adherent coatings or other detrimental materials.

Produce, handle and store the aggregates in a way that will maintain passing material properties and avoid introducing deleterious materials or segregation prior to its use in portland cement concrete.

02690.11 Alternate Grading - The Contractor may request approval to produce coarse and fine aggregates in sizes other than those stated in 02690.20 and 02690.30. The request shall be in writing, and shall state the proposed target value and specified tolerances for each of the individual sieve sizes of the materials the Contractor proposes to produce.

02690.12 Acceptance of Aggregate - Acceptance of aggregate will be according to Section 00165 and based on the Contractor's quality control testing, if verified, according to Section 00165.

(a) Aggregate Gradation - A stockpile contains specification aggregate gradation when the quality level for each sieve size calculated according to 00165.40 is equal to or greater than the quality level indicated in Table 00165-2 for a PF of 1.00. Each required sample represents a subplot. When the quality level indicated in Table 00165-2 yields a PF of less than 1.00 for any constituent, the material is non-specification.

(b) Non-specification Aggregate Gradation - Stockpiled aggregates that contain non-specification aggregate gradation will be rejected by the Engineer unless non specification material is removed from the stockpile. Do not add additional material to the stockpile until enough non-specification material is removed so that the quality level for each constituent is equal to or greater than the quality level in Table 00165-2 for a 1.00 PF.

Reprocessing of non-conforming material and the testing required for acceptance will be at no additional cost to the Agency. Acceptance of reprocessed material will be based on passing test results or accepted visually by the Engineer.

02690.20 Coarse Aggregate:

(a) Harmful Substances - Harmful substances shall not exceed the following limits:

Test	Test Method		Percent (by Weight)
	ODOT	AASHTO	
Lightweight Pieces	–	T 113	1.0
Material passing No. 200 sieve	–	T 11	1.0
Wood Particles	TM 225	–	0.05

(b) Soundness - Coarse aggregates for concrete shall be tested for soundness using sodium sulfate salt, according to AASHTO T 104. The weighted percentage loss shall not exceed 12 percent by weight.

(c) Durability - Coarse aggregates shall meet the following durability requirements:

Test	Test Method		Requirements
	ODOT	AASHTO	
Abrasion	–	T 96	30.0% Max.
Oregon Air Aggregate Degradation:			
Passing No. 20 sieve	TM 208	–	30.0% Max.
Sediment Height	TM 208	–	3.0" Max.

(d) PCC Paving Aggregate - In addition to requirements above, comply with the following:

(1) Fracture - Provide aggregate with at least two fractured faces on at least 50 percent of the particles retained on the 3/8 inch, 1/2 inch, 3/4 inch, 1 inch, and 1 1/2 inch sieves, as determined by AASHTO T 335.

(2) Elongated Pieces - Provide aggregate with elongated pieces not exceeding 10 percent by weight of the material retained on the No. 4 sieve when tested according to ODOT TM 229 with the proportional caliper device set at a ratio of 5:1.

(e) Grading and Separation by Sizes for Prestressed Concrete - Sampling shall be according to AASHTO T 2 and sieve analysis shall be determined according to AASHTO T 27 and AASHTO T 11. PCC coarse aggregate shall conform to grading and separated sizes as follows:

(1) Where indicated in Table 02690-1, the coarse aggregate shall be separated into two sizes and each separated size shall be measured into the batch in the quantity determined by the mix design.

For each of the indicated maximum sizes of coarse aggregates, the separated sizes shall be as indicated in Table 02690-2:

Table 02690-1

Maximum Nominal Size of Aggregates	Separated Sizes
1"	1" - No. 4
3/4"	3/4" - No. 4
3/4"	3/4" - 1/2" and 1/2" - No. 4
3/4"	3/4" - 3/8" and 3/8" - No. 4

(2) The grading of each of the specified separated sizes of coarse aggregate shall conform to the following:

Table 02690-2

Separated Sizes						
Sieve Size	1" - No. 4	3/4" - No. 4	3/4" - 1/2"	3/4" - 3/8"	1/2" - No. 4	3/8" - No. 4
Percent Passing (by Weight)						
1 1/2"	100	—	—	—	—	—
1"	90 - 100	100	100	100	—	—
3/4"	50 - 80	90 - 100	85 - 100	85 - 100	100	100
1/2"	—	—	0 - 15	—	85 - 100	—
3/8"	15 - 40	20 - 50	—	0 - 15	35 - 65	85 - 100
No. 4	0 - 10	0 - 10	—	—	0 - 15	0 - 15
No. 200	*	*	*	*	*	*

* See 02690.20(a). Do not evaluate material passing the No. 200 sieve according to 00165.40.

(f) Grading and Separation by Sizes for Other Concrete - Sampling shall be according to AASHTO T 2. Sieve analysis shall be according to AASHTO T 27 and AASHTO T 11. Provide aggregates meeting the gradation requirements of Tables 02690-3 and 02690-4 for structural concrete. Provide a CAqT to perform sampling and testing when required.

Table 02690-3

Gradation of Coarse Aggregates				
Sieve Size	Combined* Sizes	Separated Sizes	Separated Sizes	Separated Sizes
	1 1/2" - No. 4	1 1/2" - 3/4"	1" - No. 4	3/4" - 1/2"
Percent Passing (by Weight)				
2"	100	100	—	—
1 1/2"	90 - 100	90 - 100	100	—
1"	70 - 89	20 - 55	90 - 100	100
3/4"	35 - 70	0 - 15	—	85 - 100
1/2"	—	—	25 - 60	0 - 15
3/8"	10 - 30	0 - 5	—	—
No. 4	0 - 5	—	0 - 10	—
No. 8	—	—	0 - 5	—
No. 200	**	**	**	**

* For 1 1/2 inch coarse aggregate use two or more separated sizes which when combined shall meet the gradation limits for 1 1/2" - No. 4

** See 02690.20(a). Do not evaluate material passing the No. 200 sieve according to 00165.40.

Table 02690-4**Gradation of Coarse Aggregates**

Sieve Size	Separated or		Separated Sieves	Separated Sieves
	Separated Sieves	Combined Sieves		
	3/4" - 3/8"	3/4" - No. 4	1/2" - No. 4	3/8" - No. 8
Percent Passing (by Weight)				
1"	100	100	—	—
3/4"	90 - 100	90 - 100	100	—
1/2"	20 - 55	—	90 - 100	100
3/8"	0 - 15	20 - 55	40 - 70	85 - 100
No. 4	0 - 5	0 - 10	0 - 15	10 - 30
No. 8	—	0 - 5	0 - 5	0 - 10
No. 16	—	—	—	0 - 5
No. 200	*	*	*	*

* See 02690.20(a). Do not evaluate material passing the No. 200 sieve according to 00165.40.

02690.30 Fine Aggregates:

(a) Different Sources - Do not mix fine aggregates from different sources of supply, or store in the same pile. Do not use alternately in the same class of mix, without prior approval.

(b) Harmful Substances - The amount of harmful substances shall not exceed the following limits:

Test	Test Method (AASHTO)	Percent (by Weight)
Lightweight Pieces	T 113	2.0%
Material passing No. 200 sieve	T 11	3.0%

(c) Soundness - Fine aggregate shall be tested for soundness using sodium sulfate salt, according to AASHTO T 104. The weighted percentage loss shall not exceed 10 percent by weight.

(d) Organic Impurities - All fine aggregate shall meet the requirements of AASHTO M 6 for organic impurities.

(e) Sand Equivalent - Fine aggregate shall be tested according to AASHTO T 176 and shall have a sand equivalent of not less than 75.

(f) Sand for Mortar - Sand for mortar shall conform to the requirements of this Section.

(g) Grading - Sampling shall be according to AASHTO T 2. Sieve analysis shall be determined according to AASHTO T 27 and AASHTO T 11. Provide aggregates meeting the gradation requirements of Table 02690-5 for structural concrete. Provide a CAqT to perform sampling and testing when required.

Table 02690-5**Gradation of Fine Aggregate***

Sieve Size	Percent Passing (by Weight)
3/8"	100
No. 4	90 - 100
No. 8	70 - 100
No. 16	50 - 85
No. 30	25 - 60
No. 50	5 - 30
No. 100	0 - 10
No. 200	**

* Determine the fineness modulus according to AASHTO T 27 and AASHTO T 11. Maintain the fine aggregate fineness modulus within plus or minus 0.20 from the fineness modulus used in the Contractor's mix design. Fine aggregates in which the fineness modulus varies by more than 0.20 from the mix design target shall not be incorporated until an assessment is done to determine whether an adjustment in the aggregate proportions is necessary. Proportion changes must be performed by a CCT according to the provisions of ACI 211. Submit analysis of FM and mix design adjustments to the Engineer for approval.

** See 02690.30(b). Do not evaluate material passing No. 200 sieve according to 0165.40.

Section 02695 - Reclaimed Glass (Mixed Waste Cullet)

Description

02695.00 Scope - This Section includes the requirements for reclaimed glass (mixed waste cullet) as a substitute for Aggregates.

Materials

02695.10 Mixed Waste Cullet - Cullet shall be 1/2" - 0. It shall be clean, hard, and durable. Not more than 5 percent by weight shall pass a No. 200 sieve.

The maximum debris level shall be 10 percent except as noted below. Debris is defined as any deleterious material that impacts the performance of the backfill. Percent of debris shall be estimated.

02695.20 Cullet Applications:

Use	Maximum Cullet Content (%)	Maximum Debris Level (%)	Minimum Compaction Level (%)
Nonstructural Fill	100	10	90

02695.41 Hauling and Placing - Transport the cullet to the Project Site, add water to obtain the proper moisture content, and place in the trench by means acceptable to the Engineer, in loose Lifts of 8 inches or less.

02695.43 Compacting and Shaping - Compact each layer of material by steel wheel vibratory rollers or as directed.

02695.50 Testing - The Engineer will check gradation and density by laboratory or field testing as deemed appropriate. Impurities will be checked visually by sampling a specimen of processed cullet with a weight of approximately 1/2 pound.

Railing and Guidance Devices

Section 02810 - Bridge Rail

Description

02810.00 Scope - This Section includes the requirements for the steel in railings for Bridges.

Materials

02810.10 Shapes, Plates, and Bars - Shapes, plates and bars shall comply with ASTM A36.

The silicon content of all exposed shapes, plates and bars that are called out on drawings as "Galvanize - Control Silicon", shall be according to 02530.70.

02810.20 Structural Steel Tubing - Structural steel rail members shall comply with ASTM A500, Grade B, or ASTM A501. Steel conforming to ASTM A513 or ASTM A618 may be substituted for ASTM A500 tubing subject to the following limitations:

- Provide chemical and tensile properties test results.
- Silicon content shall be according to 02530.70.
- Strength and elongation requirements of ASTM A513 tubing shall meet the requirements of ASTM A500 tubing.

02810.30 Steel Pipe - Metal parapet rail members shall be standard steel pipe complying with ASTM A53, Grade B or ASTM A500, Grade B.

02810.40 Cast Steel Posts - Cast steel posts shall be carbon steel castings complying with AASHTO M 103 (ASTM A27), Grade 65-35.

02810.50 Metal Thrie Beam Rail - Galvanize steel thrie beam rail according to AASHTO M 180, Class A rail, Type II coating after fabrication and subject to the single spot test. Backup plates will be accepted with ungalvanized edges and bolt holes, provided these areas are field-coated with an approved galvanizing substitute according to 02530.71. Metal posts and hardware shall meet the requirements of 02820.20 and 02820.30.

02810.60 Incidentals - Plates, caps and miscellaneous pieces necessary to complete the rail shall be as shown or specified.

02810.70 Acceptance - Bridge rail Materials will be accepted according to 00165.35 and this Section.

Section 02820 - Metal Guardrail

Description

02820.00 Scope - This Section includes the requirements for forming galvanized steel sheets into metal beam rail, and the manufacture of guardrail hardware.

Materials

02820.10 Metal Beam Rail - Form metal beam rail from galvanized steel. Galvanized steel beam rail shall conform to the requirements of AASHTO M 180, Class A. The zinc coating shall conform to the requirements of AASHTO M 180, Type II, applied after fabrication and subject to the single spot test. Backup plates will be accepted with ungalvanized edges and bolt holes, provided these areas are field-coated with an approved galvanizing substitute.

02820.20 Metal Guardrail and Median Barrier Posts - Metal posts shall be of structural steel conforming to the requirements of ASTM A36 and galvanized according to AASHTO M 111 (ASTM A123).

02820.30 Guardrail Hardware - All bolts, nuts, washers and other fittings for beam type guardrail shall be galvanized steel meeting the requirements of AASHTO M 180.

All bolts, nuts, and washers shall be as detailed, with nuts tapped oversize not to exceed 1/32 inch.

02820.40 Guardrail Anchor Hardware - Provide cable and fittings for guardrail anchors that conform to the requirements of AASHTO M 30, Class AG, for Type II cable. Galvanize all fittings according to AASHTO M 111 (ASTM A123).

For steel anchors, the steel tubing shall meet the requirements of ASTM A500, Grade B, ASTM A501 or ASTM A618. The Soil plate shall meet the requirements of ASTM A36. After fabrication galvanize tubing and plate according to AASHTO M 111 (ASTM A123).

02820.50 Acceptance of Materials - ~~Manufacturing plants may be inspected periodically for compliance with specified manufacturing methods, and material samples obtained for laboratory testing for compliance with materials quality requirements. This may be the basis for acceptance of manufacturing lots as to quality.~~

Acceptance of metal guardrail Materials will be according to Section 00165.35, ~~and this Section.~~

Section 02830 - Metal Handrail**Description**

02830.00 Scope - This Section includes the requirements for the steel in handrail for stairways and pedestrian facilities.

Materials

02830.10 Shapes, Plates, and Bars - Shapes, plates, and bars shall conform to ASTM A36.

Punch anchor plate bolt holes at the locations shown before fabrication.

02830.20 Steel Pipe - Steel pipe shall conform to ASTM A500, seamless, Grade B.

02830.21 Steel Tube - Steel tube shall conform to ASTM A500, seamless, Grade B.

02830.22 Fasteners - Fasteners shall meet the requirements of Section 02560. Machine screws shall be SAE 18-8 stainless steel.

02830.30 Galvanizing - Hot-dip galvanize all handrail components according to AASHTO M 111 (ASTM A123) after shop fabrication.

02830.31 Repair of Hot-Dip Galvanizing - Repair damaged hot-dip galvanizing according to ASTM A780 and ASTM A123. Minimum zinc content for Method A2 is 94 percent on the dry film.

02830.40 Incidentals - Plates, caps, and miscellaneous pieces necessary to complete the rail shall be as shown.

02830.50 Acceptance - Acceptance of handrail Materials will be according to 00165.35 and this Section.

Illumination and Traffic Control Materials

Section 02910 - Sign Materials

Description

02910.00 Scope - This Section includes the requirements for backing, sheeting, legend, reflectors, and hardware for sign installations.

Materials

02910.10 Aluminum - The aluminum Materials shall be new and conform to the following requirements:

Aluminum Bars or Rods	ASTM B211
Aluminum Sand Castings	ASTM B26
Aluminum Sheet	ASTM B209
Extruded Aluminum Shapes	ASTM B221
Rolled or Extruded Structural Shapes	ASTM B308

Aluminum to be color coated shall be of an alloy which is compatible with the coating and the application process. The color-coated aluminum shall have a temper that, after coating and aging, provides an ultimate strength of 30,000 psi and a yield strength of 25,000 psi.

Fabricate sheet aluminum signs from aluminum alloy 6061-T6, 5052-H38, 5154-H38, or approved equal. Give a chromate treatment conforming to ASTM B449, Class 2 or a titanium-based coating according to ASTM B921. Provide certified test reports for all heats of aluminum products furnished to the Agency. Signs shall be of the thickness shown on Table 02910-1 unless otherwise indicated.

Table 02910-1

Sign Width (Horizontal Measure)	Sheet Aluminum Thickness
Less than 20"	0.063"
20" through 36"	0.080"
37" through 48"	0.100"
Over 48"	0.125"

02910.11 Plywood:

(a) General -- Plywood signs are not allowed in the Right of Way. Construct all plywood signs for permanent signing from 3/4 inch high-density overlay plywood. Construct plywood signs for temporary signs from either 3/4 inch high-density overlay plywood or 3/4 inch medium-density overlay plywood. Plywood shall be Douglas fir plywood, Grade B-B exterior or better, conforming to "Product Standard PS-1 for Douglas Fir Plywood" published by the U. S. Department of Commerce.

(b) Overlay - High-density and medium-density overlay shall be black or buff unless otherwise shown or specified. High-density and medium-density overlay shall conform to "Product Standard PS-1 for Douglas Fir Plywood".

(c) Plywood Sealer - Fill all voids in top or sides of panel with caulking compound after cutting plywood to size. Apply an approved plywood edge sealer tinted to match the color of the panel overlay material. The sealer shall be a medium oil alkyd primer.

02910.20 Reflective and Retroreflective Sheeting:

(a) General - Use retroreflective sheeting Type III, Type IV, Type VIII, and Type IX from the QPL and the following:

(1) Perforation - If required for application, the sheeting may be pre-perforated with holes not greater than 0.02 inch in diameter. The perforations shall be approximately 0.4 inch apart in rows approximately 1.5 inches apart.

(2) Surface - The sheeting and adhesive shall be compatible with non-reflective permanent cut-out legend.

(b) Acceptance - Furnish a quality compliance certification according to 00165.35, certifying that the reflective sheeting furnished meets the above requirements.

02910.21 Nonreflective Sheeting for Sign Background:

(a) General - The nonreflective sheeting shall be durable, weather resistant, gloss plastic film, and shall have a protected, precoated adhesive backing.

(b) Color - Color of the nonreflective sheeting shall conform to 00940.10. Submit for testing a 4 inch by 4 inch sample of the background color for each color of nonreflective sheeting shown.

(c) Adhesive - Adhere the nonreflective sheeting by a mildew and vandal resistant precoated adhesive that has no staining effect on the sheeting.

(d) Film:

(1) General - The nonreflective sheeting shall be flexible and easily cut to shape. The minimum tensile strength of the sheeting shall be 5 pounds per inch width.

(2) Surface - The sheeting surface shall be smooth and flat, to facilitate cleaning and wet performance. The sheeting surface shall be readily processed and compatible with recommended transparent and opaque process inks.

The sheeting shall permit cutting and color processing at minimum temperatures of 60 °F. The sheeting shall be heat resistant and shall permit force curing of applied sheeting at temperatures up to 150 °F. The sheeting surface shall be solvent resistant. Clean according to the manufacturer's recommendations.

(e) Durability - Process and apply according to the manufacturer's recommendations. The material shall be weather resistant, and following cleaning shall show no discoloration, cracking, crazing, blistering or dimensional change.

The sheeting surface shall be capable of being readily refurbished when cleaned and clear over-coated according to the manufacturer's recommendations.

(f) Acceptance - Furnish a quality compliance certificate according to 00165.35, certifying that the nonreflective sheeting furnished meets all the above requirements.

02910.32 Retroreflective Removable Legend:

(a) General - The letters and numerals for all removable legend shall conform to the design of the FHWA "Standard Rounded Capital Letter Alphabets". The letters and numerals for

removable legend for all freeway and expressway signs shall conform to the design of Series "E" modified from the FHWA "Standard Rounded Capital Letter Alphabets".

Provide mounting holes within the frames to permit the use of the mounting hardware specified in these Specifications. Provide a sufficient number of mounting holes to ensure a firm attachment of the frames to the sign and meet the requirements of 00940.45(b). This requires a minimum of four mounting holes at each joint in the border.

(b) Retroreflective Sheeting Legend - The silver-white or white letters, numerals, symbols and borders shall be of adhesive-coated retroreflective sheeting permanently adhered to a flat aluminum frame. The white retroreflective sheeting shall consist of Type IX sheeting conforming to 02910.20. The silver-white retroreflective sheeting shall consist of Type III or Type IV sheeting conforming to 02910.20.

Letters, numerals, symbols and borders shall be a minimum of 0.032 inch thick aluminum conforming to ASTM B209, alloy 3003-H14. Degrease and etch the aluminum, or treat with a light, tight amorphous chromate type coating.

Apply the reflective sheeting to the prepared aluminum according to the sheeting manufacturer's recommendations.

The finished letters, numerals, symbols and borders shall be clean-cut and sharp, and shall have a nearly plane surface.

(c) Acceptance - Acceptance of retroreflective removable legend shall be a mill test certificate from the aluminum manufacturer attesting to the correct alloy, temper, and material thickness of the metal supplied. The Engineer may reject damaged or non-specification materials regardless of the test certification furnished.

02910.33 Permanent Legends:

(a) General - Permanent legends consist of silver-white retroreflective screened, red retroreflective screened, black screened or cut-out silver-white retroreflective sheeting. The letters and numerals of all permanent legends shall conform to the design of the FHWA "Standard Rounded Capital Letter Alphabets".

(b) Retroreflective White Screened Legend - The transparent paste materials used for the reverse screening of retroreflective white legends and for the screening of retroreflective red legends shall conform to the recommendations of the manufacturer of the reflective sheeting.

(c) Retroreflective Cut-out Legend - The Material used for retroreflective cut-out legend shall conform to the requirements of 02910.20.

(d) Nonreflective Black Screened Legend - Furnish Material for nonreflective black screened legends that is compatible with the sign sheeting, as recommended by the sign sheeting manufacturer.

(e) Nonreflective Black Cut-out Legend - The Material used for nonreflective cut-out legend shall conform to 02910.21.

02910.40 Hardware - The bolts, nuts, and washers used to fabricate and erect signs shall be aluminum alloy, stainless steel, or galvanized steel. Aluminum for bolts and nuts shall conform to ASTM B211, alloys 2024-T4 or 6061-T6 as the Contractor elects. Aluminum washers shall conform to ASTM B209, alloy Alclad 2024-T4. Stainless steel shall be Type 316. Galvanized steel bolts,

nuts, and washers shall be medium carbon steel. Galvanize steel hardware according to AASHTO M 232 (ASTM A153).

Use nylon washers supplied by the sheeting manufacturer as shown or directed.

All mounting hardware shall be of the design and type shown, or if not shown shall be of such sizes and kinds as approved by the Engineer.

Blind rivets shall be 1/8 inch diameter, 1/4 inch head diameter, domed head, aluminum alloy conforming to ASTM B316. Aluminum alloys 5052 and 5056 are acceptable alloys. Blind rivets used to attach sign panels to closure strips or wind beams shall be anodized the same color as the sign background.

02910.60 Electronically Cuttable Films for Use on Retroreflective Sheeting:

(a) General - Electronically cuttable films shall consist of durable, transparent, colored films coated with a transparent pressure sensitive adhesive protected by a removable liner. The films shall be designed to be cut on knife-over-roll (sprocket fed or friction fed) and flat bed electronic cutting machines. The films shall be available in standard traffic colors, be dimensionally stable, and be designed to optimally cut, weed, lift and transfer. Use electronically cuttable films from the QPL.

(b) Acceptance - If requested, furnish with each lot or shipment a quality compliance certificate according to 00165.35, certifying that the Material supplied is an acceptable product on the QPL.

02910.75 Manufacturer Warranty - Furnish a manufacturer warranty that unconditionally warrants to the Agency the retroreflective sheeting products, sheeting with applied electronic cuttable film products, and installation under this Section against failure, according to this subsection and 00170.85(c)(1). Use Agency-supplied warranty forms, available from the Engineer.

"Unconditionally warrant" means that the warranty covers all failures, regardless of the source or cause of the failure, including, without limitation, whether the source or cause is or may be related to workmanship, inspection, or choice of materials.

The Agency inspection of any portion of the Work during the Contract and during the product installation, the Agency acceptance of the Work, corrections under the warranty, or expiration of the warranty shall not relieve the obligations under this warranty.

(a) Warranty Period:

- For retroreflective Type III and Type IV sheeting used for permanent signs, the warranty period shall be for 10 years.
- For retroreflective Type IX sheeting used for permanent signs, the warranty period shall be for 12 years.
- For retroreflective sheeting used for temporary signs, the warranty period shall be for 3 years.

(b) Failure - For purposes of the warranty, failure is defined as the deterioration of retroreflective sheeting, or sheeting with applied electronic cuttable film due to conditions inherent to the sheeting (including inks, overlay film, and electronic cuttable film) to the extent that:

- The sign shows discoloration, cracking, delamination, loss of adhesion, or

- The coefficient of retroreflection, as measured after signs are cleaned according to the manufacturer's recommendations, is less than the following:
 - 80 percent of minimum coefficient of retroreflection for designated sheeting or cuttable film according to ASTM D4956 for the first 7 years of the warranty period.
 - 70 percent of minimum coefficient of retroreflection for designated sheeting or cuttable film according to ASTM D4956 for the remaining 3 years of the warranty period for Type III and Type IV sheeting and remaining 5 years of the warranty period for Type IX sheeting.

(c) Remedy - Upon notification by the Engineer of a failure, provide the following remedy at no additional cost to the Agency:

- Repair or replace the sheeting, or sheeting with applied electronic cuttable film, within 6 months of the written notification according to the following:
 - During the first 7 years, restore the sign panel to a condition that meets the Specifications.
 - For the remaining 3 years (5 years for Type IX sheeting), furnish replacement sheeting required to restore the sign panel to a condition that meets the Specifications.
- Use Materials and procedures meeting the Specifications.
- Coordinate timing of repair Work with the Engineer.

(d) Agency's Right to Make Repairs - If, in the opinion of the Engineer, a failure causes or may cause a hazard, the failure may be temporarily corrected by Agency or other forces at no additional cost to the Agency. Replace temporary repairs with permanent repairs at no additional cost to the Agency and according to the Specifications and within the time specified in 02910.75(c).

Section 02920 - Common Electrical Materials

Description

02920.00 Scope - This Section includes the requirements for common electrical systems.

Materials

02920.01 Materials - Where shown or specified, furnish and install hardware that is hot-dip galvanized or Type 304 or 316 stainless steel screws, bolts, nuts, and washers.

02920.02 Powder Coating - Powder coat materials according to Section 00593.

02920.03 Fiberglass Poles - Poles shall be fiberglass and shall be rated for 90 M.P.H. 30% gust factor AASHTO wind load.

Post top mounting poles shall be designed for direct burial installation inside a plastic sleeve.

Fiberglass poles shall be round, hollow, and of uniform taper along their entire length and shall have a tapered wall increasing in thickness from the top to base in proportion to the load and ground line moment requirements. Poles shall be non-conductive and chemically inert. The pole shall be reinforced in areas of hardware attachments.

The pole shall be constructed from continuous fiberglass filaments combined with thermosetting isophthalic polyester resin. The fiberglass and resin ratio of the pole shall contain at least 65% glass, with the balance to be isophthalic polyester resin.

The glass filament shall be helically wound under tension first at a high angle (65-85 degrees) to the longitudinal axis of the pole with alternate layers of filaments in opposite directions for maximum circumferential (compressive) strength.

The outer core section shall be of greater weight than the inner core section, and shall be helically wound by wrapping continuous glass filaments at a low angle (3-15 degrees) to the longitudinal axis of the pole for maximum longitudinal (bending) strength.

The pole finish shall have a textured surface and shall be uniform and consistent for the entire length. The finish coating shall be pigmented urethane capable of withstanding exposure to ultraviolet light, chemicals, and extreme weather conditions. The surface coating shall be a minimum dry film thickness of 1-1/2 mil.

02920.10 Metal Conduit - Furnish metal conduit meeting the following requirements:

- **Rigid Metal Conduit** - Galvanized rigid metal manufactured of mild steel conforming to UL 6, Rigid Metal Electrical Conduit.
- **Liquid-Tight Flexible Metal Conduit** - Liquid-tight, nonmetallic, sunlight resistant outer jacket over an inner flexible metal core. Conduit shall conform to UL 360 Liquid-Tight Flexible Steel Electrical Conduit.

02920.11 Nonmetallic Conduit - Furnish nonmetallic conduit meeting the following requirements:

- **Rigid Nonmetallic Conduit** - Heavy wall, extruded, rigid polyvinyl chloride (PVC) conforming to UL 651, Schedule 40 or 80 Rigid PVC Conduit as shown.
- **Liquid-Tight Flexible Nonmetallic Conduit** - Meet the requirements of Article 354⁶ of the NEC and shall be UL1660 listed.
- **High Density Polyethylene Conduit (HDPE)** - SDR15 (Schedule 40) equivalent minimum conforming to UL651B. The conduit shall lay flat when unwound.
- **Rigid Nonmetallic Fiberglass Conduit** - Schedule 40 or Schedule 80 reinforced thermosetting resin conforming to UL1684.

02920.12 Conduit Fittings - Furnish conduit fittings meeting the following requirements:

- **Expansion Fittings** - Weatherproof, hot dip galvanized malleable iron expansion head and body. Where the Plans do not specify an Equipment grounding wire in the conduit run, furnish fittings with external bonding jumpers. The expansion fitting shall permit a 4 inch conduit movement minimum.
- **Condulets** - Hot-dip galvanized malleable iron conduit body with corrosion resistant cover and moisture proof gasket.
- **Metallic Bushings** - Galvanized steel or die cast zinc with insulated throat. Include a bonding lug if required.
- **Nonmetallic Bushings** - PVC push on end bell style or threaded bushing.
- **Conduit Hub** - Hot-dip galvanized malleable iron screw-on style with neoprene "O" ring.
- **HDPE Fittings** - Factory mechanical HDPE coupling with individual reverse locking threads and built in center stop meeting the requirements of ASTM F2176.

02920.13 Underground Marking Tape - Provide underground marking tape that is red polyethylene film, 6 inches wide, 4 mils thick minimum, and imprinted with the following or similar legend:

"CAUTION CAUTION CAUTION BURIED ELECTRIC LINE"

02920.14 Junction Boxes:

(a) General - Junction boxes and covers in vehicle traffic areas shall be rated for AASHTO H-20 highway loading. Surface-mounted boxes shall have overlapping covers.

Junction boxes and covers in incidental vehicle traffic areas shall be rated Tier 22 for the box and Tier 15 for the lid according to ANSI/SCTE 77-2010.

Junction box covers shall have the legend "SIGNALS", "STREET LIGHTING", etc. stamped or embossed on the cover as appropriate. Letter size shall be no smaller than 1/16 of the box width.

(b) Metal Junction Boxes - Construct boxes of cast iron or 1/8 inch nominal welded sheet steel. Make covers from reinforced non-slip steel plate. Hot-dip galvanize boxes and covers after fabrication according to AASHTO M 232 (ASTM A153). Each box shall have a cover gasket that will, with cover in place, form a NEMA 4 watertight fit. Provide covers with stainless steel hex-head cap screws. Recess screw heads in the cover.

Recessed covers shall fit the box so that when the cover is set in the box, the top of the cover shall be even with the top of the box, with not more than a 1/8 inch gap between any part of the top edge of the cover and the inside lip edge of the box.

Flush-mounted boxes shall be outside-flanged with recessed, checkered steel covers.

(c) Concrete Junction Boxes - ~~Concrete junction boxes not allowed.~~ If required, concrete junction boxes and covers shall be precast concrete, water meter type. Covers shall have a skid-resistant surface, and bolt to the junction box with recessed stainless steel hex-head bolts. All covers shall be recessed and fit the box so that when the cover is set in the box, the top of the cover shall be even with the top of the box.

(d) Polymer Concrete Junction Boxes - Polymer concrete junction boxes and covers shall be precast water meter type. Material shall consist of Aggregate bonded with a polyester resin and reinforced with fiberglass strands. The box and cover shall be gray in color. Covers shall have a skid-resistant surface, and bolt to the junction box with a recessed stainless steel ~~pentahex~~ hex-head bolts. All covers shall be recessed and fit the box so that when the cover is set in the box, the top of the cover shall be even with the top of the box.

(e) Hybrid Junction Boxes - ~~Hybrid junction boxes not allowed.~~ If required, hybrid junction boxes and covers shall be constructed of polymer, fiberglass, or polymer concrete. Materials shall be resistant to temperature extremes and ultraviolet light exposure. Covers shall have a skid-resistant surface and bolt to the junction box with recessed stainless steel hex-head bolts. All covers shall be recessed and fit the box so that when the cover is set in the box, the top of the cover shall be even with the top of the box.

02920.20 Cable and Wire - Unless otherwise noted, all electrical conductors shall be stranded copper conforming to ASTM B3 and ASTM B8, Class B or C. Insulation shall be 600 V plasticized polyvinyl chloride, polyethylene, or chemically cross-linked polyethylene, conforming to ASTM D2220, ASTM D1351, ASTM D2655, and ASTM D2656. Do not use polyethylene compounds where exposed to sunlight. Tape the ends of unused and spare conductors with insulating vinyl plastic tape.

02920.21 Wire and Cable Color Coding:

(a) General - ~~Factory supplied striping of conductors will be accepted when the required color insulation is not available. Color tape will not be accepted as an alternate for insulation color coding. Apply wire color coding mechanically, with striping clearly visible the entire length. Colored tape may be used where striping is worn from handling.~~

(b) Illumination Circuits - Wire insulation color shall conform to the following:

(a) For 120 volt line distribution, the conductor shall be black.

(b) For two phase 208 or 240 volt line distribution, one conductor shall be black, the other conductor shall be red. When two circuits are run in the same conduit, the second pair of conductors shall be blue and brown. Alternate colors or additional colors for additional circuits may be required with approval of the Engineer.

(c) Neutral conductors shall be white.

(d) Ground conductors shall be green insulated or non-insulated stranded wire.

~~Color coding of illumination circuits will be required for three phase systems only. Color coding of each phase conductor shall remain consistent throughout the entire electrical system.~~

(c) Traffic Signal Circuits - Color coding of traffic signal circuits shall conform to the wiring color code shown or specified.

02920.22 Cable - Furnish cable meeting the following requirements:

- **Direct Burial Cable** - All cable shown or specified as direct burial cable shall be:
 - **Underground Service Entrance Cable** - Comprised of a heat and moisture resistant cross-linked polyethylene insulated wire rated for 167 °F operation in wet or dry locations and be UL labeled as type USE cable according to the NEC.
 - **Underground Feeder and Branch Circuit Cable** - Comprised of moisture resistant thermoplastic insulated wires and a moisture and sunlight resistant thermoplastic outer covering rated for 140 °F operation in wet or dry locations and be UL labeled as type UF cable according to the NEC.
- **Messenger Cable** - Galvanized steel seven-strand conforming to ASTM A475 utility grade with Class A coating.
- **Tether and Stabilizer Cable** - Galvanized steel seven-strand conforming to ASTM A475 common grade with Class A coating.
- **Loop Feeder Cable** - Two-conductor No. 14 AWG twisted pair shielded cable with drain wire conforming to IMSA 50-2. When shown, construct loop feeder circuits of two-conductor No. 18 AWG twisted pair shielded cable with drain wire conforming to IMSA 50-2.
- **Interconnect Cable** - REA PE-38 or PE-39 cable consisting of No. ~~4922~~ AWG stranded or solid individual conductors. The cable shall contain the number of wire pairs shown.
- **Audible Pedestrian Device Cable** shall be stranded copper 4 conductor 18 AWG with 0.02" Orange XLPE insulation. Reno HR-418 or equal.
- **Control Cable** - Comply with IMSA 20-1. Outside jacket insulation shall be black in color.
- **Cable Ties** - Heavy-duty UV resistant black plastic self-locking straps approximately 5/16 inch in width, serrated gripping surfaces through a binding buckle, and a minimum tensile strength of 45 pounds.
- **TC Cable** - XHHW conductors with PVC jacket.
- **Polyethylene Pull Line** - An electrical polyethylene pull rope with a 1,200 pound minimum break strength.
- **Industrial Ethernet Cable** - Waterblock/direct burial rated, shielded enhanced, Category-6 cable with 24 AWG solid bare copper conductors, PE inner jacket, overall shield, and sunlight and oil resistant PE jacket. Terminate cable with factory installed RJ-45 connectors.

02920.23 Wire - Furnish wire meeting the following requirements:

- **TFFN Wire** - Insulated stranded copper wire rated for 194 °F operation in dry locations and be UL listed as TFFN.
- **THWN Wire** - Insulated stranded copper wire rated for 167 °F operation in wet or dry locations and be UL listed as THWN. THWN insulated wire will only be allowed for ground and bond wire, and as signal tracer wire in empty conduits for future use.
- **XHHW Wire** - Insulated stranded copper wire rated for 194 °F dry and 167 °F wet locations and be UL listed as XHHW.
- **Grounding and Bonding Wire** - Stranded copper wire. Minimum size shall be No. 6 AWG or as shown. When installed in conduit use type THWN that is green in color.
- **Loop Wire** - Insulated stranded copper No. 14 AWG type XHHW conductor inside a polyethylene tube conforming to IMSA Specification No. 51-7.
- **Coax video detection wire** - RG59U Coax wire shall be 75 ohm, 20 gauge solid copper wire that is 10.50 ohms or less per 1,000 feet, with a 95% braided copper shield. Insulation shall be PVC with a .242 nominal O.D. All coax wire shall be run un-cut and un-spliced from controller cabinet to the video camera location.

02920.24 Eyebolts - Furnish eyebolts meeting the requirements to ASTM A307.**02920.25 Electrical Splice Materials** - Furnish electrical splice Material meeting the following requirements:

Electrical wire splices shall be made using a high compression crimp type solderless connector to securely join the wires both mechanically and electrically.

Direct burial splices and splices that may be submersed in water shall be made using a heat shrink tubing with internal sealant, with Thomas and Betts "Klick-it" splices, or other approved method.

- ~~**Split Bolt** - Made of silicon bronze to securely join the wires both mechanically and electrically.~~
- **Heat-Shrink Tubing** - Surface-irradiated tube complying with UL 486, rated at 194 °F, with 600 V inner melting wall or liner to provide void-free encapsulated insulation.
- **Insulating Rubber Tape** - Electrical grade, nondrying, rubber based, elastic type conforming to ASTM D4388.
- **Insulating Vinyl Plastic Tape** - Comply with ASTM D3005, Type II and UL 510.

02920.26 In-Line Fuse Holder - The in-line fuse holder rated for 30 A at 600 V shall be designed to hold a 13/32 inch by 1 1/2 inch 10 A KTK type fuse. In-line fuse connectors to be used on single phase 120/240 V and 240/480V lighting circuits shall be designed for two-pole fusing so both poles disconnect simultaneously from both legs of the line side. The case shall be rigid plastic with a threaded coupling for joining the two halves. When threaded together, the two halves shall completely enclose the fuse and exert pressure against a neoprene "O" ring to provide a waterproof seal. The load side holder shall hold the fuse securely in place, so when the two halves are disconnected, the load side holder will retain the fuse. The line side contact point shall be spring-loaded to provide pressure between the fuse and the contact points. Wire terminals shall be ~~compression~~ set screw type rated for copper wire.

An in-line fuse holder shall be placed in all luminaire poles.

02920.27 Ground Rod and Clamp - Furnish 5/8 inch x 8 foot copper covered steel ground rods with bronze grounding wire clamps.

02920.28 Conduit Plug - Furnish conduit plug Material used to seal the ends of conduit composed of closed cell polyethylene foam or duct seal meeting the following requirements:

- **Closed Cell Polyethylene Foam** - Consisting of precut sections with a plug length of 3 inch and a plug diameter 1/2 inch larger than the conduit diameter being plugged. Approximately one third of the plug length shall be exposed after installation.
- **Duct Seal** - UL listed clay putty material designed to seal electrical conduit.

Section 02925 - Traffic Signal Materials

Description

02925.00 Scope - In addition to Section 02920, this Section includes the requirements for traffic signal installations:

Materials

02925.01 Materials - Where shown or specified, hardware shall be furnished and installed with hot-dip galvanized or Type 304 or 316 stainless steel screws, bolts, nuts and washers. Bolts and screws shall have square or hex heads. Allen head fasteners will not be allowed.

02925.33 Frangible and Transformer Bases:

(a) **General** - Bolts, nuts and washers shall conform to 02560.20 and shall be galvanized according to 02560.40.

(b) **Vehicle Signal Pedestals** - Transformer bases shall be constructed to bolt to shaft flanges. Bases shall be square with rounded corners, tapered from the base to the top and approximately 20 inches in height. They shall be made of cast aluminum and include a removable access plate.

(c) **Pedestrian Signal Pedestals** - Pedestrian signal pedestal bases shall be a frangible type and constructed of cast aluminum. Include a removable access plate and a threaded connection to accept a 4 inch nominal steel pipe.

02925.34 Anchor Rods - Anchor rods shall conform to 02560.30 and to the types and sizes shown.

Cabinets and Control Devices

02925.40 Cabinets:—

(a) **General** - Cabinet drawings including electrical circuits shall be submitted to the City for approval prior to construction. Construct all cabinets, except signal controller cabinets, from 12 gauge Type 304 stainless steel, or 10 gauge sheet steel and hot-dip galvanize after fabrication according to 02530.70, or 8 gauge 5052 - H32 powder-coated aluminum. Cabinets shall be weatherproof, NEMA type 3R rated, and constructed as shown. Pole-mounted controller cabinets shall be provided with solid bottoms or equipped with a bottom cover plate.

The internal wiring of cabinets shall be done by a UL listed facility. Cabinets shall conform to one or more of the following standards where appropriate:

- UL 50, Cabinets and Boxes
- UL 67, Panel Boards
- UL 869A, Service Equipment

Use a welded conduit hub or screw-on hub to make conduit entrances into cabinets. Welded hubs shall be securely welded to the cabinet before galvanizing.

Power service cabinets with live parts exposed shall have a dead-front panel installed with cutouts for operating handles. Dead-front panels up to and including 120 square inches in size shall have a minimum of three holding studs. Install panels larger than 120 square inches in size using an adequate number of studs to maintain rigidity of the panel.

Construct the dead-front panels of stainless steel or galvanized steel and treat all cut galvanized steel edges with zinc-rich paint. Prime galvanized steel dead-front panels with vinyl wash primer and finish with exterior polyurethane enamel. The finish color of galvanized steel shall be grey.

Mounting pans or false backs are required for circuit breakers, contactors, relays, switches, transformers or other types of electrical Equipment. They shall be securely mounted inside the cabinet.

Label circuit breakers and Equipment with an engraved permanent label on the dead-front panel to indicate the circuit controlled.

Provide each cabinet with a latching device for a standard Agency padlock.

(b) Interconnect Cabinets - Interconnect cabinets shall be NEMA Type 3R Enclosures designed to house electrical equipment.

The cabinet and doors shall be constructed of 0.125-inch minimum thickness sheet aluminum.

The inside, outside and cabinet door shall be finished in anodized aluminum after fabrication.

The cabinet shall be provided with a screened roof air vent. The air vent shall be sealed to the cabinet roof by welding, or shall be an integral part of the cabinet body. The use of caulking to seal the roof air vent will not be allowed.

Provide louvered vents in the front door with a removable air filter. The filter shall be polyblue polyester media with a cardboard frame, shall be larger than the louvered area, and shall be held firmly in place by a bottom bracket and an upper spring or spring-loaded clamp. The bottom filter bracket shall be formed into a waterproof sump with drain holes to the outside.

Door gaskets shall be 0.25-inch minimum thickness closed cell neoprene and shall be permanently bonded to the metal. The mating surface of the gasketing shall be covered with a silicone lubricant to prevent sticking to the mating surface.

The door shall be designed to completely cover the front of the cabinet opening and shall have flanged lips to increase the strength around the opening and to keep dust and liquids from dropping into the cabinet when the door is opened. The door shall and shall not be equipped with a police panel door.

The door hinge shall be either continuous hinge or two butt hinges, and shall be constructed from 14 gauge stainless steel. Each hinge shall have a fixed .120 diameter stainless hinge pin. The hinges shall be bolted to the cabinet. The hinge bolts shall not be accessible to vandals.

The door shall be provided with catches to hold the door open at 90 degrees, plus or minus 10 degrees. The catches shall be 0.25-inch diameter, minimum stainless steel. Additionally, provision shall be made to ensure it would require a conscious act on the part of the person opening the door to open it more than 90 degrees.

The cabinet door shall be equipped with a "Best" lock with an interchangeable core. The core supplied shall be a red Contractor core. Two keys shall be furnished with each cabinet.

The operating handle shall be aluminum or cadmium plated steel. The door frame shall be double-flanged out on all four sides and shall provide strikers to hold tension and form a firm seal between the door gasket and the door frame.

02925.41 Circuit Control Devices:

(a) General - Install circuit breakers, the copper neutral block, and contactors as shown.

(b) Circuit Breakers - Provide UL489 listed circuit breakers of the rating shown or specified. Circuit breakers shall be of the unenclosed, molded case bolt-on type with end conductor terminals, suitable for surface mounting in the cabinet on a false back or bracket.

(c) Terminal Blocks - Provide sectional channel mount 600 V terminal blocks of sufficient size to accommodate the wiring shown.

02925.42 Traffic Signal Control Devices - The traffic signal controllers and related Equipment shall conform to requirements of the current edition of the ODOT Standard Specification for Microcomputer Signal Controller, except as supplemented and modified by the Special Provisions.

The most current published version of the ODOT Standard Specification for Microcomputer Signal Controller, including all published errata, on ODOT's Traffic Standards website (see 00110.05(e)) at the time of Award Advertisement is the version in effect for the Project. Supplement and modify the Standard Specification for Microcomputer Signal Controller according to the Special Provisions and the following:

CHAPTER 1 GLOSSARY

(CHANGE) Engineer - The City of Eugene Traffic Engineer

(AMEND) State - The City of Eugene, where the intent is to make reference to the contracting agency.

CHAPTER 3 SPECIFICATIONS FOR CABINET MODELS 332S, 332, 334, AND 336

SECTION 2 HOUSING REQUIREMENTS

(ADD) 3.2.3.4 A porcelain lamp socket shall be installed in each controller cabinet. The lamp socket shall be located under the output file on the left hand side of the cabinet (facing the cabinet front), and shall accommodate a 67 watt traffic signal lamp. The socket shall be controlled from a switch located on the power distribution assembly through a thermostat that turns on the lamp at 65 degrees. The thermostat shall be mounted on the same side of the cabinet at least 18 inches away from the lamp.

SECTION 5 CABINET WIRING

3.5.4 Detector Test Buttons

(ADD) 3.5.4.5 The detector panel shall also include a switch to disable all inputs from the input files.

SECTION 6 CABINET TRANSIENT SURGE SUPPRESSION REQUIREMENTS

(AMEND) 3.6.1.1 The surge protector shall be the TESCO TES-10B or equal.

(ADD) CHAPTER 3 SECTION 7 - COMMUNICATIONS TERMINATION PANEL

3.7.1 Each Model 332 Cabinet shall be provided with a Communications Termination Panel, which provides a mounting location for communications cable termination blocks, overvoltage protection devices and the termination points for the C2P harness and connector.

3.7.2 The panel shall be fabricated from 0.125 inch sheet aluminum, and shall have the dimensions shown on the plans. The panel shall be drilled and tapped, as necessary, to mount the terminal blocks and other attachments described below, as well as to mount the panel to the EIA rack within the cabinet. Sharp edges or burrs caused by the cutting or drilling process shall be removed.

3.7.3 The panel shall be provided with a Communications Cable Termination Block (CTB-1). This shall be a quick connected block consisting of 50 horizontal rows of 6 clips per row, mounted in a molded self-extinguishing plastic case. The block, commonly referred to as a "66B Type" block, shall terminate 25 pairs of 20 through 24 AWG solid unskinned conductors. The blocks shall be equipped with integral fanning strips and an enclosed back to prevent grounding of clips to the panel. The block shall be mounted on the panel as shown on the plans.

3.7.4 The panel shall be provided with an Active Pairs Termination Block (CTB-2). This block shall be a ten position, dual screw closed back barrier strip and shall be mounted on the Communications Termination Panel, as shown on the plans. The strip shall be rated at 15 amperes, and shall be provided with 6-32 X 1/4 inch nickel plated brass binder head screws.

3.7.5 The panel shall be provided with a Test Point Termination Block (CTB-3). This block shall be an eight position single screw closed back barrier strip and shall be mounted on the Communications Termination Panel, as shown on the plans. The strips shall be rated at 15 amperes and shall be provided with 6-32 X 1/4 inch nickel plated brass binder head screws.

3.7.6 An overvoltage surge protector shall be provided on each of the five active communications cable pairs terminating in each cabinet (CRT-In, CRT-out, Voice, Audio-In and Audio-Out). The protectors shall be installed on the Active Pairs Termination Block (CTB-2). Protectors shall be of a Three-Electrode Gas Tube Type, and shall have the following ratings:

3.7.6.1 Impulse life, (1,000 amp, 10/1000 waveform 1000 surges minimum at one minute intervals each direction, with 2500 surges typical 500 amp on each side to ground simultaneously):

3.7.6.2 AC Discharge Current 400 amp rms
11 cycles, 60 Hz: 200 amp each side to ground simultaneously

3.7.6.3 Max. Single Impulse Discharge Current 40 ka maximum
8/20 Waveform: 20 ka/side simultaneously

3.7.6.4 Capacitance: Line-gnd.: 4pf
Line-line: 2pf

3.7.6.5 D C Holdover: 180 vdc typical at 220 ma
150 volts dc Min

3.7.6.6 DC Arc Voltage: 30 volts typical
Glow to Arc Transition Current: 1.0 amp typical
Transition Time: 0.5 Microseconds Max. Line-Gnd. Impulse Breakdown
Voltage at: 10kv/sec 1000volts maximum average

3.7.6.7 Insulation Resistance: 1000 Megohms Min at 100 vdc (line-gnd.)

3.7.6.8 The protectors shall be encapsulated, and shall be equipped with minimum of 2 inch, spade lug tipped, leads. Maximum size of each protector shall be . inch X . inch X 2 inch. The grounding lead shall be attached to the panel's grounding stud.

3.7.7 A grounding stud shall be provided on each panel. The stud shall extend through the panel. The overvoltage protection devices' ground leads shall be attached to the stud on the front side of the panel. A No. 8 AWG copper conductor shall be attached to the stud on the back side of the panel, and shall connect to the cabinet's Equipment Grounding Bus.

3.7.8 A twelve-conductor jacketed cable shall be attached to terminal blocks CTB-2 and CTB-3, with ring lugs, as shown in the Plans. The cable shall terminate in a standard C2P connector, and shall be routed through the cabinet and be of sufficient length to reach the C2S connector on the back of the 170 Controller Unit, when the unit is installed, or is being installed, in the equipment rack.

3.7.11 As shown on the plans, a feed-through opening, complete with protective grommet, shall be provided on the panel, to protect the C2P harness, CRT jack harness and voice jack harness. A strain relief device shall also be provided.

3.7.12 Two 1/4 inch diameter holes shall be provided, as shown on the Plans, for future installation of cable ties.

3.7.15 A legend shall be provided on each termination panel as shown on the plans. The legend shall be in 0.1 inch high block letters which have been silk-screened on to a properly prepared surface.

3.7.16 The panel shall be securely attached to the equipment rack assembly, under the output file and auxiliary output file, as shown in the plans.

3.7.17 The panel shall have a 1" X 4" slot in the top left hand side, as shown on the plans. This slot will facilitate feed cable from the back of the panel to the front for connection.

CHAPTER 4 SPECIFICATIONS FOR TRAFFIC SIGNAL CONTROLLERS

SECTION 2 - MODEL 2070 CONTROLLER

4.2.2 Assembly

(REPLACE) 4.2.2.1 2070-2A Field I/O Module with 2070-2E Field I/O Module

(AMEND) 4.2.2.1 2070-3B Front panel shall have a level of contrast equal to or better than the McCain 2070-3B Front Panel.

(DELETE) 4.2.2.2

(ADD) 4.2.2.2 Provide a 2070-6B 9600 Baud Modem Module.

(CHANGE) 4.2.4.1 Two 8 Mb Data keys

SECTION 5 EMERGENCY VEHICLE PREEMPTION SYSTEM

5.5.1 Requirements

(ADD) 5.5.1.2 Shall be Opticom (GTT) Model 764 Phase Selector

(ADD) 5.5.1.3 Shall include Opticom (GTT) Model 768 Auxiliary Interface Panel and cables to connect to the 764 Phase select and the Green sense inputs.

02925.51 Traffic Signal Lamps - Vehicle signal and pedestrian signals shall be illuminated by LED modules. Use only prequalified LED modules that are listed in the Traffic Signal Materials "Blue Sheets".

Signal Indication Material

02925.60 Signal Indication Material - The housings, including doors and hoods, shall have a smooth homogeneous black finish. All parts shall be clean, smooth, and free from flaws, cracks, blow holes, and other imperfections. All fasteners not specifically noted as hot-dip galvanized shall be Type 304 or 316 stainless steel installed with anti-seize compound.

02925.62 Signal and Sign Mounting Hardware:

- (a) General** - All fasteners not specifically noted as hot-dip galvanized shall be Type 304 or 316 stainless steel. All fasteners shall have either square or hex heads.
- (b) Plumbizer** - Provide plumbizers that are constructed of cast bronze. Paint the mounting hardware with two coats of zinc-rich aluminum paint.
- (c) Span Wire Hanger** - Provide span wire hangers that are constructed of cast bronze. Paint the mounting hardware with two coats of zinc-rich aluminum paint.
- (d) Adjustable Bracket** - Attach adjustable brackets to the pole with cables. A safety cable shall be supplied to capture the appurtenance in the event of a failure of the mounting bracket.
- (e) Tri-stud Adapters** - Furnish tri-stud adapters with two backing washers and omit the neoprene washer/gasket. Use silicon caulking to seal between the tri-stud adapter and the signal head.

02925.64 Vehicle Signal - Each housing shall be of the one-section expandable type. Each section shall be of one-piece construction. The design shall be such that at any time and without the use of other than simple tools, it shall be possible to convert any housing into a one-, two-, three-, four- or five-section housing by the addition or subtraction of housing sections. The entire housing shall be made dust and water resistant. Vehicle signal heads not utilizing the bottom opening for mounting shall have a screw hole plug installed and shall have a 1/4 inch drain hole drilled in the bottom of the plug. Construct vehicle signal housings and doors of die-cast aluminum alloy or polycarbonate.

- (a) Doors** - Gasket each door to provide moisture resistant construction.
- (b) Visors** - Construct visors of sheet aluminum alloy 3003-H16 (ASTM B209), nominal thickness 16 gauge or polycarbonate. Visors shall be of one-piece construction and attach to the signal housing doors with Type 304 or 316 stainless steel screws. Provide 8 inch lenses with a 7 inch visor and 12 inch lenses with a 9 1/2 inch visor. Signal housing doors, with visors attached, shall be capable of being opened a minimum of 90 degrees. Use tunnel visors on all vehicular signal indications with the bottom portion open, so the sections light output is visible directly in front of and below the signal head.
- (c) Backboards** - Construct backboards of sheet aluminum alloy 3003-H14 (ASTM B209), 14 gauge nominal thickness or polycarbonate. Aluminum backboards shall be louvered. Provide all vehicular signal heads with backboards and include all of the necessary mounting hardware for completing the installation. Backboard dimensions shall fit the signal head housings used, with no gap between backboard and housing. Backboards shall have a border width of 5 inches. Attach backboards with stainless steel screws and washers. Use washers at least 3/8 inch in diameter.

When shown or specified, use heavy duty polycarbonate vehicle signals listed on the ODOT "Blue Sheet". Assemble the heavy duty polycarbonate vehicle signal, visor, and backboard with bolted connections, stainless steel reinforcing strips, and stainless steel reinforcing plates.

02925.65 Pedestrian Signal Heads - Provide single-section pedestrian signal heads meeting the following requirements:

- (a) Housing and Door** - The housing and door shall:
 - Use a one-piece housing and sealed door constructed of die-cast aluminum alloy or polycarbonate that provides a dustproof and weatherproof enclosure.
 - Allow easy access for maintenance of the interior components with the door open.
 - Be installed with a hex head pipe plug with 1/4 inch drain hole drilled in the bottom of the plug when pedestrian signal heads are not utilizing the bottom opening for mounting.
 - Be installed with terminal blocks to accommodate wire terminations.
- (b) Visors** - The visor shall:
 - Use a one-piece z-crate or egg crate type polycarbonate plastic visor.
 - Include vertical (or angled) and horizontal members spaced to provide the required shielding and strength.
 - Be held securely to the door assembly.
- (c) Mounting** - The mounting shall be designed to use either a bracket assembly or a clamshell mounting as shown.

02925.66 Pedestrian Push Buttons and Mount:

- (a) **General** - Push buttons shall be:
- Direct contact type.
 - Free of levers, handles, or toggle switches externally or internally.
- (b) **Contacts** - Push button contacts shall be:
- Entirely insulated from the housings and operating buttons.
 - Normally open.
 - Closed only when push buttons are operated by pressure.
 - Restored immediately to the normal open position when pressure is released.
- (c) **Housing** -- H-style housing are not allowed. The housing containing the pedestrian push button shall be made with:
- A one-piece assembly of extruded aluminum containing the push button, with the signs placed directly on the extrusion.
 - A sign background of two coats of white enamel with black silk-screened legend conforming to Standard Sign as shown.
 - An outlet in the back of the housing for rigid conduit.
 - A 1/4 inch diameter drain hole in the bottom.
- (d) **External Button** - The external operating button shall:
- Be constructed of durable materials able to withstand the typical abuse inflicted by the general public.
 - Be removable from the housing with simple tools.
 - Be at least 2 inches in diameter.
 - Operate a momentary contact switch by direct contact.
 - Contain a guard completely encircling the push button, and extending far enough to prevent prying under the push button. It shall be resistant to damage associated to striking it with an object other than the hand.

02925.67 Coatings:

- (a) **Aluminum Signal Heads** - Pedestrian signal heads, vehicle signal heads, beacon heads, visors and backboards shall be powder coated inside and outside to meet Federal Standard 595b-37038 (dull black).
- (b) **Signal Controller Cabinets** - Provide signal controller cabinets that are constructed of anodize aluminum.
- (c) **Brackets and Hangers** - Apply two coats of aluminum paint to cast bronze type brackets and hangers after they have been primed. All steel shall be hot-dipped galvanized before painting. Threads and any damage to the galvanizing shall be repaired prior to painting.

02925.68 Signal Head Covers - Provide signal head covers that:

- Are yellow prefabricated nylon.
- Completely cover visors and can cover the backplate.
- Include a fine mesh insert for signal testing.
- Have integral elastic bands and clips to secure the covers to the signal.

02925.69 Audible Pedestrian Device (APD) - APD are required at all new actuated traffic signals. The APD shall provide unique sounds coincidental with the pedestrian indications. The APD shall include a solid state electronic board(s), power supply, enclosure, loudspeaker and mounting hardware necessary for fulfilling the intended use stated herein and in applicable portions of the Standard Specification for Microcomputer Signal Controller.

- (a) **General** - The exterior dimensions of the APD unit shall not exceed 14" h x 5.5" w x 3" d. Polara 3 wire Navigator or approved equal.

The APD shall include a vibro-tactile button and tactile arrow that points in direction of travel.

The mass (weight) of the APDS unit shall not exceed 1 pound.

The button actuated delay time shall be adjustable in one-second increments throughout the range of 0 to 15 seconds.

The APD unit shall have a sound inhibit circuit capable of control by an external device.

- (b) **Electrical Requirements** - The APD unit shall operate on 95 to 130 VAC, 60Hz, ≤3 W.

Provide a power protection circuit consisting of both fuse and transient protection.

Provide an optically isolated circuit allowing delayed actuation of the audible signal.

- (c) **Environmental Requirements** - The APD unit shall function properly throughout an ambient air temperature range of -35 °F to 165 °F.

- (d) **Outputs** - Provide programmable voice messages including automatic repeat capability for messages up to 20 seconds in length.

The audible signal shall be self-adjusting based on ambient noise.

The volume level at a distance of 3 feet from the APD enclosure shall be 66dB typical, with a maximum of 90dB.

The minimum volume level shall be adjustable proportionally from 66dB to 90dB without dismantling the APD unit housing.

Provide two switch-selectable electronic sounds as specified in the following:

Parameter	Sound #1	Sound #2
Sound type	"Peep-peep"	"Cuckoo"
Method	Electronic var. frequency tone	Electronic var. frequency tone
Period	1.0 sec. + 20%	1.5 sec. + 20%
Duration	0.2 sec. + 20%	0.6 sec. + 20%
Frequency Base	2800 Hz + 20%	1100 Hz + 20%
Frequency Deviation	- 800 Hz + 20%	+120 Hz + 20%

Include count down capability during the pedestrian clearance interval.

Section 02926 - Highway Illumination Materials

Description

02926.00 Scope - In addition to Section 02920 and all applicable portions of AASHTO "Roadway Lighting Design Guide" (2005) and "American Standard Practice for Roadway Lighting" (IES, RP-8, 2000), this Section includes the requirements for highway illumination installations.

Materials

02926.01 Materials - Hardware shall be furnished and installed with hot-dip galvanized or Type 304 or 316 stainless steel screws, bolts, nuts and washers. Bolts and screws shall have square or hex heads. Allen head fasteners will not be allowed.

Cabinets and Control Devices

02926.40 Cabinets - Cabinet drawings, including electrical circuits, shall be submitted to the City for approval prior to construction. Construct all cabinets from 12 gauge Type 304 stainless steel, or 10 gauge sheet steel and hot-dip galvanize after fabrication according to 2530.70. Post mount cabinets shall be weatherproof, rated as NEMA type 3R, and constructed as shown.

With 3 phase electrical system and/or main circuit breaker of 200 amp or higher, pad-mount cabinet shall be installed as shown. It shall be NEMA type 3R, with hinged double door, 3 point lockable vault handles and stainless steel hardware. Cabinet size is 48 inches x 63 inches x 18 inches deep, or as shown.

The internal wiring of cabinets shall be done by a UL listed facility. Cabinets shall conform to one or more of the following standards where appropriate:

- UL 50, Cabinets and Boxes
- UL 67, Panelboards
- UL 869A, Service Equipment

Use a welded conduit hub to make conduit entrances into cabinets. Hubs shall be of the size required and shall be securely welded to the cabinet before galvanizing. Malleable iron screw-on hubs may be used as approved.

Power service cabinets with live parts exposed shall have a dead-front panel installed with cutouts for operating handles. Each dead-front panel shall have a minimum of two holding latches to maintain rigidity of the panel.

Construct the dead-front panels of stainless steel or code-gauge galvanized steel and treat all cut galvanized steel edges with zinc-rich paint. Prime galvanized steel dead-front panels with vinyl wash primer and finish with exterior polyurethane enamel. The finish color of galvanized steel shall be aluminum.

In all outdoor locations, mounting pans are required when circuit breakers, contactors, relays, switches, transformers or other types of electrical Equipment are to be mounted inside the cabinet.

Label circuit breakers and Equipment with an engraved permanent label on the dead-front panel to indicate the circuit controlled.

Provide each cabinet with a latching device for a standard Agency padlock.

Meter base shall be made from 16 gauge galvanized sheet steel (G90), and powder coated inside and out after fabrication, or from 16 gauge Type 304 stainless steel sheet.

02926.41 Circuit Control Devices:

(a) General - Install circuit breakers, the copper neutral block, and contactors as shown.

(b) Circuit Breakers - Circuit breakers shall have voltage rating and number of poles shown or specified. Circuit breaker's interrupting rating shall meet or exceed short circuit rating of the specified electrical system.

Circuit breakers shall be UL 489 conformed, thermal magnetic molded case circuit breakers and bolt-on type with individually insulated and protected terminals, suitable for surface mounting in the cabinet on a false back or bracket.

All 100 A frame breakers shall be Class 13a for single pole breakers, Class 18a for multiple pole breakers, and 225 A frame breakers shall be Class 20a in Federal Specification W-C-375B, table "Classification of ratings".

Install overcurrent protection and relay Equipment, as shown or specified, with materials and installation conforming to the NEC.

(c) Multiple Light Contactors - Contactors shall be lighting type specifically rated for high-intensity discharge type lamp loads, electrically held. The contactors shall have a 600 V rating. All multiple light contactors shall be unenclosed single-phase, two- or three-pole, open type lighting contactors of the rating shown or specified. Construct contactors for surface mounting on a false back or bracket within a weatherproof cabinet. The contactor coil shall operate on 120 V for 240 V circuits and 240 V, 208 V, and 277 V for 480 V circuits.

(d) Test Switch - Furnish and install a 277 V AC rated test switch in the control cabinets if shown. The test switch shall be a heavy-duty single-pole switch or circuit breaker rated at 15 A and shall be installed in the control cabinet as a roadway lighting test switch. The switch shall be wired to shunt the photoelectric relay power contactor and energize the lighting circuit contactors.

(e) Photoelectric Relay - The photocell shall be of solid state design and shall meet or exceed all ANSI C136.10 requirements. House all components of the solid state photoelectric control in a weatherproof, locking type, high impact resistant, ultraviolet stabilized polypropylene container. Twist lock blades shall be solid brass. The photoelectric relay shall attach to a ANSI C136.41 seven-pin locking receptacle by a twisting motion. The photocell shall have a rated life equal to or exceeding 20-years.~~The photoelectric relay shall attach to a three-pole locking receptacle by a twisting motion.~~

The unit shall have a built-in surge protective device for protection from induced high voltage and follow-through currents. The relay shall meet or exceed the requirements of ANSI C136.10. Factory set turn-on lights shall be 1.4 footcandle \pm 0.2 footcandle at 120 V AC. When operated at 240 V AC, turn-on shall not change more than plus or minus 0.3 footcandle from the 120 V value. Maximum off-to-on ratio shall be 1.5:1.

The photoelectric relay shall be a cadmium-sulfide photocell encapsulated for humidity protection, or a silicon junction type photo-transistor.

Normal 120 volt operation shall be designed for 105-305 volt 60 Hz operation and shall have a housing color of gray. Normal 208, 240, 277 volt operation shall be designed for 200-300 volt operation and shall have a housing color of maroon.~~Normal operation shall be designed for dual voltage operation of 105 V - 285 V, 60 Hz.~~

At the designated voltage the photoelectric control shall be capable of controlling a minimum of 1,800 VA ballast type lighting load. Power consumption shall be less than 1 W.~~At the designated voltage, the photoelectric relay shall be capable of controlling a minimum mercury vapor, fluorescent or incandescent lamp load of 1000 W.~~ Minimum operating temperature range shall be from -40 °F to 150 °F.

Turn on to be instantaneous and turn off shall have a two to four second time delay to prevent false turn-offs by transient light conditions.~~A time-delay control circuit shall prevent false turn-offs by transient light conditions.~~ Provide a fail-safe circuit for the lighting load to remain on or become energized if any functional failure of the photoelectric control circuit occurs.

Lamps, Ballasts, and Luminaires

02926.50 Illumination Lamps - All high-pressure sodium lamps shall conform to ANSI Standards. All lamps of the same size and type, on a single project, shall be from the same manufacturer's lot number.

All lamp bases shall have a brass mogul base mounting with dating system.

Lamps shall have an average minimum initial lumen rating (after 100 burning hours) and an average minimum lamp life (based on 10 hours per start) as follows:

Lamp Watts	ANSI Code	Minimum	Lamp	Minimum
		Initial Vertical	Lumens Horizontal	Average Lamp Life
High-Pressure Sodium - Clear				
70	S62ME-70	6,300	6,300	24,000
100	S54SB-100	9,500	9,500	24,000
250	S50VA-250/S	29,000	29,000	24,000
400	S51WA-400	50,000	50,000	24,000
1,000	S52XB-1000	140,000	140,000	24,000

02926.52 Ballasts - High-pressure sodium ballasts shall be magnetic regulator (lag type regulator) or constant wattage auto regulator with primary and secondary windings electrically isolated from each other.

Except where operation is 480 V, ballasts shall be multi-voltage type with taps to allow the ballast to be connected to 120 V, 208 V, 240 V, or 277 V.

Unless otherwise shown or specified, the ballast shall be an integral part of the luminaire unit. It shall be of the prewired, built-in type mounted in the luminaire.

Provide a manufacturer's nameplate on the ballast housing. The nameplate shall have the manufacturer's name, model number, serial number, hook-up diagram, power supply data, lamp type and operating wattage.

The ballast shall operate the lamp within the limits specified below throughout the rated life of the lamp:

- The lamp wattage shall not vary more than the allowable range shown in the table below over the line voltage variation shown.
- The lamp wattage shall not vary more than plus or minus 5 percent of nominal when the lamp is at its rated nominal voltage (high-pressure sodium lamps only).
- The minimum efficiency of the ballast (nominal lamp watts/line watts) shall not be less than shown below.
- The ballast shall not allow the lamp arc to extinguish when a line voltage dip as shown below occurs for several seconds.
- The power factor shall not drop below 90 percent for the line voltage variation shown below.
- The line starting current shall not exceed normal line operating current.
- The ballast shall start and operate the lamp in ambient temperatures down to -20 °F.
- The lamp current crest factor shall not exceed 1.8 for line voltage variation shown below.
- The ballast shall conform to all ANSI Standards.
- The ballast shall have capacity to operate dual-arc tube lamps as well as standard lamps without modification of the luminaire.

Submit for review ballast electrical data and lamp operating volt-watt traces for nominal and ± 10 percent rated line voltage for each type of high-pressure sodium lamp ballast.

Lamp Type	Lamp Wattage Range	Line Voltage Variation	Allowable Lamp Watt Variation	Minimum Efficiency	Allowable Line Voltage Dip
HPS	70 - 100	$\pm 10\%$	$\pm 10\%$	70%	40 - 50%
HPS	150 - 400	$\pm 10\%$	$\pm 10\%$	78%	40 - 50%
HPS	1,000	$\pm 10\%$	$\pm 10\%$	92%	40 - 50%

Unless otherwise shown or specified, operate ballasts on 240 V or 480 V. When 120 V operation is specified, the ballast shall be a multi-voltage type with taps to allow the ballast to be connected to 120 V, 208 V, 240 V, or 277 V.

02926.53 High-Intensity Discharge Luminaires:

(a) General - Furnish conventional roadway luminaires for horizontal slip fitter end mounting.

Luminaires shall have a cast-aluminum housing and shall attach to 1 ¼ inch to 2 inch pipe tenons on mast arms. The luminaire attachment fitting shall provide for a minimum of plus or minus 3 degree adjustment of the luminaire in the vertical direction. The reflector of all luminaires shall be of a snap-on or easily removed design manufactured of polished aluminum or molded from prismatically formed borosilicate glass. The refractor shall be mounted in a door frame assembly hinged to the luminaire and secured in the closed position by means of an automatic latch or a draw latch. The refractor and doorframe assembly, when closed, shall exert pressure against a gasket. Gaskets shall be composed of material capable of withstanding the temperatures encountered and shall be securely held in place. Glassware shall be of the refractor type with prisms.

Reflectors and refractors provided with the luminaire shall be stamped or labeled with a part number. The luminaire photometric submittal (isocandela diagrams) shall indicate the reflector and refractor part number used.

All luminaires shall have their components secured to the luminaire frame with corrosion-resistant mounting hardware. The housing, complete with integral ballast, shall be weather tight.

If sand-cast, the aluminum housing shall be left in its natural finish. If die-cast, the housing shall be given a coat of aluminum paint.

Refractors shall be formed from heat-resistant, high-impact, molded borosilicate glass.

Lamp sockets shall be adjustable to obtain the light distribution shown or specified.

Socket opening shall be sealed with a heat-resistant filter or filtering gasket to prevent the entry of dirt, insects or moisture into the optical system.

The socket mounting mechanism shall be sufficiently rigid that upon application of a 2 pound load in any direction on the light source center, the light source center shall not deflect more than 1/16 inch.

The housing for "cobra head" type luminaires shall be the same size for 200 watt through 400 watt fixtures.

In all luminaires, a manufacturer's name plate shall be an integral part of the housing. The name plate shall have the manufacturer's name, model number, hook-up diagram, power supply data and the load in watts that the control unit is capable of operating.

The lamp socket shall be a porcelain enclosed mogul-multiple type. The socket shall contain integral lamp grips to assure electrical contact under conditions of normal vibration. The socket shall withstand a 4 kilovolt high voltage potential test.

PEC sockets on luminaires are required except for luminaries on circuit controlled systems unless shown otherwise on the plans.

(b) Classification of Luminaire Light Distribution - Furnish the following distribution types as shown or specified. The classifications listed shall conform to ANSI definitions.

(1) Vertical Light Distributions - Divide vertical light distributions into three groups: short (S), medium (M), and long (L). Classification of the three groups depends on the maximum candle power point within a grid area according to the ANSI/IES RP-8 (2000) publication for Roadway Lighting.

(2) Lateral Light Distributions - Lateral light distribution patterns shall have the following designations:

Type I
Type II
Type III
Type IV
Type V

The type designations listed above shall conform to ANSI definitions.

(3) Distribution Above Maximum Candle Power - This classification shall be used to control the candle power in the upper portion of the beam above the maximum candle power. The following three classifications shall be used:

Cutoff
Semi cutoff
Noncutoff

The classifications listed above shall conform to ANSI definitions.

02926.54 Light Emitting Diode (LED) Luminaires:

(a) General - Furnish roadway luminaires for horizontal slip fitter end mounting.

Luminaires shall attach to 1 1/4 inch to 2 inch pipe tenons on mast arms. The luminaire attachment fitting shall provide for a minimum of plus or minus 3 degree adjustment of the luminaire in the vertical direction.

All luminaires shall have their components secured to the luminaire frame with corrosion-resistant mounting hardware. The housing shall be weather tight.

In all luminaires, a manufacturer's name plate shall be an integral part of the housing. The name plate shall have the manufacturer's name, model number, hook-up diagram, and power supply data.

(b) Classification of Luminaire Light Distribution - Furnish luminaires with distribution and classification types as shown or specified.

(1) Vertical Light Distributions – Describe the vertical light distributions as short (S), medium (M), or long (L). Vertical distribution depends on the maximum candle power point within a grid area according to Annex E of the ANSI/IES RP-8-14 publication for Roadway Lighting.

(2) Lateral Light Distributions – Describe the lateral light distribution patterns as: Type I, Type II, Type III, Type IV, or Type V. Lateral distribution depends on the zone in which the maximum candlepower point lies according to Annex E of the ANSI/IES RP-8-14 publication for Roadway Lighting.

(3) Luminaire Classification System - Describe the luminaire classification using the backlight, upright, and glare ratings (B-U-G ratings) system from IES TM-15-11 Addendum A – Luminaire Classification System for Outdoor Luminaires.

(c) Luminaire Technical Requirements –

- Nominal rated Correlated Color Temperature (CCT) shall be 4000K ±300K. Except, 3000k +- 300 in natural areas.
- Color Rendering Index (CRI) shall be a minimum of 70.
- Off-state power consumption of the luminaire shall be a maximum of 2.5 watts.
- Maximum luminaire weight shall be 20 lbs.
- Maximum Effective Project Area (EPA) is 0.9.
- Luminaire shall operate normally in temperatures from -20° to +25° Celsius.
- Cooling system shall consist of a heat sink with no fans, pumps or liquids. The heat sink shall be resistant to debris buildup and heat dissipation performance shall not degrade due to debris buildup.
- Housing
 - Shall be constructed of corrosion resistant material. Cobrahead style luminaires shall have a gray finish.
 - Driver must be internally mounted and replaceable.
 - Driver must be accessible without tools.
 - No parts shall be constructed of polycarbonate unless it is UV stabilized.
 - The light engine section of the fixture shall be rated a minimum of IP66 for ingress protection.
 - Cobrahead style luminaires shall have a hinged, downward opening removal door

- For residential areas, IESNA Luminaire Classification shall meet TM-15: B1-U0-G1. For all other areas, the uplight rating shall be 0 and the backlight and glare light shall be as low as practicable while meeting the required uniformity ratios and reasonable pole spacing.
- Shall be rated for the ANSI C136.31 3-G Vibration Levels.
- Shall accommodate placement of house side light controls (shields).
- Fixtures shall include an ANSI C136.41 7-pin locking receptacle except for luminaires on circuit controlled systems, unless shown otherwise on the plans.

(d) LED Module/Array Requirements –

- Provide a summary of the LM-80 report for the LEDs used in the fixture.
- Provide the latest version of the Energy Star TM-21 Calculator spreadsheet with the LM-80 data.
- Calculated L70 per TM-21 at 85°C shall be a minimum of 100,000 hours.
- Lumen Maintenance Factor per TM-21 at 50,000 hours and 55°C shall be a minimum of 0.95.
- Lumen Maintenance Factor per TM-21 at 50,000 hours and 85°C shall be a minimum of 0.90.
- Use a Luminaire Dirt Depreciation factor of 0.9.

(e) Driver/Power Supply –

- Power supply shall have a minimum Power Factor (PF) of 0.90.
- Driver shall have a 100,000 hour rated life at 25° Celsius ambient temperature.
- Driver shall operate normally in temperatures from -20° to +50° Celsius.
- Unless otherwise shown or specified, furnish multi-voltage type drivers that allow operation at 120 V, 208 V, 240 V, or 277 V.
- Driver shall have a maximum Total Harmonic Distortion (THD) of 20% at full input power and across specified voltage range.
- Shall comply with FCC 47 CFR part 15 interference criteria for Class B (non-residential) digital devices.
- Shall have Integral 10kV surge suppression protection standard. Shall allow a minimum of three different field adjustable amperage settings.

Power supply shall be 0-10V dimmable and capable of receiving dimming signals from the 7-pin receptacle with included connectors per manufacturer's wiring diagram.

02926.54 – LED Luminaires:

(a) General Performance Requirements:

~~(1) General – Furnish each LED luminaire as a complete lighting unit manufactured according to ANSI C136.37-2011 and utilizing high-power LEDs as the light source.~~

~~All internal components shall be assembled and pre-wired using modular electrical connections. Wiring, grounding, and terminal block installation shall be according to ANSI C136.37. Luminaires shall accept a designated voltage range of 50 to 60 Hz, and operate normally with an input voltage that is within 10 percent of the specified voltage.~~

~~(2) Finished Surface – Furnish LED luminaires with a gray or silver housing. The surface of the luminaire housing shall be UL listed for wet locations (UL 1598). After 1000 hours of salt chamber exposure, according to ASTM-B117, luminaire surface shall exceed a rating of 6 for rust creepage for scribed specimens according to ASTM-D1654.~~

~~(3) Thermal Management – The luminaire shall start and operate in the ambient temperature range specified. Mechanical design of heat sink fins shall facilitate hose-down cleaning and discourage debris accumulation.~~

~~Liquids or moving parts (such as fans) shall be clearly indicated in submittals, consistent with product testing, and subject to approval by the Engineer.~~

~~(4) LED Driver Requirements – The LED driver shall meet the following minimum requirements:~~

- ~~Rated to operate in -40° C to 40° C ambient temperature~~
- ~~Total Harmonic Distortion (THD) to be less than 20 percent~~
- ~~Have minimum power factor of 90 percent~~
- ~~Comply with requirements of UL, CSA, and FCC regulations in 47 CFR Part 15~~
- ~~Rated for outdoor operation and have an ANSI/IEC rating of IP66~~

~~Furnish a dimmable driver for each high-mast, highway/street lighting luminaire, including ornamental lighting and intersection lighting on signal systems, with two leads to accept standard 0-10 V (DC), except on the luminaires of 100 watts or less. The dimming control shall be compatible with IEC 60929. If the control leads are open or the analog control signal is lost, the circuit shall default to 100 percent power. Conductors and terminals shall be identified.~~

~~(5) Electrical Parts and Safety Testing~~ For each luminaire, except ornamental, underdeck, and wall mount luminaires, provide an ANSI C136.41 compliant, 7-pin receptacle that is fully prewire for the LED driver's control. For 0-10 V dimmable LED drivers, connect control wires to the receptacle pads as specified in ANSI C136.41.

When the photo control is required, furnish and install a specified photo control unit with the specified driver on each LED luminaire. If the photo control is not required, install a shorting cap on each luminaire, as directed by the Engineer.

Luminaires shall conform to ANSI C136.2 for electrical immunity, using the combination wave test level of 6 kV/3 kA. Luminaires shall comply with interference criteria for Class A digital devices according to FCC regulations in 47 CFR Part 15.

~~(6) Identification and Labeling~~ Luminaires shall have internal and external labels according to ANSI C136.15 and ANSI C136.22.

~~(7) Surge Protection~~ Provide a surge protection device (SPD) to protect LED drivers and LED lighting arrays from electrical transients. The SPD shall be recognized according to UL1449 and rated for 10 kV/5 kA combination wave surges in accordance with ANSI/IEEE C62.41.2. The SPD shall comply with FCC regulations in 47 CFR Part 15, Subpart B for the emission of electronic noise.

~~(8) Maximum Power Consumption~~ For the control of trespassing light and glare, the following maximum power consumption values are allowed on ODOT Standard Pole mounting for State Highways:

Mounting Height (ft.)	Maximum Wattage in LED Luminaire
25.0 to < 30.0	100
30.0 to < 35.0, or when replacing 150 watt HPS	120
35.0 to < 40.0, or when replacing 200/250 watt HPS	200
40.0 to 55.0, or when replacing 310/400 watt HPS	300
Each LED luminaire in high mast tower	500

~~(b) LED Luminaire Types~~ For each type of LED luminaire shown, furnish luminaires according to the general performance requirements in 02926.54(a) and the following:

(1) LED Luminaires on Traffic Signal Supports - When furnishing an LED luminaire model that is not specified in the Special Provisions as approved, the luminaire shall meet the following requirements:

- Minimum luminaire efficacy: 95 lumens/watt (LPW)
- Nominal input power: 140 watts
- Nominal input voltage: 240 volts
- Minimum lumen output: 13,400 lumens
- Minimum lumen maintenance at 50,000 hrs.: 85% of initial lumens
- Nominal CCT (Correlated color temp.):..... 4000 ± 250° K
- Color Rendering Index (CRI) ≥ 60
- BUG rating: B3-U0-G2
- Nominal type of output pattern: Type 3 Medium
- Maximum luminaire weight: 30 lb.
- Maximum EPA: 0.7 sq. ft.
- Mounting method: 2 inch tenon, as shown
- Vibration: 3G vibration test certified (ANSI C136.31)
- Thermal: -20 - 40° C operation
- Photo control receptacle: ANSI C136.41, 7-pin
- LED driver: 0-10 V dimmable

(2) LED Luminaires on Freeway Interchange Lighting Systems - When furnishing an LED luminaire model that is not specified in the Special Provisions as approved, the luminaire shall meet the following requirements:

- Minimum luminaire efficacy: 92 lumens/watt (LPW)
- Nominal input power: 210 watts
- Nominal input voltage: 240 volts
- Minimum lumen output: 23,000 lumens
- Minimum lumen maintenance at 50000 hrs.: 85% of initial lumens

Nominal CCT (Correlated color temp.):..... 4000 ± 250° K
 Color Rendering Index (CRI): ≥ 60
 BUG rating: B3-U0-G3
 Nominal type of output pattern:..... Type 3 Medium
 Maximum luminaire weight: 30 lb.
 Maximum EPA: 1.1 sq. ft.
 Mounting method: 2 inch tenon, as shown
 Vibration:..... 3G vibration test certified (ANSI C136.31)
 Thermal:..... -20 - 40° C operation
 Control method: ANSI C136.41, 7-pin
 LED driver:..... 0-10 V dimmable

(c) Submittals - Before beginning LED luminaire installation, submit the following according to 00150.37 for review by the Engineer:

- Four copies of LED luminaire manufacturer's data sheets, including light source, drivers, surge protection device, and installation instructions.
- For the dimmable LED driver specified, diagrams illustrating light output and input power as a function of control signal.
- IES LM-79 luminaire photometric reports produced by the test laboratory, that satisfy LED Lighting Facts accreditation requirements. Reports shall include the name of the laboratory, report number, date, luminaire catalog number, luminaire description, and Backlight-Uplight-Glare (BUG) ratings.

Lumen maintenance calculations and supporting data shall be in accordance with LED Lighting Facts guidance. Computer generated photometric analysis and calculation of maintained light levels shall be in accordance with IES RP-8, Roadway Lighting. Use a Light Loss Factor (LLF) of 0.8 or less, according to the individual luminaire test report data. Do not use the Mesopic multipliers of effective luminance factors for calculation.

- IES format electronic file containing luminous intensity data associated with submitted LM-79 reports and used for point-by-point calculations.

Within 21 Calendar Days after receipt of submittals, the Engineer will review the submittals and approved, approved as noted, or returned for correction. Do not begin LED Luminaire installation before receiving written approval of submittals from the Engineer.

2926.75 Manufacturer's Warranty - Furnish a manufacturer's warranty, for warranty periods stated below, according to 00170.85(c-1) on Agency supplied warranty forms. The forms are available from the Engineer.

For LED Luminaires, the warranty shall recite that the manufacturer will warranty the LED luminaire and its components, including but not limited to the luminaire housing, wiring, connections, 7-pin receptacle, 7-pin controller, LED light source and LED driver, for a period of ten (10) years against any defects or failures. Upon return of the failed luminaire, the Manufacturer shall furnish a replacement LED luminaire to the Agency, meeting current Agency standards and at no cost to the Agency within one (1) month of the return.