02001.00 **Scope** - This Section includes the requirements for Portland cement concrete for structures, precast prestressed or paving applications.

Provide quality control and certified technicians according to Section 00165.

02001.01 **General** - Produce concrete according to these Specifications.

02001.02 **Abbreviations and Definitions**:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTV</td>
<td>Actual Strength Test Value - The average of the test cylinders' compressive strengths</td>
</tr>
<tr>
<td>cm</td>
<td>Cementitious Materials</td>
</tr>
<tr>
<td>$f'_c$</td>
<td>Minimum Specified or Compressive Strength at 28 days</td>
</tr>
<tr>
<td>$f'_{cr}$</td>
<td>Average Compressive Strength Over-design. The average strength required to assure that with normal variations, the concrete will meet $f'_c$.</td>
</tr>
<tr>
<td>GGBFS</td>
<td>Ground Granulated Blast Furnace Slag</td>
</tr>
<tr>
<td>HPC</td>
<td>High Performance Concrete</td>
</tr>
<tr>
<td>HRWRA</td>
<td>High-Range Water-Reducing Admixture (super-plasticizer)</td>
</tr>
<tr>
<td>PPCM</td>
<td>Precast prestressed concrete member</td>
</tr>
<tr>
<td>w</td>
<td>Water</td>
</tr>
<tr>
<td>WRA</td>
<td>Water Reducing Admixture</td>
</tr>
</tbody>
</table>

**Cementitious Materials** - Included but not limited to Portland cement, fly ash, silica fume, ground granulated blast furnace slag and metakaolin

**High Performance Concrete (HPC)** - Structural concrete, with enhanced durability and strength characteristics, for use in structures where improved durability and performance is required.

**Moderate Exposure** - Elevations below 1,000 feet.

**Modifiers** - Pozzolans, latex.

**Pozzolans** - Fly ash.

1097 City of Portland 2010
Severe Exposure - Elevations 1,000 feet and above.

Materials

Furnish materials meeting the following requirements:

- Admixtures
- Aggregates
- Cement
- Modifiers
- Water

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>
<thead>
<tr>
<th>Type of Concrete</th>
<th>Strength (psi)</th>
<th>Maximum w/cm Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural</td>
<td>3300</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>3300 (Seal)</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>4000</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td>4000 (Deck)</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>HPC4000</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>5000 and above</td>
<td>0.40(^1)</td>
</tr>
<tr>
<td></td>
<td>HPC5000 and above</td>
<td>0.40</td>
</tr>
<tr>
<td>Paving</td>
<td>4000</td>
<td>0.40</td>
</tr>
</tbody>
</table>

\(^1\) 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% of target air entrainment values.
Table 02001-2

<table>
<thead>
<tr>
<th>Nominal Maximum Size Aggregate</th>
<th>Severe Exposure (Percent)</th>
<th>Moderate Exposure (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8”</td>
<td>7.0</td>
<td>6.0</td>
</tr>
<tr>
<td>1/2”</td>
<td>6.5</td>
<td>5.5</td>
</tr>
<tr>
<td>3/4”</td>
<td>6.0</td>
<td>5.0</td>
</tr>
<tr>
<td>1”</td>
<td>5.5</td>
<td>4.5</td>
</tr>
<tr>
<td>1 1/2”</td>
<td>5.0</td>
<td>4.5</td>
</tr>
</tbody>
</table>

(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

<table>
<thead>
<tr>
<th>Condition</th>
<th>Slump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete without WRA</td>
<td>4” max.</td>
</tr>
<tr>
<td>Concrete with WRA</td>
<td>5” max.</td>
</tr>
<tr>
<td>Concrete with HRWRA</td>
<td>5 1/2” ± 2 1/2”</td>
</tr>
<tr>
<td>Precast Prestressed Concrete with HRWRA</td>
<td>10” max.</td>
</tr>
<tr>
<td>Seal Concrete</td>
<td>8” ± 2”</td>
</tr>
<tr>
<td>Drilled Shaft Concrete</td>
<td>8 1/2” ± 1 1/2”</td>
</tr>
</tbody>
</table>

(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 14 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 either contain cementitious material with 66% Portland cement, 30% Fly ash, and 4% silica fume; or have trial batches performed to demonstrate that the alternate mix design provides a maximum of 1,000 coulombs at 90 days when tested according to AASTHO T 277.

02001.31 Concrete Mix Design Constituents:

(a) Portland Cement - Use AASHTO M 85 or ASTM C 150 Type I or II cement for structural or paving concrete. Type III cement for precast and prestressed concrete.

(b) Pozzolans - Except for HPC or GGBFS may be used separately or in combinations up to 30% of the total cementitious materials content.

(c) Modifiers - Modifiers may be used separately or in combination as approved by the Engineer.

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

(e) 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.

(f) Aggregate - If the nominal maximum size of the coarse aggregate is not included as a part of the class of concrete shown on the plans, any size from 1 1/2 inch to 3/8 inch nominal maximum size aggregate may be used, as the Contractor elects, except:

- Use 3/4 inch nominal maximum size, or larger, aggregates in bridge decks.
- Use 1 1/2 inch nominal maximum size aggregates in concrete paving unless otherwise indicated.
- Use 3/8 inch nominal maximum size aggregates in drilled shafts unless otherwise indicated.

Proportion all HPC to include a minimum course aggregate absolute solid volume according to Table 02201-4:
<table>
<thead>
<tr>
<th>Maximum Nominal Aggregate Size</th>
<th>Cu. Yd. (aggregate)</th>
<th>Cu. Yd. (concrete)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8&quot;</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>0.38</td>
<td></td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>1&quot;</td>
<td>0.42</td>
<td></td>
</tr>
<tr>
<td>1 1/2&quot;</td>
<td>0.46</td>
<td></td>
</tr>
</tbody>
</table>

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.

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

(a) **Trial Batch Method** - Make at least one trial batch for each concrete mix design. Prepare and test the trial batch using the same materials and having the same plastic properties of concrete that will be used on the Project. Simulate haul time and mixing conditions to ensure proper workability at the jobsite.

(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 tests methods:

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling Fresh Concrete</td>
<td>WAQTC TM 2</td>
</tr>
<tr>
<td>Slump</td>
<td>AASHTO T 119</td>
</tr>
<tr>
<td>Density</td>
<td>AASHTO T 121</td>
</tr>
<tr>
<td>Yield</td>
<td>AASHTO T 121</td>
</tr>
<tr>
<td>Air Content</td>
<td>AASHTO T 152</td>
</tr>
<tr>
<td>Concrete Temperature</td>
<td>AASHTO T 309</td>
</tr>
<tr>
<td>Molding Concrete Specimens</td>
<td>AASHTO T 23 or R 39</td>
</tr>
<tr>
<td>Water-Cement Ratio</td>
<td>2</td>
</tr>
</tbody>
</table>

\(^1\) 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 3 test cylinders 6 inch x 12 inch or 4 inch x 8 inch single-use plastic molds. Cast and cure all strength specimens according to AASHTO T 23 or T 126, and test at least 28 days according to AASHTO T 22.

Cast three flexural beams for concrete paving mixtures according to AASHTO T 23. Test beams for concrete paving mixtures at 28 days according to AASHTO T 97.

---

**02001.33 Required 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  \( f'_{cr} = f'_{c} \times 1.15 \) for Class 6000 and higher.

(b) \( f'_{cr} = f'_{c} + 1.34 \times S \) Up to Class 6000  \( f'_{cr} = f'_{c} + 1.28 \times S \) for Class 6000 and higher.

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

(c) **Flexural Beams** - Flexural beams for concrete paving mixtures 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.

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

(a) **Supplier's Unique Mix Design Identification Number**

(b) **Mix Design Constituent Proportions:**

- Weight per cubic yard (pounds per cubic yard) of cementitious material, modifiers, fine and coarse aggregates (SSD), and mix water.
- Absolute volumes of cementitious material, modifiers, fine aggregates and coarse aggregates (SSD), and mix water.
- Dosage rates for 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-rod density of coarse aggregates
- Fineness modulus of sand used in the mix design calculations

| (d) Cementitious Material | For each cementitious material used, identify the following:
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Manufacturer</td>
</tr>
<tr>
<td></td>
<td>- Brand name</td>
</tr>
<tr>
<td></td>
<td>- Type</td>
</tr>
<tr>
<td></td>
<td>- Relevant Specification</td>
</tr>
<tr>
<td></td>
<td>- Source or location plant</td>
</tr>
</tbody>
</table>

| (e)Modifiers | For each modifier used, identify the following:
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Manufacturer</td>
</tr>
<tr>
<td></td>
<td>- Brand name</td>
</tr>
<tr>
<td></td>
<td>- Source</td>
</tr>
<tr>
<td></td>
<td>- Relevant specification</td>
</tr>
<tr>
<td></td>
<td>- Class</td>
</tr>
</tbody>
</table>

| (f) Admixtures | For each admixture used, identify the following:
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Manufacturer</td>
</tr>
<tr>
<td></td>
<td>- Brand name</td>
</tr>
<tr>
<td></td>
<td>- Design dosage rate</td>
</tr>
</tbody>
</table>

| (g) Water      | Identify the source of water to be used.                    |

| (h) 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. |

| (i) Compressive Strength Test Results | Report the individual test results and the ASTV of cylinders from the trial batch or the average for the cylinder sets presented for evaluation of a current mix design. |

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

| (k) 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. |
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 City.

02001.40 **Concrete Production** - Produce concrete according to the following sections of ASTM C 94, Standard Specification for Ready-Mixed Concrete:

<table>
<thead>
<tr>
<th>ASTM Section</th>
<th>ASTM Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.</td>
<td>Measuring Materials</td>
</tr>
<tr>
<td>10.</td>
<td>Batching Plant</td>
</tr>
<tr>
<td>11.</td>
<td>Mixers and Agitators</td>
</tr>
<tr>
<td>12.</td>
<td>Mixing and Delivery</td>
</tr>
</tbody>
</table>

02001.50 **Quality Control Personnel** - Provide the following certified technicians:

- **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.

- **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
  • 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 for low alkali cement except as follows:

- Cement used west of the summit of the Cascade Mountains shall have a total alkali content (sodium and potassium oxide calculated as Na₂O + 0.658 K₂O) not exceeding 0.80%.
- Types I or III shall contain a maximum of 10% tricalcium aluminate.
- The time-of-setting tests will be by either the Gillmore Test or the Vicat test.
- The maximum fineness (specific surface, square yards/pound) as determined by the air permeability test shall be 430 for any field-sampled check test. Results of field-sampled check tests will not be averaged.

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

02010.20 Blended Hydraulic Cement - Blended hydraulic cement shall be either Type IP Portland-pozzolan cement or Type SM slag-modified portland cement conforming to AASHTO M 240, supplemented or modified as follows:

- The cement constituent of the blended cement shall conform to 02010.10.
- The pozzolan constituent of the blended cement shall be a fly ash conforming to 02030.10 or ground granulated blast furnace slag (GGBF) slag conforming to 02030.40.
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, for mortar and 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 of this Section 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) Nonpotable or Unknown Quality - Water of non-potable, unknown or suspected quality will be tested at the Contractor's expense according to AASHTO T 26 before use in the Project and shall meet the following limits:

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Chloride Ion, %</td>
<td>-</td>
<td>0.15</td>
</tr>
<tr>
<td>Sulphate Ion, %</td>
<td>-</td>
<td>0.50</td>
</tr>
<tr>
<td>Total Dissolved Solids, ppm</td>
<td>-</td>
<td>6500</td>
</tr>
<tr>
<td>Total Suspended Solids, ppm</td>
<td>-</td>
<td>2000</td>
</tr>
</tbody>
</table>

If any of the test data are outside these limits, the water may be accepted on the basis of an evaluation of the reduction in 7 day compressive strength, which shall not exceed 10.0%.

In marine environments, the chloride ion percentage shall be limited to a maximum of 0.10%.

(d) Recycled Mix Water - Water from mixer washout operations may be used in mixing concrete provided it is:

- Within the limits of ASTM C 94, Table 1, Acceptance Criteria for Questionable Water Supplies, and ASTM C 94, Table 2, Chemical Limitations for Wash Water. In addition the specific gravity maximum limit is 1.03.
• Tested at a weekly interval for at least four weeks prior to use on the Project. The testing frequency may be reduced to monthly thereafter providing no single test exceeds the limits set above. Required tests include the physical tests in Table 1 of ASTM C 94, the chemical tests in Table 2 of ASTM C 94 and testing for specific gravity. The testing shall be at no additional cost to the City. The test results shall be provided to the Engineer prior to use on the Project.

• Made up from a dilution process rather than a concentration process. (A dilution process in one in which the reclaimed water is extensively diluted and continuously agitated to keep solids in a state of suspension.)

• Free of coloring agents.

• Not used when the ambient temperature is 85 °F or above.

• Not used when the ambient temperature is 40 °F or lower.

• Not used as more than 75% of the water added to the batch.

• Not used in structure decks.
Section 02030 - Modifiers

Description

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

Materials

02030.10  Fly Ash:

(a)  Types - Fly ash shall be Class C, Class F, or Class N from the CPL, and shall conform to AASHTO M 295, including Table 2, except that:

- Loss on Ignition (LOI) shall be 1.5% maximum
- Moisture content shall be 1% maximum
- Amount retained on the No. 325 sieve shall be 30% maximum

(b)  Acceptance - Fly ash will be accepted for immediate use if accompanied by a test results certificate according to 00165.35. As a check on material conformance, fly ash may be sampled at the site of work for verification testing.

02030.20  Silica Fume:

(a)  Types - Provide the silica fume admixture 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, including Table 1a, Optional Chemical Requirements.

(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 admixture 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.

02030.30  Formulated Latex Admixture - Formulated latex admixture shall be from the CPL and be a nontoxic, film-forming, polymeric emulsion in water to which all stabilizers have been added at the point of manufacture. It shall be homogeneous and uniform in composition, and meet the following requirements:
<table>
<thead>
<tr>
<th>Polymer Type Stabilizers</th>
<th>Styrene Butadiene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latex</td>
<td>Nonionic Surfactants</td>
</tr>
<tr>
<td>Portland Cement Composition</td>
<td>Polydimethyl Siloxane</td>
</tr>
<tr>
<td>Solids, % by weight, min.</td>
<td>46.0</td>
</tr>
<tr>
<td>Volume Density, lb/gal, min</td>
<td>8.4 at 77 °F</td>
</tr>
<tr>
<td>pH</td>
<td>9.0 to 11.0</td>
</tr>
<tr>
<td>Color</td>
<td>White</td>
</tr>
</tbody>
</table>

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

**02030.40 Ground Granulated Blast Furnace Slag (GGBFS)** - GGBFS shall meet the requirements of AASHTO M 302.
02040.00

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 CPL, except as follows:

An admixture that does not appear on the CPL 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 City 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% by weight of the admixture when tested according to ODOT TM 505.

Admixtures shall conform to the following requirements:

<table>
<thead>
<tr>
<th>Admixture</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air-entraining</td>
<td>AASHTO M 154 (ASTM C 260)</td>
</tr>
<tr>
<td>Water-reducing</td>
<td>AASHTO M 194 (ASTM C 494)</td>
</tr>
<tr>
<td>Retarding</td>
<td>AASHTO M 194 (ASTM C 494)</td>
</tr>
<tr>
<td>Accelerating</td>
<td>AASHTO M 194 (ASTM C 494)</td>
</tr>
</tbody>
</table>
Section 02050 - Curing Materials

Description

02050.00 Scope - This Section includes the requirements for liquid compounds, evaporation reducers, 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 CPL and meeting the requirements of AASHTO M 148, except that testing will be done according to ODOT TM 721. The specified drying time requirement will be waived. The test application rate shall be 1 gallon per 200 square feet.

All compounds shall be class A. Solvent-based compounds shall be Type 1-D.

02050.20 Polyethylene Films - Furnish clear or white polyethylene films for curing concrete meeting the requirements of AASHTO M 171.

02050.30 Curing Blankets - Furnish curing blankets from the CPL.

02050.40 Liquid Evaporation Reducer Compounds - Furnish evaporation reducer compounds from the CPL.
Section 02060 - Sealers

Description

02060.00 Scope - This Section includes the requirements for epoxy cement sealers.

Materials

02060.10 Epoxy Cement - Furnish epoxy cement from the CPL.
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 CPL.

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

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

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 CPL and use according to the manufacturer's recommendations.

02080.40 Portland Cement Grout - Furnish Portland cement grout consisting of 1 part Portland cement and 3 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 CPL that meets vertical rise requirements.

02080.60 Grout for Mortar Beds and Joints - Furnish Portland cement mortars that meet the requirements of ASTM C 270-01a and the following:

<table>
<thead>
<tr>
<th>Type</th>
<th>Average Compressive Strength At 28 days min (psi)</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>2500</td>
<td>Sidewalk mortar bed</td>
</tr>
<tr>
<td>M</td>
<td>3000</td>
<td>Street mortar bed</td>
</tr>
<tr>
<td>N</td>
<td>750</td>
<td>Sidewalk grout joint</td>
</tr>
<tr>
<td>M</td>
<td>3000</td>
<td>Street grout joint</td>
</tr>
</tbody>
</table>

Type M - Typically 3 parts Portland cement, 1 part lime and 12 parts sand.
Type N - Typically 1 part Portland cement, 1 part lime, 6 parts sand.

Mortar/unit paver bond strength (shear and tensile): 500 psi minimum
Mortar water absorption: 4% maximum
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% and meeting the following:

Grading Requirements

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing (by weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8&quot;</td>
<td>100</td>
</tr>
<tr>
<td>No. 100</td>
<td>25 maximum</td>
</tr>
</tbody>
</table>

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

02090.20 Hydrated Lime - Furnish hydrated lime meeting the requirements of ASTM C 1097.

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, except that seasoning checks, single or opposite each other, shall be limited to a total of half the thickness.

- **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 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 City'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 AWPA 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% 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 - Use only treated posts from approved suppliers as listed in the "Non-field" Testing and Acceptance Guide." 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 AWPA Standard M 4. Repair posts that have splits, checks, or where shakes have opened or deepened sufficiently to expose untreated wood by treating with a field preservative from the CPL 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 CPL 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% 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 form either Douglas fir, surface four sides (S4S) and free of heart center (FOHC) or Hem-fir (S4S) (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:

<table>
<thead>
<tr>
<th>Species</th>
<th>4” x 4”</th>
<th>Size, Inch</th>
<th>6” x 6”</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>4” x 6”</td>
<td>and Larger</td>
</tr>
<tr>
<td>Douglas Fir</td>
<td>124-c WCLIB</td>
<td>123-c WCLIB</td>
<td>131-b WCLIB</td>
</tr>
<tr>
<td></td>
<td>42.12 WWPA</td>
<td>62.12 WWPA</td>
<td>80.11 WWPA</td>
</tr>
<tr>
<td>Hem-Fir</td>
<td>124-b WCLIB</td>
<td>123-b WCLIB</td>
<td>131-a WCLIB</td>
</tr>
<tr>
<td></td>
<td>42.11 WWPA</td>
<td>62.11 WWPA</td>
<td>80.10 WWPA</td>
</tr>
</tbody>
</table>
(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 practical.

(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 D 25.

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, 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% 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.
02130.00

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 by an American Lumber Standards certified inspection agency.

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.

02140.01 Abbreviations:

AITC - American Institute of Timber Construction

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 practical 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, 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 A 123).

(b) Split Ring Connectors - Provide 2 5/8 inch and 4 inch inside diameter split rings manufactured from steel conforming to 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 A 830 (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 A 47, 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.

(d) Bolts, Nuts, Nails, and Miscellaneous Hardware - Provide machine bolts, drift bolts and dowels according to ASTM A 307 or ASTM A36. Washers may be cast ogee or malleable castings, or they may be cut from steel plate.
Galvanize rough hardware, drive pins, expansion bolts, clamps, washers, anchors, joist hangers, bolts and nuts, lag screws, wood screws, spikes and nails according to AASHTO M 232 (ASTM A 153). Provide these items in standard type and make, or as shown.

(e) **Lightweight Metal Connectors** - Lightweight metal connectors are mass produced plate or sheet steel connectors with a maximum thickness of 0.25 inches used to connect wood members to wood, concrete or masonry. Provide lightweight metal fasteners as shown with the required minimum capacities as stated in the special provisions. Provide copies of the test reports from the International Code Council (ICC-ES) showing that the supplied fastener meets the minimum capacities listed in the Special Provisions. All lightweight metal connectors shall be galvanized according to ASTM A 653 (coating designation G185), ASTM A 123, or stainless steel.

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, timber piling, guard rail 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 that only the following preservatives are allowed:

- Ammonacal Copper Quat, Type B, D, or D
- Ammoniacal Copper Zinc Arsenate
- Chromated Copper Arsenate, Type A, B, or C
- Copper Naphthenate
- Creosote
- Pentachlorophenol (any solvent)

02190.20 Drying Time - When using ACZA, air-dry items as defined in AWPA P5, a minimum of 30 calendar days before installation. Kiln drying for 2 calendar days may be substituted for 30 calendar days of air-drying. During the period September 1 through May 31, the air-drying shall be under cover at the treatment facility. During the 30 calendar day 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% 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 with a preservative listed in the CPL.
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:

- Be prepared at the factory ready for application or mixing of multi-component coatings. 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.
- Include additives for control of sagging, pigment settling, leveling, drying, dryer absorption, skinning, or other properties that affect application and curing.
- Not require a pretreatment chemical or material prior to application of the prime coat except as specifically stipulated in these specifications.
- Include required tinting and coloring materials at the time of manufacture. When successive coats are specified, each coat shall be tinted to provide contrast between coats. The tinting material shall be compatible with the coating material and not detrimental to performance.
- Not vary in composition without prior notice by the manufacturer and approval of the Engineer. No reformulation will be allowed.

All coats in the coating system shall be from the same manufacturer.

Apply coating materials 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.
- Have a lug-type crimp lid with a ring seal, and shall be equipped with ears and bails.
- Meet U.S. Department of Transportation's Hazardous Material Shipping Regulations.
02210.20

- Be lined, if necessary, to prevent attack by the coating material. The lining shall not come off the container.
- Be original and unopened.
- Be labeled with a quality compliance certificate according to 00165.35 showing the following:
  - Manufacturer's name
  - Exact title of coating material
  - City Specification number, if any
  - Manufacturer's batch number
  - Date of manufacture
  - Shelf life or expiration date
  - Identification of all toxic substances
  - Handling and application precautions

| 02210.20  | Coating Materials for Timber | Furnish coatings for timber from the CPL under the category "Timber Coatings". |
| 02210.21  | Sealer for Timber            | Furnish clear sealers for timber from the CPL under the category "Timber Sealers". |
| 02210.30  | Coating Materials for Concrete | Furnish coatings for concrete from the CPL under the category "Latex Emulsion Paint". |
Geosynthetics and Slope Protection

Section 02320 - Geosynthetics

Description

02320.00 Scope - This Section includes the requirement for geosynthetics use 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
- Free of asbestos containing material

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

- Be composed of long chain, synthetic polymeric filaments or yarns formed into a stable network that retains its relative structure during handling, placement and design service life. At least 95%, by weight, of the long chain polymers shall be a polyolefin or polyester
- Meet or exceed the properties specified in 02320.20 Table 2320-1
- Be free of any chemical treatment or coating which might significantly reduce permeability
- Have the selvage finished so the outer fibers are prevented from pulling away from the fabric

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

- A regular network of integrally connected, polymer, tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil or rock
- Dimensionally stable and able to retain their geometry under manufacture, transport and installation

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(3) HDPE Geomembrane Swale Liner

- Material shall be 40 mil High Density Polyethylene (HDPE) geomembrane, textured on both sides or approved equal. An experienced firm regularly engaged in manufacturing textured HDPE shall manufacture the geomembrane.

(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 Documentation - Furnish a Level A or Level B certification, as indicated in the Special Provisions for the applicable geosynthetics.

(1) Level A - Manufacturer’s Test Result Certificate - Furnish a Test Result Certificate according to 00165.35 from the geosynthetic manufacturer. The certificate shall:

- Include the minimum average roll values for each of the specified properties from the same production run as the delivered material
- Include test results for factory seams
- Include production run number, production plant name and location

If the geosynthetic material is modified, remanufactured, relabeled or sewn, furnish an additional certificate from the supplier making the changes that explain the altered properties, seam strength or relabeling.

(2) Level B - Manufacturer’s Quality Compliance Certificate - As a basis of acceptance, furnish either a manufacturer’s brochure or a quality compliance certificate, according to 00165.35, with geosynthetic properties shown.

If the brochure or certificate lists typical or average roll values instead of minimum average roll values, then increase by 25% the specified minimum values in Table 02320-1 for grab tensile strength, burst strength and puncture strength to determine compliance.

(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 D 4354. The production unit used for sampling shall be a roll or sheet.
(2) **Testing** - Perform the specified tests to determine Geotextile properties for the intended application(s). The tensile strength requirements shall be tested in both machine and cross-machine directions.

(e) **City Check Tests** - The City reserves the right to sample and test products for compliance with pertinent requirements according to 0165.02.

When the City performs check tests, the entire production run will be accepted or rejected according to 00150.80(g). 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%, 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% 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% of the minimum specified tensile strength values for the geotextile.
- A field-stitched seam test sample.
<table>
<thead>
<tr>
<th>Geotextile Property</th>
<th>Test Method</th>
<th>Units</th>
<th>Filtration</th>
<th>Separation</th>
<th>Reinforcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grab tensile strength (minimum)</td>
<td>ASTM D 4632</td>
<td>lb</td>
<td>80</td>
<td>200</td>
<td>120</td>
</tr>
<tr>
<td>Machine Direction</td>
<td></td>
<td></td>
<td>180</td>
<td>260</td>
<td>120</td>
</tr>
<tr>
<td>Cross Machine Direction</td>
<td></td>
<td></td>
<td>200</td>
<td>260</td>
<td>100</td>
</tr>
<tr>
<td>Grab Elongation (minimum)</td>
<td>ASTM D 4632</td>
<td>%</td>
<td>15</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Burst Strength, Diaphragm method (minimum)</td>
<td>ASTM D 3786</td>
<td>psi</td>
<td>130</td>
<td>320</td>
<td>435</td>
</tr>
<tr>
<td>Puncture strength (minimum)</td>
<td>ASTM D 4833 or ODOT TM 816</td>
<td>lb</td>
<td>35</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Apparent opening size (AOS) (maximum), U.S. Standard Sieve</td>
<td>ASTM D 4751</td>
<td>in</td>
<td>No. 70</td>
<td>No. 70</td>
<td>No. 30</td>
</tr>
<tr>
<td>Permittivity (minimum)</td>
<td>ASTM D 4491</td>
<td>s⁻¹</td>
<td>0.5</td>
<td>0.5</td>
<td>0.05</td>
</tr>
<tr>
<td>Ultraviolet stability (Retained Strength) (minimum)</td>
<td>ASTM D 4355</td>
<td>%</td>
<td>—</td>
<td>70</td>
<td>70 after 500 hours of exposure</td>
</tr>
<tr>
<td>Asphalt retention (minimum)</td>
<td>ODOT TM 817</td>
<td>oz/ft²</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Melting point (minimum)</td>
<td>ASTM D 276</td>
<td>°F</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

¹ Silt film or silt tape fabrics are not acceptable.
² As measured according to ASTM D 4632.
### Geogrid Property Values:

<table>
<thead>
<tr>
<th>Biaxial Geogrid Property</th>
<th>Test Method</th>
<th>Units</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>True Initial Modulus (Secant Modulus)</td>
<td>ASTM D 6637-01</td>
<td>lb/ft</td>
<td>27,420</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>41,130</td>
</tr>
<tr>
<td>Tensile Strength at 2% Strain</td>
<td>ASTM D 6637-01</td>
<td>lb/ft</td>
<td>410</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>545</td>
</tr>
<tr>
<td>Rib Thickness</td>
<td>ASTM D 1777</td>
<td>inch</td>
<td>0.05</td>
</tr>
<tr>
<td>Flexural Stiffness</td>
<td>ASTM D 5732-95</td>
<td>mg-cm</td>
<td>750,000</td>
</tr>
<tr>
<td>Junction Efficiency</td>
<td>GRI:GG2-87</td>
<td>%</td>
<td>90</td>
</tr>
<tr>
<td>Secant Aperture Stability Modulus at 20 kg-cm</td>
<td>US Army Corp Methodology of Torsional Rigidity</td>
<td>kg-cm/deg</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Aperture Size Range: I.D. Caliper inch 0.75 - 1.50

MD = Machine Direction along roll length
TD = Transverse Direction or cross machine direction across the roll
GRI = Geosynthetic Research Institute

**02320.22 HDPE Resin** - Resin shall be new, first quality, compounded and manufactured specifically for producing geomembrane.

**02320.23 HDPE Geo-membrane Swale Liner** - Geo-membrane shall meet the following standards for textured 40-mil HDPE.
<table>
<thead>
<tr>
<th>Tested Property</th>
<th>Test Method</th>
<th>Min. Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness, (minimum average) mil</td>
<td>ASTM D 5994</td>
<td>38</td>
</tr>
<tr>
<td>Lowest individual for 8 out of 10 values</td>
<td></td>
<td>36</td>
</tr>
<tr>
<td>Lowest individual for any of the 10 values</td>
<td></td>
<td>34</td>
</tr>
<tr>
<td>Density, g/cm³</td>
<td>ASTM D 1505</td>
<td>0.94</td>
</tr>
<tr>
<td>Tensile Properties (each direction)</td>
<td>ASTM D 6693,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type IV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dumbell, 2 ipm</td>
<td>60</td>
</tr>
<tr>
<td>Strength at Break, lb/in-width</td>
<td></td>
<td>84</td>
</tr>
<tr>
<td>Strength at Yield, lb/in-width</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Elongation at Break, %</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Elongation at Yield, %</td>
<td>G.L. = 2.0 in</td>
<td></td>
</tr>
<tr>
<td></td>
<td>G.L. = 1.3 in</td>
<td></td>
</tr>
<tr>
<td>Tear Resistance, lb</td>
<td>ASTM D 1004</td>
<td>28</td>
</tr>
<tr>
<td>Puncture Resistance, lb</td>
<td>ASTM D 4833</td>
<td>60</td>
</tr>
<tr>
<td>Carbon Black Content, %</td>
<td>ASTM D 1603</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Shall not exceed a combined maximum total 1% by weight additives other than carbon black.

Shall be free of holes, pinholes as verified by on-line electrical detection, bubbles, blisters, excessive contamination by foreign matter, and nicks and cuts on roll edges.

Furnish in roll form. Identify each roll with labels indicating roll number, thickness, length, width and manufacturer.
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" |

¹ Tensile area includes galvanizing

Welded wire shall also conform to AASHTO 55 (ASTM A 185) 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 3.9 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 A 764. High tensile fasteners shall provide a closed position tensile strength of 600 pounds.

All wire shall be galvanized according to ASTM A 641.

02340.12 Twisted Wire Mesh Gabion Baskets - Furnish gabion panels of the twisted mesh style shall be 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 shall be manufactured from 11 gauge or 9 gauge wire. The mesh shall form a nominal 3 inch by 3 inch grid pattern and conform to ASTM A 185. 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 1/3 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%. 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 is at least equal to that 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 is at least equal to that 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.
Section 02410 - Concrete and Plastic Pipe

Description

02410.00  **Scope** - This Section includes the requirements for non-reinforced and reinforced concrete pipe, polyethylene pipe and polyvinyl chloride (PVC) pipe.

Materials

02410.10  **Concrete Pipe** - Use concrete sewer pipe conforming to the requirements of the Material Specifications for Precast Concrete Products (MSPCP) Manual published by the City of Portland Materials Testing Laboratory.

(a) **Defects on Sealing Surfaces** - The surfaces of the pipe bell and spigot in contact with the gasket, and any adjacent surfaces that could contact the gasket within the specified joint movement range, shall be free from defects.

(b) **Reinforced Concrete Pipe** - Any fabrication or procurement of concrete pipe materials performed before approval of the pipe details is at the Contractor's risk. City approval of the pipe details will not relieve the Contractor of its responsibility to meet all the requirements of these Specifications and to provide pipe with details that conform to the MSPCP. The Contractor is responsible for checking pipe dimensions and for any problems arising from incorrect pipe dimensions.

(c) **Lubricants** - Use only manufacturer approved jointing material lubricants.

(d) **Jointing Materials** - Jointing materials for concrete sewer pipe shall conform to the requirements of the MSPCP.

02410.60  **High Density Polyethylene Pipe** - Use pipe made from Premium High Density Polyethylene resin qualified as Type III, Category 5, Class C, Grade P34 in ASTM D1248. This material shall have a long term hydrostatic strength of 1600 psi when tested and analyzed by ASTM D2837, and shall be listed by the Plastic Pipe Institute as a P.E. 3408 Resin. Pipe sizing shall conform to ASTM F714 and ASTM D3035.

(a) **Applicable ASTM Specifications:**

HOPE material shall comply with the following minimum engineering design specifications:

- ASTM D638  Tensile Strength Yield (2 in./min.) > 3200 psi.
- ASTM D638  Elongation at break 750%
- ASTM D638  Modulus of Elasticity 105,000 psi
- ASTM D3350  Flexural Modulus 124,000 psi
- ASTM D1693  Environmental stress crack resistance > 5000 F20 hrs. (E.S.C.R.) Condition C.
- ASTM D2837  Long Term Hydrostatic Strength at 73.4 °F. 1600 psi. (L.T.H.S)

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1140
(b) **Recycled Resin** - The pipe shall contain no recycled compound except that generated in the manufacturer’s own plant from resin of the same specification from the same raw material supplier.

(c) **Uniformity** - The polyethylene pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions or other injurious defects. The pipe shall be uniform in color, opacity, density and other physical properties.

(d) **Marking** - The following information shall be continuously marked on the pipe or spaced at intervals not exceeding 5 feet:

1. Name or trademark of the pipe manufacturer
2. Nominal pipe size
4. Resin Type
5. Manufacturer’s Standard reference.
6. A production code from which the date and place of manufacture can be determined.

(e) **Certification** - The pipe supplier shall certify compliance with requirements of these specifications in writing.

(f) **Method of Joining** - Join all High Density Polyethylene (HDPE) pipe and fittings by the heat fusion process per ASTM A2657 and the manufacturer’s specific recommendations or by approved coupler. The tensile strength at yield of the butt fusion joints shall not be less than the pipe.

(g) **Record Keeping** - Record and document the profile of each fusion joint made during the project. The data recording system shall be fully compatible with the pipe, and fusion equipment manufacturer’s recommendations. Submit documentation to confirm this agreement.

(h) **Data to be Recorded** - The data recording system shall document all recordable information for each heat fusion process joint. Information may include but it is not limited to: Date and Time, Joint Number, Project Number, Employee ID, Machine ID, Piston Area, Pipe Material and size, Interfacial Pressures, Recommended Gauge pressures and other recorded data.

(i) **Data Reporting and Compliance** - Provide the Engineer with a copy of each joint profile printout immediately after its completion. The Engineer must receive and review each joint profile printout for conformity with pipe and equipment manufacturer’s recommendation before accepting any joint. The Engineer has discretion to waive this requirement at any time. Repair and replace any joint that fails to meet these specifications at no additional cost to the City.
(j) **Fittings for HDPE Pipe** - Standard fittings and special fittings shall be manufactured from the same class of material as the pipe is manufactured and be fully compatible. Fittings shall be manufactured in accordance with ASTM D3261. Fabricated fittings shall be pressure rated to match the system piping.

(k) **Couplings** - Mechanical connections to fittings or other materials shall be by means of flanged connections (flanged coupling adapters and ANSI backup rings rated for the same pressure service as the system piping) or flexible couplings designed for joining similar or different pipe material such as a PVC coupler, as approved. Flanged joints shall use bolts of compatible material. Provide gaskets when joining to non-polyethylene materials. Evenly torque the flange bolts using a crisscross pattern following the manufacturer's recommendation. Retorque flanged joints after 1 hour or more has passed or as recommended by manufacturer.

(I) **Service Laterals** - Tee and wye fittings to connect service laterals shall be either molded butt fusion fittings, or molded saddle fusion fittings in accordance with ASTM D3261.

(m) **Connections to Manholes** - Make connection to manholes and other structures with an approved cast-in-place gasketed adapter, sanded manhole adapter or other approved method.

(n) **Corrugated Polyethylene Drain Pipe** - Furnish pipe meeting the requirements of AASHTO M 252.

02410.70 **Polyvinyl Chloride (PVC) Pipe** - All PVC pipe and fittings shall conform to ASTM D3034 SDR 35 standards. Unless otherwise approved, joints shall be bell and spigot with a rubber gasket conforming to ASTM D3212 and ASTM F477. Additives and fillers, including but not limited to, stabilizers, antioxidants, lubricants, etc. shall not exceed 10 parts by weight per 100.

(a) **Gravity pipe applications 4” to 15” Diameter PVC Pipe** - All PVC pipe and fittings shall be integral wall and spigot, rubber gasket joint, unplasticized Polyvinyl chloride (PVC) pipe. All PVC pipe shall have a minimum pipe stiffness of 46 psi at 5% deflection at 32 °F when tested in accordance with ASTM Designation D2412, external loading properties of plastic pipe. Pipe shall have a minimum impact strength based on test methods of ASTM D3034 with the exception that conditioning temperature for sample shall be 32 °F plus or minus 2 °F.

All PVC pipe and fittings manufactured and installation shall meet or exceed the ASTM recommended specifications D3034, SDR 35, unless otherwise specified, and all installation shall be in strict compliance with ASTM D2321 and the manufacturer's instructions. All pipe shall be clearly marked with the date of manufacture. All pipe shall be provided with the reference mark for proper spigot insertion. Joint gaskets shall be fabricated from a compound of which the basic polymer shall be a synthetic rubber consisting of styrene, butadiene, polyisoprene or any combination thereof and shall meet the requirements of ASTM F477.
(b) Gravity pipe applications 18 Inch to 36 Inch Diameter PVC Pipe - All PVC pipe and fittings shall be integral wall and spigot, rubber gasket joint, unplasticized Polyvinyl chloride (PVC) pipe. All PVC pipe shall have a minimum pipe stiffness of 46 psi at 5% deflection at 32 °F when tested in accordance with ASTM Designation D2412, external loading properties of plastic pipe. The pipe shall be made of PVC plastic having a minimum cell classification of 12364 or 12454 as defined in ASTM D 1784. Homopolymer PVC compounds must equal or exceed the requirements of above listed minimum cell classification number. Pipe shall have a minimum impact strength based on test methods of ASTM F679.

All PVC pipe and fittings manufactured and installation shall meet or exceed the ASTM recommended specification F679, unless otherwise specified, and all installation shall be in strict compliance with the manufacturer's directions. All pipe shall be clearly marked with the date of manufacture. All pipe shall be provided with the reference mark for proper spigot insertion. Joint gaskets shall be fabricated from a compound of which the basic polymer shall be a synthetic rubber consisting of styrene, butadiene, polyisoprene or any combination thereof and shall meet the requirements of ASTM F477.

(c) Perforated PVC Pipe - When specified, the perforations shall consist of 2 rows of 3/8 inch diameter holes at 3 inches on center. The holes shall be oriented 60° from the invert on each side of the pipe. The 2 rows of holes shall be 120° apart. Do not use perforated pipe greater than 8 inches without written approval.

02410.71 Proof Tests and Allowable Joint Deflections - The intent of this requirement is to prequalify joint system components that meet the joint requirements as to the water tightness capability of the joint system. This proof test shall be understood to apply to all pipes that are to be tested for water tightness before Acceptance. The manufacturer shall provide material and test equipment for proof testing. Joints shall meet the requirements of yard testing specified below. The pipe manufacturer shall submit results of the yard tests made, certified by an approved testing agency. When approved, a suitable joint tester may apply internal hydrostatic pressure. In general, each pipe material and joint assembly shall be subject to the following three proof tests at the discretion of the Engineer.

(a) Pipe in Straight Alignment - Assemble no less than 3 nor more than 5 pipes selected from stock by the Project Manager according to the manufacturer's installation instructions with the ends suitably plugged and restrained against internal pressure. Subject the pipe to 10 pounds per square inch (psi) hydrostatic pressure for 10 minutes. Free movement of water through the pipe joint or pipe wall will be ground for rejection of the pipe.

(b) Pipe in Maximum Deflection Position - Deflect a test section as described hereinafter for each pipe material. Subject the pipe to 10 psi hydrostatic pressure for 10 minutes. Free movement of water through the pipe joint or pipe wall will be ground for rejection of the pipe.
(c) **Joints under Differential Load** - Support the test section on blocks or otherwise as described hereinafter for each pipe material. There shall be no visible leakage when the stressed joint is subjected to 10 psi internal hydrostatic pressure for 10 minutes.

(d) **Alternative to Hydrostatic Test** - An external hydrostatic test or a vacuum test effectively meeting the same time and pressure requirements will be an alternative to the internal hydrostatic pressure test as approved.

**02410.80 Acceptance** - Except as provided in 02410.10(b)(3) above, acceptance of non-reinforced concrete pipe, reinforced concrete pipe, concrete drain pipe, concrete drain tile, polyethylene 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 A 760) 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:

- Arch-Type Pipe
- Elliptical Pipe - Full-circle pipe distorted 5% out-of-round by shop fabrication to form an elliptical cross section with the major axis vertical.
- Full-Circle Pipe - Fabricate helical rib pipe in full-circle cross section only.
- 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% 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 A 760) 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 2 coats (minimum 2 mils total thickness) of a high zinc dust content paint conforming to the general requirements of ASTM A 780.

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 permitted.

(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.
**02420.20**

**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 C150. 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 002420.20(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% of the circumference of the pipe.

**1) Pipe Not Preheated** - The temperature of the asphalt at the time of pipe immersion shall be 400 °F plus or minus 5 °F and the duration of the immersion shall conform to the following schedule:

<table>
<thead>
<tr>
<th>Metal Thickness (inch)</th>
<th>Steel</th>
<th>Aluminum</th>
<th>Minimum Immersion Time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.064</td>
<td>0.060</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>0.079</td>
<td>0.075</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>0.109</td>
<td>0.105</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>0.138</td>
<td>0.135</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>0.168</td>
<td>0.164</td>
<td>8.0</td>
<td></td>
</tr>
</tbody>
</table>

**2) Pipe Preheated** - At the time of pipe immersion the asphalt shall have a temperature of 380 °F plus or minus 5 °F and the pipe shall be preheated to a temperature 300 °F to 350 °F.
02420.30

(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 non-uniformity 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 CPL.

02420.30 **Corrugated Steel Pipe for Underdrains** - Furnish corrugated steel pipe for underdrains conforming to the requirements of AASHTO M 36 (ASTM A 760) 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 B 745), 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 B 745) 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° 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.

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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 ASTM B 745/B 745M 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 B 745). 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 B 745) 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 B 745) 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 A 761).

(b) Plates for Pipe Arches - The top plate(s) shall form an arc between 180° and 155°. The bottom plate(s) shall form an arc between 50° and 10°. Join the top plate(s) at each end to the bottom plate(s) 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°.

(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.

Unless otherwise specified, fabricate bolt holes as follows:

- Two rows along longitudinal seams
- Center-to-center spacing not more than 10 inches along circumferential seams
- Center of hole to edge of the plate at least 1.75 times the diameter of the bolt
- Longitudinal seam bolt holes shall not exceed the diameter of the bolt by more than 1/8 inch

The above provisions are for standard punching. 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 B 746). 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 A 761) and be galvanized according to AASHTO M 232 (ASTM A 153).

Furnish bolts, nuts and washers for use with aluminum alloy structural plate pipe conforming to the requirements of AASHTO M 219 (ASTM B 746) and be galvanized according to AASHTO M 232 (ASTM A 153).

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 CPL conforming to the requirements of AASHTO M 153 or AASHTO M 213. Fillers conforming to AASHTO M 213, except the binder, if other than bituminous material, may be used provided they otherwise meet this Specification and they have been demonstrated to be rot and vermin proof for a period of at least 5 years. Unless otherwise specified or indicated, the Contractor may elect to furnish either type specified in this subsection.

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

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

02440.15 Lubricant/Adhesive - Furnish a lubricant/adhesive that is recommended by 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 galvanization according to ASTM A 780.

02440.20 Preformed Joint Seals - Furnish compression joint seals conforming to the requirements of AASHTO M 297. Use strip seals conforming to ASTM D 5973.

02440.21 Elastomeric Concrete - Furnish elastomeric concrete from the CPL. Use a multi-component binder-base material designed to provide a strong matrix and to promote bond between the concrete nosing and the substrates. Mix the binder and aggregate according to the manufacturer's recommendations. Use an aggregate gradation recommended by the manufacturer.

02440.22 Epoxy Adhesive for Steel Members - Use a low-modulus epoxy adhesive to bond steel members when indicated. Bond steel members together using a Type 3 non-sag epoxy resin from the CPL, or as approved.

02440.30 Hot Poured Joint Filler - Furnish hot poured joint filler from the CPL and conforming to the requirements of AASHTO M 324, Type II (ASTM D 6690, 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 C 990).

(b) **Rubber Gaskets** - Furnish materials for O-ring manhole and concrete pipe joints conforming to AASHTO M 315 (ASTM C 443).

02440.50  Joint Materials for Concrete Precast Manhole Section Joints:

(a) **Mortar** - Furnish mortar conforming to the requirements of ASTM C 387 or proportioned 1 part Type II Portland cement to 2 parts clean, well-graded sand passing a No. 6 screen. Admixtures may be used not exceeding the following percentages by weight of cement:

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrated lime</td>
<td>10%</td>
</tr>
<tr>
<td>Diatomaceous earth</td>
<td>5%</td>
</tr>
</tbody>
</table>

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 non-epoxy (non-shrink) grout from the CPL. Place or pack non-shrink grouts only with the use of non-epoxy bonding agent from the CPL, 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% 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 D 113.
- 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 called for on the plans and meeting the following:
(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:

<table>
<thead>
<tr>
<th>Test</th>
<th>ASTM Test Method</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength, psi</td>
<td>D 412</td>
<td>1,800</td>
</tr>
<tr>
<td>Elongation, %</td>
<td>D 412</td>
<td>350</td>
</tr>
<tr>
<td>100% Modulus, psi</td>
<td>D 412</td>
<td>760</td>
</tr>
<tr>
<td>Low Temperature</td>
<td>D 746</td>
<td>-50 °F</td>
</tr>
<tr>
<td>Cold Bend Test ¹</td>
<td></td>
<td>No Failures</td>
</tr>
</tbody>
</table>

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

Furnish test samples of the material from which water stop is to be manufactured. Samples shall be in sheet form having a uniform thickness of from 1/16 inch to 1/8 inch and a total area of not less than 2 square feet. Each sample shall be comprised of pieces not smaller than 6 inch by 6 inch.

(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 D 2240.
- **Elongation** - Minimum of 450%.
- **Tensile Strength** - Minimum of 3,000 psi.
- **Water Absorption** - Maximum of 5% 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% 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% of the original tensile strength.
- **Compression Set** - Not more than 30% when tested according to ASTM D 395, 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.

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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 and sump sections, metal frames, covers, and grates.

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 C 478) and the requirements of the Material Specifications for Precast Concrete Products (MSPCP) Manual published by the City of Portland Materials Testing Laboratory.

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 C 478) and the requirements of the Material Specifications for Precast Concrete Products (MSPCP) Manual published by the City of Portland Materials Testing Laboratory.

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

<table>
<thead>
<tr>
<th>Item</th>
<th>AASHTO/ASTM Designation</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manhole frames and covers</td>
<td>M 105</td>
<td>Class 30 B</td>
</tr>
<tr>
<td>Inlet frames and grates</td>
<td>M227/A 663</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>M270/A 709/A 36</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>M 103/A 27</td>
<td>65 - 35</td>
</tr>
</tbody>
</table>

Provide steps for manholes from the CPL.

As an alternate, steps for manholes may be steel-reinforced plastic conforming to AASHTO M 199 (ASTM C 478) and AASHTO MT 280 (ASTM C 497) and the requirements of the MSPCP. The steel shall be deformed reinforcing bar conforming to AASHTO M 31 (ASTM A 615) Grade 60, No. 4 minimum. The plastic material surrounding the reinforcing monolithic steel bar shall be injection molded, with a textured, non-slip surface and a minimum thickness over the steel of 1/16 inch and conforming to ASTM A 615. Voids in the plastic will be cause for rejection of the step.

Frames, covers and grates for use one with another shall have even and uniform bearings.

02450.31 Manhole Covers Provide manhole covers meeting the non-slip requirements of 02484.35(a).

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

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Section 02470 - Potable Water Pipe Materials

Description

02470.00 Scope - This Section includes the requirements for various potable water pipe 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 (NSF 61).

Materials

02470.20 Ductile Iron Pipe:

(a) Conformance Requirements - Use centrifugally cast ductile iron pipe meeting the requirements of AWWA C151. Ductile iron pipe shall be fully gauged, standard thickness Class 52 or the thickness class specified or indicated. 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.

(b) Lining and Coating - Ductile iron pipe shall have a shop applied double thickness cement-mortar lining and asphaltic coating in accordance with AWWA C104.

(c) Flanged Pipe - Flanged ductile iron pipe with threaded ductile iron flanges shall conform to AWWA C115. Flanges shall be drilled in accordance with ASME/ANSI B16.1, Class 125 complete with styrene butadiene rubber (SBR) full face gaskets. Bolts shall protrude through the assembled nut at least 2 threads but not more than 1/2 inch. Flanged connections shall not be buried, unless shown buried. Flanges shall be wrapped with 2 layers of 10 mil tape along edge of flanges.

02470.30 Steel Pipe 6 Inch and Larger:

(a) Conformance Requirements - Steel pipe 6 inches in diameter and larger shall conform to AWWA C200, and shall have a minimum wall thickness of 1/4 inch and a minimum working pressure rating of 150 psi, or as shown. The type of protective coating and lining and other supplementary information required by AWWA C200 shall be as called for in the specifications or as indicated.

(b) Length and Diameter - Steel pipe shall have inside diameters as specified in uniform lengths with a range of 20 to 40 feet. Provide shorter lengths as required for changes in alignment and grade.
**02470.35**

**c) Pipe Ends** - Pipe shall have ends fabricated for bell and spigot (push-on) joints, flanged joints, or welded joints, as specified. Joint grout shall be chloride free and NSF 61 approved.

1. **Push-On Joints** - Pipe ends and joints shall conform to AWWA C200. Push-on joints are not acceptable on pipe larger than 48 inches in diameter.

2. **Flanged Joints** - Flanges, gaskets and bolts shall conform to AWWA C207 and shall be rated for the working pressures specified but not less than 150 psi.

3. **Welded Joints** - Joints shall conform to the requirements of AWWA C206. For pipe 36 inch nominal diameter and larger, lap joints shall be full fillet double welded.

**d) Lining and Coating:**

1. **Mortar Lining** - Pipe shall be supplied with a shop-applied NSF 61 approved, double Type II cement mortar lining, conforming to AWWA C205.

2. **Exterior Coating** - Pipe shall be supplied with an exterior protective coating in accordance with AWWA C214 (cold applied, tape coating) or AWWA C205 (cement-mortar protective coating).

**02470.35 Steel Pipe under 6 Inch** - Steel pipe less than 6 inches in diameter shall be hot-dip galvanized inside and out and meet the requirements of ASTM A 53/A 53M. Steel pipe thickness shall be Schedule 40 or the thickness class specified or indicated.

**02470.36 Concrete Cylinder Pipe:**

(a) **General** - Concrete cylinder pipe shall conform to AWWA C303 with a minimum cylinder thickness of 1/4 inches.

1. **Bonding Connection Points** - Concrete cylinder pipe shall have bonding connection points as recommended by the manufacturer.

2. **Length and Diameter** - Concrete cylinder pipe shall have inside diameters as specified in uniform lengths with a range of 20 to 40 feet. Provide shorter lengths as required for closures and changes in alignment and grade.

3. **Manufacturer Testing** - Hydrostatically test the pipe at the manufacturing plant in accordance with AWWA C303. Pipe shall have ends fabricated for bell and spigot (push-on) joints, flanged joints, or welded joints, as specified. If no information is provided about the type of joint to be used, provide push-on joints. Joint grout shall be chloride free and NSF 61 approved.
(b) **Push-On Joints** - Pipe ends and joints shall conform to AWWA C303. Push on joint gasket shall conform to AWWA C303.

(c) **Flanged Joints** - Flange joints, including gaskets, nuts and bolts shall conform to AWWA C207 and shall be rated for the working pressures specified but not less than 150 psi.

(d) **Welded Joints** - Joints shall conform to the requirements of AWWA C206.

(e) **Lining and Coating** - Pipe shall be supplied with Type II cement mortar lining and coating conforming to AWWA C303 and NSF 61 approved.

02470.50 **Polyethylene Encasement** - Polyethylene tube encasement shall conform to AWWA C105 and tube encasement shall be provided by the pipe manufacturer. Polyethylene sheet is not acceptable.

02470.60 **Detectable Marking Tape or Wire:**

(a) **External Properties** - Detectable 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, with a metallic foil core to provide the most positive detection by pipeline locators. The width of the tape shall be as recommended by the manufacturer for the depth of installation. Tape shall be blue and imprinted continuously over its entire length in permanent black ink with the words "Caution - Water", or "Water" or "Water-line".

(b) **Internal Properties** - Detectable marking wire shall be No. 12 AWG, minimum, solid copper with blue colored polyethylene insulation. Joints or splices in wire shall be waterproof. Runs less than 500 feet shall have no more than one splice for new construction.

02470.70 **Acceptance** - Potable water pipe materials will be accepted according to 00160.06, 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, steel pipe, concrete cylinder pipe and polyvinyl chloride (PVC) pipe for potable water systems.

Materials

02475.10 General:

(a) Securing Fittings - Bolts, nuts and washers used for securing fittings shall be of similar materials.

(b) Nuts and Bolts - Steel bolts shall meet the requirements of ASTM A 307 for carbon steel, or ASTM F 593 for stainless steel. Nuts shall meet the requirements of ASTM A 563 for carbon steel and ASTM F 594 for stainless steel. Iron bolts and nuts shall meet the requirements of ASTM A 536, grade 65-45-12.

(c) Galvanize - Galvanize carbon steel bolts, nuts and washers according to Section 02560.

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

(e) Pressure Ratings - All fittings and appurtenances shall meet or exceed the design pressure rating for the pipe.

02475.20 Ductile Iron Pipe Fittings:

(a) Conformance Requirements - 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.

(b) Linings and Coatings - Fittings shall be cement mortar lined and seal coated, meeting the requirements of AWWA C104. Double thickness cement mortar lining is preferred, but single thickness cement mortar lining will be accepted.

(c) Gaskets - Gaskets for flat faced or raised faced flanges shall be 1/8 inch thick rubber having a Durometer reading of 60, plus or minus 5.

(d) Bolts and Nuts - The type, material and identification mark for bolts and nuts shall be provided.

(e) Large Fittings - Fittings 24 inches to 48 inches shall be of non-compact mechanical joint type conforming to AWWA C110.
02475.30    **Fittings for Steel Pipe 6 Inches and Larger** - Fittings for steel pipe 6 inches in diameter and larger shall conform to AWWA C200, have a minimum working pressure rating of 150 psi or as specified or indicated, and shall receive a protective coating and lining to match the steel pipe provided. Flex couplings shall be compression type. When flanges are required, they shall meet the requirements of AWWA C207, and gaskets shall conform to 02475.20. Steel pipe fittings shall have a minimum wall thickness of 1/4 inch.

02475.31    **Fabricated Steel Drip Tee Fittings:**

(a) **General** - Drip tee fittings and accessories shall be new and unused. The manufacturer's identification shall be distinctly cast upon flanges and fittings. All fittings shall be shipped less accessories unless specifically stated otherwise. Drip tees are a special fabrication for the City for use in service installations and regulator installations.

(b) **Fabrication** - Drip tees shall be fabricated of steel pipe; forged steel, threaded branch connection; and ring-type steel slip-on flanges. Pipe shall conform to AWWA C200 for 6 inch pipe and larger. The 4 inch pipe shall conform to Schedule 80, ASME/ANSI B36.10 for pipe material. Branch connection shall be a Threadolet as manufactured by Bonny Forge Co., P.O. Box 359, Allentown, PA 18105, or approved equal, in the size listed below for 2 inch outlet. Flanges for the assembly shall meet AWWA C207, Class D, 175 psi rating.

(c) **Coating** - Fabricated assembly shall be coated with a fusion bonded epoxy coating in conformance with AWWA C213.

(d) **Special Requirements** - Fabricated assembly uses the following components and shall be of overall length as shown. The branch connection (Threadolet, or approved equal) shall be oriented so that the fitting can be at the top or rolled 90° for side outlet use, and centered between the flanges.

<table>
<thead>
<tr>
<th>Fabricated Assembly</th>
<th>Branch Outlet</th>
<th>Ring-type Slip-on Flanges</th>
<th>Overall Assembly Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>4x4x2</td>
<td>4-3-1/2x2</td>
<td>2-Class D</td>
<td>9 inches</td>
</tr>
<tr>
<td>6x6x2</td>
<td>6x2</td>
<td>2-Class D</td>
<td>9 inches</td>
</tr>
<tr>
<td>8x8x2</td>
<td>10-8x2</td>
<td>2-Class D</td>
<td>11 inches</td>
</tr>
<tr>
<td>12x12x2</td>
<td>18-12x2</td>
<td>2-Class D</td>
<td>11 inches</td>
</tr>
</tbody>
</table>

02475.32    **Plain End Fittings** - Factory cast plain-end fittings are only allowed as shown.

02475.35    **Fittings for Steel Pipe under 6 Inches** - Fittings for steel pipe less than 6 inches in diameter shall be malleable iron threaded type with a pressure rating of 150 psi or as specified or indicated. Dimensions shall meet the requirements of ANSI B16.3. Threading shall meet the requirements of ANSI B2.1. Material shall meet the requirements of ASTM A 47/A47M, Grade 22010. Fittings shall be banded and hot-dip galvanized inside and out.

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02475.36 Fittings for Concrete Cylinder Pipe - Fittings for concrete cylinder pipe shall conform to AWWA C303 with a minimum cylinder thickness of 3/16 inches and shall have bonding connection points as recommended by the manufacturer.

02475.50 Restrained Joints - Restrain ductile iron pipe, fittings and valves by using a manufacturer and Engineer approved system. Provide the restraint system to operate at a working pressure equal to the hydrostatic test pressure required in 01140.51(a) or as shown. No device utilizing round point set screws will be permitted. Provide gaskets and core 10 type or better T-bolts from same manufacturer of the restrained systems or manufacturer’s supplier. Loose bound (bulk) gaskets and bolts shall have accompanying documentation from the manufacturer.

02475.60 Bolted, Sleeve-Type Couplings for Plain-End Pipe:

(a) Conformance Requirements - 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 to connect ductile iron, gray cast iron or PVC pipe shall be ductile iron. Buried couplings for connecting steel pipe to steel pipe shall be steel, coated and lined to match the steel pipe provided.

(b) Shop Coat Enamel - Ductile iron sleeves and end rings shall have a shop coat enamel finish.

(c) Epoxy Finish - Steel sleeves and end rings shall have fusion bonded epoxy finish suitable for potable water systems meeting NSF 61 regulations.

(d) Bolts - Bolts shall be high strength, low-alloy steel manufactured to ASTM A325 with heavy hexagon nuts manufactured to ASTM A563.

(e) Gaskets - Full gaskets shall be rubber of all new materials compounded to resist oil, acids, alkalis, and water.

02475.70 Acceptance - Acceptance of fittings, restrained joints and couplings will be according to 00160.06, 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, ball valves, power actuating devices, valve boxes, valve stem extensions, tapping sleeve and valve assemblies, check valves, hydraulically operated valves, combination air release/air vacuum valves, and backflow prevention devices for potable water systems.

Materials

02480.20 Gate Valves - Gate valves shall meet the requirements of AWWA C509.

(a) Conformance Requirements - The minimum design working pressure shall be 200 psi for valves 2 inches to 12 inches in diameter. Non-rising stems shall be used for buried valves. Sizes not specified in AWWA C509 shall not be allowed for use without approval prior to purchase.

(b) Directional Indicator - Each valve shall open left (counterclockwise) and shall have an arrow showing the direction of opening. Position indicators will not be required.

(c) Component Properties - The valve gate shall be cast gray or ductile iron, with guide bars or channels for controlled movement, and may have an integral 2 inch bronze stem nut. The gate and gate guide bars or channels shall be fully encapsulated by a resilient rubber material bonded to the metal. The gate stem hole, if not also encapsulated, shall be epoxy coated. The method used to provide the rubber-to-metal bond shall be in accordance with the requirements of ASTM D429. The peel strength shall not be less than 75 pounds per inch.

02480.22 Butterfly Valves:

(a) Conformance Requirements - Butterfly valves shall be rubber seated and shall meet the requirements of AWWA C504, Class 150B. Shaft seals shall be standard O-ring seals, designed for replacement under line pressure.

(b) Operating Criteria - Valves shall be bi-directional flow, capable of performing in applications involving throttling service, frequent operation, and operation after long periods of inactivity.

(c) Valve Construction - Valve construction shall meet the following requirements:

   (1) Valve shafts - Wrought stainless steel or Monel.

   (2) Valve seat mating surface - Stainless steel, Monel or plasma welded nickel-chrome.
(3) **Valve coatings** - Valves with a complete rubber liner shall not be accepted. Butterfly valves shall have fusion bonded epoxy coating for the exterior valve body.

(4) **Thrust Bearing** - Two-way type.

(5) **Valve Testing** - Valves shall be tested in accordance with AWWA C504. Leakage tests shall be performed in both directions.

(d) **Large Butterfly Valves** - Butterfly valves 30 inches and larger in diameter shall be constructed so that complete seat replacement can be made without valve disassembly, and without removing the valve from the line.

(e) **Valve Operators** - Valve operators shall be of the traveling nut or worm gear type, 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 ground water. Operators for buried services shall be equipped with a 2 inch square operating nut. Valves shall close with a clockwise rotation of the nut. Operator nut shall be installed between the water main and the short side to the curb.

(f) **Open to Close** - Minimum number of turns from fully open to fully closed shall be as follows:

<table>
<thead>
<tr>
<th>Size Range</th>
<th>Turns</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 inches to 8 inches</td>
<td>16</td>
</tr>
<tr>
<td>10 inches to 12 inches</td>
<td>28</td>
</tr>
<tr>
<td>14 inches to 18 inches</td>
<td>30</td>
</tr>
<tr>
<td>20 inches to 24 inches</td>
<td>44</td>
</tr>
<tr>
<td>30 inches</td>
<td>60</td>
</tr>
<tr>
<td>36 inches</td>
<td>72</td>
</tr>
<tr>
<td>48 inches</td>
<td>96</td>
</tr>
<tr>
<td>54 inches and larger</td>
<td>200</td>
</tr>
</tbody>
</table>

02480.23 **Ball Valves:**

(a) **Conformance Requirements** - Ball valves shall be double seated, with rubber seat materials mating with metal seating surface, and shall meet the requirements of AWWA C507. The minimum design working pressure shall be 150 psi. Shaft seals shall be standard O-ring seals, designed for replacement under line pressure.
(b) **Valve Operators** - Valve operators shall be of the traveling nut or worm gear type, sealed, gasketed and permanently lubricated for buried service. Valve operators shall be constructed to the standard of the valve manufacturer to withstand all anticipated operating torques and shall resist submergence in ground water.

**02480.24 Power-Actuating Devices** - Power-actuating devices for valves shall meet the requirements of AWWA C540. The type of power-actuating devices to be furnished and the operating requirements will be as indicated and shown.

**02480.25 Valve Boxes** - City will furnish valve boxes and covers (CIV). The 8 inch PVC pipe, ASTM D3034, shall be Contractor-furnished.

**02480.26 Valve Operator Extensions** - Valves with an operating nut more than 4 feet below the finished grade shall have valve operator extensions installed. Valve operator extensions shall be manufactured per plan. Hot dip galvanize operator extensions after fabrication.

**02480.30 Tapping Sleeve and Valve Assemblies:**

(a) **General** - The City shall perform all tapping on the active/live water system unless otherwise specified.

1. **Tapping Sleeves** - Tapping sleeves shall be capable of installation on several classes of ductile iron pipe as well as A and C cast iron. Installation shall require no special tools, shims, welding, or caulking.

2. **Tapping Valves** - Furnish tapping valves with flanged inlet end connections. The outlet ends shall conform in dimensions to the ASME/ANSI B16.1 for hub or mechanical joint connections, except that the outside of the hub shall have a large flange for attaching a drilling machine.

3. **Associated Equipment** - The valves shall be used with a Mueller drilling machine, Model No. CC-25, or approved equal. The seat opening of the valve shall permit a diameter cut no less than 1/2 inch smaller than the valve size.

4. **Conformance Requirements** - Valves specifically designed for tapping meeting the requirements of AWWA C500, and valves meeting the requirements of AWWA C509, will be permitted. Tapping valves shall be of the same type as other valves on the Project.

5. **Assembly Rating** - The installed assembly must be rated by the manufacturer for a minimum working pressure of 175 psi and capable of a minimum test pressure of 125% without leakage or pressure loss.

(b) **Steel - Flanged - Tapping Sleeves** – Sleeves shall be manufactured from materials per AWWA C200 and be finished with fusion bonded epoxy, minimal 12 mils exterior, NSF 61 approved. Fabrication shall be in accordance with AWWA C200 and C207.
(c) **Ductile Iron - Mechanical Joint - Tapping Sleeves** – Sleeves shall be manufactured from materials per AWWA C110, C111, C115, C150, or C153 as applicable. Sleeves shall be manufactured in accordance with MSS SP111.

(d) **Outlet Flanges** – Flanges shall be recessed to mate with standard tapping valves per MSS SP60 up through 12 inches in size. Steel flanges shall comply with AWWA C207, Class D with ASME/ANSI B16.5, 150 psi drilling. Ductile iron flanges shall comply with AWWA C110, C115, C150 with ASME/ANSI 16.1, class 125 drilling.

### Check Valves:

(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 14 inch and 16 inch diameters. Check valves shall be nonassisted, 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.

(c) **Hydraulic Cushion Check Valves** - Hydraulic cushion check valves shall be of bronze, cast or ductile iron, with bronze disc and disc faces, seat rings and pivot pins. The valves shall provide droptight sealing. The valves shall be fitted with adjustable speed, integrally mounted, oil dashpot mechanical snubber systems. The minimum design working pressure of the valves shall be 150 psi.

### Hydraulically Operated Valves:

(a) **General** - Hydraulically operated valves shall be pilot controlled and diaphragm operated, bronze or stainless steel mounted with bronze, cast or ductile iron body, globe or angle orientation as indicated. Provide valve position indicators. The minimum design working pressure of the valves shall be 175 psi. Pilot controls and piping shall be bronze, designed to operate the main valves as indicated, and shall include stop valves, strainers and adjustable closing speed controls.

(b) **Size 2 ½ Inches and Under** - Valve shall have cast iron body with female IPT threaded ends and shall be direct acting or pilot operating depending on system requirements. Valve shall have adjustable outlet pressure ranging from 15 to 75 psi.

(c) **Size 3 Inches and Above** - Valve shall have cast iron body, globe style with flanged ends of either 125 or 250 drilling based on system requirements. Valve shall have adjustable outlet pressures ranging from 15 to 100 psi.
02480.51 Pressure Relief Valves - Valve, 1/2 to 2 1/2 inches in size, shall have bronze body with soft seat design and shall have female IPT ends with inlet ranging from 1/2 to 2 inches and outlet ranging from 3/4 to 2 1/2 inches. Orifice sizes range from 0.121 to 1.399 square inches. The valve shall have a temperature range of –20 °F to 800 °F and average pressure range of 15 to 500 psig. Valve shall meet ASME Section VIII, designed for high capacity, low pressure applications on assorted media.

02480.60 Combination Air Release/Air Vacuum Valves:

(a) General - Combination air release/air vacuum valves shall operate with potable water under pressure to permit discharging a surge of air from an empty line when filling, and relieve the vacuum when draining the system. The valves shall also release an accumulation of air when the system is under pressure. This shall be accomplished in a single valve body designed to withstand 300 psi.

(b) Conformance Requirements - Combination air release/air vacuum valves shall meet the requirements of AWWA C512. The body and cover shall be cast iron conforming to ASTM A 48/A 48M, Class 30. Floats shall be stainless steel conforming to ASTM A 240/A 240M 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 Principle Backflow Prevention Assembly - Reduced pressure principle 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 Check Valve Backflow Prevention Assembly - Double 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.

02480.71 Blowoff Assemblies - Use materials as shown.

02480.80 Acceptance - Acceptance of potable water valve materials will be according to 00160.06, 00165.35 and this Section.
Section 02484 - Precast Concrete Vault Materials

Description

02484.00 Scope - This Section includes the material requirements for precast concrete vaults.

Materials

02484.10 General - Furnish a precast concrete vault complete with floor, roof, grated sump, access door, manhole riser ring(s) and lid, ladder, ladder extension, coal tar epoxy joint sealer, waterproofing surface sealer, incidentals and appurtenances, as shown. Provide vault type and size with the appropriate top to accommodate either an access door or manhole, as specified and shown or as directed. Vault shall be watertight and shall support a minimum of H-20 traffic loading. Vault shall have solid walls 4 inches thick minimum with no knock outs.

02484.20 Concrete Vault Sections - Concrete vault sections shall be designed and manufactured per ACI 318-89, AASHTO 92 and ASTM C913/857, with H-20 loading and 30% impact factor over an 8 inch wide x 20 inch long area. Design loading assumptions are as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>pcf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Cover (5 foot Maximum)</td>
<td>100</td>
</tr>
<tr>
<td>Fluid Pressure above water table</td>
<td>30</td>
</tr>
<tr>
<td>Fluid Pressure below water table</td>
<td>75</td>
</tr>
</tbody>
</table>

Concrete shall have a minimum 28-day compressive strength of 4500 psi. Details and placement of reinforcing bar shall be in accordance with ASTM A-615. Concrete components shall meet the following standards:

<table>
<thead>
<tr>
<th>Description</th>
<th>ASTM Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type II/III Cement</td>
<td>C-150</td>
</tr>
<tr>
<td>3/4” Rock (washed)</td>
<td>C-33</td>
</tr>
<tr>
<td>Sand</td>
<td>C-33</td>
</tr>
<tr>
<td>Plasticizer</td>
<td>C-494</td>
</tr>
<tr>
<td>Water Reducer</td>
<td>C-494</td>
</tr>
<tr>
<td>Air Entrainment</td>
<td>C-260</td>
</tr>
<tr>
<td>Reinforcing Mesh</td>
<td>A-185</td>
</tr>
<tr>
<td>Reinforcing Bar</td>
<td>A-615 GR 60</td>
</tr>
</tbody>
</table>

Removable lifting eyes shall be provided for each individual section.

02484.25 Precast Vault Roof - Provide precast vault roof with access hatch or manhole and valve box opening of the dimensions and orientation as shown.

02484.27 Joint Sealant - Butyl rubber joint sealant shall be provided for the vault and manhole section joints and for all riser rings.

02484.30 Pipe Penetration Seals - Pipe penetrations through walls or vaults shall be made watertight by the use of a modular-mechanical type seal
consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.

02484.35 Access Doors:

(a) General - Access doors where required shall be of spring-assisted diamond plate type with locking latch and angle iron frames cast in one 6 inch minimum concrete riser ring. Doors shall be water-tight, rated for H-20 loading and be constructed of steel, hot dipped galvanized after fabrication; or aluminum, with non-slip surface having a static coefficient of friction between 0.60 and 1.00 as determined by ASTM C1028. Access hatches on inclines greater than 4% shall have a coefficient of 0.80 to 1.00.

(b) Single and Double Doors - Doors shall be a single opening or double opening lid secured with non-removable, penta head bolts. Single doors shall utilize one bolt. Double doors shall have two bolts mounted on the corners of the overlapping door. Each door shall have two 90° 'hold open' arms.

02484.40 Ladder and Ladder Extension - Center/Base vault sections shall include chamber ladder and extension. Use structural steel with a minimum yield strength of 36,000 psi per ASTM A-36. Ladder and all mounting hardware shall be hot dipped galvanized after fabrication, in accordance with ASTM A-123. Nuts and bolts shall be all stainless steel, minimum 1/2 inch in diameter. Length of ladder and mounting details shall be as shown.

02484.45 Grates - Grates shall be hot dipped galvanized after fabrication in accordance with ASTM A-123.

02484.50 Valve Box and Cover (CIV) - CIV boxes and covers for installation into the vault roof as shown will be furnished by the City. Provide non-shrink grout around valve boxes.

02484.55 Paint, Sealers and Coatings - A two coat system, aluminum mastic, with all paint material, shall be Carbo Mastic 15 as manufactured by Carboline, Inc., or approved equal.

02484.60 Bedding Backfill and Cover - The aggregate used for bedding and backfill shall be Class B and conform to Section 02630. Cover material shall be as shown.

02484.65 Filter Fabric - Filter fabric shall be non-woven meeting the requirements of Section 00350.

02484.70 Drain Rock - Drain rock shall be washed round aggregate, with a maximum size of 3 inches with 0% passing the No. 4 screen.

02484.80 Sump Drain Valve - The sump drain valve shall be model 4FH manufactured by Flood-Guard or approved equal.

02484.85 Acceptance - Precast concrete vault materials will be accepted according to 00160.06, 00165.35, and this Section.
Section 02485- Hydrants and Appurtenance Materials

Description

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

Materials

02485.10 Fire Hydrants:

(a) General - Fire hydrants shall be dry-barrel, conforming to AWWA C502, of standard manufacture and of a pattern approved by the City. Hydrants shall be designed for a minimum working pressure of 150 psi.

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

(c) Seals and O-rings - Hydrants shall have O-ring stem and valve seals. Main valve seat ring and seat ring bushing shall be bronze. Removal of main valve assembly including seat ring shall be by a tool that engages the stem either at the breakaway stem coupling or the upper stem section.

(d) Lubricant Fixtures - Operating nut thrust collar and threaded stem drive shall be one piece bronze. Oil filler plug or grease fitting shall be furnished in bonnet to lubricate thrust collar and stem drive. Lubricant reservoir shall be a permanently sealed reservoir. Anti-friction thrust washer shall be Teflon, or equal, fitted on top of thrust collar. Furnish a positive stop to prevent over travel of the stem.

(e) Drain Valves - Furnish two or more bronze bushed drain valves. Drain valve shall close within 6 turns, at start of opening hydrant.

02485.20 End Connections - End connections shall be mechanical joint conforming to the requirements of AWWA C110 and C111.

02485.30 Hydrant Dimensions and Nozzles:

(a) Configuration - Hydrant connection pipes shall be 6 inches inside diameter with 6 inch auxiliary gate valve. Hydrant length, measured from the bottom of the hydrant to the sidewalk ring shall provide sufficient cover at each installed location. Valve openings shall be 5 inches minimum diameter. Hydrants shall have two 2 1/2 inch hose nozzles and one 4 1/2 inch pumper nozzle.

(b) Nozzles - Nozzle threads shall conform to National Fire Protection Association (NFPA) No. 1963 - Standard Specification for National Fire Hose Coupling Screw Threads. Hydrant nozzle caps shall have inside neoprene gaskets. Do not furnish nozzle cap chains or cable. Hydrant nozzles shall be lug or screw type and shall be brass.
(c) **Nozzle Caps** - Fit nozzles with cast iron threaded caps with operating nuts of the same design and proportions as the hydrant stem nuts. Operating and nozzle cap nuts shall be pentagon shape, 1 1/4 inches from point to opposite flat at base of nut and 1 3/16 inches from point to opposite flat at top of nut with a tolerance of 1/64 inches for each dimension from flat to opposite point. Thread caps to fit the corresponding nozzles and fit with suitable gaskets to ensure positive water tightness under test pressure. The direction of opening shall be counterclockwise and shall be clearly marked on the operating nut or hydrant top.

**02485.40 Hydrant Extensions:**

(a) **General** - 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.

(b) **Operating Stem Extensions** - 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. Aluminum couplings are not acceptable.

**02485.51 Other Materials** - Drain rock shall conform to Class D backfill as specified in Section 00405. Geotextile fabric for drain rock shall conform to Type 1 drainage geotextile as specified in Section 02320. Furnish material conforming to Section 00440 for concrete hydrant pads.

**02485.52 Out of Service Cover** - Provide yellow or orange plastic bag or cover with reflective tape and, if necessary, approved plastic hydrant out-of-service rings.

**02485.70 Guard Posts** - If shown, guard posts for hydrants shall be galvanized steel pipe, 6 inches in diameter, meeting the requirements of ASTM A53/A 53M, Schedule 40, filled with commercial grade concrete, and with the concrete domed at the top.
02485.75  **Painting** - Hydrants shall be painted in accordance with AWWA C502. Exterior paint shall conform to Federal Specification TT-E-489 G. Furnish the hydrant with standard exterior colors as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrant Barrel</td>
<td>OSHA Safety Orange</td>
</tr>
<tr>
<td>Nozzle Caps</td>
<td>Black</td>
</tr>
<tr>
<td>Pumper Caps</td>
<td>OSHA Safety Red</td>
</tr>
<tr>
<td>Dome or Top</td>
<td>OSHA Safety Orange</td>
</tr>
</tbody>
</table>

02485.80  **Acceptance** - Acceptance of hydrants and hydrant appurtenances will be according to 00160.06, 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 materials for potable water service connections 2 inches in diameter and smaller, and sampling stations.

Materials

02490.10 General - Service line materials shall conform to the latest version of AWWA C800 and these specifications. Unless otherwise specified, the minimum working pressure rating of all service line materials shall be 150 psi. In addition, all service line materials provided shall be rated for the test pressures indicated in Section 01140.51. All materials in contact with potable water shall conform to ANSI/NSF Standard 61, Drinking Water System Components - Health Effects (NSF 61).

02490.11 Stops and Valves - All corporation stops, curb stops and meter valves shall be of the ball-valve design with full port opening and have a flow passage area equivalent to the fitting outlet flow area.

02490.12 Padlock Wings - Curb Stops and meter valves shall be provided with padlock wings.

02490.13 Valve Balls - Balls for the corporation and curb valves shall be fabricated from the same material as the body. A Teflon or Nitrile seat or another material proven not to deteriorate when exposed to chemicals such as chloramines shall support the ball.

02490.14 Gaskets - Each compression nut shall be fitted with a gasket and shall contain a groove in its inner surface to locate a stainless steel gripper band. The gasket shall contain a built-in metal conductor spring at one-end to provide electrical continuity between the copper tubing and the coupling.

02490.20 Saddles - Saddles shall be bronze. Saddles used for 1 inch services may be single strap saddles and have AWWA tapered thread outlet. Saddles used for 2 inch services shall be double strap and have AWWA tapered thread outlet.

02490.30 Corporation Stops:

(a) General - Make corporation stops of bronze alloy. Corporation stops for direct tapping shall have AWWA tapered thread inlet and outlet connections compatible with copper tubing.

(b) Threads - Corporation stops used with 1 inch and 2 inch outlet saddles shall have AWWA tapered thread inlets and outlet connections compatible with copper tubing. Thread patterns for the saddle outlet and corporation stop inlet shall be the same.
02490.40  

**Service Pipe and Fittings:**

(a) **Copper Pipe & Tubing** - Copper tubing shall be in accordance with ASTM B 88. Tubing shall be Type K, seamless, and annealed. Sizes 1 inch and below shall be soft drawn design, 0.065 inch wall thickness. Sizes larger than 1 inch shall be hard drawn design, 0.083 inch wall thickness.

(b) **Brass Pipe** - Brass Pipe shall conform to the standard dimensions, weights, and tolerances for “regular” weight pipe in accordance with ASTM B43. Material composition shall be copper alloy UNS No. C23000. Pipe shall be furnished in the annealed condition to Standard No. “O 61” in accordance with ASTM B601. Pipe shall meet the test requirements of ASTM B43.

(c) **Brass and Bronze Service Fittings** - Brass and bronze service fittings shall have an alloy composition of copper, tin, lead and zinc in accordance with ASTM B62. The material shall be copper alloy UNS No. 83600. Mechanical services shall have a 100% machine finish with no gaps or low spots due to insufficient parent material. All fittings shall either be stamped or embossed with the manufacturer’s name.

(d) **Brass and Bronze Pipe Nipples** - Brass pipe nipples shall be in conformance with ASTM B687. Material, composition and mechanical properties for pipe nipples furnished shall be the same as for Category B copper alloy UNS No. C83600. Threads for pipe nipples will conform to Sections 6 and 11 of AWWA C800, and ASME/ANSI Standard B1.1 as noted in Category B. Standard length and size of nipples shall conform to Section 7 and Table 2 of ASTM B687 for standard close nipples. All other provisions of ASTM B687 "Brass, Copper and Chromium-Plated Pipe Nipples" shall apply to the materials furnished.

02490.50  

**Meter Setters:**

(a) **General** - Meter Resetters shall be made of materials as per AWWA C800 specifications and assembled with lead-free solder.

(b) **Properties** - Resetters shall be made of Type “L” copper tubing and 85-5-5 quality brass and shall have saddle nuts for easy resetting of meters. The length between the saddle nuts will be the same as the brass bar that is threaded and the length of the meter desired.

(c) **Resetter Support** - Resetter shall have a brass bar to support the front and back side. Resetter support shall have the same length of existing meter, with matching threads. Connect before the old existing meter couplings (meter threads).
(d) **Configuration** - The inlet side shall have a length of copper tubing bent to the size ordered and soldered (lead-free) into the brass bar from the top of the brass bar of 90° bend. At the top of the copper tubing, solder (lead-free) an IPT brass bushing with an angle curb stop with a saddle nut shall be attached. The outlet side shall have a length of copper tubing bent to the size ordered and soldered (lead-free) into the brass bar from the top of the brass bar for a 90°bend. At the top of the copper tubing, it will be formed to a flat surface of 1/4 inches with a saddle nut for ease in service installation of meter.

(e) **2 Inch Meter Setters** - The 2 inch meter setters shall be specially designed and must conform to approved drawings on file.

**02490.70 Meter Boxes** - Meter boxes will be City-furnished and installed by the Contractor.

**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 00160.06, 00165.35, and this Section.
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 - Deformed bar reinforcement shall conform to the requirements of ASTM A 706 or AASHTO M 31 (ASTM A 615). Unless otherwise specified or shown, all reinforcing bars shall be Grade 420 (Grade 60).

02510.11 Epoxy Coated Reinforcement:

(a) General - Epoxy coated reinforcement shall conform to the requirements of AASHTO M 284 (ASTM A 775) and (b), (c) and (d) below.

(b) Coating Voids - Patch visible voids in the coating, regardless of cause, according to 00530.48.

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

(d) Coated Reinforcement Ties and Supports - Ties for coated reinforcement shall be nonmetallic coated. Where coated bars are tied to uncoated bars, the ties shall be nonmetallic coated.

(e) Prequalification, Sampling and Testing - Prequalify all epoxy coating and patching/repair material according to ASTM A 775/A 775M. All testing shall be performed by a qualified private testing laboratory. The Department's Materials Laboratory will review all test data to determine whether the material meets the prequalification requirements.

At the time of epoxy coated reinforcing bar shipment, furnish the Engineer a written certification that the coated bars were cleaned, coated and tested according to ASTM A 775/A 775M and according to (b), (c), and (d) above, and that the coating material used on the project is the same as that prequalified.

(f) Plant Certification - Epoxy coated reinforcement shall be produced in a Concrete Reinforcing Steel Institute (CRSI) Certified Epoxy Coating Plant.
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 CPL that develop at least 135% of the specified minimum yield strength of the reinforcing bars in tension. 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% of the specified minimum yield strength of the reinforcing bar.

02510.30 Galvanized Reinforcement:

(a) General - Galvanized reinforcement shall conform to the requirements of ASTM A 767/A 767M, Class II, including Supplementary Requirement S3, and ASTM A 143.

(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 A 767/A 767M 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.


02510.50 Dowels - Dowels shall conform to the requirements of AASHTO M 31 (ASTM A 615), for Grades 40 and 60, or AASHTO M 227 (ASTM A 663) for Grades 70, 75, and 80.

02510.60 Wire Reinforcement - Wire reinforcement shall conform to the requirements of AASHTO M 32 (ASTM A 82). Deformed wire shall conform to the requirements of AASHTO M 225 (ASTM A 496).

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 A 416), 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 A 421).

02515.30 Bars, High Tensile Strength - High strength steel bars shall conform to the requirements of AASHTO M 275 (ASTM A 722).

02515.40 Seven-Wire Strand Epoxy Coated Reinforcement - Epoxy coated reinforcement shall conform to the requirements of ASTM A 882.

02515.50 Tendon Duct - Provide rigid galvanized steel ducts 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% 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 prestressing 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 prestressed 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 of in AASHTO M 1605 (ASTM A 6).

(b) Steel Pipe Piles - Steel pipe piles shall be either spirally welded or longitudinally welded, constant in section and conforming to ASTM A 252, Grade 2. 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. Add the following:

Provide cutting shoes conforming to the following:

   ASTM A 27, Grade 65 - 35
   ASTM A 27, Grade 70 - 36
   ASTM A 27, Grade 70 - 40
   ASTM A 148, all grades

(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 A 36. 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 A 328).

(e) Reinforced Pile Tips - Reinforce the tips of steel H-piles points, pipe pile shoes, or points of any proprietary steel pile tip reinforcement. Legibly mark or tag each cast steel point 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 or if the mark or tag is missing, the point or shoes will be rejected.

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

   ASTM A 27, Grade 65 - 35
   ASTM A 27, Grade 70 - 36
   ASTM A 27, Grade 70 - 40
   ASTM A 148, all grades
For steel H-piles provide no less than a 5/16 inch fillet weld full width of each flange.

The Engineer may randomly sample from each heat or lot number, at least one pile tip or up to 10% of the tips for larger projects, of the pile tips delivered for incorporation into the Project.

The selected tip(s) shall be non-destructively tested as follows:

- Determine the weight of the tip(s)
- Grind 5 smooth spots on each randomly selected tip

The Engineer will test each smooth spot on each tip with an ODOT portable hardness tester. The hardness reading of each spot shall be greater than or equal to 74 on the "B" scale.

Three or more spots with a "B" scale reading below 74, will be cause for rejection of the tested tip and may result in rejection of the entire lot. Replace rejected tips with new tips and rejected lots with new lots at Contractor's expense. New tips and new lots may also be tested according to the requirements above.

Install cast steel point according to manufacturer's recommendations but with no less than a 5/16 inch fillet weld full width of each flange.

No other cast steel points will be accepted unless the following conditions are met at the Contractor's expense:

- Install proposed cast steel points on 3 piles
- Drive the piles to ultimate capacity
- Pull piles and examine the points
- No damage to the cast steel points is discernible

(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% of the tips for larger projects, of the pile tips delivered for incorporation into the project.

The selected tip(s) shall be tested as follows:

- Grind 5 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 3 or more of the 5 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 tip(s). Each cast steel H-pile point shall have a weight not less than 30% 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 City. Replace rejected tips with new tips and rejected lots with new lots at no additional cost to the City. 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 3600 - 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 A 615), 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 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 A 709, Grade 36)
- AASHTO M 270, Grade 50 (ASTM A 709, Grade 50)
- AASHTO M 270, Grade 50W (ASTM A 709, Grade 50W)
- AASHTO M 270, Grade HPS 70 (ASTM A 709 Grade HPS 70)
- AASHTO M 270, Grade HPS 70W (ASTM A 709 Grade HPS 70W)

Supplementary Requirement S4 AASHTO M 270 (ASTM A 709), Fracture-Critical, F, Material; Toughness Tests 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 ASTM A 6/A 6M 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 A 6), 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 A 709, Grade 36)
- ASTM A 36
- AASHTO M 270, Grade 50 (ASTM A 709, 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.
02530.21 **Structural Steel for Pipe Sign Posts** - Use Schedule 40 pipe that shall conform to the following, or as shown or specified:

- ASTM A53, Grade B

02530.40 **Ultrasonic Inspection of Plate** - Ultrasonically inspect flanges 2 inches and thicker for welded plate girders before fabrication according to ASTM A 578 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 City.

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

- AASHTO M 111 (ASTM A 123)
- AASHTO M 232 (ASTM A 153)

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% or 0.15% - 0.25%. 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 A 780 and ASTM A 123. Minimum zinc content for Method A2 is 94% 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 A 668), Class C
- Alloy steel forgings ................. AASHTO M 102 (ASTM A 668), Class G

02540.20 Steel Shafting - Steel shafting shall be cold-finished and shall conform to AASHTO M 169 (ASTM A 108), Grades 1016 - 1030, inclusive.

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

- Carbon steel castings.............. AASHTO M 103 (ASTM A 27), Grade 70-36
- Alloy steel castings.............. AASHTO M 163 (ASTM A 743), 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 off 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 105, Class 35 with the test bar size, A, B, C or S as appropriate to the dimensions of the casting.

- Ductile Iron Castings - ASTM A 536, Grade 60-40-18, or as specified. 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 A 47, Grade 32510.

Finish iron castings according to Section 02540.30.

Clean iron castings according to Section 02540.30.
02540.50  **Nonferrous Materials** - Nonferrous materials shall conform to the following:

- Bronze castings.................................. AASHTO M 107 (ASTM B 22) Copper
  Alloy UNS No. C91100
- Copper alloy plates............................. AASHTO M 108 (ASTM B 100) 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 A 307, Grade A.

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

Plain (Non-coated) Bolts:
- 1/4 inch - 1 1/2 inch - AASHTO M 291 (ASTM A 563), Grade A, hex
- Over 1 1/2 inch - 4 inch - AASHTO M 291 (ASTM A 563), Grade A, heavy hex

Galvanized Bolts:
- All - AASHTO M 291 (ASTM A 563), Grade A, C, D, or DH, heavy hex

(c) Washers - Washers for carbon steel bolts shall conform to ASTM F 436.

02560.20 High-Strength Fasteners:

(a) Bolts - High-strength bolts shall conform to AASHTO M 164 (ASTM A 325). 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 (Non-coated) Bolts:
- All - Heavy Hex AASHTO M 291 (ASTM A 563), Grade C, D, or DH

Type 1 Galvanized Bolts:
- All - Heavy Hex AASHTO M 291 (ASTM A 563), Grade DH
Type 3 Bolts:

- All - Heavy Hex AASHTO M 291 (ASTM A 563), Grade C3 or DH3

(c) Washers - Washers for high-strength bolts shall conform to ASTM F 436. 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 F 959. 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 ASTM A 325 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 A 780.

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Type 3 fasteners do not require coating.

02560.30 Tie Rods and Anchor Rods:

(a) Carbon Steel Tie Rods and Anchor Rods - Carbon steel tie rods and anchor rods shall conform to: AASHTO M 314, Grade 36 or 55; ASTM F 1554, Grade 36 or 55; or ASTM A 307.

(b) High-Strength Tie Rods and Anchor Rods - High-strength tie rods and anchor rods shall conform to: AASHTO M 314, Grade 105; ASTM F 1554, Grade 105; or ASTM A 449, Type 1.

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

Plain Carbon Steel Tie Rods and Rods:

- All - Heavy Hex AASHTO M 291 (ASTM A 563), Grade A

Galvanized Carbon Steel Tie Rods and Anchor Rods:

- All - Heavy Hex AASHTO M 291 (ASTM A 563), Grade A, C, D, or DH

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

- All - Heavy Hex AASHTO M 291 (ASTM A 563), Grade DH, heavy hex

(d) Washers - Washers for anchor rods shall conform to ASTM F 436, Type 1.

02560.40 Galvanizing and Coating of Fasteners, Tie Rods, and Anchor Rods:

(a) Galvanizing of Fasteners, Tie Rods, and Anchor Rods - Hot-dip galvanize fasteners, tie rods, anchor rods, nuts and washers according to AASHTO M 111 (ASTM A 123) or AASHTO M 232 (ASTM A 153) as appropriate to the product.

When specified, mechanically galvanize fasteners according to ASTM B 695, Class 50, Type 1.

Match galvanized bolts, tie rods, and anchor rods with appropriate galvanized nuts for assembly. Ship nuts in the same container consisting of bolts, tie rods, or anchor rods.

Overtap nuts for galvanized fasteners, galvanized tie rods, 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.
(b) **Galvanizing of Direct Tension Indicators** - All galvanized compressible washer-type direct-tension indicators shall be mechanically galvanized according to ASTM B 695, Class 50, Type 1, by the manufacturer.

(c) **Repair of Hot-Dip Galvanizing** - Repair damaged hot-dip galvanizing according to ASTM A 780. Minimum zinc content for Method A2 is 94% on the dry film.

**Testing**

02560.60 **Testing:**

(a) **Rotational Capacity Test** - Test all high-strength fasteners, except anchor rods and tie 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 or washers with the hole size the same nominal diameter as the hole in the washer for the fastener to be tested. Allow 3 to 5 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% 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 3 to 5 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% 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.
02560.70

(b) Other Test Requirements - Proof load testing on all high-strength bolts and nuts is mandatory. Test bolts according to ASTM F 606, Method 1, and nuts according to ASTM F 606, paragraph 4.2, with frequency of tests according to paragraph 9.3 of ASTM A 563. 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 F 606, paragraph 3.5, with frequency of testing according to ASTM A 325. 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 3 extra high strength bolt assemblies per size per lot for check testing.

Provide 1 extra high strength tie rod or anchor bolt per size per lot for check testing.

02560.70 Lubricating Fasteners - Lubricate all galvanized and coated fasteners with a lubricant containing a visible dye of any color that contrasts with the color of galvanizing or coating so a visual check can be made for the lubricant at the time of field installation. Black fasteners shall be "oily" to the touch when installed.

Lubricate galvanized fasteners using commercial wax and coated fasteners using commercial water-soluble wax. Lubricants for galvanized and coated fasteners shall be from the CPL.

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

Protect fasteners from dirt and moisture at the job site. Clean, lubricate and retest weathered or rusted fasteners before installing. Do not re-lubricate tension control fasteners designed to automatically provide the tension without consulting with the manufacturer.

The outer surface of the collar in lock-pin and collar fasteners shall be coated with a lubricant as approved by the manufacturer. This lubricant allows the installation tool to swage the collar without removing the corrosion protection from the outer surface.

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 material requirements for composite bearings.

Materials

02570.10 Materials - Provide materials meeting the following requirements:

Structural steel ................................................................. 02530.20
Stainless steel sliding surfaces .................................. ASTM A 240, Type 304
Flat brass rings for pot bearings .......................... ASTM B 36, half hard
Cap screws .................................................. ASTM A 574 or ASTM F 835
Bolts and nuts .......... AASHTO M 164 (ASTM A 325) and Section 02560
Galvanized Bolts, Nuts, Washers, Cap Screws,
Sole Plates and Base Plates .......................... 02530.70 and 02560.40
Woven Polytetrafluoroethylene
(PTEE) ................................................. 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% virgin natural polyisoprene (natural rubber) or 100% virgin chloroprene (neoprene) meeting the following requirements:

NATURAL POLYISOPRENE (Natural Rubber):

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th>ASTM Test Method</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>Hardness, Durometer D</td>
<td>D 2240</td>
<td>50 ± 5</td>
</tr>
<tr>
<td>Tensile strength, minimum, psi</td>
<td>D 412</td>
<td>2,250</td>
</tr>
<tr>
<td>Ultimate elongation, minimum, %</td>
<td>D 412</td>
<td>450</td>
</tr>
</tbody>
</table>

Heat Resistance

<table>
<thead>
<tr>
<th>ASTM Test Method</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D 573</td>
<td>+10</td>
</tr>
<tr>
<td>70 hour</td>
<td></td>
</tr>
<tr>
<td>at 158 °F</td>
<td>-25</td>
</tr>
</tbody>
</table>

Compression Set

<table>
<thead>
<tr>
<th>ASTM Test Method</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D 395, Method B</td>
<td>25</td>
</tr>
</tbody>
</table>

<p>| 1193 | City of Portland 2010 |</p>
<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Test Method</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ozone</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 pphm ozone in air by volume, 20% strain, 100 °F ± 2 °F</td>
<td>D 1149</td>
<td>No Cracks</td>
</tr>
<tr>
<td>48 hours mounting Procedure</td>
<td>D 518, Procedure A</td>
<td></td>
</tr>
<tr>
<td><strong>Adhesion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bond made during vulcanization, lb/in</td>
<td>D 429, Method B</td>
<td>40</td>
</tr>
<tr>
<td><strong>Low Temperature Test</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Britteness at -40 °F</td>
<td>D 746, Procedure B</td>
<td>No Failure</td>
</tr>
</tbody>
</table>

**VIRGIN CHLOROPRENE:**

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Test Method</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Properties</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardness, Durometer D</td>
<td>D 2240</td>
<td>50 ± 5</td>
</tr>
<tr>
<td>Tensile strength, minimum, psi</td>
<td>D 412</td>
<td>2,500</td>
</tr>
<tr>
<td>Ultimate elongation, minimum, %</td>
<td>D 412</td>
<td>400</td>
</tr>
<tr>
<td><strong>Heat Resistance</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in durometer hardness, maximum points</td>
<td>D 573</td>
<td>+15</td>
</tr>
<tr>
<td>Change in tensile strength, maximum, %</td>
<td>at 212 °F</td>
<td>-15</td>
</tr>
<tr>
<td>Change in ultimate elongation, maximum, %</td>
<td>-40</td>
<td></td>
</tr>
<tr>
<td><strong>Compression Set</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 hours at 212 °F, maximum, %</td>
<td>D 395 Method B</td>
<td>35</td>
</tr>
<tr>
<td><strong>Ozone</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 pphm ozone in air by volume, 20% strain, 100 °F ± 2 °F</td>
<td>D 1149</td>
<td>No Cracks</td>
</tr>
<tr>
<td>100 hours mounting Procedure</td>
<td>D 518, Procedure A</td>
<td></td>
</tr>
<tr>
<td><strong>Adhesion</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bond made during vulcanization, lb/in</td>
<td>D 429, Method B</td>
<td>40</td>
</tr>
</tbody>
</table>
Low Temperature Test

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Test Method</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Britleness at -140 °F</td>
<td>D 746 Procedure B</td>
<td>No Failure</td>
</tr>
</tbody>
</table>

When test specimens are cut from the finished product a 10% 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:

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Range of Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness, Durometer D</td>
<td>ASTM D2240</td>
<td>62 + 2</td>
</tr>
<tr>
<td>Tensile stress, psi</td>
<td>ASTM D412</td>
<td>2,000 min</td>
</tr>
<tr>
<td>at 100% elongation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>at 200% elongation</td>
<td></td>
<td>3,700 min</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>ASTM D412</td>
<td>5,000 min</td>
</tr>
<tr>
<td>Ultimate elongation %</td>
<td>ASTM D412</td>
<td>220 min</td>
</tr>
<tr>
<td>Compression set, 22 hrs</td>
<td>ASTM D395</td>
<td>40 max</td>
</tr>
<tr>
<td>at 158 °F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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 1 two-ply cotton yarn or a single-ply 50-50 blend cotton-polyester weighing 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 thread 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** - The manufacturer shall have a typical bearing either tested and certified by an independent testing laboratory, or shall test a typical bearing with the test witnessed and attested to by an independent testing laboratory, for compliance with specified performance requirements as listed below. Tests shall have been performed within five years before Award of the Contract. Provide a test results certificate according to 00165.35 with the submittal of shop drawings.
(a) **Friction Test** - 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 3,500 psi. Determine the coefficient of friction at 68 °F according to the requirements of section 18.8.3 of the AASHTO RFD Bridge Construction Specifications.

(b) **Proof Load Test:**

1. **Vertical Proof Load Test** - Apply a vertical load equal to 150% of the vertical design capacity of the tested bearing for a period of one hour. 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 bearing tested for vertical proof load shall have a vertical design capacity no more than 50% greater or no less than 50% smaller than the capacity of the required bearing. 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% of the design vertical capacity and no engineer’s calculations are submitted. Apply a horizontal load equal to 100% of the horizontal design capacity while also applying a vertical load equal to 100% 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% of the design capacities of bearings specified for use on the Project.

(c) **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% virgin chloroprene (neoprene) meeting the requirements of section 18 of the AASHTO LRED Bridge Construction Specifications including the properties from the following table:

Table 02571-1

<table>
<thead>
<tr>
<th>Properties</th>
<th>ASTM Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness, Durometer D</td>
<td>D 2240</td>
<td>60 ± 5</td>
</tr>
<tr>
<td>Tensile strength, min., psi</td>
<td>D 412</td>
<td>2,200</td>
</tr>
<tr>
<td>Ultimate elongation, min., %</td>
<td>D 412</td>
<td>350</td>
</tr>
<tr>
<td>Heat Resistance:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in durometer hardness, max. points after 70 hr. at 212 °F</td>
<td>D 2240</td>
<td>+15</td>
</tr>
<tr>
<td>Change in tensile strength, max. % after 70 hr. at 212 °F</td>
<td>D 573</td>
<td>-15</td>
</tr>
<tr>
<td>Change in ultimate elongation, max. % after 70 hr. at 212 °F</td>
<td>D 573</td>
<td>-40</td>
</tr>
<tr>
<td>Compressive set, max. % after 22 hr. at 212 °F</td>
<td>D 395</td>
<td>Method B</td>
</tr>
<tr>
<td>Adhesion: Bond made during vulcanization, lb/in</td>
<td>D 429</td>
<td>Method B</td>
</tr>
<tr>
<td>Tear Resistance, psi</td>
<td>D 624</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>Die C</td>
<td></td>
</tr>
</tbody>
</table>

02571.15 Metal Reinforcement - Metal reinforcement shall be rolled, mild steel sheets 14 gauge thick and conforming to ASTM A 1011, Grade 36 Type 1, or ASTM A 1008, 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 LRED Bridge Construction Specifications for fabrication tolerances.


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 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 bearings 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 City. Provide the sample pad and perform all testing at no additional cost to the City.

Mark all bearings in indelible ink or flexible paint with the Contract number, lot number, date of manufacture, 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 °F and proof load for a compressive load 5 times the maximum design load. The load shall be held for five minutes, removed, then reapplied for a second period of five 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 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 D 429 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 testing laboratory test results according to 02571.30(a).
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 will be determined according to AASHTO T 27. The material shall meet the following requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing (by Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8&quot;</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>54 - 82</td>
</tr>
<tr>
<td>No. 10</td>
<td>34 - 58</td>
</tr>
<tr>
<td>No. 40</td>
<td>9 - 17</td>
</tr>
<tr>
<td>No. 100</td>
<td>0 - 3</td>
</tr>
</tbody>
</table>

(b) Sand Equivalent - Special filter material will be tested according to AASHTO T 176 and shall have a sand equivalent of not less than 25.
Section 02620 - Bedding and Joint Sand

Description

02620.00 Scope - This Section includes the requirement for bedding and joint sand for pavers.

Materials

02620.10 Bedding Sand - Furnish a specially graded material of coarse sand that meets the following requirements:

(a) Grading for Sidewalk Use - Sieve analysis will be determined according to AASHTO T 27. The bedding sand shall meet the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8&quot;</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>95 - 100</td>
</tr>
<tr>
<td>No. 8</td>
<td>80 - 100</td>
</tr>
<tr>
<td>No. 16</td>
<td>50 - 85</td>
</tr>
<tr>
<td>No. 30</td>
<td>25 - 60</td>
</tr>
<tr>
<td>No. 50</td>
<td>5 - 30</td>
</tr>
<tr>
<td>No. 100</td>
<td>0 - 10</td>
</tr>
<tr>
<td>No. 200</td>
<td>1</td>
</tr>
</tbody>
</table>

(b) Grading for Street Use - Sieve analysis will be determined according to AASHTO T 27. The material shall be comprised of naturally occurring silica sand. The bedding sand shall meet the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4&quot;</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>95 - 100</td>
</tr>
<tr>
<td>No. 8</td>
<td>80 - 100</td>
</tr>
<tr>
<td>No. 16</td>
<td>50 - 75</td>
</tr>
<tr>
<td>No. 30</td>
<td>25 - 45</td>
</tr>
<tr>
<td>No. 50</td>
<td>0 - 10</td>
</tr>
<tr>
<td>No. 100</td>
<td>0 - 2</td>
</tr>
<tr>
<td>No. 200</td>
<td>0</td>
</tr>
</tbody>
</table>

(c) Sand Equivalent - Bedding sand will be tested according to AASHTO T 176 and shall have a sand equivalent of not less than 25.

(d) Particle Shape - For street use, the shape of the sand grain shall be cuboid. The particles of sand shall be angular and of approximately cubic shape. The shape shall be verified by a picture from an electron microscope.

(e) Geological Deposits - For street use, the sand shall be from Quarternary deposits. The type of deposit shall be verified in writing by a geologist who has visited the quarry site.
Joint Sand - Furnish a specially graded material of coarse sand that meets the following requirements:

(a) **Grading for Sidewalk Use** - Sieve analysis will be determined according to AASHTO T 27. The joint sand shall meet the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Natural Sand Percent Passing</th>
<th>Manufactured Sand Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>No. 8</td>
<td>95 - 100</td>
<td>95 - 100</td>
</tr>
<tr>
<td>No. 16</td>
<td>70 - 100</td>
<td>70 - 100</td>
</tr>
<tr>
<td>No. 30</td>
<td>40 - 75</td>
<td>40 - 100</td>
</tr>
<tr>
<td>No. 50</td>
<td>10 - 35</td>
<td>20 - 40</td>
</tr>
<tr>
<td>No. 100</td>
<td>2 - 15</td>
<td>10 - 25</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 - 1</td>
<td>0 - 10</td>
</tr>
</tbody>
</table>

(b) **Grading for Street Use** - Sieve analysis will be determined according to AASHTO T 27. The material shall be comprised of naturally occurring silica sand. The joint sand shall meet the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4&quot;</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>95 - 100</td>
</tr>
<tr>
<td>No. 8</td>
<td>80 - 100</td>
</tr>
<tr>
<td>No. 16</td>
<td>50 - 75</td>
</tr>
<tr>
<td>No. 30</td>
<td>25 - 45</td>
</tr>
<tr>
<td>No. 50</td>
<td>0 - 10</td>
</tr>
<tr>
<td>No. 100</td>
<td>0 - 2</td>
</tr>
<tr>
<td>No. 200</td>
<td>0</td>
</tr>
</tbody>
</table>

(c) **Sand Equivalent** - Joint sand will be tested according to AASHTO T 176 and shall have a sand equivalent of not less than 25.

(d) **Particle Shape** - For street use, the shape of the sand grain shall be cuboid. The particles of sand shall be angular and of approximately cubic shape. The shape shall be verified by a picture from an electron microscope.

(e) **Geological Deposits** - For street use, the sand shall be from Quarternary deposits. The type of deposit shall be verified in writing by a geologist who has visited the quarry site.
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 will be determined according to AASHTO T 27. The aggregates shall conform to one of the grading requirements of Table 02630-1 as called for in the Special Provisions or indicated by the pay item(s) in the Schedule of Items.

Table 02630-1
Grading Requirements for Dense-Graded Aggregate

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>2 1/2&quot; - 0</th>
<th>2&quot; - 0</th>
<th>1 1/2&quot; - 0</th>
<th>1&quot; - 0</th>
<th>3/4&quot; - 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot;</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 1/2&quot;</td>
<td>95 - 100</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2&quot;</td>
<td>-</td>
<td>95 - 100</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 1/2&quot;</td>
<td>-</td>
<td>-</td>
<td>95 - 100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>1 1/4&quot;</td>
<td>55 - 75</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>1&quot;</td>
<td>-</td>
<td>55 - 75</td>
<td>-</td>
<td>90 - 100</td>
<td>100</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>-</td>
<td>-</td>
<td>55 - 75</td>
<td>-</td>
<td>90 - 100</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>55 - 75</td>
<td>-</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>55 - 75</td>
</tr>
<tr>
<td>1/4&quot;</td>
<td>30 - 45</td>
<td>30 - 45</td>
<td>35 - 50</td>
<td>40 - 55</td>
<td>40 - 60</td>
</tr>
<tr>
<td>No. 10</td>
<td>i</td>
<td>i</td>
<td>i</td>
<td>i</td>
<td>i</td>
</tr>
</tbody>
</table>

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

(b) Fracture of Rounded Rock - Fracture of rounded rock will be determined according to AASHTO TP 61. 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 % of Fractured Particles by Weight of Material

<table>
<thead>
<tr>
<th>Designated Size</th>
<th>Retained on 1/4 inch Sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2&quot; - 0 and larger</td>
<td>50</td>
</tr>
<tr>
<td>Smaller than 1 1/2&quot; - 0</td>
<td>70</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abrasion Degradation (Coarse Aggregate)</td>
<td>AASHTO T 96</td>
<td>35.0% maximum</td>
</tr>
<tr>
<td>Passing No. 20 sieve Sediment Height</td>
<td>ODOT TM 208</td>
<td>30.0% maximum</td>
</tr>
</tbody>
</table>

(d) Sand Equivalent - Dense-graded aggregate will 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>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>100</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>80 - 98</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>60 - 85</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>30 - 65</td>
</tr>
<tr>
<td>No. 10</td>
<td>5 - 20</td>
</tr>
<tr>
<td>No. 40</td>
<td>0 - 6</td>
</tr>
<tr>
<td>No. 100</td>
<td>0 - 3 (Dry Sieve)</td>
</tr>
</tbody>
</table>
(b) Fracture of Rounded Rock - Fracture of rounded rock will be determined according to AASHTO TP 61. Open-graded aggregate fracture requirements shall conform to the following:

<table>
<thead>
<tr>
<th>Material Retained on 3/4&quot;, 1/2&quot;, and 1/4&quot; Sieves (2 fractured faces)</th>
<th>Material Retained on No. 10 Sieve (1 fractured face)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of Fracture by Weight</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>75</td>
</tr>
</tbody>
</table>

(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 will 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 called for in the Special Provisions or indicated by the pay item in the Schedule of Items.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>1&quot; - 0</th>
<th>3/4&quot; - 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2&quot;</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>1&quot;</td>
<td>90 - 100</td>
<td>100</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>—</td>
<td>90 - 100</td>
</tr>
<tr>
<td>1/4&quot;</td>
<td>40 - 55</td>
<td>40 - 60</td>
</tr>
</tbody>
</table>

(b) Fracture of Rounded Rock - Fracture of rounded rock will be determined according to AASHTO TP 61. Provide at least one fractured face based on the following percentage of particles retained on the 1/4 inch sieve for the designated size:

<table>
<thead>
<tr>
<th>Designated Size</th>
<th>Retained on 1/4&quot; Sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2&quot; - 0 and Larger</td>
<td>50</td>
</tr>
<tr>
<td>1 1/2&quot; - 0</td>
<td>50</td>
</tr>
</tbody>
</table>
(c) **Durability** - The produced aggregates shall meet the following requirements:

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abrasion</td>
<td>AASHTO T 96</td>
<td>35.0% maximum</td>
</tr>
<tr>
<td>Degradation (Coarse Aggregate)</td>
<td>ODOT TM 208</td>
<td>30.0% maximum</td>
</tr>
<tr>
<td>Passing No. 20 sieve Sediment Height</td>
<td>ODOT TM 208</td>
<td>3.0” maximum</td>
</tr>
</tbody>
</table>

(d) **Sand Equivalent** - Shoulder aggregate will be tested according to AASHTO T 176, and shall have a sand equivalent of not less than 25.
Section 02690 - PCC Aggregates

Description

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

Materials

02690.10 Materials - 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.

02690.20 Coarse Aggregate:

(a) General Requirements - Coarse aggregate shall consist of rock, or other approved inert material of similar characteristics having hard, strong, durable pieces free from adherent coatings.

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

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Method</th>
<th>Percent (by Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightweight Pieces</td>
<td>T 113</td>
<td>1.0</td>
</tr>
<tr>
<td>Material passing No. 200 sieve</td>
<td>T 11</td>
<td>1.0</td>
</tr>
<tr>
<td>Wood Particles</td>
<td>TM 225</td>
<td>0.05</td>
</tr>
</tbody>
</table>

1 For crushed aggregates, if the material finer than the No. 200 sieve consists of fracture dust, essentially free of clay or shale and is non-plastic, the percentage may be increased to 1.5%.

The materials shall be reasonably free from all other deleterious substances.

(c) Soundness - Coarse aggregates for concrete shall be tested for soundness using sodium sulfate salt, according to AASHTO T104. The weighted percentage loss shall not exceed 12% by weight.

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

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abrasion</td>
<td>T 96</td>
<td>30.0% Max.</td>
</tr>
<tr>
<td>Oregon Air Aggregate</td>
<td>TM 208</td>
<td>30.0% Max.</td>
</tr>
<tr>
<td>Degradation:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passing No. 20 sieve</td>
<td>TM 208</td>
<td>3.0&quot; Max.</td>
</tr>
<tr>
<td>Sediment Height</td>
<td>TM 208</td>
<td></td>
</tr>
</tbody>
</table>

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(e) **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% 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 TP 61.

2. **Elongated Pieces** - Provide aggregate with elongated pieces not exceeding 10% 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.

(f) **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

<table>
<thead>
<tr>
<th>Maximum Nominal Size of Aggregates</th>
<th>Separated Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&quot;</td>
<td>1&quot; - No. 4</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>3/4&quot; - No. 4</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>3/4&quot; - 1/2&quot; and 1/2&quot; - No. 4</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>3/4&quot; - 3/8&quot; and 3/8&quot; - No. 4</td>
</tr>
</tbody>
</table>

2. The grading of each of the specified separated sizes of coarse aggregate shall conform to the following:
### Table 02690-2
#### Separated Sizes

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>1&quot;-No.</th>
<th>3/4&quot;-No.</th>
<th>3/4&quot;-</th>
<th>3/4&quot;-</th>
<th>1/2&quot;-No.</th>
<th>3/8&quot;-</th>
<th>No. 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2&quot;</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1&quot;</td>
<td>90 -</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>50 -</td>
<td>90 - 100</td>
<td>85 - 100</td>
<td>85 - 100</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>1/2&quot;</td>
<td></td>
<td>0 - 15</td>
<td></td>
<td>85 - 100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>15 -</td>
<td>20 - 50</td>
<td></td>
<td>0 - 15</td>
<td>35 - 65</td>
<td>85 - 100</td>
<td></td>
</tr>
<tr>
<td>No. 4</td>
<td>0 - 10</td>
<td>0 - 10</td>
<td>0 - 15</td>
<td>0 - 15</td>
<td>0 - 15</td>
<td>0 - 15</td>
<td></td>
</tr>
</tbody>
</table>

1 See 02690.20(b)

### (g) 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 on projects with more than 100 cubic yards of concrete. Provide a CAgT to perform sampling and testing when required.

### Table 02690-3
#### Gradation of Coarse Aggregates

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Combined 1</th>
<th>Separated Sizes</th>
<th>Separated Sizes</th>
<th>Separated Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 1/2&quot; - No. 4</td>
<td>3/4&quot; - 1/2&quot;</td>
<td>1&quot; - No. 4</td>
<td>3/4&quot; - 1/2&quot;</td>
</tr>
<tr>
<td>2&quot;</td>
<td>100</td>
<td>100</td>
<td>95 - 100</td>
<td>100</td>
</tr>
<tr>
<td>1&quot;</td>
<td>95 - 100</td>
<td>90 - 100</td>
<td>95 - 100</td>
<td>100</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td></td>
<td>20 - 55</td>
<td>95 - 100</td>
<td>100</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>35 - 70</td>
<td>0 - 15</td>
<td>85 - 100</td>
<td></td>
</tr>
<tr>
<td>1/2&quot;</td>
<td></td>
<td>25 - 60</td>
<td></td>
<td>0 - 15</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>10 - 30</td>
<td>0 - 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 4</td>
<td></td>
<td>0 - 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 8</td>
<td></td>
<td>0 - 5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 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
Table 02690-4
Gradation of Coarse Aggregates

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Separated Sizes</th>
<th>Separated or Combined Sizes</th>
<th>Separated Sizes</th>
<th>Separated Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot; - 3/8&quot;</td>
<td>90 - 100</td>
<td>90 - 100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>20 - 55</td>
<td>40 - 70</td>
<td>85 - 100</td>
<td>100</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>0 - 15</td>
<td>0 - 10</td>
<td>10 - 30</td>
<td>0 - 10</td>
</tr>
<tr>
<td>No. 4</td>
<td>0 - 5</td>
<td>0 - 5</td>
<td>0 - 5</td>
<td>0 - 5</td>
</tr>
<tr>
<td>No. 8</td>
<td>0 - 5</td>
<td>0 - 5</td>
<td>0 - 5</td>
<td>0 - 5</td>
</tr>
<tr>
<td>No. 16</td>
<td>0 - 5</td>
<td>0 - 5</td>
<td>0 - 5</td>
<td>0 - 5</td>
</tr>
</tbody>
</table>

Percent Passing (by Weight)

**02690.30 Fine Aggregates:**

(a) **General Requirements** - Fine aggregate shall consist of natural or crushed aggregates or other inert material consisting of hard, strong, durable particles and conforming to a specified grading.

(b) **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.

(c) **Harmful Substances** - The amount of harmful substances shall not exceed the following limits:

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Method (AASHTO)</th>
<th>Percent (by Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lightweight Pieces</td>
<td>T 113</td>
<td>2.0%</td>
</tr>
<tr>
<td>Material passing No. 200 Sieve 1</td>
<td>T 11</td>
<td>4.0%</td>
</tr>
</tbody>
</table>

If this material consists of fracture dust, essentially free of clay and non-plastic, the percentage may be increased to 6.0%.

The material shall also be reasonably free from all other harmful substances, such as shale, alkali, mica, coated grains, and soft and flaky particles.

(d) **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% by weight.

(e) **Organic Impurities** - All fine aggregate shall meet the requirements of AASHTO M 6 for organic impurities.

(f) **Sand Equivalent** - Fine aggregate shall be tested according to AASHTO T 176 and shall have a sand equivalent of not less than 68.
(g) **Sand For Mortar** - Sand for mortar shall conform to the requirements of this Section.

(h) **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 on projects with more than 100 cubic yards of concrete, and all prestressed concrete. Provide a CAgT to perform sampling and testing when required.

<table>
<thead>
<tr>
<th>Table 02690-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradation of Fine Aggregate</td>
</tr>
<tr>
<td>Sieve Size</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>3/8&quot;</td>
</tr>
<tr>
<td>No. 4</td>
</tr>
<tr>
<td>No. 8</td>
</tr>
<tr>
<td>No. 16</td>
</tr>
<tr>
<td>No. 30</td>
</tr>
<tr>
<td>No. 50</td>
</tr>
<tr>
<td>No. 100</td>
</tr>
<tr>
<td>No. 200</td>
</tr>
</tbody>
</table>

1 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 be rejected unless an adjustment in the aggregate proportions is performed by a CCT according to the provisions of ACI 211.

2 For manufactured sand, where the material passing No. 200 is non-plastic rock dust crusher fines, the specification limits may be increased to 6%.
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 A 36.

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 A 500, Grade B, or ASTM A 501. Steel conforming to ASTM A 513 or ASTM A 618 may be substituted for ASTM A 500 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 A 513 tubing shall meet the requirements of ASTM A 500 tubing.

02810.30 Steel Pipe - Metal parapet rail members shall be standard steel pipe complying with ASTM A 53, Grade B or ASTM A 500, Grade B.

02810.40 Cast Steel Posts - Cast steel posts shall be carbon steel castings complying with AASHTO M 103 (ASTM A 27), Grade 65-35.

02810.50 Metal Thrie Beam Rail - Galvanize steel thrie beam rail according to AASHTO M 180, for Class A rail, Type II coating after fabrication and subject to the single spot test. Backup plates will be accepted with un-galvanized 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 un-galvanized 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 A 36 and galvanized according to AASHTO M 111 (ASTM A 123).

**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 C, for Type II cable. Galvanize all fittings according to AASHTO M 111 (ASTM A 123).

For steel anchors, the steel tubing shall meet the requirements of ASTM A 500, Grade B, ASTM A 501 or ASTM A 618. The soil plate shall meet the requirements of ASTM A 36. After fabrication galvanize tubing and plate according to AASHTO M 111 (ASTM A 123).

**02820.50 Acceptance of Materials** - If feasible, manufacturing plants will 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 - Handrail

Description

02830.00 Scope - This Section includes the requirements for the steel in handrail for bridges and stairways.

Materials

02830.10 Shapes, Plates and Bars - Shapes, plates and bars shall comply with ASTM A 36.

The silicon content of all exposed shapes, plates and bars that are called out on drawings as "Galvanize - Control Silicon", shall according to 02530.70.

02830.20 Steel Pipe - Steel pipe used for handrail members shall comply with ASTM A 53 or ASTM A 500.

02830.30 Incidentals - Plates, caps and miscellaneous pieces necessary to complete the rail shall be as shown.

02830.40 Acceptance - Acceptance of handrail materials will be according to 00165.35 and this Section.
Section 02910 - Sign Materials

Description

02910.00 Scope - This Section includes the requirements for backing, sheeting, legend, reflectors and hardware for sign installations.

02910.02 Types of Signs - Traffic signs are classified by sign type as follows:

"B"  Blue Type III or Type IV sheeting background with silver-white Type III or Type IV permanent or removable legend, or silver-white Type III or Type IV sheeting overlaid with blue transparent paste background with retroreflective silver-white screened legend.

"B1"  Blue Type I sheeting background with silver-white Type III or Type IV permanent or removable legend, with retroreflective silver-white screened legend.

"B2"  Blue Type III or Type IV sheeting background with white Type VII or Type IX permanent removable legend.

"B3"  Blue Type IX sheeting background with white Type VII or Type IX permanent or removable legend or white Type IX sheeting overlaid with blue transparent paste background, with retroreflective silver-white screened legend.

"C"  Brown Type III or Type IV sheeting background with silver-white Type III or Type IV permanent or removable legend, or silver-white Type III or Type IV sheeting overlaid with brown transparent paste background, with retroreflective silver-white screened legend.

"C1"  Brown Type III or Type IV sheeting background with white Type VII or Type IX permanent or removable legend.

"C2"  Brown Type IX sheeting background with white Type VII or Type IX permanent or removable legend or white Type IX sheeting overlaid with brown transparent paste background, with retroreflective silver-white screened legend.

"C3"  Brown prismatic lens retroreflective sheeting on extruded aluminum panels, with white prismatic lens retroreflective removable legend.

"F"  Silver-white Type III or Type IV sheeting background overlaid with red and blue transparent paste background with retroreflective silver-white screened legend or silver-white Type III or Type IV permanent legend.

"F1"  White Type IX sheeting background overlaid with red and blue transparent paste background with white Type VII or Type IX permanent legend.
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;G&quot;</td>
<td>Green Type III or Type IV sheeting background with silver-white Type III or Type IV permanent or removable legend, or silver-white Type III or Type IV sheeting background overlaid with green transparent paste background with retroreflective silver-white screened legend.</td>
</tr>
<tr>
<td>&quot;G1&quot;</td>
<td>Green Type III or Type IV sheeting background with white Type VII or Type IX removable legend.</td>
</tr>
<tr>
<td>&quot;G2&quot;</td>
<td>Green Type III or Type IV sheeting background with white Type VII or Type IX permanent legend.</td>
</tr>
<tr>
<td>&quot;G3&quot;</td>
<td>Green Type IX sheeting background with white Type VII or Type IX permanent legend, or white Type IX sheeting background overlaid with green transparent paste background with retroreflective silver-white screened legend.</td>
</tr>
<tr>
<td>&quot;G4&quot;</td>
<td>Green Type IX sheeting background with white Type VII or Type IX removable legend.</td>
</tr>
<tr>
<td>&quot;G5&quot;</td>
<td>Green encapsulated lens retroreflective sheeting background with white prismatic lens retroreflective permanent legend, or white prismatic lens retroreflective sheeting background overlaid with green transparent paste background with white retroreflective screened legend with a screened red transparent paste rose on sheet aluminum. (Street Name Sign)</td>
</tr>
<tr>
<td>&quot;O&quot;</td>
<td>Orange Type I sheeting background with black nonreflective permanent or removable legend.</td>
</tr>
<tr>
<td>&quot;OO&quot;</td>
<td>Orange Type III or Type IV sheeting background with black nonreflective permanent or removable legend.</td>
</tr>
<tr>
<td>&quot;O3&quot;</td>
<td>Fluorescent orange Type VII, Type VIII, Type IX, or Type X sheeting background with black nonreflective permanent legend and red retroreflective symbol (Stop or Yield Ahead Symbol Sign).</td>
</tr>
<tr>
<td>&quot;O4&quot;</td>
<td>Fluorescent orange Type VII, Type VIII, Type IX, or Type X sheeting background with black nonreflective permanent legend.</td>
</tr>
<tr>
<td>&quot;O5&quot;</td>
<td>Fluorescent orange Type VII, Type VIII, Type IX or Type X sheeting background with black nonreflective removable legend.</td>
</tr>
<tr>
<td>&quot;R&quot;</td>
<td>Silver-white Type III or Type IV sheeting background overlaid with red transparent paste background with silver-white Type III or Type IV permanent legend. (Stop Sign, Wrong-Way, Do Not Enter.)</td>
</tr>
<tr>
<td>&quot;R1&quot;</td>
<td>White Type IX sheeting background overlaid with red transparent paste background with white Type VII or Type IX permanent legend.</td>
</tr>
<tr>
<td>&quot;R2&quot;</td>
<td>Silver-white Type III or Type IV sheeting background overlaid with screened red transparent paste triangle and legend or red Type III or Type IV triangle and permanent legend. (Yield Sign)</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>R3</td>
<td>White Type IX sheeting background overlaid with screened red transparent paste triangle and permanent legend.</td>
</tr>
<tr>
<td>R4</td>
<td>Rubber STOP flap made of natural rubber with a red background and white lettering.</td>
</tr>
<tr>
<td>W1</td>
<td>Silver-white Type III or Type IV sheeting background with black nonreflective screened, cut-out permanent or removable legend.</td>
</tr>
<tr>
<td>W2</td>
<td>Silver-white Type III or Type IV sheeting background with a screened black nonreflective legend overlaid with a screened red transparent paste circle and continuous diagonal bar. (Prohibition)</td>
</tr>
<tr>
<td>W3</td>
<td>Silver-white Type III or Type IV sheeting background with transparent brown screened legend or brown Type III or Type IV cut-out permanent legend.</td>
</tr>
<tr>
<td>W4</td>
<td>Silver-white Type III or Type IV sheeting background with transparent red screened legend or red Type III or Type IV cut-out permanent legend.</td>
</tr>
<tr>
<td>W5</td>
<td>Silver-white Type III or Type IV sheeting background with transparent green screened legend or green Type III or Type IV cut-out permanent legend.</td>
</tr>
<tr>
<td>W6</td>
<td>White Type IX sheeting background with a screened or cut-out black nonreflective legend overlaid with a screened red transparent paste circle and continuous diagonal bar. (Prohibition sign overhead)</td>
</tr>
<tr>
<td>W7</td>
<td>White Type IX sheeting background with black nonreflective screened or cut-out permanent legend.</td>
</tr>
<tr>
<td>W8</td>
<td>Silver-white Type III or Type IV sheeting background with blue transparent screened legend or blue Type III or Type IV cut-out permanent legend.</td>
</tr>
<tr>
<td>W9</td>
<td>Silver-white Type III or Type IV sheeting background with blue nonreflective screened or cut-out permanent legend.</td>
</tr>
<tr>
<td>W10</td>
<td>White Type IX sheeting background with black nonreflective removable legend.</td>
</tr>
<tr>
<td>W11</td>
<td>Silver-white Type III or Type IV sheeting background with black nonreflective screened or cut-out permanent legend with red Type III or Type IV symbol. (Bicycle Stop or Bicycle Yield symbol signs)</td>
</tr>
<tr>
<td>Y1</td>
<td>Yellow Type III or Type IV sheeting background with black nonreflective screened, cut-out permanent or removable legend.</td>
</tr>
<tr>
<td>Y2</td>
<td>Yellow Type III or Type IV sheeting background with a screened or cut-out black nonreflective legend and red and green Type III or Type IV...</td>
</tr>
</tbody>
</table>
IV circles. The center yellow circle part shall be part of the background sheeting. (Signal Ahead Symbol Sign)

"Y3" Yellow Type IX sheeting background with black nonreflective screened, cut-out permanent or removable legend.

"Y4" Yellow Type III or Type IV sheeting background with black nonreflective screened or cut-out permanent legend and red Type III or Type IV symbol. (Stop or Yield Ahead Symbol Sign)

"Y5" Fluorescent yellow Type IX sheeting background with black nonreflective screened cut-out permanent legend, or removable legend.

"Y6" Fluorescent yellow Type IX sheeting background with black nonreflective screened or cut-out permanent legend and red and green Type IX circles. The center yellow circle shall be part of the background sheeting. (Signal Ahead Symbol Sign overhead)

"Y7" Fluorescent yellow Type IX sheeting background with black nonreflective screened or cut-out permanent legend and red Type VII or Type IX symbol. (Stop or Yield Ahead Symbol Sign)

"Y8" Yellow Type III or Type IV sheeting background with black nonreflective screened or cut-out permanent legend and silver-white Type III or Type IV symbol. (Speed Reduction Symbol Sign)

"YG" Fluorescent yellow-green Type IX sheeting background with black non-reflective legend or cut-out permanent legend.

"YGW" Fluorescent yellow-green Type IX sheeting background with black nonreflective screened or cut-out permanent legend and silver-white Type III or Type IV symbol with black nonreflective screened or cut-out permanent legend and red Type III or Type IV symbol. (In-Street Pedestrian Crossing Symbol Sign)

02910.10 Aluminum - The aluminum materials shall be new and conform to the following requirements:

- Aluminum bars or rods ............................................. ASTM B 211
- Aluminum sand castings ............................................ ASTM B 26
- Aluminum sheet ....................................................... ASTM B 209
- Extruded aluminum shapes ....................................... ASTM B 221
- Rolled or extruded structural shapes .............................. ASTM B 308

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, and give a chromate treatment conforming to
02910.20

ASTM B 449, Class 2. Provide certified test reports for all heats of aluminum products furnished to the City. Signs shall be of the thickness shown on Table 02910-1 below unless otherwise indicated.

Table 02910-1

<table>
<thead>
<tr>
<th>Sign Width (Horizontal Measure)</th>
<th>Sheet Aluminum Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 20&quot;</td>
<td>0.063&quot;</td>
</tr>
<tr>
<td>20&quot; through 30&quot;</td>
<td>0.080&quot;</td>
</tr>
<tr>
<td>31&quot; through 48&quot;</td>
<td>0.100&quot;</td>
</tr>
<tr>
<td>Over 48&quot;</td>
<td>0.125&quot;</td>
</tr>
</tbody>
</table>

Sheeting

02910.20  Reflective and Retroreflective Sheeting:

(a) General - Use reflective sheeting Type I and retroreflective sheeting Type III, Type IV, Type VII, Type VIII, Type 1X, and Type X from the CPL 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 00165.10(b), 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 00940.02. 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 ReflectORIZED Removable Legend:**

(a) **General** - The letter 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 version of 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 VII or Type 1X 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 B 209/B 209M, 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.
02910.33

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 reflective 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 - The screen process ink for nonreflective legends shall be Naz-Dar 811 Black Screen Process Ink (Naz-Dar Company), Sherwin Williams Kem Screen Process, color D22-B2 (Sherwin Williams Company), or approved equal.

(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 B 211, alloys 2024-T4 or 6061-T6 as the Contractor elects. Aluminum washers shall conform to ASTM B 209, 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 A 153).

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 B 316. 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 CPL.

(b) Acceptance - If requested, furnished with each lot or shipment a quality compliance certificate according to 00165.35, certifying that the material supplied is an acceptable product on the CPL.

02910.75 Manufacturer’s Warranty - Furnish a Warranty, for Warranty periods stated below from the manufacturer and signed by a Manufacturer’s Representative, conforming to the following requirements:

For retroreflective Type III, Type IV, and Type VII sheeting used for permanent signs, provide a Warranty, for a Warranty period of 10 years, for restoring sign panels and replacing sheeting if the sheeting has failed as defined below.

For retroreflective Type IX sheeting used for permanent signs, provide a Warranty, for a Warranty period of 12 years, for restoring sign panels and replacing sheeting if the sheeting has failed as defined below.

For retroreflective sheeting used for temporary signs, provide a Warranty, for a period of 3 years, for restoring sign panels and replacing sheeting if the sheeting has failed as defined below.

For purposes of the Warranty, the retroreflective sheeting will be deemed to have failed if it has deteriorated 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 is less than the following:
  - 80% of minimum coefficient of retroreflection for designated sheeting or cuttable film according to ASTM D 4956 for the first 7 years of the Warranty period.
  - 70% of minimum coefficient of retroreflection for designated sheeting or cuttable film according to ASTM D 4956 for the remaining 3 years of the Warranty period for Type III, Type IV, and Type VII sheeting and remaining 5 years of the Warranty period for Type IX sheeting.

All coefficient of retroreflection measurements will be made after signs are cleaned according to the Manufacturer’s recommendation.
The Warranty shall recite that, upon written notification by the City that the supplied sheeting or supplied sheeting with applied cuttable film, used according to the Manufacturer’s recommendations, has failed, the Manufacturer shall 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, the Manufacturer shall restore the sign panel to a condition that meets the remaining warranty conditions at no cost to the City (100% full replacement covering all material and labor costs).
- For the remaining 3 years, (5 years for Type IX sheeting) the Manufacturer shall furnish replacement sheeting required to restore the sign panel to a condition that meets the remaining warranty conditions at no cost to the City (100% sheeting replacement).

When the City makes written notification to the Manufacturer of sheeting failure, the Warranty period will stop for the effected signs until required repairs or replacements are made and accepted.

All repaired or replaced signs and sheeting shall meet current sheeting specifications and be warranted for the remaining Warranty period.

The City will date all approved signs at the time of inspection at the City’s material laboratory. That date is the start of the Warranty period.

Applicable warranties for sign sheeting shall be turned over to the City. The City shall be named obligee on all manufacturer’s warranties. The warranty document shall have an identifying document number assigned to it that is unique to the project that it is submitted for, such that warranty claims can be processed under a specific document number. The warranty document shall be dated to reflect the date that the document is submitted to the City for approval.
Section 02920 - Common Electrical Materials

Description

02920.00 Scope - This Section includes the requirements for common electrical systems.

Materials

02920.02 Powder Coating - Powder coat materials according to Section 00594:

(a) Galvanized Steel - After galvanizing light brush blast according to SSPC-SP-7 that removes surface contaminants and provides a profile but does not destroy the integrity of the galvanizing. Hand sand and debur as needed to remove rough areas. Preheat galvanized steel before powder coating to eliminate off gassing during curing. Electrostatically apply and oven cure a TGIC Polyester powder according to manufacture specifications to achieve a 50 micron minimum dry film thickness. The time from brush blasting to curing shall take no longer than 8 hours to reduce surface oxidation. Coated galvanized steel shall have a salt spray resistance of 1,000 hours using ASTM B117 without loss of adhesion. Retap threads as required.

(b) Aluminum - Solvent clean according to SSPC-SP-1 followed by a light brush blast according to SSPC-SP-7. Preheat aluminum before powder coating to eliminate off gassing during curing. Electrostatically apply and oven cure a TGIC Polyester powder according to manufacture specifications to achieve a 50 micron minimum dry film thickness. The time from solvent cleaning to curing shall take no longer than 8 hours to reduce surface contamination. Coated aluminum shall have a salt spray resistance of 1,000 hours using ASTM B117 without loss of adhesion. Retap threads as required.

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 conforming to the following:
• **Rigid Nonmetallic Conduit** - Heavy wall, extruded, rigid polyvinyl chloride (PVC) conforming to UL 651, Schedule 80 Rigid PVC Conduit as shown.

• **Liquid-Tight Flexible Nonmetallic Conduit** - Liquid-tight, flexible nonmetallic conduit shall meet the requirements of Article 351 of the NEC and shall be UL 1660 listed.

• **High Density Polyethylene Conduit (HDPE)** - HDPE conduit shall be Schedule 80 conforming to UL651B. The conduit shall lay flat when unwound and not assume an exaggerated spiral configuration.

02920.12 **Conduit Fittings:**

• **Expansion Fittings** - Expansion fittings shall be weatherproof, malleable iron expansion head and body with a hot-dip galvanized finish. Where the plans do not specify an equipment ground wire in the conduit run, furnish fittings with external bonding jumpers.

• **Expansion-Deflection Fittings** - For rigid metallic conduit furnish water-tight expansion-deflection fittings according to NEMA 4, with an integral bonding jumper.

• **Condulets** - Condulets shall be malleable iron conduit body hot dip galvanized with cover and moisture-proof gasket.

• **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 2176.

02920.13 **Underground Marking Tape** - Provide underground marking tape that is red polyethylene film, 6 inches wide, 4 miles thick minimum, and imprinted with the following or similar legend:

```
*CAUTION CAUTION CAUTION BURIED ELECTRIC LINE
```

02920.14 **Junction Boxes:**

(a) **General** - Junction box covers in vehicle traffic areas shall be rated for AASHTO H-20 highway loading. Surface-mounted boxes shall have overlapping covers.

Junction box covers shall have the appropriate legend either "SIGNALS" or "STREET LIGHTING" stamped or embossed on the cover as appropriate. Letter size shall be no smaller than 1/16 of the box width.

Cover shall be recessed non-slip material with a static coefficient of friction of between 0.8 and 1.0 as determined by ASTM Designation C 1028-89 and verified by an independent testing laboratory.

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(b) **Metal Junction Boxes** - Construct metallic junction boxes of cast iron or 1/8 inch nominal welded sheet steel. Make covers from reinforced non-slip steel plate. Use commercial quality steel. Hot-dip galvanize metallic boxes and covers after fabrication according to ASTM A 153/A 153M. 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 shall be precast concrete, water meter type. Covers shall be capable of withstanding a load of 15,000 pounds over a 10 inch by 10 inch square surface. Covers shall have a skid-resistant surface with a static coefficient of friction of at least 0.8 as determined by ASTM Designation C 1028-89 verified by an independent testing laboratory, and bolt to the junction box with recessed stainless steel hex-head bolts. All covers for concrete junction boxes shall be recessed.

- Steel lids shall be galvanized and bonded.

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.

02920.20 **Cable and Wire** - Unless otherwise noted, all electrical conductors shall be approved stranded copper conforming to ASTM B 3 and ASTM B 8, Class B or C. Insulation shall be 600 V plasticized polyvinyl chloride, polyethylene, or chemically cross-linked polyethylene, conforming to ASTM D 2220, ASTM D 1351, ASTM D 2655, and ASTM D 2656. Do not use polyethylene compounds where exposed to sunlight. Tape the ends of unused and spare conductors with insulating vinyl plastic tape.

02920.21 **Color Coding:**

(a) **General** - 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** - 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 requirement:

- **Messenger Cable** - ASTM A 475 utility grade, Class A coating.
- **Tether and Stabilizer Cable** - Galvanized steel seven-strand conforming to ASTM A 475 with Class A coating.
- **Loop Feeder Cable** - Two-conductor No. 14 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. 19 AWG stranded or solid individual conductors. The cable shall contain the number of wire pairs shown.
- **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 minimum tensile strength of 45 pounds.
- **TC Cable** - XHHW conductors with PVC jacket.
- **Polyethylene Pull Line** - An electrical polyethylene pull rope with 1,200 pound minimum break strength.

**02920.23 Wire**:

- **THHN/THWN Wire** - Insulated stranded copper wire rated for 167 °F operation in wet or dry locations and be UL listed as THWN.
- **XHHW Wire** - Insulated stranded copper wire rated for 194 °F dry and 167 °F wet locations and be UL labeled as XHHW.
- **Ground and Bond Wire** - All ground or bond wire shall be stranded copper wire conforming to the NEC. Ground wire circuits shall be THWN green in color when installed in conduit. Minimum size shall be No. 6 AWG or as shown.
- **Loop Wire** – Insulated stranded copper No. 14 AWG Type XHHW conductor inside a polyethylene tube conforming to ISMA Specification N. 51-7.
- **Overhead Service Wire** - Wire used for overhead service installation shall be XHHW-Type 2.

**02920.24 Eyebolts** - 3/4 inch diameter eyebolts meeting the requirements of ASTM A 307.
02920.25 Electrical Splice Materials - Furnish electrical splice material meeting the following requirements:

- **Split Bolt** - Made of silicon bronze to securely join the wires both mechanically and electrically.

- **Heat-Shrink Tubing** - Surface-irradiated tube listed UL 486, 194 °F, with 600 V inner melting wall or liner to provide a void-free encapsulated insulation.

- **Insulating Rubber Tape** - Electrical grade, nondrying, rubber based, elastic-type conforming to ASTM D 4388.

- **Vinyl Plastic Tape** Comply with ASTM D 3005, Type II and UL 510.

02920.26 In-Line Fuseholder - The in-line fuse holder rated for 30 A at 600 V shall be designed to hold a 5 amp KTK fuse.

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 of the 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 set screw type rated for copper wire. Each in-line fuse connector shall be supplied with a 5 amp KTK fuse.

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 inches 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 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 Bases:

(a) General - Bolts, nuts and washers shall conform to 02560.20 and shall be galvanized according to 02560.40.

(b) Vehicle Signal Pedestals - Frangible transformer for vehicle signal pedestals shall be used only when shown or specified. 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, and made of cast aluminum.

(c) Pedestrian Signal Pedestals - Pedestrian signal pedestal bases shall be a frangible base 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 Bolts - Anchor bolts shall conform to 02560.30 and to the types and sizes shown.

Cabinets and Control Devices

02925.40 Cabinets - 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, rated NEMA Type 3R, and constructed as shown. Pole-mounted controller cabinets shall be provided with solid bottoms or covers for openings provided for foundation mounting and only the appropriate openings for a conduit connection. 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 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. Conduit entrances into poles from cabinets may be from the bottom of the cabinet through an LB conduit and conduit nipple.

The service cabinet shall be raintight and fabricated from 14 gauge stainless steel with all joints spot welded. A 1 inch stainless steel hub shall be welded to the top of the cabinet and centered near the back. A 1/4 inch stainless steel padlock hasp shall be spot welded to the bottom of the cabinet in such a manner that the hasp will protrude through the front cover when the cover is closed.

Where the plans call for the service cabinet to be mounted on a steel pole, the cabinet shall have a 1 1/4 inch hole drilled in the center of the back near the bottom of the cabinet. A 1/8 inch stainless steel bracket shall be welded to the back near the top of the cabinet for use in banding the cabinet to the pole.

The cabinet shall be 10 inches x 7 inches x 4 inches and shall contain one 40 amp. and one 15 amp. SPST circuit breaker. Space shall be provided for one additional breaker. A blank cover shall be secured to the faceplate to cover the opening for the additional breaker.

Provide each cabinet with a latching device for a standard City padlock.

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 - Traffic signal control equipment shall meet the specifications of the 2001 Oregon Department of Transportation Standard Specifications for Microcomputer Signal Controller modified and supplemental as follows:
CHAPTER 1
GENERAL SPECIFICATIONS FOR TRAFFIC SIGNAL CONTROL EQUIPMENT

Replace Section 7, Unit 5 (1.7.5):

1.7.5.1 After successful testing of controller equipment, the Contractor shall pick up and install all tested equipment, except that the City of Portland shall have the option of providing all or selected cabinet control equipment as indicated on the plans. Successful completion of the ODOT test does not relieve the Contractor of equipment warranty obligations.

1.7.5.2 On project where the City of Portland provided controller equipment, the Contractor will pick up the equipment from the City and install the equipment on site.

CHAPTER 2
SPECIFICATIONS FOR MODEL 170E/HC-11 CONTROLLER UNIT

Replace 2.1.10, with the following:

2.1.10 The City licensed traffic signal control program for the Model 170E/HC-11 Controller will be furnished by the City.

CHAPTER 5
SPECIFICATION FOR DETECTOR SENSOR UNITS, ELEMENTS, ISOLATORS, AND DISCRIMINATORS

Replace the entire SECTION 2 - MODEL 222 AND 222T LOOP DETECTOR UNIT REQUIREMENTS with the following:

5.2.1 The loop amplifier shall have an LCD display at least 19.39 mm X 36.49 mm.

5.2.2 The LCD display shall provide for the following displays:

1. Sensitivity Level
2. Actual loop frequency
3. Delay time in seconds
4. Extension time in seconds
5. Display change in inductance during the "Call" state
6. Display of the loop inductance during the "No-Call" state

5.2.3 The detector shall automatically tune and be operational within 2 seconds after application of power or being reset.

5.2.4 Detectors shall reach full sensitivity and hold within 30 seconds after application power or reset signal.
5.2.5 The detector shall be fully self-compensating for environmental changes and loop drift over the full temperature range and the entire loop inductance range.

5.2.6 The detector shall continue to operate with a point short to ground on the loop or loop lead-in. The detector shall tolerate, without damage, a 10 microfarad capacitor charged to 2000 volt being discharged between either loop terminal and earth ground. Should the total inductance of the loop input network go out of range specified for each detector channel, or rapidly changes by more than ± 25%, the detector shall immediately enter the fail-safe mode and display Loop Fail on the front panel. The type of loop failure shall be displayed indicating open loop or shorted loop conditions. The condition shall continue as long as the fault exists. The fail-safe mode shall generate a continuous call in Presence Mode and no calls in Pulse Mode. When the loop is functional, the loop fail message on the front panel shall extinguish and the channel will resume normal operation. Each loop failure shall be accumulated and logged in to Loop Fail Memory.

5.2.7 The response time of the detector shall conform to table shown on typical response times.

| 5.2.7.1 Scanning: |
| 5.2.7.1.1 The loops connected each detector channel shall activate alternately to minimize cross talk between adjacent loops. |
| 5.2.7.2 Non-Scanning: |
| 5.2.7.2.1 The loops connected to each detector channel shall continuously be activated. |

<table>
<thead>
<tr>
<th>SENSITIVITY</th>
<th>RESPONSE (MILLISECONDS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>8</td>
<td>130</td>
</tr>
<tr>
<td>9</td>
<td>260</td>
</tr>
</tbody>
</table>
5.2.7.2.2 Typical non-scanning response times shall not exceed the following:

<table>
<thead>
<tr>
<th>SENSITIVITY</th>
<th>RESPONSE (MILLISECONDS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
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<tr>
<td>2</td>
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<tr>
<td>8</td>
<td>65</td>
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<tr>
<td>9</td>
<td>130</td>
</tr>
</tbody>
</table>

5.2.8 All detector settings shall be operator settable from the front panel.

5.2.8.1 The detector shall provide 8 selectable loop frequency settings per channel in the range of 20 to 100 Kilohertz. These settings shall be programmable from the front panel. LCD shall display the loop frequency for each channel on the front panel.

5.2.8.2 The detector shall provide 9 sensitivity levels for each channel, plus Continuous Call and Channel-Off.

5.2.8.2.1 The sensitivity levels shall correspond to the following ranges of changes in inductance:

<table>
<thead>
<tr>
<th>SENSITIVITY AND DELTA L/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>SENSITIVITY</td>
</tr>
<tr>
<td>--------------</td>
</tr>
<tr>
<td>Off</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
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<td>7</td>
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<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>Call</td>
</tr>
</tbody>
</table>
5.2.8.2.1.1 When the detector is set to the Continuous Call state, the channel output will be continuously in the call state regardless of the presence or absence of vehicles over the loop. The option shall be selectable from the sensitivity menu.

5.2.8.2.1.2 When the detector is set to the Channel Off state, the channel output is continuously in the No-Call state regardless of the presence or absence of vehicles over the loop.

5.2.8.3 The detector delay timer will be adjustable from 0 to 255 seconds in 1-second increments (per channel). The Call Delay timer shall be displayed on the front panel and will start counting down when a vehicle enters the loop detection zone. The detector extension timer shall be adjustable from 0 to 25.5 seconds in 0.1 increments (per channel). Extension timer shall be displayed on the front panel and will start counting down when the last vehicle leaves the loop detection zone. Any vehicle entering the loop detection zone during the extension time period shall cause the channel to return to the detect state, and later, when the last vehicle leaves the loop detection zone, the full extension time starts count down again.

5.2.8.4 The detector shall display the total loop inductance on the front panel LCD for each channel (actual Loop Inductance plus actual lead in inductance) in microhenries with an accuracy of ± 15% for loop inductance with values less than 700 microhenries.

5.2.8.5 The detector shall display the loop's delta L/L value on the front panel LCD as a percentage change for each channel (where L is the actual loop inductance plus actual loop lead-in inductance) during the Call State.

5.2.9 The detector shall have two exclusive modes of operation for each channel.

5.2.9.1 Pulse Mode:

5.2.9.1.1 The detector shall have a pulse of 125 ± 10 milliseconds duration generated for each vehicle entering the loop detection zone. Each detected vehicle is automatically tuned out if it remains in the loop detection zone more than 2 seconds. After each vehicle leaves the loop detection zone, the channel shall be capable of detecting another vehicle entering the zone of detection.

5.2.9.2 Presence Mode:

5.2.9.2.1 The detector shall have a call hold time of 4 minutes minimum regardless of vehicle size and typically 1 to 3 hours for an automobile or truck. The detector amplifier shall be capable of operating in either a scanning and non-scanning mode.
5.2.10 The detector shall provide an option for “tuning out” adjacent lane pick or loop drift. The detector shall provide an option of logic generated outputs for queued vehicles and direction detection. The detector shall provide an option for directional detection.

5.2.11 The amplifier units shall pass operational performance testing by the City of Portland.

5.2.11.1 The following amplifier units have been approved by the City:
1. Reno Model C

Add the following Section 5 to Chapter 5:

SECTION 5 - OPTICOM DISCRIMINATOR UNIT REQUIREMENTS

5.5.1 The Model 752 and 754 discriminators and all cable and installation hardware as required shall be “Opticom” brand, manufactured by the 3M Company.

CHAPTER 6
SPECIFICATIONS FOR CABINET MODEL 332, 334 AND 340

Modify SECTION 1 - GENERAL REQUIREMENTS AND CABINET MODEL COMPOSITION as follows:

6.1.1 Add a 203mm bolted riser frame and a rack mounted communications terminal block.

Modify or replace portions of SECTION 2 - HOUSING REQUIREMENTS as follows:

6.2.1 Delete the Police Panel and add a 203mm bolted riser frame and communications terminal rack.

6.2.3.3 When the door is closed and latched, the door shall not be locked. The door locks shall be padlocks on the latching handle. The handles shall be on the right side of the front door and the left side of the rear door. Door lock holes, if present, shall be securely sealed with watertight stainless steel plugs (Hoffman A-S 100SS or an approved equal).

6.2.3.4 The padlocks shall be Best Company Padlocks 21B722-L-606 Series (or an approved equal) with green construction cores. Two keys shall be supplied with each cabinet. The keys shall be removable in the locked position only.

6.2.6 Police Panel (Delete the entire section. If a police panel is present the door shall be bolted securely shut with stainless steel hardware and all police panel switches shall be disconnected.)

Add the following:

City of Portland 2010 1236
6.2.8  Riser Frame

6.2.8.1 An 8” high aluminum bolted riser frame as shown on ODOT Standard Drawing Number TM423 shall be provided with each cabinet.

Modify portions of SECTION 4 - CABINET ASSEMBLY REQUIREMENTS as follows:

6.4.1  General Requirements

5.4.1.4.1.7 Add the following sentence: The guides shall be plastic.

Modify, add or replace portions of SECTION 5 - CABINET WIRING REQUIREMENTS as follows:

6.5.6  Detector Test Buttons (Delete the entire section. The City of Portland does not require detector test buttons.)

Add the following to SECTION 5 – CABINET WIRING REQUIREMENTS:

6.5.1.4 An electronic version of the cabinet wiring diagram in “.dgn” format shall be provided with the controller.

6.5.2.8.1 Two 10 position or one 20 position AC- terminal bus shall be installed in the cabinet.

6.5.7  Rack Mounted Communication Panel

6.5.7.1 Furnish and install quick telephone - Type 66 termination blocks of the type manufactured by Siemon or Reliance or an approved equivalent, for terminating #22 AWG communications cable and an eight position isolated open faced barrier strip. The termination block shall be six rows across by twenty five rows long and shall not require standoff brackets to be mounted. The barrier strip shall be an 8 position terminal block with 8/32 by 1.11mm (7/16”) nickel plated brass binder head screws and nickel plated brass inserts. The blocks shall be mounted on a 140 mm wide aluminum recessed communications terminal panel attached between the uprights of the cabinet cage supports in the top section of the rear of the cabinet.

CHAPTER 7
SPECIFICATIONS FOR CABINET MODEL 336, 336S AND 344

Modify SECTION 1 - GENERAL REQUIREMENTS AND CABINET MODEL COMPOSITION as follows:

7.1.1 Add a rack mounted communications terminal block.

Modify or replace portions of SECTION 2 – HOUSING REQUIREMENTS as follows:

1237 City of Portland 2010
7.2.1 Delete the Police Panel and add a communications terminal rack.

7.2.3.3 When the door is closed and latched, the door shall not be locked. The door locks shall be padlocks on the latching handle. The handles shall be on the right side of the front door and the left side of the rear door. Door lock holes, if present, shall be securely sealed with watertight stainless steel plugs (Hoffman A-S 100SS or an approved equal).

7.2.3.4 The padlocks shall be Best Company Padlocks 21B722-L-606 Series (or an approved equal) with green construction cores. Two keys shall be supplied with each cabinet. The keys shall be removable in the locked position only.

7.2.6 Police Panel (Delete the entire section. If a police panel is present the door shall be bolted securely shut with stainless steel hardware and all police panel switches shall be disconnected.)

Add portions of SECTION 4 - CABINET ASSEMBLY REQUIREMENTS as follows:

7.4.1.4.1.7 Add the following sentence: The guides shall be plastic.

Add the following to SECTION 5 - CABINET WIRING REQUIREMENTS:

7.5.1.4 An electronic version of the cabinet wiring diagram in "dgn" format shall be provided with the controller.

7.5.6 Detector Test Buttons (Delete the entire section. The City of Portland does not require detector test buttons.)

7.5.7 Rack Mounted Communication Panel

7.5.7.1 Furnish and install quick telephone - Type 66 termination blocks of the type manufactured by Siemon or Reliance or an approved equivalent, for terminating #22 AWG communications cable and an eight position isolated open faced barrier strip. The termination block shall be six rows across by twenty-five rows long and shall not require standoff brackets to be mounted. The barrier strip shall be an 8 position terminal block with 8/32 by 1.11mm (7/16") nickel-plated brass binder head screws and nickel-plated brass inserts. The blocks shall be mounted on a 140mm wide aluminum recessed communications terminal panel attached between the uprights of the cabinet cage supports in the top section of the rear of the cabinet.
Use the following Chapter 9 for City of Portland projects:

CHAPTER 9
SPECIFICATIONS FOR MODEL 2070L CONTROLLER

SECTION 1 - GENERAL REQUIREMENTS

The Model 2070L shall be furnished, ready for operation, with the following composition:

A Model 2070L complete controller shall consist of:

2070-Chassis including: Lite Cage, 1B CPU Module, 2A C1 Field I/O Module with C-1 and C-11 Connector,
3B Front Panel with 8X40 LCD Display,
4B Power Supply Module, 6B 9600 Baud Modem Card and 2 MB Data Key

The controller shall include an OS-9 version 3.3 or later operating system (Ethernet Capable). The controller shall include a Boot Code compatible with NW Signal Voyage Software.

The assemblies listed above shall be compliant with the State of California Department of Transportation (Caltrans) “Transportation Electrical Equipment Specifications” dated August 16, 2002 along with "Errata 1" published August 16, 2002 and "Errata 2" published June 8, 2004.

The following 2070L controllers have been approved by the City of Portland:

1. Econolite Control Products, Inc. (Boot Code 2002 V1.01.08.02b or more recent approved version)
2. Siemens/Eagle - (Boot Code OSO V3.3.0 Operating System 7.0.0.0.0.15 or more recent approved version)

The current approved version of NWS Voyage Software shall be installed prior to delivery to the Traffic Systems Service Unit of the Oregon Department of Transportation. The installation process shall include the following steps:

1. Load Voyage firmware
2. Load default database
3. Verify I/O functionality
4. Verify Communications Port functionality
5. Run for 24 hours without failure
CHAPTER 12
SPECIFICATIONS FOR CABINET MODEL 337

SECTION 1 - GENERAL REQUIREMENTS AND CABINET MODEL COMPOSITION

12.1.1 Unless otherwise specified, the model shall be furnished, ready for operation, with the following composition:

12.1.1.1 A Model 337 Intersection Cabinet shall consist of:

<table>
<thead>
<tr>
<th>Housing (337)</th>
<th>C1 Harness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Distribution Assembly</td>
<td>C2 Harness</td>
</tr>
<tr>
<td>Input File</td>
<td>Service Panel</td>
</tr>
<tr>
<td>Output File</td>
<td>Communications Terminal Rack</td>
</tr>
<tr>
<td>DIN Rail Mounted Auxiliary Relay Socket</td>
<td></td>
</tr>
</tbody>
</table>

12.1.1.2 The controller unit with Model 400 Modem shall be furnished with the Model 337 cabinet. The cabinet shall have all input and output files installed and wired complete for 4-phase operation. However, only those input and output devices, such as detector sensor units, isolator units, and switch packs necessary to provide the operation required by the plans or specifications shall be furnished.

12.1.1.3 A heavy-duty side-opening clear plastic pouch shall be furnished. The pouch shall be mounted on the front door of the cabinet and provide easy access and storage of the wiring diagrams.

12.1.1.4 Cabinet model interface wiring shall be per specified C1 Harness, detailed wiring lists, and required cabinet wiring diagram.

12.1.2 Cabinet Shipping Requirements

12.1.2.1 The cabinet shall be delivered mounted on a plywood shipping pallet. The pallet shall be bolted to the cabinet base. The cabinet housing doors shall be blocked to prevent movement during transportation.

12.1.3 Cabinet Finish

12.1.3.1 Inside and outside of walls, doors, and ceiling of the cabinet shall be anodized after fabrication.

12.1.3.2 All nuts, bolts, washers, screws [4 mm (or larger)], hinges, and hinge pins shall be stainless steel unless otherwise specified.
12.1.3.3 A clear area for the controller unit shall be provided in Model 337 cabinets. The area shall extend 38 mm in front of and 406 mm behind the front EIA mounting angles. A minimum of 184 mm above the supporting portion of the angle shall be kept clear for the controller.

12.1.3.3 All conductors, terminals, and parts that could be hazardous to maintenance personnel shall be protected with suitable insulating material.

SECTION 2 - HOUSING REQUIREMENTS

12.2.1 The housing shall include, but not be limited to the following:

| Enclosure | Communications Terminal Rack |
| Doors | Ventilation |
| Latches/Locks | Gaskets |
| Hinges and Door Catches | Light Fixture |

12.2.2 Housing Construction

12.2.2.1 The housing shall be rainproof with the top of the enclosure crowned to prevent standing water. It shall have single front and rear doors.

12.2.2.2 The enclosure including doors, lifting eyes, gasket channels, police panel (where furnished) and all supports welded to the enclosure and doors shall be fabricated of 3.2 mm minimum thickness, aluminum sheet alloy 5052-H32 or 6061-T6. Bolted-on supports shall either be the same material and thickness as the enclosure.

12.2.2.3 All exterior seams for enclosure and doors shall be continuously welded and shall be smooth. All edges shall be filed to a radius of 0.8 mm, minimum. ER5356 aluminum alloy bare welding electrodes conforming to AWS A5.10 requirements shall be used for welding on aluminum. Procedures, welders, and welding operators shall conform to the requirements and practices on AWS B3.0 and C5.6 for aluminum.

12.2.2.4 Aluminum surfaces shall conform to the following:

12.2.2.4.1 An anodic coating shall be applied to the aluminum surface after the surface has been cleaned and etched. The cleaning procedure shall be to immerse in inhibited alkaline cleaner [Oakite 61A, Diversey 909 (or equivalent) in mix of 45 to 60 g per liter of distilled water] at 71°C for 5 minutes. Rinse in cold water. The etching procedure shall be to immerse in a sodium solution [3.7 g sodium fluoride plus 37.5 g sodium hydroxide mix per liter of distilled water] at 66°C for 5 minutes. Rinse in cold water. Desmut in a 50% by volume nitric acid solution at 20°C for 2 minutes. Rinse in cold water.
12.2.2.4.2 The anodic coating shall conform to MIL-A-8625C (Anodic Coatings for Aluminum and Aluminum Alloys) for Type II, Class I Coating except the outer housing surface coating shall have a 0.018 mm minimum thickness and a 20 mg per 500 mm² minimum coating weight. The anodic coating shall be sealed in a 5% aqueous solution (pH 5.0 to 6.5) of nickel acetate at 99°C for 15 minutes.

12.2.2.5 The enclosure doorframes shall be double flanged out on all four sides and shall have strikers to hold tension on and form a firm seal between the door gasket and the frame. The dimension between the door edge and the enclosure external surface when the door is closed and locked shall be 4 (±2) mm.

12.2.2.6 Gaskets shall be provided on all door openings and shall be dust-tight. Gaskets shall be 6 mm minimum thickness, closed cell neoprene or silicone [BOYD R-10480 (or equal)] and shall be permanently bonded to the metal. If neoprene is used, the mating surface of the gaskets shall be covered with a silicone lubricant to prevent sticking to the mating metal surface. A gasket top channel shall be provided to support the top gasket on the door (prevents gasket gravitational fatigue).

12.2.2.7 The cabinet base layout shall accommodate a standard 101.6mm pedestal slipfitter. The cabinet shall provide sufficient resistance to flexing and eventual metal fatigue at the mounting point. The cabinet shall be supplied with a bolt on adapter for the bottom of the cabinet. The adapter shall provide for the adaption of the 101.6mm pedestal slipfitter to a 63.5mm conduit mount for pole mounting.

12.2.2.8 The cabinet shall be designed to allow for pole mounting. The cabinet shall provide sufficient resistance to flexing and shall withstand pole mounting without warping the cabinet. The cabinet shall be supplied with all required mounting accessories for mounting the cabinet to standard signal poles and pedestals.

12.2.2.9 All exterior bolt heads shall be tamperproof type.

12.2.2.10 Rails shall be provided both front and rear, as an integral part of the cabinet. The rails shall extend the full height of the cabinet and shall conform to the dimensional requirements of Standard EIA RS-310-C. Equipment mounting holes shall be provided with 10-32 threads and shall be located to secure equipment provided.
12.2.3 Door Latches and Locks

12.2.3.1 The latching handles shall have provision for padlocking in the closed position. Each handle shall be 20mm minimum diameter stainless steel rod. The padlocking attachment shall be placed at 100 mm from the handle shank center. An additional 100mm minimum gripping length shall be provided.

12.2.3.2 The latching mechanism shall be a 3-point draw roller type. The pushrods shall be 9.5mm minimum diameter stainless steel rods.

12.2.3.3 When the door is closed and latched, the door shall not be locked. The door locks shall be padlocks on the latching handle. The padlocks shall be Best Company Padlocks 21B722-L-606 Series (or an approved equal) with green construction cores. Two keys shall be supplied with each cabinet. The keys shall be removable in the locked position only. The handles shall be on the right side of the front door and the left side of the rear door. Door lock holes, if present, shall be securely sealed with watertight stainless steel plugs (Hoffman A-S 100SS or an approved equal).

12.2.3.4 The center latch cam shall be fabricated of 4.8mm minimum thickness stainless steel.

12.2.4 The general requirements for housing ventilation including intake, exhaust, filtration, fan assembly, and environmental control, as follows:

12.2.4.1 The front door shall be provided with louvered vents. The louvered vent depth shall be a maximum of 6 mm. A removable air filter shall be housed behind the door vents. The filter filtration area shall cover the vent opening area. A filter shell shall be provided that fits over the filter, providing mechanical support for the filter. The shell shall be louvered to direct the incoming air downward. The shell sides and top shall be bent over a minimum of 5 mm to house the filter. The filter and shell shall be held firmly in place with a bottom bracket and a spring-loaded upper clamp. No incoming air shall bypass the filter. The bottom filter bracket shall be formed to create a waterproof sump with drain holes to the outside housing.

12.2.4.1.1 The filter shall be 152 mm high by 406 mm wide by 22 mm thick. The filter shall trap particles 2 microns and larger.

12.2.4.2 The intake (including filter with shell) and exhaust areas shall pass a minimum of 0.74 m³ of air per minute.

12.2.4.3 The housing shall be equipped with an electric fan with ball or roller bearings and a capacity of at least 2.8 m³ of free air delivery per minute. The fan shall be mounted within the housing and vented.
12.2.4.4 The fan shall be thermostatically controlled and shall be manually adjustable to turn on between 33°C and 65°C with a differential of not more than 6°C between automatic turn on and off. The fan circuit shall be protected at 125% of the fan motor ampacity. The manual adjustment shall be graded in 10° increments.

12.2.5 **Hinges and Door Catches**

12.2.5.1 Hinges with 2 bolts per leaf shall be provided to bolt the door to the enclosure. Each door shall have 3 stainless steel hinges. Each hinge shall be 90mm minimum length and have a fixed pin. The pin ends shall be welded to the hinge and ground smooth.

12.2.5.2 Front and rear doors shall be provided with catches to hold the door open at both 90° and 180° (plus or minus 10°). The catches shall be 6mm minimum diameter stainless steel rods. The catches shall be capable of holding the door open at 90° in a 95 km/hr wind, acting at an angle perpendicular to the plane of the door.

12.2.6 **Police Panel**

12.2.6.1 If a police panel is present the door shall be bolted securely shut with stainless steel hardware and all police panel switches shall be disconnected.

12.2.7 **Cabinet Light Fixture**

12.2.7.1 An 8-watt, self-starting fluorescent cabinet light shall be installed in each controller cabinet (see Cabinet Details Drawings). The fixture shall be mounted to the cabinet exhaust area cover plate by screw and self-locking nut. The mounting hardware shall not penetrate the exterior of the cabinet shell. The fixture and fluorescent tube shall not interfere with access to any cabinet component or TBK. The fixture will be controlled from a door-operated switch located at the rear door. The fixture power shall be switched “ON” when the rear door is opened. In addition to the rear door switch, the fixture circuit shall incorporate an accessible power “ON-OFF” switch. Power for the light fixture shall be supplied from the load side of the 15 amp Equipment breaker of the PDA through an “in-line” type fuse holder (1 amp fuse) through the normally closed cabinet rear door switch to the light fixture (see Equipment Mounting Drawings).
SECTION 3 - CABINET ASSEMBLY REQUIREMENTS

12.3.1 Rack Assembly

12.3.1.1 The rack assembly shall be self-supporting and shall allow a free space beneath the lowest horizontal surface and between the side panels of 432mm wide by 406mm deep by 229mm high with both cabinet doors closed. The assembly shall be equipped with mounting ears to allow mounting of Standard EIA rails. Overall width of the assembly shall conform to Standard EIA RS-310-C. Two supports shall be supplied to support the controller unit. The supports shall be designed to support a minimum of 23 kg each. The horizontal side of each support shall be a minimum of 75 mm.

12.3.1.2 The rack assembly shall provide for a Model 204 Flasher, an input file to support 11 input slots, an auto/flash switch, a flash relay, three flash transfer relays, a power distribution assembly, a model 210 conflict monitor and 6 load switches.

12.3.1.2.1 Socket types for the following equipment shall be:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Socket Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch Pack</td>
<td>BEAU S-5412-XX (or equal)</td>
</tr>
<tr>
<td>Heavy Duty Relay</td>
<td>BEAU S-5408-XX (or equal)</td>
</tr>
<tr>
<td>Flasher Unit</td>
<td>BEAU S-5406-XX (or equal)</td>
</tr>
<tr>
<td>210 Monitor Unit</td>
<td>PCB 28/56S</td>
</tr>
<tr>
<td>Power Distribution Assembly</td>
<td>BEAU S-5413-XX (or equal)</td>
</tr>
<tr>
<td>Auxiliary Relay Socket</td>
<td>PB 27E891</td>
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</table>

12.3.1.2.2 Connector sockets for flasher unit, power supply, and switch pack modules shall be mounted so that the front face of all plug-in assemblies shall be flush with the front face of the rack assembly. The sole exception shall be the flash relay, which may be mounted with its socket on the same plane as the flash transfer relay sockets.

12.3.1.2.3 The Auxiliary Relay Socket shall be mounted on a 102mm section of DIN Rail Track attached on the left lower portion of the rack assembly as viewed from the back door.

12.3.1.3 The front face of the rack assembly may be inset from the EIA rails a maximum of 13mm.

12.3.1.4 The rack assembly depth shall not exceed 330mm from the front surface of the front EIA rails. Assembly or file depth dimension shall include TBKs.

12.3.1.5 Guides (top and bottom) shall be provided for switch pack modules, flasher units, monitor unit, detector and isolator modules. The guides shall begin 25 (plus or minus 13) mm in from the front panel surface and extend to within 13 mm of the connector socket face.
All fuses, circuit breakers, switches (except police panel switches, fan fuse and cabinet light fuse) and indicators shall be readily visible and accessible when the cabinet front door is open.

All equipment in the cabinet, when required shall be permanently and clearly labeled. The marker strips shall be made of material that can be easily and legibly written upon using a pencil or ballpoint pen. Marker strips shall be located immediately below the item they are to identify and must be clearly visible with all items installed.

Assemblies and files shall be fabricated of 1.5 mm minimum thickness aluminum or stainless steel sheet. The metal surface shall be treated with clear chromate.

Resistor-capacitor transient suppression shall be provided at all AC relay sockets (across relay coil) except for the flash transfer relays (FTR) in the output files, where one suppression device may be common for all.

A leakage resistor which permits a small amount of current to pass through the heavy duty relay coil, shall be installed across the terminals of relay sockets to overcome the residual magnetism.

All assemblies and files shall allow air circulation through the top and bottom unless specifically called out otherwise.

Input File (Model 337Cabinets)

The file shall have a maximum depth of 215 mm and shall intermate with and support 11, 2-channel detector or isolator units supported top and bottom with plastic guide rails.

The file shall provide a PCB 22/44S connector which shall be a DALE EB7CS22GY (or equal) and shall be centered vertically for each 2-channel detector. The associated number and letter side connectors shall be shorted internally. Pins D, E, F, J, K, L, and W shall be brought out to an 8-position TBK on the back of the file. The output emitters shall be common grounded with the ground terminating at TB 15, position 4. Position 8 of the TBK is assigned to EG and is used to terminate lead-in shields.

The input file shall be provided with marker strips to identify isolators and detectors in the file.
12.3.2.4 TBK terminal screw size shall be 8-32.

12.3.2.4 TB2, TB3, TB4 and TB5 shall be provided and mounted vertically and parallel to the cabinet sides. In viewing from the back door, TB2 and TB3 shall be mounted on the right side of the cabinet and connected to input file slots 1-3 and 4-5. In viewing from the back door, TB4 and TB5 shall be mounted on the left side of the cabinet and connected to input file slots 6-8 and 9-11.

12.3.2.5 Each detector lead-in pair from the field terminals to the input file terminals, shall be a cable of IMSA Type 50-2 (or better). The stranded, tinned, copper drain wire shall be connected to the “L” terminal on the input file TBKs. This input terminal shall be connected to the equipment grounding bus through a single conductor. Each connection shall be made by using a crimp connector that is soldered after the connector is crimped to the wire. These cables shall be heat shrunk protected - both the drain wire and the foil shield, to prevent shorting against the contacts on the back of the input file.

12.3.3 **Output File** (Model 337 Cabinets)

12.3.3.1 The Output File shall be capable of containing six Model 200 switch packs, three Model 430 Flash Transfer Relays, one Model 210 Monitor Unit and one Flash Relay. The construction plans shall determine the number of flash transfer relays and switch packs that will be furnished with the output file.

12.3.3.2 The output file shall be provided with marker strips to identify switch packs when mounted in the file.

12.3.3.3 The depth of the file shall not exceed 368 mm.

12.3.3.4 Switch pack connectors, monitor unit connectors, flash transfer relay sockets, and flash programming connectors shall be accessible from the back of the output file without the use of tools or removal of any other equipment.

12.3.3.5 TBK 01 terminal screw size shall be 8-32.

12.3.3.6 TBK 02 terminal screw size shall be 6-32.

12.3.3.7 Field wire TBKs shall be mounted vertically on the back of the assembly. The output file shall have 3 TBKs with 6 positions clearly labeled by both position number and function. Terminal position screw size shall be 10-32.
12.3.3.8 The flash programming connectors shall be Molex Type 1375 (or equal). The receptacle shall be mounted on the file with a programmable plug connected. The plug connector, with programming jumpers, shall be furnished for each circuit to allow red, yellow or pedestrian flash programming. Requirements are: 4 red, 3 yellow and 3 pedestrian plug connectors. Connectors shall be readily accessible without the removal of any other equipment. Plug pins shall be crimped and soldered.

12.3.3.7 Output file connectors and sockets shall be hand wired; printed circuit boards will not be acceptable for current carrying circuits.

12.3.3.8 The monitor unit connector shall be a rigidly supported printed circuit board edge connector, having 2 rows of 28/56 independent double readout bifurcated contacts on 0.156 inch centers. The CMU connector shall be mounted on a printed circuit board that provides the capability of changing the channel assignments by wire jumper. Jumper wires shall be installed to enable the pedestrian switch pack centers to be used as shown on the plans. The connector shall intermate with the monitor unit.

12.3.3.9 It shall be possible to remove the Model 210 monitor unit without causing the intersection to go into flashing operation. The cabinet shall be wired so that, with the front cabinet door closed and with the monitor unit removed, the intersection shall go into flashing operation.

12.3.3.10 The output file shall have plastic guide rails

12.3.4 **Power Distribution Assembly**

12.3.4.1 The power distribution assembly shall be completely removable from the cabinet without removing any other equipment and using only a slotted or Phillips screwdriver. The PDA shall be electrically and mechanically interchangeable with any 337 cabinet assembly unit.

12.3.4.2 The following equipment shall be provided with the power distribution assembly:

- 1 - 1 Pole, 30 amp, 120 VAC Main Circuit Breaker
- 1 - 1 Pole, 15 amp, 120 VAC Equipment Circuit Breaker
- 1 - 1 Pole, 30 amp, 120 VAC Signal Bus and Breaker
- 1 - 2 Pole Ganged, 20 amp, 120 VAC Flash Bus Circuit Breaker
- 1 - 24 VDC Power Supply
- 1 - Power Relay and Socket
- 1 - AUTO/FLASH Control Switch
- 1 - Signals/Off Switch
- 1 - FLASH On Indicator Light
1 - 13 Position Connector to intermate with rack assembly
2 - Test Points
2 - Power Supply Fuses (AC and DC)

12.3.4.3 Breaker ratings shall be shown on face of breaker or handle. Breaker function shall be labeled below breaker on front panel.

12.3.4.4 The AUTO/FLASH switch, when placed in FLASH position (down), shall energize the power relay coil and apply a stop time to the controller. When the switch is placed in the AUTO position (up), the switch packs shall control the signal indications. The switch shall be a double-pole single-throw toggle control switch rated for 15 amperes at 120 volts AC.

12.3.4.5 The Power Indicator, labeled "24 VDC PWR", shall be a 24 VDC lamp, Dialight 507 Series LED Cartridge Type 507-4761-3331-500 with Dialight Datalamp Cartridge Holder Type 508-8738-504 or equivalent. The lamp shall be tied across the Power supply output on the fused side.

12.3.4.6 The FLASH indicator light labeled "FLASH ON" shall be mounted on the PDA front panel. The Flash Indicator shall be a 120 VAC lamp, Dialight 507 Series Neon Cartridge Type 507-4537-0937-640 with Dialight Datalamp Holder Type 508-8745-504 or equivalent. The lamp shall be tied across the Power Relay coil.

12.3.4.7 The SIGNALS/OFF switch, when placed in the off position (down), shall energize the power relay coil and interrupt power to the flasher. The switch shall be a 3 pole double throw switch rated for 15 amperes at 120 volts AC. Two of the three poles shall be tied in parallel to provide sufficient switching capacity for flasher power.

12.3.4.8 All conductors from the power distribution assembly routed to the cabinet wiring shall be connected to the TBK on the common side, except for the AC power conductor between the service TBK and main circuit breaker. All internal conductors terminating at the blocks shall be connected to the other side of the blocks.

12.3.4.8 Equipment Circuit Breaker - A 15 amp, 120 volt AC circuit breaker shall be installed for equipment circuit protection. The breaker shall be placed on the load side of the main breaker. The breaker shall be located on the front panel of the PDA assembly next to the Main breaker.

12.3.4.9 Signal Bus Circuit Breaker - A 30 amp, 120 volt AC circuit breaker with medium trip delay characteristic shall be provided.

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12.3.4.10 A power supply shall be provided to supply +24 VDC to the input and output files for use by their associated devices. The front panel shall include AC and DC fuses, "POWER ON" light, and test points for monitoring the output voltages. The power supply shall be of ferro-resonant design having no active components and will conform to the following requirements:

1. Line Regulation: 2% from 90 to 135 VAC at 60 Hz, plus an additional 1.6% for each additional 1% frequency change
2. Load Regulation: 5% from 1 amp to 5 amps with a maximum temperature rise of 30°C above ambient
3. Design Voltage: +24 (±0.5) VDC at full load, 30°C, 115 VAC incoming after a 30 minute warm-up period
4. Full Load Current: 5 amps, minimum
5. Ripple Noise: 2 volts peak-to-peak and 500 mV RMS at full load
6. Line Voltage: 90 to 135 VAC
7. Efficiency: 70% minimum
8. Minimum Voltage: +22.8 VDC
9. Circuit capacitors shall be rated for 40 volts, minimum.

12.3.4.11 Two 0.5 Ω, 10 watt minimum, wire-wound power resistors with a 0.2 μH inductance shall be provided; 1 on the AC+ power line and 1 on the AC- line. Three MOV surge arrestors rated for 20 Joules minimum, shall be provided between AC+ and EG, AC- and EG, and between AC+ and AC-. A 0.68 μF capacitor shall be placed across AC+ and AC- between the 2 power resistors and the MOV’s.

12.3.5 Cabinet Harnesses (337 Cabinet)

12.3.5.1 Connector C1P shall contain 104 pin contact positions and shall intermate with Connector C1S mounted on the controller chassis. Corner guide pins for connector C1P shall be stainless steel and shall be 27.9mm in length. Corner guide socket assemblies shall be stainless steel and shall be 15.9mm in length.

12.3.5.2 Connector C4 shall contain 24 contacts and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. The plug Connector C4 shall be mounted on the Rack Assembly.

12.3.5.3 Connector blocks for Connector C1 pin and socket connectors shall be constructed of diallyl phthalate or better. Contacts shall be secured in the blocks with springs of stainless steel.

12.3.5.4 All wires terminating in connectors, unless otherwise noted, shall be crimped or soldered.
12.3.6 Rack Mounted Communications Panel

12.3.6.1 Furnish and install quick telephone - Type 66 termination blocks of the type manufactured by Siemon or Reliance or an approved equivalent, for terminating #22 AWG communications cable and an eight position isolated open faced barrier strip. The termination block shall be six rows across by twenty-five rows long and shall not require standoff brackets to be mounted. The barrier strip shall be an 8 position terminal block with 8/32 by 1.11mm (7/16”) nickel-plated brass binder head screws and nickel-plated brass inserts. The blocks shall be mounted on a 140mm wide aluminum recessed communications terminal panel attached between the uprights of the cabinet rack assembly in the lower section of the front of the cabinet.

SECTION 4 – CABINET WIRING REQUIREMENTS

12.4.1 Cabinet Wiring Diagram

12.4.1.1 The cabinet wiring diagram for Models 337 cabinets shall be furnished on current ODOT drawings for the appropriate cabinet model. One full-sized reproducible master copy of the drawing will be furnished, upon request.

12.4.1.2 The Contractor shall add to the drawing all information and details required giving an accurate description of the wiring and operation of each individual cabinet. The information required includes the following:

1. Software program number and C1 connector pin program assigned functions
2. Input file phase and loop number references
3. Output file phase references
4. Location and phase reference for all input/output devices furnished
5. Modifications made to standard cabinet wiring
6. Intersection layout
7. Phase sequence diagram
8. Preemption sequence diagram (if applicable)

12.4.1.3 The intersection layout shall include all vehicle signals, pedestrian signals, vehicle detectors, push buttons, lane usage arrows, and special devices located and identified as shown on the plans. A north arrow shall also be included and the intersecting streets shall be identified.

12.4.1.4 The phase and preemption sequence diagrams shall refer to the phase designations and sequence shown on the plans for both normal phase rotation and preemption.
Four OZALID-type (or equivalent) copies of the wiring diagram shall be furnished with each Model 337 controller cabinet. The copies shall not be reduced in size.

12.5.1.6 An electronic version of the cabinet wiring diagram in “.dgn” format shall be provided with the controller.

12.4.2 **Conductors** (Model 337 Cabinets)

12.4.2.1 All conductors used in cabinet wiring shall terminate with properly sized, insulated, spring spade type terminals except when soldered to a through-panel solder lug on the rear side of the TBK or as specified otherwise. All spade connectors on wires connecting the input panel to the input files shall be crimped and soldered to the wires.

12.3.2.2 All crimp-style connectors shall be applied with a tool that prevents opening of the handles until the crimp cycle is completed.

12.4.2.3 All conductor sizes shown are AWG.

12.4.2.4 Conductors between the service terminal AC- and EG and their associated bus, the EG bus conductor to power distribution assembly and cage rail, and the AC- bus to power distribution assembly shall be No. 10 (or larger).

12.4.2.5 All conductors, unless otherwise specified, shall be stranded No. 22 (or larger). Conductors shall be rated for 600 volts and shall conform to IMSA Specification 50-2 (or better). The insulation shall have a minimum thickness of 10 mils and shall be Nylon-jacketed polyvinyl chloride, except that conductors No. 14 and larger may have Type THHN/THWN insulation.

12.4.2.6 All conductors, except those that can be readily traced, shall be labeled. Labels attached to each end of the conductor shall identify the destination of the other end of the conductor.

12.4.2.7 All conductors shall conform to the following color-code requirements:

1. The grounded conductors of AC circuits shall be identified by a continuous white or gray color.
2. The equipment-grounding conductors shall be identified by a solid green color or by a continuous green color with one or more yellow stripes.
3. The DC logic ground conductors shall be identified by a solid white color with a red stripe.
4. The ungrounded conductors shall be identified by any color not specified in 1, 2, or 3 above.
12.4.2.8 All wiring harnesses shall be neat, firm, and routed to minimize crosstalk and electrical interference.

12.4.2.9 Wiring containing AC shall be routed and bundled separately or shielded separately from all logic voltage control circuits.

12.4.2.10 Cabling shall be routed to prevent conductors from being in contact with metal edges. Cabling shall be arranged so that any removable assembly may be removed without disturbing conductors not associated with that assembly.

12.4.2.11 Within the cabinet, the DC logic ground and EG shall be electrically isolated from the AC grounded conductor and each other by 500 MΩ when tested at 250 volts DC, with the power line surge protector disconnected.

12.4.2.12 The AC copper terminal bus shall not be grounded to the cabinet or connected to logic ground. Nylon screws with a minimum diameter of 6mm shall be used for securing the bus to the service panel.

12.4.2.13 An equipment grounding bus shall be provided in each cabinet. The bus shall be copper and connected to the cabinet chassis.

12.4.2.14 Each detector lead-in pair from the field terminals to the input file terminals, shall be a cable of IMSA Type 50-2 (or better). The stranded, tinned, copper drain wire shall be connected to the “L” terminal on the input file TBKs. This input terminal shall be connected to the equipment grounding bus through a single conductor. Each connection shall be made by using a crimp connector that is soldered after the connector is crimped to the wire. These cables shall be heat shrunk protected - both the drain wire and the foil shield, to prevent shorting against the contacts on the back of the input file.

12.4.3 Terminal Blocks (Model 337 Cabinets)

12.4.3.1 The TBKs shall be barrier type, rated at 20 amps, 600 volts RMS, minimum. The terminal screws shall be 7.9 mm minimum length, nickel-plated, brass binder head type with screw inserts of the same material. Screw size is called out under associated cabinet assembly, file or side panel.

12.4.3.2 The terminals of the power line service TBK shall be labeled “AC+”, “EG”, and “AC-” and shall be covered with an insulating material to prevent inadvertent contact. Terminating lugs large enough to accommodate No. 4 conductors shall be furnished for the service TBK. The AC+, AC-, and EG conductors connecting to the service terminals and appropriate busses shall not be spade lugged.
12.4.4 Detector Test Buttons

12.4.4.1 The City of Portland does not require detector test buttons.

12.4.5 Auxiliary Relay Socket

12.4.5.1 An auxiliary relay socket shall be mounted on a 102mm DIN rail attached to the left side of the rack assembly as viewed from the rear door. C1-100 shall be landed on position 2 of the socket and 24 VDC+ from TB02 position 1 shall be landed on position 7. This relay will be used for controlling auxiliary devices with an output from the controller.

SECTION 5 – CABINET TRANSIENT SURGE SUPPRESSION REQUIREMENTS

12.5.1 Power Line

12.5.1.1 The power line surge protector shall be metal oxide varistor (MOV). One shall be installed between AC+ and EG and the other between AC- and EG. The MOV shall have the following ratings:

<table>
<thead>
<tr>
<th>Recurrent peak voltage:</th>
<th>212 volts</th>
</tr>
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<tbody>
<tr>
<td>Energy rating:</td>
<td>50 Joules, maximum</td>
</tr>
<tr>
<td>Power dissipation:</td>
<td>0.85 watt, average</td>
</tr>
<tr>
<td>Peak current for pulses:</td>
<td>2,000 amps for less than 6 µS</td>
</tr>
<tr>
<td>Standby current:</td>
<td>Less than 1 mA</td>
</tr>
</tbody>
</table>

12.5.1.2 The power line surge protector shall also include a Three-Electrode Gas Tube Type and shall have the following ratings:

| Impulse Breakdown:     | less than 1,000 volts in less than 0.1 microseconds at 10 kilovolts/microsecond. |
| Standby Current:       | less than one mA |
| Striking Voltage:      | greater than 212 volts DC. |

12.5.1.2.1 The three-electrode gas tube type surge protector shall be capable of withstanding 15 pulses of peak current each of which will rise in 8 microseconds and fall in 20 micro-seconds to one half the peak voltage at 3 minute intervals. Peak current rating shall be 20,000 Amps.
12.5.2 Modern Interconnect Lines (Model 337 Cabinets)

12.5.2.1 General Requirements:

1. Shall be installed in all cabinets
2. Shall suppress bipolar and bi-directional transients
3. Shall fail in the open circuit configuration
4. Shall be of solid state design and contain no spark gap or gas tube
5. Leakage current to ground, maximum: 0.2 mA
6. Circuit impedance loading: <25\(\Omega\)

12.5.2.2 TVSS Performance:

1. Rated single transient energy: 75 (10 x 100 \(\mu\)S, Joules)
2. Single pulse transient current: 2,000 (8 x 20 \(\mu\)S, amps peak)
3. Maximum clamping voltage: 36 (1 kV, 200 A 8 x 50 \(\mu\)S, V peak)

12.5.2.3 Physical Characteristics:

1. Operating temperature: -34\(^\circ\)C to 74\(^\circ\)C
2. Dimensions, maximum: L 125 mm x W 100 mm x D 50 mm
### CITY OF PORTLAND 337 DETAIL #1

#### 337 CABINET

<table>
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<td>PED 4 C1-69</td>
<td>OFFSET 2 C1-77</td>
<td>PH. 7 E &amp; C C1-61</td>
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#### INPUT FILE

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## MODEL 337 CABINET

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<td>IF10-F</td>
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<td>104</td>
<td>DC-GND</td>
<td>L-GND</td>
<td>IF15-4</td>
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NA = NOT ASSIGNED  
NC = NO CONNECTION  
IF = INPUT FILE CONNECTOR
## CITY OF PORTLAND 337 DETAIL SHEET #3
### CONNECTOR PIN ASSIGNMENTS
#### CABLE C4

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<td>TB 02-2</td>
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<td>3</td>
<td>C 1-92</td>
<td>TB 02-2</td>
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<td>C 1-81</td>
<td>IR-N.O.</td>
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<td>C 1-82</td>
<td>MU-BB</td>
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<td>C 1-103</td>
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<td>C 1-7</td>
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FIELD TERMINAL ASSIGNMENTS

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<td>SWPK4-Y</td>
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</tr>
<tr>
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<td>SWPK2-G</td>
<td>116</td>
<td>SWPK4-G</td>
<td>126</td>
<td>SWPK6-G</td>
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02925.51 Traffic Signal Lamps - ITE compliant flange mounted traffic signal light emitting diode (LED) modules shall be used for all signal indications. The manufacturer shall submit reports from ETL/Intertek that certify full compliance of LED signal modules to these specifications across the temperature range of -40 °F to 165 °F. All LED modules shall have a uniform, non-pixilated appearance, and be supplied from the same manufacturer. The LED unit shall have a conformally coated power supply.

Standard 18 AWG jacketed wires, 3 feet in length shall be provided. The termination end shall terminated with insulated quick connect terminals and spade tab adapters.

(a) LED Ball Signal Modules - 8 inch and 12 inch - All LED Ball signal modules shall be fully compliant to the ITE VTCSH LED Circular Supplement specifications. Typical or Nominal wattage not to exceed the following:

<table>
<thead>
<tr>
<th>Indication</th>
<th>8 Inch Lens</th>
<th>12 Inch Lens</th>
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<tbody>
<tr>
<td>Color</td>
<td>Watts</td>
<td>Watts</td>
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<tr>
<td>Red</td>
<td>6</td>
<td>8</td>
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<tr>
<td>Yellow</td>
<td>7</td>
<td>12</td>
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<tr>
<td>Green</td>
<td>8</td>
<td>9</td>
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</tbody>
</table>

(b) LED Omni-Directional Arrows - All LED arrow signal modules shall be fully compliant to the ITE VTCSH Part 3 LED Vehicle Arrow Traffic Signal Modules specifications. Typical or Nominal wattage not to exceed the following:

<table>
<thead>
<tr>
<th>Indication</th>
<th>12 Inch Lens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>watts</td>
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<tr>
<td>Red</td>
<td>7</td>
</tr>
<tr>
<td>Yellow</td>
<td>9</td>
</tr>
<tr>
<td>Green</td>
<td>7</td>
</tr>
</tbody>
</table>

City of Portland 2010 1260
02925.60 Signal Indication Material - The housings, including doors and hoods, shall have a smooth homogeneous finish. Construct the pedestrian and vehicle signal housings and doors of die-cast aluminum alloy. All parts shall be clean, smooth, and free from flaws, cracks, blow holes, and other imperfections. Parts shall be finished inside and out according to 00990.48. All fasteners not specifically noted as hot-dip galvanized shall be Type 304 or 316 stainless steel installed with anti-seize compound.

Except for brass terminal screws, all hardware on pedestrian and vehicle signal heads shall be Type 304 or 316 stainless steel. The stainless steel latching device shall utilize a wing nut or a positive fastener to hold the door securely in place. The reflector retaining rings shall be stainless steel, black powder-coated aluminum, or polycarbonate. All lamp sockets shall be brass with a phosphor bronze center contact. Aluminum sockets are not acceptable.

02925.61 Illuminated Signs:

(a) Part-Time Restriction Signs - Use LED part-time restriction sign:

(1) Cabinet - Furnish a cabinet having a frame constructed of extruded aluminum alloy. The back panel shall be polycarbonate plastic, ABS plastic or sheet aluminum. All panels and frame members shall be of sufficient strength and thickness to prevent warping and bowing. Aluminum frame members shall be 6063-T5 and aluminum panels shall be hot-dip galvanized or Type 304 or 316 stainless steel. Provide easy access to the components of the sign for maintenance. Wash exposed exterior aluminum with a cleaning solvent and when dry, apply two coats of flat black paint.

(2) Visor - Attach to the sign frame a visor that projects over the sign face and sides. Projection over the sign face shall be approximately 5 inches at the top of the sign and approximately 2 inches at the bottom of the sign. Construct the visor of sheet aluminum of sufficient strength and thickness to prevent warping and bowing. Attach the visor to the sign frame with stainless steel screws and paint as specified in paragraph (a)(1) above.

(3) Legend - The legend shall be clearly legible in bright sunlight within 250 feet of the sign. The face of the sign shall be black and the legend shall not be visible even in direct sunlight when the sign is off. The color of the legend shall be as shown on the plans. Obtain the Engineer's approval of the layout and letters prior to construction.

(4) Lighting - The legend shall be made up of strings of LEDs. The LEDs have a minimum viewing angle of 22° and a maximum viewing angle of 30°. The LEDs shall be energized from at least two circuits, to maintain visibility in the event of an LED failure.
(5) **Physical** - The minimum size of the sign face shall be 30 inches wide by 36 inches high, and may vary with the approved legend. The sign shall be capable of continuous operation over a temperature range of -35 °F to 165 °F.

(6) **Mounting** - Mount the sign using mounting hubs. Tether signs installed on messenger cables. Use a minimum of two hubs and two letters, installed as shown.

**02925.62 Signal and Sign Mounting Hardware** - Use cast bronze to construct elevator plumbizers, standard plumbizers, and span wire hangers. Paint the mounting hardware with two coats of zinc-rich aluminum paint. All fasteners not specifically noted as hot-dip galvanized shall be Type 304 or 316 stainless steel, including all hardware and fasteners on tri-stud adapters, spanwire hangers, and plumbizers. The fasteners shall have either square or hex heads. Allen head fasteners are not allowed. Use nylon insert lock nuts on tri-stud adapters and for mounting signal sections together.

Furnish tri-stud adapters with two backing washers and omit the neoprene washer/gasket. Use silicon to seal between the tri-stud and the signal head. The 1/8 inch reinforced plate for the 30 inch by 36 inch interior illuminated signs shall have a minimum 24 square inch bearing surface.

Use silicon to seal between the tri-stud and the signal head. Use an adjustable bracket for vehicle signal assemblies that incorporate 4 or more sections (lenses). The 1/8 inch reinforced plate for the 30 inch by 36 inch interior illuminated signs shall have a minimum 24 square inch bearing surface.

On span wire hangers, use hot-dip galvanized or stainless steel U-bolts in the messenger cable clamp.

**02925.64 Signal Heads** - 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 proof and water proof. Vehicle signal heads shall have the screw hole plug installed and shall have a 1/4 inch drain hole drilled in the bottom of the casing or in the plug.

Color code all leads inside vehicle signal heads re, yellow, green, and white.

(a) **Lenses** - Vehicular signal lenses shall conform to ITE Specifications and shall be:

- Glass with a minimum light transmittance of 92%
- Free of bubbles, flaws and other imperfections
- Circular with a nominal diameter as shown or specified. All arrow indications shall have nominal diameter of 12 inches.
- Mounted in a separate door hinged to the signal housing.
• Mounted in an endless composition rubber gasket that completely encompasses the edge of the lens and provides a cushion and positive seal between the lens and the door. Use at least 4 lens clips to secure the lens and gasket to the door.

• Designed so the lens, when illuminated, is clearly visible to the traffic controlled by the signal face at all distances up to 1,000 feet under all light and atmospheric conditions, except dense fog.

• Designed so the sun’s rays do not reflect and produce any appreciable sun phantom effect, even with the sun shining directly into the lens face.

(b) Doors - Gasket each door to provide moisture resistant construction, so when closed it fits snugly against the reflector. Doors shall open and close easily with one hand.

(c) Reflectors - Illuminate each lens independently of any other lens and provide with a parabolic Alzak®-finished aluminum reflector. Hinge reflector frames to either the door or the housing, so access to the rear of the reflector is allowed without breaking the light circuit. Use suitable clips to hold each reflector firmly to its frame so lamp socket inspection is permitted without removing the reflector.

Removal of the reflector shall not be necessary to replace the lamps on either vehicle or pedestrian signals.

(d) Visors - Construct visors of sheet aluminum alloy ASTM B 209/B 209M, nominal thickness 16 gauge. 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°. Use tunnel visors with the bottom portion open, so the signal is visible directly in front of and below the signal head, on all vehicular signal indications.

(e) Backboards - Construct backboards of sheet aluminum alloy ASTM B 209/B 209M, 14 gauge nominal thickness. All 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 conform to the general design shown. Backboards shall have a border width of 5 inches and a maximum border width of 5 1/2 inches. Powder-coat backboards according to 00990.48(b).

Attach backboards with stainless steel screws and washers. Use washers at least 3/8 inch in diameter.
02925.65 Pedestrian Signal Heads and Pushbutton Devices - Furnish pedestrian signal heads and pushbutton devices meeting the following requirements:

(a) Signal Heads - All pedestrian signal indications shall be single-section LED countdown pedestrian signals.

The light source shall be fully compliant with the ITE PTSCI Part 2: LED Pedestrian Traffic Signal Modules specifications. The manufacturer shall submit to the City of Portland, reports from ETL/Intertek that certify full compliance of LED signal modules to these specification across the temperature range of 40° centigrade to +74° centigrade. Combined nominal wattage for the Hand/Person Countdown pedestrian signal will not exceed 19 watts. All modules shall have a uniform non-pixilated appearance.

Standard 18 AWG jacketed wires, 3 feet in length shall be provided. The wires will be cut 8 inches from the module and terminated on the module side with a fully insulated male tab connector (T&B TNF 18-250FD or approved equal). The module end of the remaining wire shall be terminated with a fully insulated male tab connector (T&B TNF 18-250MD or approved equal). The termination end shall terminated with quick connect terminals and spade tab adapters.

LED Pedestrian Modules - Typical or Nominal wattage not to exceed the following for individual displays:

<table>
<thead>
<tr>
<th>Indication</th>
<th>Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand</td>
<td>8</td>
</tr>
<tr>
<td>Man</td>
<td>6</td>
</tr>
<tr>
<td>Countdown</td>
<td>5</td>
</tr>
</tbody>
</table>

(b) "H" Bracket Pedestrian Push Button - Where "H" bracket style push buttons are specified, they shall be within an extruded aluminum bracket with signs placed directly on both sides of the extrusion.

(c) APS Pedestrian Push Buttons - Furnish APS pushbuttons for the Project as shown and specified.

02925.67 Coatings:

(a) Signal Heads - Pedestrian signal heads, vehicle signal heads, beacon heads, and backboards shall be powder coated inside and outside to meet Federal Standard 595b-37038 (dull black). Powder coating shall consist of 3 mils of primer and 2 mils of moisture-cured polyurethane.

(b) Signal Controller Cabinets - Anodize signal control cabinets constructed of aluminum.
(c) **Brackets and Hangers** - All exposed conduits and fittings including signal mounting hardware shall be galvanized in conformance with AASHTO M 111 and then primed with 3 mil DFT, dry film thickness, of Wasser MC Ferrox B and top coated with 3 mil DFT Wasser MC-Luster Topcoat. Apply MC-Luster Topcoat Signal Bronze (W21.0298) in accordance with the manufacturer’s recommendations and Steel Structure Painting Council SSPCPA 1 - “Good Painting Practices.”

(d) **Interior Illuminated Metallic Sign Cabinets (Fluorescent Tube)** - Paint cabinets according to the following:

1. **Inside of Cabinet** - Wash all exposed aluminum and steel parts with a metal cleaning solvent. When metal is thoroughly dry, spray on one coat of zinc chromate paint. When dry, finish with two coats of high quality white enamel.

2. **Outside of Cabinet** - Apply 2 coats of aluminum paint to any exposed metal parts, other than aluminum, on the outside of the cabinet.

3. **Handling** - Refinish any scratches or abrasions on the finished surface of the cabinet to the Engineer’s satisfaction.

(e) **Interior Illuminated Metallic Sign Cabinets (Neon Tube)** - Paint cabinets according to the following:

1. **Inside of Cabinet** - Follow the procedure of (d)(1) above, except after the zinc chromate paint is dry, finish with three coats of a dull, flat, gray or white, weather-resistant paint. Finish the front, exposed face louvers and the tube supports on the inside of the hood with three coats of the same paint.

2. **Outside of Cabinet** - Prime the outside of the cabinet and apply two coats of the flat black enamel.

3. **Handling** - Same as (d)(3) above.

(f) **Fiber-optic Sign Cabinets** - Paint cabinets according to the following:

1. **Inside of Cabinet** - Do not paint interior surfaces of the cabinet.

2. **Outside of Cabinet** - Same as (e)(2) above.

3. **Handling** - Same as (d)(3) above.

(g) **Equipment Control Cabinets** - Flasher cabinets, and remote amplifier cabinets which are not stainless steel or anodized shall be primed with 3 mil DFT of Wasser MC Ferrox B and top coated with 3 mil DFT of Wasser with top coat color as indicated on plans or specifications in accordance with the manufacturer’s recommendations and Steel Structure Painting Council SSPCPA 1 – “Good Painting Practices.”
(h) **Reused Material** - Where the plans or specifications allow the reuse of certain materials, such materials shall be cleaned, shot or sand blasted to bare metal. All surfaces shall be clean, dry, sound, and free of all contaminants. Existing unsound paint shall be scraped away by hand to bare metal; and any and all rust, dirt, debris, and unsound material shall be removed by hand with a wire brush and sandpaper. Remove oil or grease with solvent such as turpentine mineral spirits, or xylol in compliance with SSPC-SPI-63 Solvent Cleaning. Care should be taken to ensure a clean, smooth, sound continuous surface for painting.

All surfaces which have been cleaned down to bare metal should be primed within 8 hours when practical, but in any event not later than 24 hours before any visible detrimental rusting can occur.

After cleaning and priming the reused equipment shall be painted as specified for new equipment.

(i) **Terminal Cabinets** - Terminal cabinets shall be galvanized in conformance with AASHTO M 111 and shall be primed with 3 mil DFT of Wasser MC Ferrox B and top coated with 3 mil DFT of Wasser with top coat color as indicated in plans or specifications in accordance with the manufacturer’s recommendations and Steel Structure Painting Council SSPCPA 1 - “Good Painting Practices.”
Section 02926 - 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 - 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.

Cabinets and Control Devices

02926.40 Cabinets - Construct all cabinets 14 gauge, 304 stainless steel. Cabinets shall be weatherproof, rated as NEMA Type 3R, and be constructed as shown. A 14 gauge stainless steel nameplate shall be attached to the door with a minimum of 6 stainless steel tamperproof fasteners. The nameplate shall be inscribed "Street Lighting" in letters approximately 3/8 inch high.

Construction of pedestal-type cabinets is to be open-bottom with a bottom frame that can be employed to bolt the unit to a concrete pad at a minimum of four points. All working hardware shall be stainless steel. All metal and non-hardware metal parts shall have all slag, burrs, and rough spots cleaned and ground smooth. The service enclosures shall be delivered to the site complete with all equipment installed and wired for correct operation. Arrangement of equipment and wiring shall be in general conformance with the plans and details. All work on the construction of the service cabinets and panels shall be a UL listed facility and the services enclosures shall carry a UL label of approval for use as "service entrance equipment".

All switch gear, relays clocks, etc., shall be mounted on a mounted on a mounting pen, and the enclosure is to be fitted with a dead front panel. No equipment or devices are to be attached to the dead front panel. Dimensions of the service enclosures shall be as specified on the plans and details. These dimensions are minimum and nominal. The dead front panels and mounting pans shall be 14 gauge stainless steel.

Panels controlling two or more circuits shall have schedule affixed to the interior of the cabinet which shall clearly indicate the pole number each pole that is connected to each circuit breaker. Each circuit breaker shall be numbered or otherwise identified.

02926.41 Circuit Control Devices:

(a) General - Install circuit breakers, the copper neutral block, and contactors as shown.
(b) Circuit Breakers - Circuit breakers for illumination shall be GE Type TEB for all 150 amp breakers or smaller; GE Type TED shall be used for all breakers greater than 150 amps.

Circuit breakers shall be 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.

Circuit breakers shall conform to Federal Specification W-C-375B. All 100 A frame breakers shall be Class 13a for single pole breakers, and Class 18a for multiple pole breakers. 225 A frame breakers shall be Class 20a, 400 A frame breakers shall be Class 21a, and 800 A frame breakers shall be Class 23a.

Install overcurrent protection and relay equipment, as shown or specified, according to the best common practice, with materials and installation conforming to the NEC.

(c) Multiple Light Contactors - For illumination projects, the contactor shall be model Square D 8903, or approved equal.

(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 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 foot-candle plus or minus 0.2 foot-candle at 120 V AC. When operated at 240 V AC, turn-on shall not change more than plus or minus 0.3 foot-candle from the 120 V value. Maximum off-to-on ratio shall be 1.5:1.

The photoelectric shall be a cadmium-sulfide photocell encapsulated for humidity protection, or a silicon junction type photo-transistor.

Normal operation shall be designed for dual voltage operation of 105 V - 285 V, 60 Hz.

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.

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.

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Lamps, Ballasts, and Luminaires

02926.50 Illumination Lamps - All mercury vapor, high-pressure sodium and metal halide 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:

<table>
<thead>
<tr>
<th>Lamp Watts</th>
<th>ANSI Code</th>
<th>Minimum Initial Vertical Lumens</th>
<th>Minimum Horizontal Lumens</th>
<th>Minimum Average Lamp Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>S68MS-50</td>
<td>4,000</td>
<td>4,000</td>
<td>24,000</td>
</tr>
<tr>
<td>70</td>
<td>S62ME-70</td>
<td>6,300</td>
<td>6,300</td>
<td>24,000</td>
</tr>
<tr>
<td>100</td>
<td>S54SB-100</td>
<td>9,500</td>
<td>9,500</td>
<td>24,000</td>
</tr>
<tr>
<td>150</td>
<td>S55SC-150</td>
<td>16,000</td>
<td>16,000</td>
<td>24,000</td>
</tr>
<tr>
<td>200</td>
<td>S66MN-200</td>
<td>22,000</td>
<td>22,000</td>
<td>24,000</td>
</tr>
<tr>
<td>250</td>
<td>S50VA-250/S</td>
<td>29,000</td>
<td>29,000</td>
<td>24,000</td>
</tr>
<tr>
<td>310</td>
<td>S67MR-310</td>
<td>37,000</td>
<td>37,000</td>
<td>24,000</td>
</tr>
<tr>
<td>400</td>
<td>S51WA-400</td>
<td>50,000</td>
<td>50,000</td>
<td>24,000</td>
</tr>
</tbody>
</table>

02926.52 Ballasts - Unless otherwise specified on plans, the luminaire ballasts shall be normal power factor reactor type for 150 watt or smaller. Ballasts for 200 watt and larger shall be magnetic regulator type.

If remote-mounted ballasts are shown or specified, mount the ballasts in weatherproof ballast enclosures of corrosion-free aluminum or fiberglass reinforced polyester. A 1 inch threaded nipple shall be molded into the cover. Provide a minimum of 10 inch color-coded and identified leads.

Ballasts directly exposed to rain or water shall have enclosures completely filled with epoxy resin or other suitable material to lock capacitors, core, and coils firmly in place and maintain a watertight seal. Mount starting-aid circuits for high-pressure sodium lamps 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 plus or minus 5% of nominal when the lamp is at its rated nominal voltage (high-pressure sodium lamps only).
- The ballast shall not allow the lamp arc to extinguish when a line voltage dip as shown below occurs for several seconds.
- 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.
- 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 slipfitter end mounting.

Luminaires shall have a cast-aluminum housing and shall attach 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.

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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 will not deflect more than 1/16 inch.

All luminaires shall bear a UL label (or Oregon approved equivalent). Light distribution shall be medium Type III cutoff unless otherwise indicated on plans. Luminaire glassware, reflector and lamp shall be thoroughly cleaned before installation.

(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 (1990) 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      |
| Semicutoff  |
| Noncutoff   |

The classifications listed above shall conform to ANSI definitions.

(c) Standard Luminaires - The luminaire shall be as specified on the plan set. All exposed hardware shall be made of stainless steel. The fixture provided shall be as specified for the project, or an approved equivalent.
02926.67  Coating:

(a) Service Cabinets - Pole mounted service cabinets shall be painted to match the pole as specified in Section 00962.48.

(b) Reused Material - Where the plans or specifications allow the reuse of certain materials, such materials shall be cleaned, shot or sand blasted to bare metal. All surfaces shall be clean, dry, sound, and free of all contaminants. Existing unsound paint shall be scraped away by hand to bare metal; and any and all rust, dirt, debris, and unsound material shall be removed by hand with a wire brush and sandpaper. Remove oil or grease with solvent such as turpentine mineral spirits, or xylol in compliance with SSPC-SPI-63 Solvent Cleaning. Care should be taken to ensure a clean, smooth, sound continuous surface for painting.

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