

RPP-SPEC-62663  
Revision 0

# CONSTRUCTION SPECIFICATION FOR: TSCR UPGRADES, WASTE FEED DELIVERY & TSCR IXC STORAGE PAD

Prepared by

**RL Nelson**

Atkins Energy Federal EPC, Inc. (by Sargent & Lundy) for  
Washington River Protection Solutions, LLC

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**ATKINS ENERGY FEDERAL EPC**

prepared by

**SARGENT & LUNDY**  
1100 Jadwin Avenue, Suite 400  
Richland, Washington 99352-3425  
(509) 946-3300



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**SECTION 02 41 00****DEMOLITION****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Existing pit configuration.
- B. Concrete cover blocks.
- C. Removal of abandoned or out-of-service items.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. Code of Federal Regulations (CFR)
  - 29 CFR Part 1910.94 Occupational Health and Environmental Control, Subpart G, U.S. Department of Labor, Occupational Safety and Health Administration (OSHA)
  - 29 CFR Part 1926 Safety and Health Regulations for Construction
- B. National Fire Protection Association®<sup>1</sup> (NFPA®<sup>1</sup>)
  - NFPA 70®<sup>1</sup>, 2017 National Electrical Code®<sup>1</sup> (NEC®<sup>1</sup>)
  - NFPA 70E Standard for Electrical Safety in the Workplace

**1.3 SUBMITTALS**

Not Used.

**1.4 PERMITS**

- A. Obtain and conspicuously post all required permits before starting work under this Section. Permits are addressed by TOC work control process.

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<sup>1</sup> National Fire Protection Association, NFPA, NFPA 70, National Electrical Code, and NEC are registered trademarks of the National Fire Protection Association, Quincy, Massachusetts.

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**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Before beginning demolition, survey existing work and examine the Drawings and Specifications to determine extent of work. Coordinate work of this Section with other work.
- B. Determine contamination levels if applicable and if any type of chemicals, gases, flammable materials, or other dangerous materials have been used in pipes or other equipment based on job hazard evaluation or Excavation Permit. Remove these materials prior to demolition activity as directed by TOC Construction Representative.

**3.2 PREPARATION**

- A. Personnel Protection: Provide safeguards, including warning signs, barricades, and temporary closures required for protection of construction personnel and others during demolition and removal operations.
- B. Disconnect existing utility services specified by Washington River Protection Solutions (WRPS) Engineering Change Notice (ECN) or Mission Support Alliance Engineering Change Request (ECR). If no direction is included in an ECN or ECR, proceed as directed by TOC Construction Representative.

**3.3 PERFORMANCE**

- A. Demolition Operations.
  - 1. Remove equipment from tanks in accordance with applicable Work Packages, ECNs, and required work controls, such as Radiological Work Permit.
  - 2. Dispose of debris in accordance with Contract Statement of Work requirements.

END OF SECTION 02 41 00

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**SECTION 03 15 00****POST-INSTALLED CONCRETE ANCHORS (NON-SAFETY RELATED)****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Purchasing and installing post-installed concrete anchors.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. Hanford Documents

Form A-6004-239	Expansion Anchor Installation Report (or company approved equivalent)
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- B. International Code Council (ICC)

IBC, 2015	International Building Code® <sup>2</sup>
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- C. ICC Evaluation Service, Inc. (ICC-ES)

ICC-ES ESR-1917	Hilti Kwik Bolt® <sup>3</sup> TZ Carbon and Stainless Steel Anchors in Cracked and Uncracked Concrete
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ICC-ES ESR-1545	Hilti HSL-3 Carbon Steel and HSL-3-R Stainless Steel Heavy Duty Expansion Anchors for Cracked and Uncracked Concrete
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ICC-ES ESR-1546	Hilti HDA Carbon Steel and Stainless Steel Undercut Anchors for Cracked and Uncracked Concrete
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**1.3 SUBMITTALS**

- A. See the Contract Statement of Work for the submittal process.

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<sup>2</sup> International Building Code and IBC are registered trademarks of International Code Council, Inc., Brea, California.

<sup>3</sup> Kwik Bolt is a registered trademark of Hilti Corporation, Schaan, Liechtenstein.

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**B. Approval Required**

1. Certificate of Compliance: Provide Certificate of Compliance for cast-in-place anchors indicating they meet the requirements of this Specification.
2. Training Records (Paragraph 1.4.A): 5 days before installation.
3. Special Inspection Qualifications (Paragraph 1.4.C): Five days minimum before start of installation.
4. Installation Inspection Reports (Paragraph 3.4.A.1): Within ten days after work is complete.

**C. Approval Not Required**

1. Drawings, Diagrams, Templates, and Instructions: Within ten days after work is complete.

**1.4 QUALITY ASSURANCE**

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

- A. Contractor shall train post-installed anchor installers. Installers shall be trained to the anchor manufacturer's installation instructions, design document requirements, and the anchor installation report. Contractor shall deliver installer training records to the Company.
- B. Misrepresented Products: See the Contract Statement of Work for required measures to prevent use of misrepresented products.
- C. Post-Installed Anchor Special Inspector Qualifications.
  1. Two years' experience in concrete inspection and/or certification from American Concrete Institute, ICC, International Conference of Building Officials, or other recognized concrete inspection agency to be provided by the Tank Operations Contractor (TOC).

**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. See Contract Statement of Work for general requirements.

**PART 2 PRODUCTS****2.1 SUBSTITUTES**

- A. See Contract Statement of Work for substitution approvals.



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**2.2 MATERIALS**

- A. Post-installed anchors: Industry standard wedge-type having a published evaluation report (by ICC-ES), with anchor descriptions, tables of allowable tension and shear loads (including seismic and wind qualifications), and test findings.
- B. Hilti Corporation or approved equal:
  - 1. Kwik Bolt TZ Expansion Anchor.
  - 2. HDA Metric Undercut Anchor.
- C. Anchors located in dry, interior locations may be carbon steel. Anchors located in wet or potentially wet interior locations (e.g., water building installations) and exterior locations shall be stainless steel.

**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Examine areas where expansion anchors are to be installed and notify the Washington River Protection Solutions TOC Construction Representative, in writing, of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

**3.2 PREPARATION**

- A. For expansion anchors larger than 3/8 in., locate rebar by scanning before drilling. For expansion anchors 3/8 in. or smaller, avoid cutting rebar by using a drill with a concealed-metal detector shutoff.
- B. Do not install anchors in concrete prior to 28 days after concrete placement unless it can be shown by testing (via field-cured test cylinders) that the concrete design strength has been obtained.

**3.3 INSTALLATION**

- A. Expansion Anchor Installation
  - 1. Install anchors shown on the Drawings in accordance with training.
  - 2. Metal embedded in existing concrete may be cut when drilling for installation of anchors. Notify the TOC Construction Representative if metal is encountered when drilling for evaluation.
  - 3. When an anchor is replaced with an anchor of diameter one size larger, maintain the spacing requirements and effective embedment depth of the original size anchor.

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**3.4 FIELD INSPECTIONS AND TESTS**

- A. Special Inspection is required for all anchor bolt installations. This shall be done in accordance with Section 4 of the applicable ICC-ES Evaluation Report. The special inspector shall be on the jobsite during anchor installation to verify anchor type, anchor dimensions, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, drill bit size, anchor embedment, and tightening torque.

Special Inspection Services referenced herein shall be provided by an off-site testing and inspection agency with personnel that have the proper certification as noted in Paragraph 1.4.

1. Complete inspections shall be documented by the inspector on Form A-6004-239, "Expansion Anchor Installation Report" (or Company-approved equivalent) and submitted to the TOC Construction Representative for approval.

END OF SECTION 03 15 00

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**SECTION 03 15 21****POST-INSTALLED CONCRETE ANCHORS (SAFETY SIGNIFICANT)****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Purchasing, installing, inspecting and testing safety-related, post-installed concrete anchors.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. American Society for Mechanical Engineers (ASME)
  - ASME NQA-1, 2008/2009 Quality Assurance Requirements for Nuclear Facility Applications (2008 with ASME NQA-1a-2009 Addenda)
- B. Hanford Documents
  - Form A-6004-239 Expansion Anchor Installation Report (or company-approved equivalent)
- C. International Code Council (ICC)
  - IBC, 2015 International Building Code
- D. ICC Evaluation Service, Inc. (ICC-ES)
  - ICC ESR-1545 Hilti HSL-3 Carbon Steel and HSL-3-R Stainless Steel Heavy Duty Expansion Anchors for Cracked and Uncracked Concrete
  - ICC ESR-1917 Hilti Kwik Bolt TZ Carbon and Stainless Steel Anchors in Cracked and Uncracked Concrete
- E. WAC 173-303-640 Dangerous Waste Regulations Washington State

**1.3 SUBMITTALS**

- A. See the Contract Statement of Work for the submittal process.
- B. Approval Required

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1. Subcontractor Quality Assurance (QA) Plan (QAP), including all sub-tier subcontractors, that meets the basic requirements of ASME NQA-1.
  2. Material Test Reports with traceability to purchase order and material for all supplied materials.
  3. Commercial Grade Dedication (CGD) Plans (if required) compliant with NQA-1, Part II, Subpart 2.14, and as included within this Section in accordance with Subcontractor's QAP as approved by TOC Construction Representative.
  4. Submit technical documentation of the product, including, but not limited to, anchor design strength in shear and tension, minimum spacing and edge distances, anchor dimensions, materials and coatings used, installation instructions, and all required design parameters.
  5. An inspection plan that complies with Subcontractor's QAP and Section 4.4 of the applicable ICC-ES Evaluation Report. Subcontractor shall prepare comprehensive inspection plan that includes all inspections and tests required by codes, standards, and CGD Plans applicable to the work.<sup>4</sup>
  6. Documentation required by inspection plan such as logs and results of tests and inspections performed.
  7. Documentation that testing agencies have an NQA-1-compliant quality program prior to performing any work.
  8. Special Inspection Qualifications (Paragraph 1.4.A): Five days minimum before start of installation.
  9. Installation Inspection Reports (Paragraph 3.5.A.1): Within ten days after work is complete.
- C. Approval Not Required
1. Drawings, Diagrams, Templates, and Instructions: Within ten days after work is complete.

## 1.4 QUALITY ASSURANCE

The Seller shall comply with the following QA requirements in addition to those of the Contract Statement of Work:

- A. Post-Installed Anchor Special Inspector Qualifications: Manufacturer's representative shall train post-installed anchor installers to the anchor manufacturer's installation instructions, design document requirements, and the anchor installation report. Contractor shall deliver installer training records to the Company.

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<sup>4</sup> This includes hold points associated with the inspections and tests required by IBC Ch. 17.

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- B. Misrepresented Products: See the Contract Statement of Work for required measures to prevent use of misrepresented products.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. See Contract Statement of Work for general requirements.

**PART 2 PRODUCTS****2.1 SUBSTITUTES**

- A. See Contract Statement of Work for substitution approvals.

**2.2 MATERIALS**

- A. Post-installed anchors: Industry standard having a published evaluation report (by ICC-ES), with anchor descriptions, tables of allowable tension and shear loads (including seismic and wind qualifications), and test findings.
- B. Hilti Corporation or approved equal:
  - 1. Kwik Bolt TZ Expansion Anchor
  - 2. HSL-3 and HSL-3-R Expansion Anchor
- C. Anchors located in dry interior locations may be carbon steel unless otherwise noted. All other anchors shall be stainless steel.

**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Examine areas where expansion anchors are to be installed and notify the TOC Construction Representative, in writing, of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

**3.2 PREPARATION**

- A. Locate existing reinforcing steel (rebar) in the concrete prior to drilling. Pilot holes shall be drilled with a carbide-tip bit to avoid rebar damage.
- B. Rebar cutting is only permitted with pre-approval by TOC Construction Representative. Multi-cutting of the same bar is considered as one cut. Rebar approved to be cut must be shown on as-built drawings at completion of Project.
- C. Rebar will be considered cut if:
  - 1. For #4 through #7 – Cuts, nicks, or drill into bar body is greater than 1/16 in.
  - 2. For #8 and larger – Cuts, nicks, or drill into bar body is greater than 1/8 in.

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- D. When installing anchors through cut rebar, the anchoring mechanism shall be located at least two anchor diameters clear beyond the cut rebar.

**3.3 INSTALLATION**

- A. Before installation: Notify TOC Construction Representative prior to placement of concrete supporting tank system components for witnessing of activities by an Independent Qualified Installation Inspector or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.
- B. Anchor Installation
1. Install anchors shown on the Drawings in accordance with training and manufacturer's instructions.
  2. Do not install anchors in concrete or grout prior to 28 days after placement, unless it can be shown by testing (via field-cured test cylinders) that the concrete design strength has been obtained.
  3. Each anchor must be installed in the location, at the spacing, and with the embedment depth and edge distance(s), and installation Type indicated on the project drawings, and in accordance with, in priority order, 1) this specification, and 2) the manufacturer's installation instructions.
  4. Anchors may be relocated a maximum of 1 in. in order to avoid contacting existing rebar.
  5. Anchors must be installed perpendicular to the concrete surface within a  $\pm 5$ -degree tolerance. Post-installation verification of this criterion may be satisfied by visual inspection to verify proper seating of the nut and washer. When an anchor is replaced with an anchor of diameter one size larger, maintain the spacing requirements and effective embedment depth of the original size anchor.
  6. Do not damage the length identification code on the head of the anchor. Anchor projection may be cut off subject to pre-approval by TOC Construction Representative and documentation of the location, embedment, and length code on the inspection report prior to cutting.

**3.4 REPAIRS**

- A. Repair abandoned holes with grout material specified in Section 03 30 21, "Cast-in-Place Concrete (Safety Significant)." The repair material shall have strength equal to or larger than the strength of the concrete.
- B. Unused anchors shall be driven in and cut off flush. Cut-off anchors shall be considered an abandoned ungrouted hole for future anchor spacing requirements.
- C. Anchors installed near an abandoned anchor or abandoned repaired or unrepaired hole must be located as follows.

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1. The center-to-center distance between a new hole and an exploratory or unused hole, or an abandoned cut-off anchor shall not be less than three times the diameter of the larger hole or 1 in. of clear concrete between the holes, whichever is greater. When exploratory or unused holes are grouted and the grout has attained the strength of the concrete, the center-to-center distance shall not be less than 1.5 times the diameter of the larger hole or 1 in. of clear concrete between holes, whichever is greater.

**3.5 FIELD INSPECTIONS**

- A. Special Inspection is required for all anchor bolt installations. This shall be done in accordance with Section 4.4 of the applicable ICC-ES Evaluation Report. The Special Inspector shall be present as stated in Section 4.4 of the applicable ICC-ES Evaluation Report.

Special Inspection Services referenced herein shall be provided by personnel with proper certification as noted in Paragraph 1.4.

1. Complete inspections shall be documented by the inspector on Form A-6004-239, "Expansion Anchor Installation Report" (or TOC-approved equivalent) and submitted to the Buyer for approval.

END OF SECTION 03 15 21

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**SECTION 03 30 00****CAST-IN-PLACE CONCRETE (NON-SAFETY RELATED)****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Tank-Side Cesium Removal (TSCR) Ion Exchange Column (IXC) Haul Path and Storage Pad
  - 1. Formwork
  - 2. Reinforcement
  - 3. Cast-In-Place Items
  - 4. Concrete
  - 5. Non-shrink grout

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. American Association of State Highway and Transportation Officials (AASHTO)
  - AASHTO M 254                      Standard Specification for Corrosion-Resistant Coated Dowel Bars
- B. American Concrete Institute (ACI)
  - ACI 117                              Tolerances for Concrete Construction and Materials
  - ACI 301, 2010                      Specification for Structural Concrete
  - ACI 305.1                            Standard Specification for Hot Weather Concreting
  - ACI 306.1                            Standard Specification for Cold Weather Concreting
  - ACI 308.1                            Specification for Curing Concrete
  - ACI 318, 2014                      Building Code Requirements for Structural Concrete and Commentary



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- |                        |  |
|------------------------|--|
| ACI CP-1               | Technical Workbook for ACI Certification of Concrete Field Testing Technician-Grade 1  |
| <br>                   |  |
| C.                     | ASTM International (ASTM)  |
| ASTM A615              | Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement   |
| ASTM A706              | Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement  |
| ASTM A853              | Standard Specification for Steel Wire, Carbon, for General Use   |
| ASTM C33               | Standard Specification for Concrete Aggregates   |
| ASTM C94               | Standard Specification for Ready-Mixed Concrete  |
| ASTM C150              | Standard Specification for Portland Cement   |
| ASTM C231              | Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method  |
| ASTM C260              | Standard Specification for Air-Entraining Admixtures for Concrete  |
| ASTM C494              | Standard Specification for Chemical Admixtures for Concrete  |
| ASTM C881              | Standard Specification for Epoxy Resin Based Bonding Systems for Concrete  |
| ASTM C1077             | Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation       |
| ASTM C1107             | Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)   |
| ASTM D1752             | Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction |
| <br>                   |  |
| D.                     | National Ready Mixed Concrete Association (NRMCA)  |
| Quality Control Manual | Certification of Ready Mixed Concrete Production – Section 3 Facilities  |
| <br>                   |  |
| E.                     | Washington Administrative Code (WAC)   |
| WAC 173-303-640        | Dangerous Waste Regulations Washington State   |

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**1.3 SUBMITTALS**

- A. See Contract Statement of Work for submittal procedures.
- B. Approval Required.
  - 1. Concrete Data: Before mixing, submit concrete materials, mix design, and mix proportions, in accordance with ACI 301, Section 4.1.2. Identify each material to be used in concrete, including amount, by weight, to be utilized in each cubic yard of plastic mix.
  - 2. Product Data: Admixtures, bonding agent, bond breaker, expansion joint material, grout, and patching materials.
  - 3. Reinforcement Shop Drawings: Prior to fabrication of reinforcement, submit placement drawings that detail fabrication, bending, and placement. Include bars sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
  - 4. Setting drawings, diagrams, templates, and instructions: Prior to fabrication, submit information for installation of anchorages, such as concrete inserts, anchor bolts, and miscellaneous items having integral anchors, to be embedded in concrete.
  - 5. Detailed plan for cold weather placements including curing and protection of concrete placed and cured in ambient temperature below 40°F.
  - 6. Detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 80°F.
  - 7. Concrete Placement drawings: Prior to setting of forms, submit placement drawings indicating planned pouring sequence and locations of any planned joints, including those not shown on the Contract drawings.
  - 8. Concrete repair methods and materials.
  - 9. Submittals shall include the documentation listed in Paragraph 1.4.

**1.4 QUALITY ASSURANCE**

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

- A. The concrete supplier shall be currently certified by the NRMCA's "Certification of Ready Mixed Concrete Production Facilities" with compliance to ASTM C94 requirements for production facilities and equipment.
- B. Qualification of Concrete Inspection/Testing Laboratory: The laboratory including equipment, personnel, and procedures shall meet the requirements of ASTM C1077 and shall be currently accredited by an independently recognized authority.

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- C. Deliverable Documentation: The following documents and records, required by this Section, shall be delivered to the TOC Construction Representative in accordance with Contract Documents.

<u>Document</u>	<u>Paragraph</u>
Supplier Certification	1.4.A
Laboratory Qualifications	1.4.B
Inspection Personnel Qualification Records	1.6.A & 1.6.B
Pre-Pour Inspection Checklist and Trip Tickets	3.2.C.1.b, 3.2.C.1.c, and 3.4.B
Concrete Test Results	3.4.C

- D. Perform work in accordance with the applicable sections of ACI 117, ACI 301, and ACI 318.
- E. Suspect and Misrepresented Products: See Contract Statement of Work for required measures to prevent use of misrepresented products.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. See the Contract Statement of Work for general requirements.

## 1.6 QUALIFICATION OF CONCRETE INSPECTORS

- A. Personnel performing field testing of concrete shall be ACI Concrete Field Testing Technicians, Grade 1, who have received formal certification in accordance with ACI CP-1 or equivalent. Equivalent certification programs shall include requirements for written and performance examination as stipulated in ACI 301, Section 1.6.2.
- B. Personnel performing laboratory testing shall be certified as an ACI Concrete Laboratory Technician—Grade I.

## PART 2 PRODUCTS

### 2.1 SUBSTITUTION

- A. See the Contract Statement of Work for substitution approvals.

### 2.2 MATERIALS

- A. Concrete
1. Cement: ASTM C150, Type I or II.
  2. Aggregates: ASTM C33, 3/4 in. maximum size.
  3. Admixtures: Furnish from one manufacturer.

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- a. Characteristics: Compatible with each other and free of chlorides or other corrosive chemicals.
  - b. Air-entraining admixture: ASTM C260, Sika Chemical Company "SIKA AER," Chem-Masters Corporation "Adz-Air," or Protex Industries "AES."
  - c. Water-reducing admixture: ASTM C494, Type A or Type D.
  - d. High-range water reducing admixture (superplasticizer): ASTM C494, Type F or Type G.
4. Properties (if not specified on drawings):
- a. Minimum allowable compressive strength:
    - i. TSCR IXC Haul Path and Storage Pad: 4,500 psi at 28 days.
    - ii. All other concrete: 3,000 psi at 28 days.
  - b. Slump range at site:
    - i. 4.5 in. minimum, 8 in. maximum for concrete with a high range water reducing admixture.
    - ii. 3 in. minimum, 5 in. maximum for concrete without a high range water reducing admixture.
  - c. Air content: Four to six percent when tested in accordance with ASTM C231.
  - d. Proportions: In accordance with ACI 301, Section 4.2.3, and ASTM C94.
  - e. Time of discharge: In accordance with ASTM C94, Section 12, and ACI 301, Sections 4.1.2.12 and 4.3.2.2, unless otherwise approved based on trial batch test results.
5. Measuring, Mixing, and Delivery: In accordance with ASTM C94.
- B. Controlled Density Fill: Portland cement based, minimum compressive strength of 100 psi at 28 days, maximum compressive strength of 300 psi at 28 days.
- C. Reinforcing Steel
1. Steel bars: ASTM A615 or ASTM A706, deformed, Grade 60.
  2. Tie wire: ASTM A853 carbon steel, 16-gage minimum, annealed.
- D. Post-Installed Anchors: See Section 03 15 00, "Post-Installed Concrete Anchors (Non-Safety Related)."

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- E. Expansion joint filler: ASTM D1752, Type II, flexible foam, Ceramar<sup>5</sup> by W.R. Meadows, 1/2 in. thick.
- F. Expansion joint filler (between asphalt and concrete): ASTM D1752, asphalt impregnated fiberboard or felt, 1/2 in. thick.
- G. Joint sealants: See Section 07 92 00, "Joint Sealants."
- H. Forms: Wood, steel, plywood or Masonite Corporation "Concrete Form Presswood," as required for various specified finishes.
- I. Bonding Agent: Epoxy resin emulsion appropriate for bonding fresh concrete to existing set concrete, ASTM C881, Type IV.
- J. Non-Shrink Grout: ASTM C1107, premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.
- K. Joint Dowel Bars: ASTM A615, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs. Install with grease/epoxy or a sleeve.
  - 1. Paint with one coat of paint conforming to AASHTO M 254 and coat one half of the bar with grease.
  - 2. Plastic or gage metal (26 gage minimum) sleeves with an inside diameter of 1/16-in. greater than the dowel bar that it encases, that have the strength, durability, and design to provide free movement of the dowel relative to the concrete slab and that are specifically manufactured for this purpose.

**PART 3 EXECUTION****3.1 PREPARATION**

- A. Form Construction
  - 1. Install formwork in accordance with ACI 301, Section 2.3. Interior shape and rigidity shall be such that finished concrete will meet requirements of Drawings and approved shop drawings within tolerances specified in ACI 117, Section 4.
  - 2. Prepare form surfaces in accordance with ACI 301, Section 2, using specified form coating materials, or as described below.
  - 3. Forms for surfaces which will be permanently concealed from view may be saturated with water, before placing concrete, instead of other treatment. In freezing weather, forms shall be treated with oil or stearate.
  - 4. Clean forms of foreign material before placing concrete.

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<sup>5</sup> Ceramar is a registered trademark of W. R. Meadows, Inc., Hampshire, Illinois.

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- B. Prepare setting drawings, diagrams, templates, and instructions for installation of anchorages, such as concrete inserts, anchor bolts, embedded plates, and miscellaneous items having integral anchors, to be embedded in concrete.

### 3.2 INSTALLATION

#### A. Reinforcing Steel

1. Fabricate and place bars to dimensions shown on Contract drawings, within tolerances shown in ACI 117, Sections 2.1 and 2.2.
2. Tie to prevent displacement during placement of concrete.
3. Do not force into concrete after initial set has started.
4. Provide concrete cover for reinforcement protection per dimensions given in ACI 301, Section 3.3, except where shown otherwise on Contract drawings or approved shop drawings.
5. Reinforcement shall be supported and fastened together to prevent displacement by construction loads, or placement of concrete beyond specified tolerances. Reinforcement supported from ground shall rest on precast, square concrete blocks, with a minimum surface area of 4-in<sup>2</sup> and having a compressive strength equal to specified compressive strength of concrete being placed. Other means of support require prior approval.

- B. Verify that reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete. Document inspection on the Pre-Pour Inspection Checklist.

#### C. Concrete

1. Before placing:
  - a. Notify TOC Construction Representative prior to placement of concrete supporting tank system components for witnessing of activities by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.
  - b. Approve "Pre-Pour Inspection Checklist," including identification of sections of structure to be placed, maximum size of coarse aggregate, and design strength.
  - c. For each truck load, collect "Trip Ticket." Trip Tickets shall contain information listed in ASTM C94, paragraphs 14.1.1 through 14.1.10, and water to cementitious material ratio. Before test sampling and placing concrete, Trip Ticket shall be reviewed by the Testing Agency's field inspector. After depositing concrete, Trip Ticket shall be completed and submitted.

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- d. Discharge concrete rinsate at Company-approved location.
  - e. Place in accordance with ACI 301, Section 5.3. Do not drop more than 5 ft.
  - f. Slump field adjustment only as permitted in ACI 301, Section 4.3.
2. Placing concrete against subgrade/base material: Place on or against firm, damp surfaces free of frost, ice, and free water. Obtain required earth compaction in accordance with Section 31 20 00, "Earth Moving," before concrete placement. Dampen earth surfaces to receive fresh concrete.
  3. Consolidation: Consolidate concrete in accordance with ACI 301, Section 5.3.2.5. Avoid contact between vibrator head and forms, reinforcement, or embedded items.
  4. Construction joints: Make in accordance with ACI 301, Section 5.3.2.6. Coat joints with epoxy resin, in accordance with manufacturer's recommendations.
  5. Expansion and Contraction joints:
    - a. Make in accordance with ACI 301, Section 2.2.2.5.
    - b. Saw cuts are used to create control joints in concrete. The cuts should be made at a predetermined spacing and only after the concrete has obtained sufficient strength to prevent raveling but before internal cracking begins. Typically these cuts are made the morning following the pour.
    - c. Install control joint filler in accordance with manufacturer's instructions.
    - d. Install joint filler 1/2 in. (6 mm) below concrete finish level.
    - e. Prior to sealing, slide expansion joint cap over the expansion joint.
    - f. After concrete is placed and cured, install screwdriver through the top of expansion joint cap, pull free and discard.
    - g. Seal with suitable joint sealant as specified in Section 07 92 00, "Joint Sealants."
  6. Form Removal and Concrete Repair:
    - a. Form removal: Remove in accordance with ACI 301, Section 2.3.2.
    - b. Cut back form ties and examine concrete surfaces for defects. Repair only after permission for patching is given by the TOC Construction Representative.
    - c. Place concrete repair mortar within one hour after mixing. Do not re-temper mortar.

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- d. Repair surface defects in accordance with ACI 301, Section 5.3.7. Cure concrete repairs same as new concrete. Repair and patch defective areas when approved by the TOC Construction Representative. Remove and replace concrete that cannot be repaired and patched to TOC Construction Representative's approval. Complete all concrete repairs prior to final acceptance.
7. Concrete Finishes and Tolerances
- a. Measuring for tolerances shall be performed in accordance with ACI 301, Section 5.3.4.2.
  - b. Formed surfaces: Start finishing following concrete repair and complete within 96 hours after forms have been removed. Finish in accordance with ACI 301 Section 5.3.3.
    - i. Surfaces exposed to earth backfill: Rough form finish.
    - ii. Exterior surfaces exposed to view and/or weather: Smooth form finish.
  - c. Unformed surfaces: Finish in accordance with ACI 301, Section 5.3.4.
    - i. Exterior slabs: Broom finish. Surface shall be Flat per ACI 117, Section 4.8.
- D. Place non-shrink grout where shown on Contract drawings, in accordance with manufacturer's recommendations.

**3.3 CONCRETE PROTECTION AND CURING**

- A. Weather conditions: Protect concrete in accordance with ACI 301, ACI 308.1, and ACI 305.1 or ACI 306.1, if weather conditions so dictate.
- B. Cure concrete in accordance with ACI 301, Section 5.3.6. Clear curing compounds shall be tinted or applied to surfaces marked to show extent of spraying.
- C. Protect concrete during adverse weather conditions in accordance with ACI 301.
- D. Protect concrete from mechanical damage in accordance with ACI 301, Section 1.8.

**3.4 FIELD INSPECTIONS AND TESTS**

- A. Engage a qualified special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Pre-Pour Inspection: The concrete Pre-Pour Inspection Checklist shall be prepared and signed off prior to any concrete pouring. The inspection checklist shall include inspection of the following items prior to pouring concrete: forms, reinforcement, design mix, chamfer of exposed concrete edges, subgrade, embedments, and other items that may need inspection.



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Ensure rebar is correctly located, supported, and tied. Document on Pre-Pour Inspection Checklist along with other required attributes.

- C. Sample and test concrete in accordance with ACI 301, Sections 1.6.3.2 (d) and (e). Record results. Engage a qualified independent testing agency to perform material evaluation tests.
- D. Personnel performing laboratory testing shall be certified as an ACI Concrete Laboratory Technician—Grade I.

END OF SECTION 03 30 00

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**SECTION 03 30 21****CAST-IN-PLACE CONCRETE (SAFETY SIGNIFICANT)****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Tank-Side Cesium Removal (TSCR) Process Enclosure Foundation, Balance of Facilities (BOF) Pad, and BOF Pad Shield Wall
1. Formwork.
  2. Reinforcement.
  3. Cast-in-place items.
  4. Concrete.
  5. Joint fillers.
  6. Bonding agents.
  7. Non-shrink grout.
  8. Repair materials.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. American Association of State Highway and Transportation Officials (AASHTO)
- |              |  |
|--------------|--|
| AASHTO M 254 | Standard Specification for Corrosion-Resistant Coated Dowel Bars |
|--------------|--|
- B. American Concrete Institute (ACI)
- |               |  |
|---------------|--|
| ACI 117       | Tolerances for Concrete Construction and Materials |
| ACI 301, 2010 | Specification for Structural Concrete              |
| ACI 305.1     | Standard Specification for Hot Weather Concreting  |
| ACI 306.1     | Standard Specification for Cold Weather Concreting |

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ACI 308.1	Specification for Curing Concrete
ACI 318, 2014	Building Code Requirements for Structural Concrete and Commentary
ACI CP-1	Technical Workbook for ACI Certification of Concrete Field Testing Technician-Grade 1
C.	American Society for Mechanical Engineers (ASME)
ASME NQA-1, 2008/2009	Quality Assurance Requirements for Nuclear Facility Applications (2008 with ASME NQA-1a-2009 Addenda)
D.	ASTM International (ASTM)
ASTM A615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A853	Standard Specification for Steel Wire, Carbon, for General Use
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C881	Standard Specification for Epoxy Resin Based Bonding Systems for Concrete
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars

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- |  |  |
|--|--|
| ASTM C1077   | Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation       |
| ASTM C1107   | Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)   |
| ASTM C1240   | Standard Specification for Silica Fume Used in Cementitious Mixtures   |
| ASTM C1293   | Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction  |
| ASTM C1315   | Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete                           |
| ASTM C1602   | Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete  |
| ASTM D1752   | Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction |
| ASTM E329  | Standard Specification for Agencies Engaged in Construction Inspection and/or Testing  |
| E. International Code Council (ICC)                  |  |
| IBC, 2015  | International Building Code  |
| F. National Ready Mixed Concrete Association (NRMCA) |  |
| Quality Control Manual                               | Certification of Ready Mixed Concrete Production – Section 3 Facilities  |
| G. Washington Administrative Code (WAC)              |  |
| WAC 173-303-640                                      | Dangerous Waste Regulations Washington State   |

**1.3 SUBMITTALS**

- A. See Contract Statement of Work for submittal procedures.
- B. Approval Required.
  - 1. Subcontractor Quality Assurance (QA) Plan (QAP), including all sub-tier subcontractors, that meets the basic requirements of ASME NQA-1, including Part II, Subpart 2.5, as applicable.

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2. Commercial Grade Dedication (CGD) Plans compliant with NQA-1, Part II, Subpart 2.14 for concrete, concrete constituents, and reinforcing steel, as required, and as included within this Section in accordance with Subcontractor's QAP as approved by WRPS.
3. An inspection plan that complies with Subcontractor's QAP and the IBC, Section 1705.3. Subcontractor shall prepare comprehensive inspection plan that includes all inspections and tests required by codes, standards, and CGD Plans applicable to the work.<sup>6</sup>
4. Documentation required by inspection plan such as logs and results of tests and inspections performed.
5. Documentation that testing agencies have an NQA-1-compliant quality program prior to performing any work.
6. QA/Quality Control Program and applicable Implementing Procedures of the concrete supplier to be implemented during material receiving, storage, and handling; concrete batching and production; and delivery.
7. Product Data and Material Certificates: Submit for each of the following, signed by the manufacturers:
  - a. Cementitious materials.
  - b. Admixtures.
  - c. Steel reinforcement.
  - d. Curing compounds.
  - e. Bonding agents.
  - f. Adhesives.
  - g. Joint-filler.
  - h. Grout.
  - i. Repair materials.
8. Field Quality Control Reports: Submit reports from a qualified testing agency indicating compliance with requirements:
  - a. Steel reinforcement placement.
  - b. Verification of use of required design mix.

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<sup>6</sup> This includes hold points associated with the inspections and tests required by IBC Ch. 17.

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- c. Concrete placement, including conveying and depositing.
  - d. Curing procedures and maintenance of curing temperature.
  - e. Composite sample (slump, air content, concrete temperature) tests.
  - f. Unit weight tests.
  - g. Compressive strength tests.
9. Steel reinforcement, reinforcement supports, embeds and accessories:
- a. Reinforcing-bar manufacturer's Certified Material Test Reports (CMTRs) traceable to the heat number or test identification number on the shipping tags.
  - b. Reinforcement Shop Drawings: Prior to fabrication of reinforcement, submit placement drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, and grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
  - c. CMTRs for other construction materials such as Form Savers, etc. Mechanical splice submittals shall also be provided with ICC Evaluation Service, Inc. (ICC-ES) Evaluation Service Reports (ESRs), or equivalent independent third-party-evaluation document, showing full compliance with the IBC.
10. Concrete Data:
- a. CMTRs and/or Certificate of Compliance and/or test reports and/or test results and/or manufacturer data showing conformance with requirements for aggregates, cement, other cementitious materials, water source, and all admixtures.
  - b. Methodology and test data used to establish mixture proportions.
  - c. Mix proportions and characteristics.
  - d. Information on types, classes, producers' names, and plant locations for cementitious materials; types, pit or quarry locations, producers' names, gradings, and properties required by ASTM C33 for aggregates; types, brand names, and producers' names for admixtures; and source of supply for water and ice. Except for admixtures and water, test results confirming conformance to applicable ASTM specifications shall not be older than 90 days. Test results for aggregate soundness, abrasion, and reactivity may be older than 90 days, but not older than one year, provided test results for the other properties specified in ASTM C33 indicate that aggregate quality has not changed.

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- e. Test reports for mix design, all materials, and testing as required by this Section and/or referenced codes and standards.
- 11. Finisher qualifications for finisher contractor and finishers per ACI 301, Section 5.1.2.
- 12. Floor surface flatness and levelness measurements.
- 13. Detailed plan for cold weather placements including curing and protection of concrete placed and cured in ambient temperature below 40°F.
- 14. Detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 80°F.
- 15. Concrete Placement drawings: Prior to setting of forms, submit placement drawings indicating planned pouring sequence and locations of any planned joints, including those not shown on the Contract drawings.
- 16. Concrete repair materials and methods per ACI 301, Section 5.1.2.
- 17. Minutes of preinstallation conference.
- 18. Submittals shall include the documentation listed in Paragraph 1.4.

#### 1.4 QUALITY ASSURANCE

The Seller shall comply with the following QA requirements in addition to those of the Contract Statement of Work:

- A. Subcontractors shall identify, collect, compile, maintain, and protect complete files and all quality-related records for supplied equipment in accordance with their approved QAP.
- B. All safety-related material shall be procured from a supplier meeting NQA-1 or procured as Commercial Grade Items in accordance with NQA-1 Part II Subpart 2.14 and Subcontractor's QAP with a nuclear safety designation.
- C. The placement of all concrete (including implementation of hot or cold weather concrete plans) and reinforcing shall be performed in accordance with NQA-1 and Subcontractor's approved QAP.
- D. The concrete supplier shall be currently certified by the NRMCA's "Certification of Ready Mixed Concrete Production Facilities" with compliance to ASTM C94 requirements for production facilities and equipment.
- E. Acquire cement, aggregate, and fly ash from same source as used to produce the specific mix design for all work. Formally notify TOC Construction Representative of any material source changes at least one month prior to concrete delivery, including the test agency test documentation.

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- F. **Qualification of Concrete Inspection/Testing Laboratory:** The laboratory including equipment, personnel, and procedures shall meet the requirements of ASTM C1077 and ASTM E329 and shall be accredited by an independently recognized authority. The testing agency shall perform work under an NQA-1 compliant program. Field and laboratory testing agencies, including laboratory locations shall be approved by TOC Construction Representative, or designee, in accordance with the contract documents, and provisions of the IBC.
- G. The rebar fabricator shall maintain Heat Number Traceability for all rebar to ensure heat numbers for the rebar are traceable to the rebar delivered. These heat numbers (or lot numbers if they correlate to the heat numbers on the CMTR documentation) must be identified on the tags attached to the rebar bundles and traceable to the associated CMTR(s). Once the tags on the rebar bundles are confirmed to match the associated CMTRs by the appropriate receiving inspection; the bundles may be broken and the rebar located as required. Traceability shall be maintained in accordance with the associated requirements herein.
- H. **Deliverable Documentation:** The following documents and records, required by this Section, shall be delivered to TOC Construction Representative in accordance with Contract Documents.

<u>Document</u>	<u>Paragraph</u>
Supplier Certification	1.4.D
Laboratory Qualifications	1.4.F
Inspection Personnel Certification and Qualification Records	1.6.A & 1.6.B
Pre-Pour Inspection Checklist and Trip Tickets	3.2.C.1.b, 3.2.C.1.c, and 3.4.B
Concrete Test Results	3.4.C

- I. Perform work in accordance with the applicable sections of ACI 117, ACI 301, and ACI 318.
- J. TSCR Process Enclosure Foundation is Safety Significant as shown on the Drawings.
1. All safety-related Structures, Systems, and Components will be procured, inspected, accepted, and verified in accordance with contract requirements.
  2. Critical characteristics apply to concrete as well as all embedded items shown on the structural drawings, including, but not limited to, reinforcing, steel embeds, etc.
  3. The critical characteristics are:
    - a. Concrete compressive strength.



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- b. Reinforcing yield strength.
  - c. Placement of concrete and reinforcing per ACI 301 and ACI 117.
- K. Suspect and Misrepresented Products: See Contract Statement of Work for required measures to prevent use of misrepresented products.
- L. Preinstallation Conference: Conduct conference at Project site.
- 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
    - a. Contractors' superintendent.
    - b. Independent testing agency.
    - c. Ready-mix concrete manufacturer.
    - d. Concrete subcontractor.
  - 2. Coordinate meeting. Request the following representatives attend:
    - a. TOC Construction Representative.
    - b. WRPS Quality Assurance.
    - c. Structural engineer.
  - 3. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold and hot-weather concreting procedures, fall protection, lifts, critical lifts, curing procedures, construction contraction and isolation joints, and joint-filler strips, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. See the Contract Statement of Work for general requirements.
- B. Handling, storage, shipping and receiving of all items in this Section shall be in accordance with Contract Statement of Work.
- C. Reinforcing material shall be stored in such a manner as to permit inventory control and to preclude damage or degradation of properties to less than ASTM-specification requirements. Protect from contaminants such as grease, oil, and dirt. Reinforcing steel, by groups of bars or shipments, shall be identifiable by documentation, tags, or other means of control, to a specific heat number or heat code until review of the

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certified material test report has been performed. Ensure bar sizes can be accurately identified after bundles are broken and tags removed. Painting on reinforcement, other than for traceability requirements identified herein, must be approved in writing by TOC Construction Representative.

**1.6 QUALIFICATION OF CONCRETE INSPECTORS**

- A. Personnel performing field testing of concrete shall be ACI Concrete Field Testing Technicians, Grade 1, who have received formal certification in accordance with ACI CP-1, at a minimum, or equivalent. Equivalent certification programs shall include requirements for written and performance examination as stipulated in ACI 301, Section 1.6.2.
- B. Personnel performing laboratory testing shall be certified as an ACI Concrete Laboratory Technician—Grade I, at a minimum.

**PART 2 PRODUCTS****2.1 SUBSTITUTES**

- A. See the Contract Statement of Work for substitution approvals.

**2.2 MATERIALS**

- A. Concrete
  - 1. Cement: ASTM C150, Type II.
  - 2. Fly ash or other pozzolans used as admixtures shall conform to ASTM C618.
  - 3. Ground-granulated blast-furnace slag used as an admixture shall conform to ASTM C989.
  - 4. Silica fume used as an admixture shall conform to ASTM C1240.
  - 5. Aggregates: ASTM C33, 3/4 in. maximum size.
  - 6. Water used in mixing concrete shall be potable or, if not potable, shown to be in compliance with ASTM C1602.
  - 7. Admixtures: Furnish from one manufacturer.
    - a. Admixtures to be used in concrete shall be submitted with the mixture design and approved by TOC Construction Representative prior to use.
    - b. Characteristics: Compatible with each other and free of chlorides or other corrosive chemicals.
    - c. Air-entraining admixture: ASTM C260.

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- d. Water-reducing admixtures, retarding admixtures, accelerating admixtures, water-reducing and retarding admixtures, and water-reducing and accelerating admixtures: ASTM C494.
  - e. High-range water-reducing admixture (superplasticizer): ASTM C494, Type F or Type G.
8. Properties (if not specified on drawings):
- a. Minimum allowable compressive strength: 4,500 psi at 28 days.
  - b. Slump range at site:
    - i. 4.5 in. minimum, 8 in. maximum for concrete with a high range water reducing admixture.
    - ii. 3 in. minimum, 5 in. maximum for concrete without a high range water reducing admixture.
  - c. Air content: Four to six percent when tested in accordance with ASTM C231.
  - d. Proportions: In accordance with ACI 301, Section 4.2.3, and ASTM C94.
  - e. Time of discharge: In accordance with ASTM C94, Section 12, and ACI 301, Sections 4.1.2.12 and 4.3.2.2, unless otherwise approved based on trial batch test results.
9. Measuring, Mixing, and Delivery: In accordance with ASTM C94.
- B. Reinforcing Steel
- 1. Steel bars: ASTM A615 or ASTM A706, deformed, Grade 60.
  - 2. Manufacturer's CMTRs are required for each delivery and they must be traceable to the reinforcing steel tag bundles via the lot or heat number. Once the documentation is confirmed to be adequate and traceable by the responsible receiving inspection personnel, the bundles may be broken. All reinforcement within a specific lot/heat number shall be painted with a non-permanent marking paint. Each lot shall be assigned a specific color, and each bar in a lot shall be painted with the respective assigned color at each end. The paint strip shall be 2 in. to 6 in. wide maximum. If the painted ends are cut off or the paint otherwise removed during fabrication or installation, the paint shall be reapplied. If bars are to be cut, the paint markings shall be transferred on bars prior to cutting. Bars shall be traced by lot/heat numbers by location in the structure. A location map shall be provided to TOC Construction Representative by the Subcontractor for review prior to concrete placement.
  - 3. Tie wire: ASTM A853 carbon steel, 16-gage minimum, annealed.

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4. Couplers: Couplers shall be Type 2 couplers or WRPS-approved alternates and shall meet the following requirements:
  - a. Mechanical splices shall develop 125% of the yield strength of the bar in compression.
  - b. Mechanical splices shall develop the specified tensile strength of the bar.
  - c. Mechanical splices shall have an ICC-ES ESR (or equivalent) that is compliant with the code of record for the Project.
- C. Embedded conduit couplings: Stub-EASE™ by CSUE Technologies or approved equal.
- D. Post-Installed Anchors: See Section 03 15 00, “Post-Installed Concrete Anchors (Non-Safety Related).” For Safety-Significant anchors, see Section 03 15 21, “Post-Installed Concrete Anchors (Safety Significant).”
- E. Expansion joint filler: ASTM D1752, Type II, flexible foam, Ceramar by W.R. Meadows, 1/2 in. thick.
- F. Joint sealants: See Section 07 92 00, “Joint Sealants.”
- G. Forms: Wood, steel, plywood, or Masonite Corporation “Concrete Form Presdwood®<sup>7</sup>,” as required for various specified finishes.
- H. Bonding Agent: Epoxy resin emulsion appropriate for bonding fresh concrete to existing set concrete, ASTM C881, Type IV.
- I. Non-Shrink Grout: ASTM C1107, premixed compound consisting of non-metallic aggregate, cement, water-reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.
- J. Curing Compound: ASTM C309 or C1315.
- K. Joint Dowel Bars: ASTM A615, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs. Install with grease/epoxy or a sleeve.
  1. Paint with one coat of paint conforming to AASHTO M 254 and coat one half of the bar with grease.
  2. Plastic or gage metal (26 gage minimum) sleeves with an inside diameter of 1/16-in. greater than the dowel bar that it encases, that have the strength, durability, and design to provide free movement of the dowel relative to the concrete slab and that are specifically manufactured for this purpose.

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<sup>7</sup> Presdwood is a registered trademark of Masonite Corporation, Chicago, Illinois.

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**PART 3 EXECUTION****3.1 PREPARATION****A. Form Construction**

1. Install formwork in accordance with ACI 301, Section 2.3. Interior shape and rigidity shall be such that finished concrete will meet requirements of Drawings and approved shop drawings within tolerances specified in ACI 117, Section 4.
2. Prepare form surfaces in accordance with ACI 301, Section 2, using specified form-coating materials, or as described below.
3. Forms for surfaces which will be permanently concealed from view may be saturated with water, before placing concrete, instead of other treatments. In freezing weather, forms shall be treated with oil or stearate.
4. Clean forms of foreign material before placing concrete.

- B.** Prepare setting drawings, diagrams, templates, and instructions for installation of anchorages, such as concrete inserts, anchor bolts, embedded plates, and miscellaneous items having integral anchors, to be embedded in concrete.

**3.2 INSTALLATION****A. Reinforcing Steel**

1. Fabricate and place bars to dimensions shown on Contract drawings, within tolerances shown in ACI 117, Sections 2.1 and 2.2.
2. Tie to prevent displacement during placement of concrete.
3. Do not force into concrete after initial set has started.
4. Provide concrete cover for reinforcement protection per dimensions given in ACI 301, Section 3.3, except where shown otherwise on Contract drawings or approved shop drawings.
5. Reinforcement shall be supported and fastened together to prevent displacement by construction loads, or placement of concrete beyond specified tolerances. Reinforcement supported from ground shall rest on precast, square concrete blocks, with a minimum surface area of 4-in<sup>2</sup> and having a compressive strength equal to specified compressive strength of concrete being placed. Other means of support require prior approval.

- B.** Verify that reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete. Document inspection on the Pre-Pour Inspection Checklist.

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## C. Concrete

1. Before placing:
  - a. Notify TOC Construction Representative prior to placement of concrete supporting tank system components for witnessing of activities by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.
  - b. Approve "Pre-Pour Inspection Checklist," including identification of sections of structure to be placed, maximum size of coarse aggregate, design strength, formwork, reinforcing, and embedded items.
  - c. For each truck load, collect "Trip Ticket." Trip Tickets shall contain information listed in ASTM C94, paragraphs 14.1.1 through 14.1.10, and water to cementitious material ratio. Before test sampling and placing concrete, Trip Ticket shall be reviewed by the Testing Agency's field inspector. After depositing concrete, Trip Ticket shall be completed and submitted.
  - d. Discharge concrete rinsate at Company-approved location.
  - e. Place in accordance with ACI 301, Section 5.3. Do not drop more than 5 ft.
  - f. Slump field adjustment only as permitted in ACI 301, Section 4.3.
2. Placing concrete against subgrade/base material: Place on or against firm, damp surfaces free of frost, ice, and free water. Obtain required earth compaction in accordance with Section 31 20 00, "Earth Moving," before concrete placement. Dampen earth surfaces to receive fresh concrete.
3. Consolidation: Consolidate concrete in accordance with ACI 301, Section 5.3.2.5. Avoid contact between vibrator head and forms, reinforcement, or embedded items.
4. Construction joints: Make in accordance with ACI 301, Section 5.3.2.6. Coat joints with epoxy resin, in accordance with manufacturer's recommendations.
5. Expansion and Contraction joints:
  - a. Make in accordance with ACI 301, Section 2.2.2.5
  - b. Saw cuts are used to create control joints in concrete. The cuts should be made at a predetermined spacing and only after the concrete has obtained sufficient strength to prevent raveling but before internal cracking begins. Typically these cuts are made the morning following the pour.
  - c. Install control joint filler in accordance with manufacturer's instructions.

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- d. Install joint filler 1/2 in. (6 mm) below concrete finish level.
  - e. Prior to sealing, slide expansion joint cap over the expansion joint.
  - f. After concrete is placed and cured, install screwdriver through the top of expansion joint cap, pull free, and discard.
  - g. Seal with suitable joint sealant as specified in Section 07 92 00, "Joint Sealants."
6. Form Removal and Concrete Repair:
- a. Form removal: Remove in accordance with ACI 301, Section 2.3.2.
  - b. Cut back form ties and examine concrete surfaces for defects. Repair only after permission for patching is given by the TOC Construction Representative.
  - c. Place concrete repair mortar within one hour after mixing. Do not re-temper mortar.
  - d. Repair surface defects in accordance with ACI 301, Section 5.3.7. Cure concrete repairs same as new concrete. Repair and patch defective areas when approved by the TOC Construction Representative. Remove and replace concrete that cannot be repaired and patched to TOC Construction Representative approval. Complete all concrete repairs prior to final acceptance.
7. Concrete Finishes and Tolerances
- a. Measuring for tolerances shall be performed in accordance with ACI 301, Section 5.3.4.2.
  - b. Formed surfaces: Start finishing following concrete repair and complete within 96 hours after forms have been removed. Finish in accordance with ACI 301 Section 5.3.3.
    - i. Surfaces exposed to earth backfill: Rough form finish.
    - ii. Exterior surfaces exposed to view and/or weather: Smooth form finish.
  - c. Unformed surfaces: Finish in accordance with ACI 301, Section 5.3.4.
    - i. Exterior slabs: Broom finish. Surface shall be Flat per ACI 117, Section 4.8.
- D. Place non-shrink grout where shown on Contract drawings, in accordance with manufacturer's recommendations.

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**3.3 CONCRETE PROTECTION AND CURING**

- A. Weather conditions: Protect concrete in accordance with ACI 301, ACI 308.1, and ACI 305.1 or ACI 306.1, if weather conditions so dictate.
- B. Cure concrete in accordance with ACI 301, Section 5.3.6. Clear curing compounds shall be tinted or applied to surfaces marked to show extent of spraying.
- C. Protect concrete during adverse weather conditions in accordance with ACI 301, Section 1.8.
- D. Protect concrete from mechanical damage in accordance with ACI 301, Section 1.8.

**3.4 FIELD INSPECTIONS AND TESTS**

- A. Engage a qualified special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Pre-Pour Inspection: The concrete Pre-Pour Inspection Checklist shall be prepared and signed off prior to any concrete pouring. The inspection checklist shall include inspection of the following items prior to pouring concrete: forms, reinforcement, design mix, chamfer of exposed concrete edges, subgrade, embedments, and other items that may need inspection.
  - 1. Ensure rebar is correctly located, supported, and tied. Document on Pre-Pour Inspection Checklist along with other required attributes.
- C. Sample and test concrete in accordance with ACI 301, Sections 1.6.3. Record results.

END OF SECTION 03 30 21



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**SECTION 03 30 53****MISCELLANEOUS CAST-IN-PLACE CONCRETE****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Cast in place concrete placements. (Cover Blocks, Pipe Anchors, Riser Caisson, etc.)

**1.2 RELATED SECTIONS**

- A. Section 31 23 33, "Trenching and Backfilling."

**1.3 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M 254	Standard Specification for Corrosion-Resistant Coated Dowel Bars
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- B. American Concrete Institute (ACI)

ACI 117	Tolerances for Concrete Construction and Materials
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ACI 301, 2010	Structural Concrete for Buildings
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ACI 305R	Guide to Hot Weather Concreting
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ACI 306.1	Standard Specification for Cold Weather Concreting
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ACI 318, 2014	Building Code Requirements for Structural Concrete and Masonry
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ACI 349, 2013	Code Requirements for Nuclear Safety-Related Concrete Structures
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- C. ASTM International (ASTM)

ASTM A108	Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
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ASTM A185	Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
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ASTM A615, 2016	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A706	Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
ASTM A853	Standard Specification for Steel Wire, Carbon, for General Use
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C94, 2016	Standard Specification for Ready-Mixed Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM F593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Standard Specification for Stainless Steel Nuts
D.	Concrete Reinforcing Steel Institute (CRSI)
	CRSI RB4.1 Supports for Reinforcement Used in Concrete
E.	National Ready Mixed Concrete Association (NRMCA)
	Quality Control Manual Certification of Ready Mixed Concrete Production – Section 3 Facilities
F.	American Welding Society (AWS)
	AWS D1.1/D1.1M, 2015 Structural Welding Code-Steel
G.	Washington Administrative Code (WAC)
	WAC 173-303-640 Dangerous Waste Regulations Washington State

**1.4 SUBMITTALS**

- A. See Contract Statement of Work for submittal procedures.

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## B. Approval Required.

1. Certified Material Test Reports: Before fabrication, submit manufacturer's certified test reports showing chemical analysis and physical tests made on each heat or heats of steel from which reinforcement was manufactured. Furnish separate certificates for each group of items furnished by each Supplier.
2. Drawings for new concrete items: Before fabrication, submit complete reinforcing steel details, including lap splices and bend radiuses not shown on the Drawings.
3. Concrete Data: Before mixing, submit concrete materials, mix design, and mix proportions, in accordance with ACI 301 Section 4. Identify each material to be used in concrete, including amount, by weight, to be utilized in each cubic yard of plastic mix.
4. Reinforcement Shop Drawings: Prior to fabrication of reinforcement, submit placement drawings that detail fabrication, bending, and placement. Include bars sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
5. Setting drawings, diagrams, templates and instructions: Prior to fabrication, submit information for installation of anchorages, such as concrete inserts, anchor bolts and miscellaneous items having integral anchors, to be embedded in concrete.
6. Certificate of Compliance: Provide Certificate of Compliance for cast-in-place anchors indicating they meet the requirements of this Specification.
7. Concrete Placement drawings: Prior to setting of forms, submit placement drawings indicating planned pouring sequence and locations of any planned joints, including those not shown on the Contract drawings.
8. Concrete curing procedure: Before mixing, submit a description of materials and methods of curing, in accordance with ACI 301, Section 5.3.6.
9. Cold Weather Concreting Procedures: Before placement and if concrete will be placed during cold weather, submit procedure meeting requirements of ACI 301, Section 5.3.2.1(b) and ACI 306.1. If concrete will not be placed during cold weather, submit a statement to that effect.
10. Hot Weather Concreting Procedures: Before placement and if concrete will be placed during hot weather, submit procedure meeting requirements of ACI 301, Section 5.3.2.1(c). If concrete will not be placed during hot weather, submit a statement to that effect.
11. Product data of non-shrink grout.
12. Submittals shall include the documentation listed in Paragraph 1.5.

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## C. Informational Submittals:

## 1. Field Quality Control Reports:

- a. **Pre-Pour Inspection:** The concrete pre-pour inspection checklist shall be prepared and signed off prior to any concrete pouring. See Paragraph .3.3.B.1.b The inspection checklist shall include inspection of the following items prior to pouring concrete: forms, concrete thickness, re-bar size and placement, bonding electrode placement, subgrade, embedments, weather conditions, concrete mix, concreting procedures, testing requirements, and other items that may need inspection.

**1.5 QUALITY ASSURANCE**

- A. **Certification of Concrete Production Facility:** The concrete supplier shall be certified according to NRMCA “Certification of Ready Mixed Concrete Production Facilities,” with compliance to ASTM C94 requirements for production facilities and equipment.
- B. **Qualification of Concrete Inspection/Testing Laboratory:** The laboratory including equipment, personnel, and procedures shall meet the requirements of ASTM C1077 and shall be accredited by an independently recognized authority within the last two years to perform the work described in this Section.
- C. **Pour Slip:** The concrete pour slip shall be signed off prior to any concrete pouring. The pour slip shall include inspection of the following items prior to pouring concrete; forms, re-bar, subgrade, embedments, and other items that may need inspection.
- D. **Deliverable Documentation:** The following documents and records, required by this Section, shall be delivered to Construction Document Control in accordance with Contract Documents.

DocumentParagraph

Supplier Certification	1.5.A
Laboratory Qualifications	1.5.B
Inspection Personnel Qualification Records	1.6.A
Pre-Pour Inspection Checklist and Trip Tickets	1.4.C.1, 1.6.B, 3.3.B.1.b, and 3.3.B.1.d
Concrete Test Results	3.5.F

- E. Perform work in accordance with the applicable sections of ACI 117, ACI 301, ACI 318, and ACI 349.
- F. **Suspect and Misrepresented Products:** See Contract Statement of Work for required measures to prevent use of misrepresented products.

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**1.6 QUALIFICATION OF CONCRETE INSPECTORS**

- A. Personnel performing field testing of concrete shall be certified as ACI Concrete Field Testing Technician Grade 1. Equivalent certification programs shall include requirements for written and performance examination as stipulated in ACI 301, Section 1.6.1.2.
- B. Pre-Pour Inspection: The concrete pre-pour inspection checklist shall be prepared and signed off prior to any concrete pouring. The inspection checklist shall include inspection of the following items prior to pouring concrete: forms, re-bar, subgrade, embedments, and other items that may need inspection.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. See the Contract Statement of Work for general requirements.
- B. Steel reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- C. Waterstops: Store waterstops under cover to protect from moisture dirt, oil, sunlight, and other contaminants.

**PART 2 PRODUCTS****2.1 SUBSTITUTION**

- A. See the Contract Statement of Work for substitution approvals.

**2.2 MATERIALS**

- A. Concrete
  - 1. Cement: ASTM C150, Type II (low alkali).
  - 2. Aggregates: ASTM C33, 3/4-in. maximum size. Fine aggregate: free of materials with deleterious reactivity to alkali in cement.
  - 3. Air-entraining admixture: ASTM C260, Sika Chemical Company "SIKA AER," Chem-Masters Corporation "Adz-Air," or Protex Industries "AES."
  - 4. Properties:
    - a. Minimum allowable compressive strength: 4,500 lb/in<sup>2</sup> at 28 days, or as required by design documents.
    - b. Slump: 4 in. in accordance with ACI 301, Section 4.2.2.2.
    - c. Air content: In accordance with ACI 301, Table 4.2.2.4.

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- d. Proportions: In accordance with ACI 301, Section 4.2.3, and ASTM C94.
  - e. Time of discharge: In accordance with ASTM C94, Section 12 and ACI 301, Section 4.3.2.2.
  - f. Measuring, Mixing, and Delivery: In accordance with ASTM C94.
5. Controlled Density Fill: Refer to Section 31 23 23.33, “Flowable Fill (Controlled Density Fill).”
  6. Reinforcing Steel
    - a. Steel bars: ASTM A615, deformed, Grade 60 or ASTM A706, deformed.
    - b. Tie wire: ASTM A853 carbon steel, 16-gage minimum, annealed.
    - c. Welded Steel Wire Fabric: ASTM A185 plain type in flat sheets.
  7. Joint Dowel Bars: ASTM A615, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs. Install with grease/epoxy or a sleeve.
    - a. Paint with one coat of paint conforming to AASHTO M 254 and coat one half of the bar with grease.
    - b. Plastic or gage metal (26 gage minimum) sleeves with an inside diameter of 1/16-in. greater than the dowel bar that it encases, that have the strength, durability, and design to provide free movement of the dowel relative to the concrete slab and that are specifically manufactured for this purpose.
  8. Non-shrink Grout
    - a. In accordance with ASTM C1107
    - b. Minimum strength of fluid grout, 2,000 psi at 1 day, 4,000 psi at 3 days, and 7,500 psi at 28 days.
  9. Headed Weld Stud Anchors: ASTM A108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
  10. Cast-In-Place Anchors: ASTM F593 CW2 threaded rods with ASTM F594 nuts.
  11. Post-Installed Anchors: See Sections 03 15 00, “Post-Installed Concrete Anchors (Non-Safety Related),” and 03 15 21, “Post-Installed Concrete Anchors (Safety Significant).”

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12. Forms: Wood, steel, or plywood as required for various specified finishes.
  - a. Form facing panels shall provide continuous, true, and smooth concrete surfaces.
  - b. Form release agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
13. Waterstops: Self-expanding Butyl strip, manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 in.

### 2.3 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement in accordance with ACI 301, Section 3.2.2.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Form Construction
  1. Install form work in accordance with ACI 301, Section 2.3 to support vertical, lateral, and construction loads that might be applied, until structure can support such loads.
  2. Construct formwork such that interior shape and rigidity of finished concrete will meet requirements of the Drawings and approved shop drawings within tolerances specified in ACI 117, Section 4.
  3. Prepare form surfaces in accordance with ACI 301, Section 2 using specified form coating materials, or as described below.
  4. Forms for surfaces which will be permanently concealed from view may be saturated with water, before placing concrete, instead of other treatment. In freezing weather, forms shall be treated with oil or stearate.
  5. Clean forms of foreign material before placing concrete.
- B. Prepare setting drawings, diagrams, templates, and instructions for installation of anchorages, such as concrete inserts, anchor bolts and miscellaneous items having integral anchors, to be embedded in concrete.
- C. Notify TOC Construction Representative prior to placement of concrete support tank system components for witnessing of activities by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.

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**3.2 EMBEDDED ITEMS**

- A. Prepare setting drawings, diagrams, templates, and instructions for installation of anchorages, such as concrete inserts, anchor bolts, and miscellaneous items having integral anchors, to be embedded in concrete.
- B. Place and secure anchorage devices and other embedded items as required for adjoining work that is attached to or supported by cast-in-place concrete. All embedded items shall be securely supported to prevent displacement during concrete placement and finishing.
- C. Verify that anchors, plates, edge angles, reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete. Document inspection on pour slip.

**3.3 INSTALLATION****A. Reinforcing Steel**

- 1. Fabricate and place bars to dimensions shown on Contract drawings, within tolerances shown in ACI 117, Section 2.1, Figure 2.1.
- 2. Place as shown on Drawings, within tolerances specified in ACI 117, Section 2.2 and ACI 301, Section 3.3.2.
- 3. Tie to prevent displacement during placement of concrete.
- 4. Do not force into concrete after initial set has started.
- 5. Provide concrete cover for reinforcement protection per dimensions given in ACI 301, Section 3.3.2.3, except where shown otherwise on Contract Drawings or approved Drawings.
- 6. Reinforcement shall be supported and fastened together to prevent displacement by construction loads, or placement of concrete beyond specified tolerances. Reinforcement supports shall meet the requirements of Contract drawings and CRSI RB4.1.

**B. Concrete**

- 1. Before placing:
  - a. Verify that anchors, plates, reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete, and that required inspections have been performed. Document inspection on pour slip.
  - b. Contractor shall develop a Concrete Pre-Pour Checklist. Checklist shall be reviewed with the Buyer's TOC Construction Representative prior to placing concrete. At a minimum, the checklist shall include:



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- i. Formwork placement
- ii. Earth compaction
- iii. Reinforcement placement
- iv. Embedded items
- v. Bonding electrode
- vi. Concrete Mix
- vii. Testing Requirements
- viii. Weather conditions
- ix. Approval of all submittals prior to pour
- x. Availability of associated materials and labor

Note: Use separate checklist for each day and each concrete mix.

- c. Approve "Pour Slip," including identification of sections of structure to be placed, maximum size of coarse aggregate, and design strength.
  - d. For each truck load, collect "Trip Ticket." Trip Tickets shall contain information listed in ASTM C94, paragraphs 14.1.1 through 14.1.10, and water/cement ratio.
  - e. Discharge concrete rinsate at Company-approved location.
  - f. Place in accordance with ACI 301, Section 5.3.2. Do not drop more than 5 ft.
  - g. Note: the 5 ft drop is not an ACI 301 requirement.
  - h. Temper only as permitted in ACI 301, Section 4.3.2.
2. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, Section 4.3.2.
    - a. Addition of water shall be in accordance with ASTM C94.
    - b. Do not add water to concrete after adding high-range, water-reducing admixtures to mixture.
  3. Before test sampling and placing concrete, batch/trip ticket shall be reviewed by the Testing Agency's field inspector. After depositing concrete, batch ticket shall be completed and submitted.

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4. Cold Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.
  - a. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  - b. When the average the highest and lowest ambient temperature from midnight to midnight is expected to be less than 40°F for more than three successive days, deliver concrete to meet the following minimum temperatures immediately after placement unless otherwise specified:
    - i. 55° for sections with least dimension less than 12 in.
    - ii. 50° for sections with least dimension 12 to 36 in.
    - iii. 45° for sections with least dimension 36 to 72 in.
    - iv. 40° for sections with least dimension greater than 72 in.
  - c. The temperature of concrete as placed shall not exceed these values by more than 20° F. These minimum temperature requirements may be terminated if temperatures above 50°F occur during more than half of any 24-hour duration.
  - d. Do not use frozen materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
5. Hot Weather Placement: Comply with ACI 301 and ACI 305R and as follows:
  - a. Maintain concrete temperature below 90°F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  - b. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
6. Place nonshrink grout where shown on Contract drawings, in accordance with manufacturer's recommendations.
7. Placing concrete against subgrade/base material: Place on or against firm, damp surfaces free of frost, ice, and free water. Obtain required earth compaction in accordance with Section 31 23 33, "Trenching and Backfilling," before concrete placement. Dampen earth surfaces to receive fresh concrete.
8. Consolidation: Consolidate concrete in accordance with ACI 301, Section 5.3.2.5.
  - a. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.

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- b. Maintain reinforcement in position on chairs during concrete placement.
  - c. Screed slab surfaces with a straight edge and strike off to correct elevations.
  - d. Slope surfaces uniformly to drains/trenches where required.
9. Form Removal and Concrete Repair
- a. Form removal: Remove in accordance with ACI 301, Sections 2.3.2 and 2.3.4.
  - b. Cut back form ties and examine concrete surfaces for defects. Repair only after permission for patching is given by the TOC Construction Representative.
  - c. Place concrete repair mortar within 1 hour after mixing. Do not re-temper mortar.
  - d. Repair surface defects in accordance with ACI 301, Section 5.3.7. Cure concrete repairs same as new concrete.
10. Concrete Finishes and Tolerances
- a. Measuring for tolerances shall be performed in accordance with ACI 301, Section 5.3.4.2.
  - b. Finish in accordance with the following ACI 301 sections, as required:
    - i. Cover block top surface                      Section 5.3.4.2.c
    - ii. Power trowel is not required.
  - c. Finish top of cover blocks to the following tolerance: Measure by placing a freestanding (unleveled) 10 foot straightedge anywhere on the top surface. The gap below the straightedge shall not exceed 1/8 in.
  - d. Cover block weight and testing: Determine weight of each block after fabrication. Load test blocks by adding 25% (+) 5% (-) 0% of block weight to the block and lift combined weight. Conduct load test after concrete strength has achieved 28 day minimum design strength as determined by standard and field cured test cylinders.
  - e. Formed surfaces: Start finishing following concrete repair and complete within 96 hours after forms have been removed. Finish in accordance with Contract drawings and ACI 301 Section 5.3.3.
    - i. Surfaces exposed to earth backfill: Rough form finish.
    - ii. Exterior surfaces exposed to weather: Smooth form finish.

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- iii. Repair and patch tie holes and defects.
- iv. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
- v. Unformed surfaces: Finish in accordance with ACI 301, Section 5.3.4.
  - Exterior equipment slabs subject to foot traffic: Broom finish.

**3.4 CONCRETE PROTECTION AND CURING**

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather and ACI 301 for hot-weather protection during curing.
- B. Cure concrete in accordance with ACI 301, Section 5.3.6. Clear curing compounds shall be tinted or applied to surfaces marked to show extent of spraying.
- C. Do not use curing compound on surfaces to receive special protective coating.
- D. Protect concrete during adverse weather conditions in accordance with ACI 301, Section 1.8.3.
- E. Protect concrete from mechanical damage in accordance with ACI 301, Section 1.8.2.

**3.5 FIELD INSPECTIONS AND TESTS**

- A. Sample and test concrete in accordance with ACI 301, Sections 1.6.3.2 (d) and (e). Record results. Engage a qualified independent testing agency to perform material evaluation tests.
- B. Engage a special inspector and qualified independent testing agency to perform field material evaluation tests and inspections, and prepare testing and inspection reports.
- C. Document the weights and load test results of the cover blocks determined in Paragraph 3.3.B.10.d.
- D. Inspections:
  - 1. Steel reinforcement placement.
  - 2. Headed bolts and studs.
  - 3. Verification of use of required concrete design mixture.
  - 4. Concrete placement, including conveying and depositing.
  - 5. Inspect blocks after fabrication for dimensions as found on the drawing. Document dimension results.
  - 6. Curing procedures and maintenance of curing temperature.

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- E. After fabrication and before installation, place cover blocks together and verify cover blocks fit as required by drawings and that cover block painting diagram is correct as noted on drawings. Document results.
- F. Concrete Tests:
  - 1. Testing of concrete samples of fresh concrete shall be obtained according to ACI 301, Section 1.6.3.2.(d) and ASTM C172.
  - 2. Testing shall be performed according to ACI 301, Sections 1.6.4.2.(d) and (e). Record results.
- G. Provide nonshrink grout cube molds onsite. Non-shrink grout cubes shall test equal to or greater than minimum strength specified.

END OF SECTION 03 30 53

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**SECTION 05 50 00****METAL FABRICATIONS****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Tank-Side Cesium Removal Ion Exchange Column Storage Pad Embed Plates, conduit and piping support plus other miscellaneous metal fabrications.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. American Society of Mechanical Engineers (ASME)

ASME B&PVC, 2017      Boiler and Pressure Vessel Code

Section IX      Qualification Standard for Welding and Brazing  
Procedures, Welders, Brazers, and Welding and  
Brazing Operations

- B. American Society for Nondestructive Testing (ASNT)

ASNT SNT-TC-1A, 2016      Personnel Qualifications and Certification in  
Nondestructive Testing

- C. ASTM International (ASTM)

ASTM A36      Standard Specification for Carbon Structural Steel

ASTM A240/A240M      Standard Specification for Chromium and Chromium-  
Nickel Stainless Steel Plate, Sheet, and Strip for Pressure  
Vessels and for General Applications

ASTM A500      Standard Specification for Cold-Formed Welded and  
Seamless Carbon Steel Structural Tubing in Rounds and  
Shapes

ASTM A992      Standard Specification for Structural Steel Shapes

- D. American Welding Society (AWS)

AWS D1.1/D1.1M, 2015      Structural Welding Code – Steel

AWS D1.6/D1.6M, 2017      Structural Welding Code – Stainless Steel  
05 50 00 – 1

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AWS QC1

Certification of Welding Inspectors

**1.3 SUBMITTALS**

- A. See the Contract Statement of Work for submittal procedures.
- B. Approval Required.
  - 1. Welding personnel qualifications: Five days minimum before start of fabrication, submit Welder Performance Qualification Records and Welder Continuity Logs as required by Paragraph 1.4.B.1.
  - 2. Welding procedure qualifications: Five days minimum before first use, submit Weld Procedure Specifications and Procedure Qualification Records as required by Paragraph 1.4.B.1.
  - 3. Examination personnel certifications and qualifications: Five days minimum before first use, submit examination personnel qualification as required by Paragraph 1.4.B.2.
  - 4. Examination procedures: Five days minimum before start of fabrication, submit examination procedures as required by Paragraph 1.4.B.3.a.
  - 5. Carbon Steel Weld Examination as required by Paragraph 3.5.A.1.
  - 6. Shop drawings and production travelers.
- C. Approval Not Required: None.

**1.4 QUALITY ASSURANCE**

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

- A. Misrepresented Products: See the Contract Statement of Work for required measures to prevent use of misrepresented products.
- B. Qualifications of Welding Personnel and Procedures
  - 1. Personnel and procedures for welding structural carbon steel shall be qualified in accordance with AWS D1.1/D1.1M for steel structure before welding. Qualification of welding personnel and procedures in accordance with ASME B&PVC, Section IX, may be substituted for components welded in accordance with AWS D1.1/D1.1M. Maintain copy of welding procedure specifications, procedure qualification records, and welder performance qualification test results and renewal of qualification documentation. Where stainless steel materials are welded to carbon steel, (or stainless to stainless), AWS D1.6/D1.6M procedures shall govern, unless ASME B&PVC, Section IX, was substituted.
  - 2. Qualification of examination personnel: Maintain copies of examination personnel certifications and written examination performance procedures.

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- a. Personnel performing visual examinations shall be Certified Welding Inspectors who have received certification in accordance with AWS QC1.
  - b. Personnel performing other nondestructive examinations (NDEs) shall be certified in accordance with approved procedure, which shall meet the requirements of ASNT SNT-TC-1A. Use Level II or III personnel to interpret results.
3. Qualification and certification of NDE personnel shall be in accordance with the vendor's written practice based on the Recommended Practice ASNT SNT-TC-1A.
- a. Examination procedures: Examination procedures shall be in accordance with AWS D1.1/D1.1M or AWS D1.6/D1.6M as applicable, and this Specification. Examination shall use statically loaded criteria for both codes. Maintain copies of examination procedures.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. See the Contract Statement of Work for general requirements.

**1.6 PROJECT CONDITIONS**

- A. General: Every item shipped is to arrive at the job site in the same condition it was in when it passed all quality control inspections and tests.
- B. Preservation and Packaging: All items shall be dried and cleaned to protect against rust and corrosion. Do not wrap the assemblies in shrink wrap or other substance that can cause condensation to collect inside the wrapper. All items shall be protected from dirt, soil, and moisture and packaged for long-term storage in an unprotected exterior environment. All items shall be boxed or crated or otherwise packaged to eliminate damage during shipping, handling, and storage.
- C. Marking: Packages shall be suitably marked on the outside to facilitate identification of the purchase order, the procurement specification, the package contents, and any special handling instructions.

**1.7 PERMITS**

- A. Obtain and conspicuously post the following permits before starting work under this Section.
  1. Hot Work Permit: See the Contract Statement of Work.

**PART 2 PRODUCTS****2.1 SUBSTITUTES**

- A. See the Contract Statement of Work for substitution approvals.



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**2.2 MATERIALS**

Use the following materials unless otherwise shown on Contract drawings:

- A. Rolled Steel Shapes, Plates, and Bars: ASTM A36, ASTM A992 - Gr. 50, or ASTM A240 Grade 304L.
- B. Hollow Structural Sections (i.e. Steel Tubing): ASTM A500, Grade B
- C. Fasteners
  - 1. Weld studs: Nelson Stud Welding Co., Type H4L or approved substitute.
- D. Welding Electrodes/Filler Metal:
  - 1. Carbon steel – Matching filler metal with  $F_u = 70,000$  psi (minimum).
- E. Coating: See Section 09 91 00, “Painting.”
- F. Zinc-Rich Coating: Sherwin Williams®<sup>8</sup> “Zinc Clad®<sup>8</sup> 200,” or ZRC Products Company “Z.R.C.®<sup>9</sup>”

**2.3 FABRICATION**

- A. General
  - 1. Verify measurements, including field measurements, before fabrication. Provide miscellaneous bolts and anchors, supports, braces, and connections necessary for completion of metal fabrications. Cut, reinforce, drill, and tap metal fabrications shown to receive finish hardware and similar items. Weld or bolt connections as shown on the Drawings.
  - 2. Perform welding of steel connections in accordance with AWS D1.1/D1.1M or AWS D1.6/D1.6M as applicable.
- B. Miscellaneous Steel Items: Supply required clips, frames, equipment supports, and other fabrications not shown on the Drawings. Fabricate parts from standard structural sections or shapes, to sizes required. Wherever miscellaneous parts are exposed, grind edges, corners, and rough cuts smooth and free of snags. Shop paint parts except those to be embedded in concrete or those that require other specific finishes.

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<sup>8</sup> Sherwin Williams, MACROPOXY, Zinc Clad, and SEAGUARD are registered trademarks of SWIMC LLC, Cleveland, Ohio.

<sup>9</sup> Z.R.C. is a registered trademark of Norfolk Corporation, Marshfield, Massachusetts.

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## C. Finishes

1. Prime and paint ferrous metal in accordance with Section 09 91 00, "Painting." Do not coat members to be embedded in concrete, surfaces and edges to be field welded, or items to be galvanized. Shop paint may extend into embedded areas where impractical to remove.
2. Touch up damaged zinc surfaces with zinc-rich coating. Apply in accordance with manufacturer's instructions.

**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Examine areas where metal fabrications are to be installed and notify the TOC Construction Representative in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until detrimental conditions have been corrected.

**3.2 PREPARATION**

- A. Prepare setting drawings, diagrams, templates, and instructions for installation of anchorages, such as concrete inserts and miscellaneous items having integral anchors, to be embedded in concrete. Coordinate with TOC Construction Representative for delivery of items to Site.

**3.3 INSTALLATION**

- A. Install metal fabrications plumb, level, or as shown on the Drawings.
- B. Make field connections as neatly as possible with joints flush and smooth. Grind smooth exposed field welds before field painting. Repair welds in galvanized work with two coats of zinc-rich coating.
- C. Weld Studs: Installation, testing and welder qualification shall be in accordance with the manufacturers' written instructions and AWS D1.1/D1.1M, Section 7 for carbon steel, or AWS D1.6/1.6M, Section 9, for stainless steel.

**3.4 APPLICATION**

- A. After installation has been completed, clean and paint connections with primer. Touch-up shop prime coat wherever damaged. Repair breaks in galvanized coating with zinc-rich coating.

**3.5 FIELD INSPECTIONS AND TESTS**

- A. Weld Examination
  1. Perform visual examination of carbon steel welds in accordance with AWS D1.1/D1.1M, Sections 6.5 and 6.9 (statically loaded structures). Record examination results.

END OF SECTION 05 50 00

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**SECTION 07 92 00****JOINT SEALANTS****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Clean and prepare joint surfaces.
- B. Apply sealant and backing materials.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. Code of Federal Regulations (CFR)
  - 40 CFR 59 National Volatile Organic Compound Emission Standards for Consumer and Commercial Products
- B. ASTM International (ASTM)
  - ASTM C920 Elastomeric Joint Sealants

**1.3 SUBMITTALS**

- A. Submit the following in accordance with the Contract Statement of Work.
  - 1. Catalog Data: Manufacturer's data sheets on each product to be used, including, preparation instructions and recommendations, storage and handling requirements and recommendations, as well as installation methods. Additional information to include Material Safety Data Sheet, shelf life, and temperature range of storage and application.

**1.4 QUALITY ASSURANCE**

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

- A. Installer qualifications: Trained and/or experienced in the application of sealants to be used.
- B. Source limitations: Obtain each type of joint sealant through one source from a single manufacturer.

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**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with the Contract Statement of Work.
- B. Store products in manufacturer's unopened packaging, with labels intact, until ready for installation.
- C. Store products off ground; if stored on roof, do not exceed structural capacity of deck.
- D. Store materials at minimum of 68°F for at least 24 hours prior to installation, regardless of temperature at location.
- E. Do not allow materials to freeze prior to application.

**PART 2 PRODUCTS****2.1 PRODUCT OPTIONS AND SUBSTITUTIONS**

- A. See the Contract Statement of Work for substitution approvals.

**2.2 MATERIALS**

- A. General: Provide exterior sealants that comply with the following limits for volatile organic compound content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
  - 1. Sealants for Nonporous Substrates: 250 g/L.
  - 2. Sealants for Porous Substrates: 775 g/L.
- B. Sealant: Single component, traffic-grade, neutral-curing silicone joint sealant: ASTM C920, Type S, Grade NS or P, Class 100/50.

**2.3 ACCESSORIES**

- A. Joint Cleaner: Noncorrosive and nonstaining type, recommended by sealant manufacturer; compatible with joint-forming materials.
- B. Joint Filler: See Section 03 30 21, "Cast-in-Place Concrete (Safety Significant)."
- C. Bond Breaker: Pressure-sensitive tape recommended by sealant manufacturer to suit application.

**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Prior to installation, ensure that joint dimensions and physical and environmental conditions are suitable for application of joint sealers.

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- B. By beginning the Work of this Section, Subcontractor warrants it has examined and verified that existing conditions are in accordance with provisions of Paragraph 3.1.A.

**3.2 PREPARATION**

- A. Clean, prepare, and size joints in accordance with manufacturer's instructions. Remove any loose materials and other foreign matter that might impair adhesion of sealant.
- B. Verify that joint-shaping materials and release tapes are compatible with sealant.
- C. Examine joint dimensions and size materials to achieve required width/depth ratios.
- D. To allow sealants to perform properly, use joint filler to achieve required joint depths.
- E. Use bond breaker where required.

**3.3 INSTALLATION**

- A. Install sealant per manufacturer's instructions.
- B. Apply sealant within recommended temperature ranges. Consult manufacturer when sealant cannot be applied within recommended temperature ranges.
- C. Tool joints as indicated on Drawings.
- D. Joints: Free of air pockets, foreign embedded matter, ridges, and sags.
- E. Coverage: Replace sealants that fail because of loss of cohesion or adhesion onto surfaces applied or that do not cure. If the sealant can be detached from a surface by rubbing the surface contact point with a finger, than the surface adhesion is inadequate.
- F. Follow manufacturer's recommended cure time before painting or over coating.

END OF SECTION 07 92 00

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**SECTION 09 91 00****PAINTING****PART 1 GENERAL****1.1 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. Society for Protective Coatings (SSPC)
  - SSPC-SP 3 Power Tool Cleaning
  - SSPC-SP 7/NACE No. 4 Brush-Off Blast Off Cleaning
  - SSPC-SP 10/NACE No. 2 Near White Blast Cleaning

**1.2 SUBMITTALS**

- A. See the Contract Statement of Work for submittal procedures.
- B. Approval Required
  - 1. List of materials: Unless specified on the design media, before delivery, submit complete list of materials, colors, and location to be used. List shall enumerate percentage of volatile and nonvolatile materials and percentage of component parts of each type of material and the conversion factors to determine dry film thickness from applied wet film thickness.
  - 2. Dry film thickness test results as required by Paragraph 3.6.A.
- C. Approval Not Required: None.

**1.3 QUALITY ASSURANCE**

- A. See Division 01 – General Requirements.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. See the Contract Statement of Work for general requirements. Store materials indoors.

**1.5 PROJECT CONDITIONS**

- A. General: Ensure that surfaces are dry and have attained required temperatures and conditions before starting work or continuing previously started work.

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- B. Weather: No exterior work shall be performed on unprotected surfaces if rain or moisture from other sources is present or expected before applied finishes can dry or attain proper cure.
- C. Dust: No finishes shall be applied if dust is being generated at worksite.
- D. Temperature
1. Unless recommended otherwise by paint manufacturer, apply coatings when the following temperatures exist.

<u>Coating</u>	<u>Ambient Temperature</u>	<u>Surface Temperature</u>
Epoxy	As recommended by manufacturer	
  2. If necessary, provide temporary heat until specified temperatures exist for required time periods. Maintain temporary heat for 24 hours after paint application.
- E. Humidity: Follow manufacturer's directions for extremes.
- F. Ventilation: Provide ventilation recommended for extremes.

**PART 2 PRODUCTS****2.1 SUBSTITUTIONS**

- A. See the Contract Statement of Work for substitution approvals.

**2.2 MATERIALS**

- A. Furnish Sherwin-Williams MACROPOXY®<sup>8</sup> 646 Fast Cure Epoxy, Part A (B58-600) and Part B (B58V600).
- B. Furnish Sherwin-Williams Zinc Clad®<sup>8</sup> IV Coating, Part U (B69A8) and Part V (B69V8).
- C. Furnish Sherwin-Williams SEAGUARD®<sup>8</sup> MP Multi-Purpose Epoxy Primer, Part A (N12Y200) and Part B (N12V200).
- D. Furnish PPG®<sup>10</sup> Amercoat®<sup>10</sup>/Amerlock®<sup>10</sup> 400, Low VOC/ High-solids epoxy coating.
- E. Furnish PPG PSX®<sup>10</sup> 700, Engineered Siloxane Coating.
- F. Furnish appropriate applicators per manufacturer's recommendations.

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<sup>10</sup> PPG, PSX, Amercoat, and Amerlock are registered trademarks of PPG Industries Ohio, Inc., Cleveland, Ohio.

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**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Examine surfaces scheduled to receive coatings for conditions that will adversely affect execution, permanence, and quality of work, and which cannot be corrected through specified preparation.
- B. Report in writing to TOC Construction Representative conditions that may affect proper application of finish. Correct unsuitable conditions before beginning surface preparation or coating application.

**3.2 PREPARATION**

- A. Protection
  - 1. Provide and install drop cloths, shields, and other protective devices to protect surfaces adjacent to areas being painted. Keep spatter, smears, droppings, and over-run of paint materials to a minimum and remove as painting work progresses.
  - 2. Promptly remove spills, splashes and splatter. Use removal methods which do not damage surfaces being cleaned/painted.
  - 3. Repair or replace surfaces damaged by painting work as directed by TOC Construction Representative.
  - 4. Remove electrical outlet and switch plates, mechanical diffusers, escutcheons, registers, surface hardware, fittings, fastening, and similar items before starting work.
- B. New Surface Preparation
  - 1. Deleted.
  - 2. Carbon Steel
    - a. Prepare surfaces for scheduled finish systems in accordance with SSPC-SP 10/NACE No. 2.
  - 3. Stainless Steel
    - a. Prepare surfaces for scheduled finish systems in accordance with SSPC-SP 7/ NACE No. 4
  - 4. Obtain written approval from TOC Construction Representative before using dry or liquid abrasive blasting.



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## C. Old Surface Preparation

1. Prepare touch up area for scheduled touch-up system in accordance with SSPC-SP 3.

**3.3 APPLICATION**

- A. Perform work in accordance with manufacturer's instructions and this Section.

**3.4 CLEANING**

- A. Furnish and maintain at Site, closed metal containers for disposal of waste materials. Collect materials spotted or soaked with paint, oil, or solvents and place in containers.
- B. At completion of coating work, remove materials, containers, rags, cloths, brushes, tools, and equipment from site.

**3.5 SCHEDULES**

## A. Paint and Finish

1. Carbon Steel: Light and ordinary exposures (not galvanized)
  - a. Primer: Sherwin-Williams Zinc Clad. Shop apply one coat. Coat should be 3 mils in thickness. Apply per manufacturer's instructions.
  - b. Top Coat: Sherwin-Williams MACROPOXY 646. Field apply two coats. Coats should be 5-6 mils in thickness. Apply per manufacturer's instructions.
2. Stainless Steel indoors
  - a. Primer: Sherwin-Williams SEAGUARD MP. Shop apply one coat. Coat should be 2-3 mils in thickness. Apply per manufacturer's instructions.
  - b. Top Coat: Sherwin-Williams MACROPOXY 646. Field apply two coats. Coats should be 5-6 mils in thickness. Apply per manufacturer's instructions.
3. Touch-Up
  - a. Sherwin-Williams MACROPOXY 646. Field apply two coats. Coats should be 5-6 mils in thickness. Apply per manufacturer's instructions.
4. Stainless Steel Pre-fabricated Heat-Traced and Insulated Pipe Spools for Above Grade Piping Runs as Specified on the Drawings
  - a. Sherwin-Williams SEAGUARD MP. Shop apply two coats. Coats should be 5-6 mils in thickness.

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5. Stainless Steel outdoors, above and below grade
  - a. Sherwin-Williams SEAGUARD MP. Field apply two coats. Coats should be 5-6 mils in thickness.

**3.6 FIELD INSPECTIONS AND TESTS**

- A. Measure the Wet Film Thickness (WFT) of each coat of material with a notched WFT gage (Nordson®<sup>11</sup> 790-015) at a minimum of five evenly spaced points for each 100 ft<sup>2</sup> of surface area or portion thereof to verify the application will provide the specified minimum dry film thickness. Document results in work package or fabrication documentation.
- B. Inspection and testing will be performed by Quality Control Inspector.

END OF SECTION 09 91 00

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<sup>11</sup> Nordson is a registered trademark of Nordson Corporation, Westlake, Ohio.

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**SECTION 10 14 53****TRAFFIC SIGNAGE****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Traffic signs.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. American National Standards Institute (ANSI)

ANSI D6.1	Manual on Uniform Traffic Control Devices for Streets and Highways
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- B. Washington State Department of Transportation (WSDOT)

WSDOT M41-10	Standard Specifications for Road, Bridge, and Municipal Construction
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WSDOT QPL	Qualified Product List
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**1.3 SUBMITTALS**

- A. See contract Statement of Work for submittal procedures.

- B. Approval Required.

- 1. Before delivery, submit complete list of materials and location to be used.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with the Contract Statement of Work.

- B. Store products in manufacturer's unopened packaging, with labels intact, until ready for installation.

- C. Store materials in accordance with manufacturer's recommendations.

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**PART 2 PRODUCTS****2.1 PRODUCT OPTIONS AND SUBSTITUTIONS**

- A. See the Contract Statement of Work for substitution approvals.

**2.2 MATERIALS**

- A. Signs: Reflectorized aluminum in accordance with WSDOT M41-10, Section 9-28 using WSDOT QPL-listed manufacturer.
- B. Posts: Perforated steel, square in accordance with WSDOT M41-10, Section 9-06.16.

**PART 3 EXECUTION****3.1 INSTALLATION**

- A. Placement and installation of signs shall be in accordance with ANSI D6.1, WSDOT M41-10, Section 8-21, and the Drawings.

END OF SECTION 10 14 53

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**SECTION 13 47 13.13****CATHODIC PROTECTION FOR UNDERGROUND AND SUBMERGED PIPING****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. This Section includes requirements for materials, installation, and repair to underground cathodic protection systems.

**1.2 RELATED DOCUMENTS/CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

## A. ASTM International (ASTM)

ASTM B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

ASTM D1248 Standard Specifications for Polyethylene Plastics Extrusion Materials for Wire and Cable

## B. Erico Products

A-7D-01, 1985 Installers and Inspectors Guide

## C. Hanford Documents

H-2-94086 Cathodic Protection Details, Cables, Boxes & Jumpers

H-14-011500 Tank Farm Cathodic Protection General Notes & Details

H-14-031501 through H-14-031539 Test Station Matrices

RPP-SPEC-62666 Procurement Specification for Fabrication of Double Containment Piping System for Tank Farm Upgrades/Waste Feed Delivery

## D. NACE International (NACE)

NACE SP0169 Control of External Corrosion on Underground or Submerged Metallic Piping Systems

NACE SP0285 Corrosion Control of Underground Storage Tank Systems by Cathodic Protection

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|----|--|--|
|    | NACE SP0286                                    | Electrical Isolation of Cathodically Protected Pipelines   |
|    | NACE TM0101                                    | Measurement Techniques Related to Criteria for Cathodic Protection of Underground Storage Tank Systems |
| E. | National Fire Protection Association (NFPA)    |  |
|    | NFPA 70, 2017                                  | National Electrical Code   |
| F. | Underwriters Laboratories (UL® <sup>12</sup> ) |  |
|    | UL 510   | Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape                              |
| G. | Washington Administrative Code (WAC)           |  |
|    | WAC 173-303-640                                | Dangerous Waste Regulations Washington State   |

**1.3 SUBMITTALS**

Not Used.

**1.4 QUALITY ASSURANCE**

- A. The installation shall conform to the National Electrical Code, applicable local codes, and Standard Practices (SP) of NACE, SP0285, SP0286, and SP0169.
- B. Electrical/Electronic Product Acceptability: Provide labeling and documentation in accordance with the Statement of Work and Section 26 05 53, "Identification for Electrical Systems."
- C. Misrepresented Products: See the Statement of Work for required measures to prevent use of misrepresented products.

**1.5 PERMITS**

- A. Permits are addressed by TOC work control process.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. See the Contract Statement of Work for general requirements.

**PART 2 PRODUCTS****2.1 SUBSTITUTES**

- A. See the Contract Statement of Work for substitution approvals.

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<sup>12</sup> UL is a registered trademark of UL LLC, Northbrook, Illinois.

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**2.2 MATERIALS**

- A. 3M<sup>TM13</sup> Scotchkote<sup>TM13</sup> Electrical coating or equivalent.
- B. Test Station
  - 1. Hoffman Enclosure per Detail 11 on H-14-011500.
  - 2. ER Sensor and Current Span Test Station per Detail 9 on H-14-011500.
  - 3. Test Station Rack Assembly per Detail 27 on H-14-011500.
- C. Anode Junction Boxes:
  - 1. Stand Alone
    - a. 12 in. x 16 in. NEMA 4 Enclosure per H-14-011500 details.
- D. Plastic Warning Tape:
  - 1. Plastic warning tape for horizontal runs of buried leads in cable trenches shall be a minimum of 4-mils-thick and 6-in.-wide inert, yellow, plastic film designed for prolonged use underground. The tape shall have the words, CAUTION CATHODIC PROTECTION CABLE BELOW,” or similar, clearly visible in repeating patterns along its entire length.
  - 2. Plastic warning tape for anodes shall be buried according to H-14-011500.
- E. Conductors:
  - 1. Direct buried: High Molecular Weight Polyethylene Cathodic Protection Cables: 600 Volts, Single Conductor, and Stranded Copper cable for direct burial. Conductor shall conform to ASTM B8-11. Insulation shall conform to ASTM D1248-12. Size specified on the Drawings.
  - 2. Bonding: Type “CP” wire, No. 4 AWG, or as shown on drawings.
  - 3. Anode header and loop: Type “CP” wire, No. 2 AWG, or as shown on drawings.
- F. Anode
  - 1. Zinc Ribbon Anodes for Cathodic Protection, standard size, Plattline<sup>®14</sup> or equivalent. Plattline II Alloy.
  - 2. Weld Coating
    - a. Coating for all welds shall be a cold-applied, fast-drying mastic consisting of bituminous resin and solvents. The minimum percentage

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<sup>13</sup> 3M, Scotchkote, Scotchcast, and Scotch and are trademarks of 3M Company, St. Paul, Minnesota.

<sup>14</sup> Plattline is a registered trademark of The Platt Bros. & Co., Waterbury, Connecticut.

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of solids shall be 80 percent. Substitute coating materials shall be compatible with cable insulation, pipe coating and environment. Manufacturer of Contractor's choice.

- b. Ensure manufacturer's installation and inspection procedures are provided with product. Procedures for "Cadweld®<sup>15</sup>" items are contained in Erico Products "Installers and Inspectors Guide" (A-7D-01, 1985).
- G. Fusion Bonded Epoxy Coating Repair: Scotchkote Liquid Epoxy Coating 323
1. Power tool clean the area per manufacturer's recommendations before coating application.
  2. Remove dust.
  3. Brush or roll application is acceptable for repairs at a minimum thickness of 30 mils, (full requirements are found in RPP-SPEC-62666, Section 3.2.3. Apply per manufacturer's recommendations.
- H. Splice Kit, Conductor:
1. Cadweld CASS Type cable splice kit, by Erico Products, or approved substitute. Suffix based on conductor size.
  2. Cadweld CATA Type cable splice kit, by Erico Products, or approved substitute. Suffix based on conductor size.
  3. Epoxy potting compound for encapsulating electrical wire splices or terminated wires buried underground (for use as required), 3M Company, Scotchcast<sup>TM13</sup> Multi-Mold Resin Splicing Kit, 85-10, or approved substitute.
- I. Tape, Electrical Insulating
1. Scotch<sup>TM13</sup> rubber splicing tape #23
  2. Scotch electrical tape #33
    - a. Plastic: UL 510, 3/4-in. wide
    - b. Self-vulcanizing: UL 510, 3/4-in. wide
- J. 3M Scotchkote Electrical Coating FD
- K. Touch-up compound for polyvinyl chloride (PVC) Conduit Coating: Material of Contractor's choice.

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<sup>15</sup> Cadweld is a registered trademark of Erico International Corporation, Solon, Ohio.



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- L. Wire marker: Tubular plastic, imprinted or typed with indelible ink, or plastic tag typed with indelible ink, fastened securely to wire with plastic wire tie.
- M. Damp and Dry Cloth

**PART 3 EXECUTION****3.1 PREPARATION**

- A. Field Measurements: Scale dimensions on the Drawings show desired and approximate location of equipment, actual locations, distances, and levels shall be governed by field conditions.
- B. Before Installation: Notify TOC Construction Representative prior to placement of concrete supporting tank system components for witnessing of activities by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.

This installation of a field fabricated corrosion protection system must be supervised by an independent corrosion expert to ensure proper installation.

**3.2 INSTALLATION**

- A. General
  - 1. The Contractor shall furnish all tools, equipment, materials and supplies, and shall perform all labor required to provide complete corrosion control systems in accordance with the requirements of the Contract Documents.
  - 2. Perform work in accordance with NFPA 70, the Specifications, and the Drawings.
  - 3. Use appropriate calibrated special tools when installing devices for which manufacturer recommends special installation tools.
  - 4. Refer to Section 31 23 33, "Trenching and Backfilling," for excavation or backfill of soil.
- B. Test Station: Install above grade test stations per design.
- C. Junction boxes
  - 1. Install junction boxes according to design. Junction box details located on H-14-011500.
  - 2. Label boxes according to design.
  - 3. Conductor labels should indicate where the cables originate from (e.g., A241-CATH-RECT-015, J 42-5, etc.)

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## D. Conductors

## 1. Test Stations

- a. Wire brush to remove surface contaminants and mechanically grind or file pipe at connection location to bare metal surface, free of oil and dirt. **Note:** Enough pipe surface should be prepared to accommodate the corrosion protection product to be applied after the connection is complete. Make exothermic weld of conductors to pipe in accordance with approved manufacturer's instructions.
- b. Where two or more wires are welded to the metallic structure, the minimum spacing between exothermic welds shall be 6 in.
- c. The lead wire end to be welded shall be stripped so that a copper sleeve of suitable size can be fitted over the bare section.
- d. After the weld is performed, test the bond by removing the molten slag with a hammer. If the weld comes loose, or is not completely connected, remove previous weld and perform a second weld.
- e. Inspect exothermic welds for mechanical integrity in accordance with manufacturer's instructions. If weld fails, make another weld at least 3 in. from previous weld attempt and inspect.
- f. Install the cables with sufficient slack so that the cable insulation and conductors will not be damaged due to ground or structure movement. Cables may be secured to the pipe with duct tape or tie wraps during trench activity and backfill operations.
- g. Apply approved coatings on all exposed copper wire, connector material, and bared pipe. Overlap approved coating on copper wire insulation on pipe coating or on bared surface a minimum of 1 in.
- h. Use conductors as specified on appropriate Test Station details.
- i. Repair damaged pipe test conductor wires by cleaning and removing any fraying insulation. Roughen up outer insulation for approximately 4 in. each side of the defect with utility knife to prepare for application of tapes. Using two (2) half-lapped layers of Scotch rubber splicing # 23 tape and two (2) half-lapped layers of Scotch electrical #33 plus tape, start from the center of the defect to ensure a double wrap of each layer. Apply 3M Scotchkote Electrical Coating FD over taped repair prior to backfill.
- j. Make connections to existing conductor wires using a Cadweld CASS type connector, Burndy®<sup>16</sup>-type mechanical connector, or appropriately

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<sup>16</sup> Burndy, Hyground, and Kellems are registered trademarks of Hubbell Incorporated, Shelton, Connecticut.

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sized copper split bolt per manufacturer's instructions, and encase splice point in a 3M Company, Scotchcast Multi-Mold Resin Splicing Kit, Model 85-10 (or equivalent). **Note:** ALL buried wire splices must be completely encased in a 3M Company, Scotchcast Multi-Mold Resin Splicing Kit, Model 85-10 (or equivalent) prior to burial.

- k. New conductor wires shall be sufficient length to extend from the point of installation on the pipeline (or the severed cable connection), to the new test station.
  - l. Wires to be direct buried in the ground shall be laid straight without kinks.
  - m. Identify end of each conductor using specified wire marker with typewritten or imprinted pipe number to which conductor is connected.
  - n. Newly installed test station(s): Identify the end of each pipe test conductor using specified wiremarker with typewritten or imprinted pipe number to which conductor is connected.
  - o. Terminate conductors on specified terminals and locations in ER Sensor and Current Span test station as directed in H-14-011500, Detail 9, and the test station matrices located on the appropriate cathodic protection farm drawings. (Note: test station matrices are located on drawings H-14-031501 through H-14-031539).
  - p. Backfill in accordance with Section 31 23 33, "Trenching and Backfilling."
2. Jumpers
- a. Wire brush to remove surface containments and mechanically grind or file pipe at connection location to white metal surface, free of oil and dirt. Note: Enough pipe surface should be prepared to accommodate the corrosion protection product to be applied after the connection is complete. Make exothermic weld of conductors to pipe in accordance with approved manufacturer's instructions.
  - b. Where two or more wires are connected to the metallic structure, the minimum spacing between the connections shall be 6 in.
  - c. The lead wire end to be welded shall be stripped so that a copper sleeve of suitable size can be fitted over the bare section.
  - d. After the weld is performed, test the bond by removing the molten slag with a hammer. If the weld comes loose, or is not completely connected, remove previous weld and perform a second weld.

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- e. Inspect exothermic welds for mechanical integrity in accordance with manufacturer's instructions. If weld fails, make another weld at least 3 in. from previous weld attempt and inspect.
  - f. Install the cables with sufficient slack so that the cable insulation and conductors will not be damaged due to ground or structure movement. Cables may be secured to the pipe with duct tape or tie wraps during trench activity and backfill operations.
  - g. Apply approved coatings on all exposed copper wire, connector material, and bared pipe. Overlap approved coating on copper wire insulation on pipe coating or on bared surface a minimum of 1 in.
  - h. New conductor wires shall be sufficient length to extend from the points of installation on the pipelines. Splices, if required, shall be made using a Cadweld CASS type connector, Burndy Type mechanical connector, or appropriately sized copper split bolt per manufacturer's instructions, and encase splice point in a 3M Company, Scotchcast Multi-Mold Resin Splicing Kit, Model 85-10 (or equivalent). **Note:** ALL buried wire splices must be completely encased in a 3M Company, Scotchcast Multi-Mold Resin Splicing Kit, Model 85-10 (or equivalent) prior to burial.
  - i. Wires buried in the ground shall be laid straight without kinks.
  - j. Bond per H-2-94086, Details 3 and 5.
3. Anode header, loop, and lead cables
- E. Anode Ribbon: Install per manufactures instructions and applicable CP drawings. Run anode lead cable in field as required. Splices to existing leader cable shall be made using a Cadweld CATA type connector per Drawings.

### 3.3 FINAL TESTING

- A. Conductors
- 1. Perform conductor continuity testing at the pipeline following installation per SP0285-2011.
  - 2. Perform isolation testing on the conductors after landing in the test box per SP0285-2011.
- B. Electrical Resistance (ER) Sensors
- 1. Perform acceptance and Start-up testing of the ER sensors per the applicable ER sensor test procedure.

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**3.4 FIELD TESTING AND QUALITY CONTROL**

- A. Field Testing shall be in accordance with NACE TM0101-2012, SP0169-2013, SP0285-2011, NACE SP0286-2007, and any other applicable codes and standards. Quality Assurance shall be in accordance with applicable codes and standards.
- B. Connections
  - 1. Document connection of conductors to new and existing pipe. Include the following:
    - a. Bonding jumper: Identification of each pipe to which connected and general location of jumper and splice connection as applicable.
    - b. Verification that connections complies with manufacturer's installation and inspection requirements.

END OF SECTION 13 47 13.13

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**SECTION 21 13 13****BALANCE OF FACILITIES PAD WET PIPE FIRE PROTECTION SYSTEM****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Installation of new fire sprinkler piping/tubing located between the Process Enclosure, Ancillary Enclosure, and the Control Enclosure located on the Balance of Facilities Pad at the Tank-Side Cesium Removal facility.

**1.2 RELATED DOCUMENTS/CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. ASTM International (ASTM)
- |           |  |
|-----------|--|
| ASTM A53  | Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-coated, Welded and Seamless   |
| ASTM A182 | Standard Specification for Forged or Rolled Alloy Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service |
| ASTM A269 | Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service   |
| ASTM A403 | Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.   |
- B. American Society of Mechanical Engineers (ASME)
- |            |   |
|------------|---|
| ASME B16.3 | Malleable Iron Threaded Fittings Class 150 and 300      |
| ASME B16.5 | Pipe Flanges and Flange Fittings NPS 1/2 Through NPS 24 |
- C. Factory Mutual Global (FM)
- FM Approval Guide Fire Protection
- D. National Fire Protection Association (NFPA)
- |         |  |
|---------|--|
| NFPA 13 | Standard for the Installation of Sprinkler Systems |
|---------|--|

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## E. Underwriters Laboratories (UL)

## UL Directory Fire Protection Equipment

**1.3 SUBMITTALS**

## A. Product Data

1. Cut sheets shall be submitted for all new system components.

## B. Drawings

1. The Subcontractor shall submit layout drawings for review and authorization to proceed prior to construction.
2. As-built drawings in both electronic format and hard copy shall be submitted.

## C. Procedures

1. Subcontractor shall submit a hydrostatic test procedure.

## D. Inspection and Test Reports

1. Subcontractor shall submit an acceptance test document for each system.
2. The acceptance test documents shall be submitted for review and approval prior to use.

## E. Calculations

1. A copy of the calculations used in sizing the sway bracing shall be submitted for review prior to final acceptance of the installation. Calculation format shall follow Figure A.9.3.5(a), as shown in NFPA 13.
2. Electronic copies of input used in hydraulic calculations, compatible with HASS 8.8 or later, shall be submitted.

## F. Certificates of Conformance

1. Subcontractor's Material and Test Certificate for Aboveground Piping per NFPA 13, shall be completed and accepted for the work covered by this specification prior to final acceptance of the installation.

**1.4 QUALITY ASSURANCE**

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

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- A. Subcontractor Experience
  - 1. A firm with at least five years of successful design and installation experience on projects with fire sprinkler piping, similar to that required for this project. Subcontractor shall be licensed by the State of Washington as a Fire Protection Sprinkler Contractor.
- B. Supplier Experience
  - 1. Firms regularly engaged in the manufacture of fire sprinklers and piping accessories of types and sizes required, whose products have been in satisfactory use in similar service for not less than five years.
- C. Engineering Compliance
  - 1. All Work shall be done in a skillful and workmanlike manner. Subcontractor shall do all construction work associated with the installation of equipment. No modifications or rearrangements, not shown on the drawings, shall be made without prior approval from Contractor's Fire Protection Engineer. One set of approved fire protection design drawings shall be maintained on the Project Site during construction.

**1.5 DELIVERY, STORAGE, AND PROTECTION**

- A. Care shall be taken during the handling, storage, and cleaning of items to control and prevent damage or loss and to minimize deterioration.
- B. Items shall be inspected for damage upon delivery to the site. Pipe ends and fittings shall be covered or plugged to prevent the intrusion of any type of contaminant. Likewise, all threaded items shall be protected to prevent thread damage. Small items such as couplings, elbows reducers, tees etc. shall be stored inside in a clean dry environment.

**1.6 DESIGN REQUIREMENTS**

- A. System Description
  - 1. The sprinkler system shall be a wet pipe sprinkler design.
- B. Layout Requirements
  - 1. The layout and installation of the wet pipe sprinkler system shall be in accordance with NFPA 13.
  - 2. Hanging and bracing of the sprinkler piping shall meet the requirements of NFPA 13.



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## C. Design Conditions

1. The design objective for the fire protection systems shall be based on a useful life expectancy of 40 years with normal periodic maintenance.

## D. Mechanical Requirements

1. Material and equipment shall be new and of the latest design and engineered for the detection of fires, control the spread of fire, and suppress fires involving all designated areas of the buildings.

## E. Piping

1. All above ground piping used in this project for wet pipe systems shall conform to the Product section of this Specification. All visually exposed piping shall be painted red and labeled.

## F. Seismic Bracing

1. Earthquake sway bracing shall be provided in accordance with FM Data Sheet 2-8 and NFPA 13, using a horizontal force factor for this calculation of 0.5. Calculations, using the zone of influence method, showing the forces on the attachments, shall be done to verify that the minimum requirements outlined, are not exceeding the allowable strengths of listed equipment, or allowable strength of the building structure at the point of attachment. Details of the sway bracing shall be provided on the shop drawings and bracing calculation sheets.
2. Subcontractor shall be responsible for coordinating with Contractor's Structural Engineer to assure the structure is capable of supporting both the static and dynamic loads imposed by the sprinkler system layout. The forces developed at the point of connection to the structure must be taken into account and approved by Contractor's Structural Engineer.
3. Piping installed such that it is supported by trapeze shall be secured in place to resist vertical moment as if it were hanging from the same members or trapeze.

## G. Hangers

1. Hangers shall be of the type and installed for locations with working water pressures greater than 100 psi.

## H. Concrete Anchor

1. Post-installed concrete anchors, listed for use in cracked concrete, may be used with approval of Contractor's Structural Engineer.

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**PART 2 PRODUCTS****2.1 SUBSTITUTION**

- A. See the Contract Statement of Work for substitution approvals.

**2.2 MATERIALS**

- A. Provide sprinkler piping, fittings, and devices with a UL listing and FM approval unless a specified product is only covered by one of the agencies. Exceptions will be made on a case-by-case basis for the products submitted as or equals. If no product exists that has both a UL listing and FM approval, it will be acceptable to use a product that has been published in either organization's publications.
- B. Only new and approved pipe, fittings, sprinklers, and devices shall be employed in the installation of the automatic sprinkler system following the requirements of NFPA 13.

**2.3 PROHIBITED MATERIALS**

- A. Bushings.
- B. Plain-end fittings.
- C. Used material.
- D. Plug type anchors, set by driving anchor bodies into holes and over plugs.

**2.4 GENERAL REQUIREMENTS**

- A. Sprinkler and Standpipe Piping
  - 1. Black pipe schedule 40, conforming to the requirements of ASTM A53, shall be used.
  - 2. Stainless Steel Tubing: High quality fully annealed stainless steel hydraulic tubing, ASTM A269 seamless and welded tubing. Tubing to be free of scratches, suitable for bending and flaring.
    - a. Flanges & Fittings: ASTM A403, ASTM A182, or ASME B16.5. Unless dictated on design media compression tube fittings and adapter fittings shall be used.
    - b. Tubing and fittings used in the compressed air system shall be cleaned to remove oil, grease, and loose particles that typically remain on products and components following industrial manufacturing processes. Lubricants and coatings are an exception and shall be applied to mating surfaces.
    - c. The minimum nominal wall thickness for compressed air tubing shall comply with the following table:

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**Table 1 – Tube Wall Minimum Thickness**

<b>Tubing Size (inches)</b>	<b>Minimum Wall Thickness (inches)</b>
1/4	0.028
3/8	0.035
1/2	0.049
3/4	0.065
1	0.083

**B. Pipe Fittings**

1. Reduction in pipe size shall be made with one-piece reducing fittings.
2. Regular fittings used on schedule 40 piping shall be flanged per ASME B16.5, grooved, or ASME B16.3 threaded malleable iron.
3. The grooving machine, used to prepare the piping, shall be approved for use with the fitting by the fitting manufacturer.

**C. Pipe Couplings**

1. Couplings used on schedule 40 piping shall be flanged per ASME B16.5, grooved, or ASME B16.3 threaded malleable iron.
2. Flexible grooved couplings in pipelines shall be Victaulic Style 75, 77 or Gruvlock®<sup>17</sup> style 7000 or 7001 or Contractor-approved equal.
3. Rigid grooved couplings in pipelines shall Victaulic styles 005 or 07 or Gruvlock style 7400 or 7401 or Contractor-approved equal.
4. The grooving machine, used to prepare the piping, shall be approved for use with the coupling by the coupling manufacturer.

**D. Mechanical Tees**

1. All bolted branch outlets shall be Victaulic Style 72, 920 or Gruvlock style 7045(U bolt not acceptable) or 7046 for pipe sizes 2 in. and larger, Victaulic Style 925 Snap-Let Outlets or Gruvlock style 7044 Branch Outlet shall be used for piping smaller than 2 in. or Contractor's approved equal.
2. Coupons shall be attached for verification.

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<sup>17</sup> Gruvlok is a registered trademark of Anvil International, Inc., Portsmouth, New Hampshire.

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## E. Signs

1. Test valve shall have permanently marked weatherproof metal or rigid plastic identification signs. Lettering shall be red letters on white background or white letters on red background. Letters shall be a minimum of 2-in. high.
2. The identification sign shall be secured with corrosion-resistant wire, chain, or other approved means.

## F. Earthquake Sway Bracing

1. Sway bracing shall be designed and installed in accordance with NFPA 13.
2. Hangers:
  - a. C-Type beam clamps with retaining strap. Tolco Fig. 65, 66, or Contractor-approved equal.
  - b. Retaining strap Tolco Fig. 69 or Contractor-approved equal.
  - c. Ring Hanger: Tolco Fig. 200 or Contractor-approved equal.

## G. Concrete Anchors

1. Post-installed anchors shall be Factory Mutual approved for use in poured concrete. Hilti Kwik Bolt TZ or Contractor-approved equal.
2. Sprinkler Heads:
  - a. Horizontal sidewall sprinklers shall be standard spray, high temperature, Victaulic Model V2709, Reliable Model F1, or Contractor-approved equal.
  - b. Upright shall be standard spray, high temperature, Victaulic Model V2703, Reliable Model F1, or Contractor-approved equal.

**PART 3 EXECUTION****3.1 INSTALLATION**

## A. Post Installed Concrete Anchors

1. Concrete anchors, used as part of a pipe hanger assembly, shall be installed in accordance with the product listing and the manufacturers' installation instructions.
2. Concrete anchor bolts used for seismic restraint shall be installed following manufacturers installation instructions, International Council of Building Officials/International Code evaluation service report, and per shop drawings and calculations.

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## B. Cleanliness

1. Remove dirt, oil, and grease, loose mill-scale, weld spatter and other foreign matter from interior and exterior surfaces prior to installation.

**3.2 LABELING AND IDENTIFICATION**

- A. Install identifying labels and devices for fire sprinkler piping/tubing. Comply with requirements TFC-ENG-STD-12, "Tank Farm Equipment Identification Numbering and Labeling Standard."

**3.3 FIELD QUALITY CONTROL**

## A. Hydrostatic Testing

1. All new fire sprinkler piping, except the final connection to the existing sprinkler system, shall be hydrostatically tested at 225 psi for two hours with no visible leakage. All leaks shall be repaired, and the system retested.
2. The final connection to the existing sprinkler system shall be hydrostatically tested at normal system pressure. The water system shall be confirmed to be operating at normal pressure before the beginning of the test.

- B. Contractor may witness all hydrostatic pipe testing. Surveillance will be performed by the Contractor to verify compliance of the work to the drawings and specifications.

- C. The completed Subcontractor's Material and Test Certificate for Aboveground Piping shall be submitted for review and approval by the cognizant Fire Protection Engineer.

## D. Final Inspection

1. Subcontractor's Certified Engineering Technician or Professional Engineer responsible for overseeing this project shall make a complete and final inspection of the installation, checking out all valves, piping, seismic bracing, hangers, etc.

END OF SECTION 21 13 13

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**SECTION 22 05 29****BALANCE OF FACILITIES PAD HANGERS AND SUPPORTS FOR PLUMBING, PIPING  
AND EQUIPMENT****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Furnish and install pipe hangers, supports, and other positive fastenings for mechanical non-structural components such that gravity loads are safely transferred to the structure.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. American Society of Mechanical Engineers (ASME)
  - ASME B31.3, 2016                      Process Piping
  - ASME B31.9                              Building Services Piping
- B. Metal Framing Manufacturers Association (MFMA)
  - MFMA-4                                  Metal Framing Standards
- C. National Fire Protection Association (NFPA)
  - NFPA 13                                  Standard for the Installation of Sprinkler Systems

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for the following; include Product Data for components:
  - 1. Pipe clamps.
  - 2. Metal framing systems.

**PART 2 PRODUCTS****2.1 PRODUCT OPTIONS AND SUBSTITUTIONS**

- A. See contract Statement of Work for substitution procedures.

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**2.2 PIPE HANGERS AND SUPPORTS**

- A. Support manufacturers, models, and locations are as shown on contract drawings.

**2.3 FRAMING CHANNEL SYSTEMS**

- A. Furnish galvanized U-channel framing systems that conform to MFMA-4 and are fabricated using minimum 12-gage steel.
- B. Furnish galvanized fittings and accessories that mate and match with U-channel and are of the same manufacturer. Use two-piece, single bolt type conduit straps on U-channel supports.
- C. Manufacturers:
  - 1. General Service: Unistrut®<sup>18</sup>, B-Line®<sup>19</sup>, Superstrut®<sup>20</sup>.
  - 2. Safety Significant: Unistrut.

**PART 3 EXECUTION****3.1 PIPE HANGERS AND SUPPORTS**

- A. Support piping to maintain its alignment, and prevent sagging.
- B. Place supports as shown on contract drawings.
- C. Prime coat exposed steel hangers and supports. Refer to Section 09 91 00, "Painting." Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

**3.2 HANGER SPACING**

- A. Process Piping
  - 1. Comply with the requirements of ASME B31.3, for hanger spacing and materials.
- B. Fire Protection Piping
  - 1. Comply with the requirements of NFPA 13, for hanger spacing and materials.
- C. Air and Laboratory Gas Building Services Piping, up to 150 psig
  - 1. Comply with the requirements of ASME B31.9, Building Services Piping.

END OF SECTION 22 05 29

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<sup>18</sup> Unistrut is a registered trademark of Unistrut International Corporation, Wayne, Michigan.

<sup>19</sup> B-Line is a registered trademark of Cooper Technologies Company, Houston, Texas.

<sup>20</sup> Superstrut and Blackburn are registered trademarks of ABB Asea Brown Boveri Ltd, Zurich, Switzerland.

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**SECTION 22 07 13****BALANCE OF FACILITY PAD PIPING INSULATION****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Piping insulation (Note: Per ASME B31.9 materials designated tube or tubing are treated as pipe when intended for pressure service.)

**1.2 RELATED DOCUMENTS/CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. ASTM International (ASTM)

ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

ASTM C547 Standard Specification for Mineral Fiber Pipe Insulation

ASTM C1136 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation

ASTM C1695 Standard Specification for Fabrication of Flexible Removable and Reusable Blanket Insulation for Hot Service

ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials

B. Factory Mutual Research (FM Global)

Approval Guide, 2010 Edition

C. Underwriters Laboratories (UL)

UL 723 Standards for Test for Surface Burning Characteristics of Building Materials



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**1.3 DEFINITIONS**

- A. Finished Areas: Areas where floor, walls, ceilings, trim, or exposed steel are painted, tiled, or similarly finished.

**1.4 SUBMITTALS**

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).
- B. Manufacturer's Installation Instructions: Manufacturers published literature indicating proper installation procedures.

**1.5 QUALITY ASSURANCE**

- A. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84 and UL 723.
- B. Provide insulation material 100 percent asbestos-free.
- C. Provide products that do not promote or support the growth of mold, fungi, or bacteria.

**1.6 ENVIRONMENTAL REQUIREMENTS**

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesive, mastic, and insulation cements.
- B. Maintain temperature during installation per manufacturer's instructions.
- C. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

**PART 2 PRODUCTS****2.1 PRODUCT OPTIONS AND SUBSTITUTIONS**

- A. See contract Statement of Work for substitution procedures.

**2.2 GENERAL**

- A. K-factors (thermal conductivity) shown are expressed in BTU•in/hr•ft<sup>2</sup>•F.

**2.3 MANUFACTURERS**

- A. Armaflex®
- B. Knauf Fiber Glass
- C. Owens/Corning Fiberglass
- D. Armstrong

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- E. CertainTeed
- F. Johns Manville

**2.4 FIBERGLASS PIPE INSULATION**

- A. Insulation: Rigid molded in compliance with ASTM C547, Class 1, minimum density 3.5 pounds/cubic foot, K-factor of approximately 0.23 at 75°F, suitable for temperatures from 0°F to 850°F.
- B. Jacket: Factory applied vapor barrier reinforced foil kraft with self-sealing adhesive joints, ASTM C1136.
- C. Valves and Fitting Covers: Pre-molded polyvinyl chloride (PVC) covers with fiber glass insert. Manufacturers: Proto Corp., Ceelco.

**2.5 ELASTOMERIC PIPE INSULATION**

- A. Manufacturer: Armacell AP Armaflex.
- B. Insulation: Cellular closed cell in compliance with ASTM C534, Type 1, minimum density 5 pounds/cubic foot, K-factor of approximately 0.30 at 75°F, suitable for temperatures up to 300°F.
- C. Valve and fitting covers: Same as pipe insulation, cut to fit.
- D. Weather Resistant Protective Finish: Acrylic latex enamel paint. Manufacturer: WB Armaflex finish.

**2.6 METAL JACKETING - PIPING/DUCTWORK**

- A. Jacketing: Aluminum, 0.016 in. thick, embossed surface, with factory bonded moisture barrier.
- B. Valve and Fitting Insulation Covers: Fabricate from same material as jacketing or use prefabricated insulation covers made in two matching halves.
- C. Metal Jacketing Bands: 3/8 in. wide, 0.010 in. thick stainless steel.

**2.7 PROTECTION SADDLES AND SHIELDS**

- A. Provide factory engineered galvanized steel hanger shields on horizontal insulated pipe complying with MSS SP-58 standards for gauge and length of saddle.
- B. Saddles (Piping/tubing up to 2 in.):
  - 1. Use 180 degree saddle on systems utilizing teardrop type hangers. B-Line B3151 or B3153 Series.
  - 2. Use 360 degree saddle on systems utilizing trapeze hangers or clamps. B-Line B338 Series.

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**2.8 REMOVABLE INSULATION COVERS**

- A. Manufacturer: Auburn Manufacturing. Style: Evergreen Cut 'N Wrap.
- B. ASTM C1695, fiberglass inner core and high-performance-polymer coated woven glass fiber fabric outer layer on both sides.
  - 1. Maximum temperature 500°F
  - 2. Weight, oz/ft<sup>2</sup>: 7.65

**2.9 EQUIPMENT NOT FACTORY INSULATED****PART 3 EXECUTION****3.1 EXAMINATION**

- A. Verify that items to be insulated have been pressure tested and approved before applying insulation material.
- B. Verify that surfaces are clean, foreign material removed, and dry.

**3.2 INSTALLATION - GENERAL**

- A. Install materials in accordance with manufacturer's instructions.
- B. Do not insulate factory-insulated equipment.
- C. Do not insulate nameplates.
- D. Fit insulation tightly against surface to which it is applied.
- E. Do not insulate flexible connections.
- F. For non-fire rated barriers (e.g., wall, floor, ceiling, or roof) continue insulation and vapor barrier through penetrations. For fire rated barriers, provide UL/FM approved through penetration stop systems.
- G. Weatherproof outdoor installations of piping or ductwork covered with aluminum jacket. Provide watershed lap joints and seal with mastic as required.
- H. Replace existing insulation where it has been damaged or removed as a result of modifications. Vapor barrier shall be continuous. Thickness of insulation that is replaced shall match new.
- I. Do not install insulation until the Testing, Adjusting and Balancing (TAB) has been completed and the TAB test report accepted by WRPS.

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**3.3 INSTALLATION - PIPING**

- A. On exposed piping located in finished areas, locate insulation and cover seams in least visible area.
- B. Provide calcium silicate shields or saddles through pipe hangers or supports. Do not notch insulation.
- C. Where insulation terminates, taper to pipe and finish with insulating cement or acrylic mastic.
- D. Cover insulated pipes located outdoors or in utility tunnels with aluminum jacket. Secure with aluminum bands and screws as required.
- E. Tape circumferential joints of pipe insulation with 3 in. wide white vinyl tape.
- F. Insulate fitting and valves where required with same material thickness as specified for adjacent pipe.

**3.4 INSULATION SCHEDULE**

- A. Process Piping, Fire Sprinklers, and Air (1/2 in. to 3/4 in.): 1/2 in. thick Systems: Use fiberglass or elastomeric pipe insulation.

END OF SECTION 22 07 13

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**SECTION 22 08 13****TESTING FOR BALANCE OF FACILITIES PAD PIPING****PART 1 GENERAL****1.1 SUMMARY OF WORK**

A. Pressure testing of the following systems:

1. Fire protection piping
2. Compressed air piping
3. Instrument air piping
4. Process Piping (ASME B31.3)

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American Society of Mechanical Engineers (ASME)

ASME 31.3, 2016                      Power Piping

ASME B31.9                              Building Services Piping

B. ASTM International (ASTM)

ASTM E515-11                      Standard Practice for Leaks Using Bubble Emission Techniques

ASTM E1003-13                      Standard Practice for Hydrostatic Leak Testing

C. International Association of Plumbing and Mechanical Officials (IAPMO)

IAPMO UPC-2012                      Uniform Plumbing Code

D. National Fire Protection Association (NFPA)

NFPA 13                                      Standard for the Installation of Sprinkler Systems

E. Underwriters Laboratories (UL)

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UL 404 Standard for Gauges, Indicating Pressure, for Compressed Gas Service

F. Washington Administrative Code

WAC 173-303-640 Dangerous Waste Regulations Washington State

### 1.3 SUBCONTRACTOR REQUIREMENTS

- A. Notify WRPS Subcontract Technical Representative at least 24 hours (1 working day) in advance to arrange for onsite witnessing by WRPS inspector of the piping test (a hold/witness point).
- B. Notify WRPS immediately in the event of any accidental discharge.
- C. Notify TOC Construction Representative at least 24 hours (1 working day) in advance to arrange for onsite witnessing of the above described testing (a hold/witness point) by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.

### 1.4 SUBMITTALS

A. Action Submittals

1. Test plan for approval that includes:

- a. Material of construction
- b. Design pressures
- c. Test pressures and duration of tests
- d. Test medium and method of achieving the test pressure
- e. Certification on calibration of pressure gauges
- f. Method to exclude personnel from the area containing the system to be tested.
- g. Over-pressurization protection/prevention: Device make/model number, certification, pressure relief set point, point of installation in system.

B. Informational Submittals

1. Test Reports: Submit within 10 working days of successful test.

## PART 2 PRODUCTS

### 2.1 MATERIALS

A. Furnish instruments, equipment, material and labor necessary to conduct tests.

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- B. Calibrate testing equipment at reasonable intervals with devices of accuracy traceable to National Institute of Standards and Technology (NIST). Test pressure shall be within the calibration range.
- C. Test gauges used shall be in accordance with IAPMO UPC-2012, Section 318.
  - 1. Pressure gauges meeting Underwriters Laboratories (UL) in accordance with UL 404, "Standard for Gauges, Indicating Pressure, for Compressed Gas Service" Standard for Safety.
  - 2. Gauges shall be protected by tempered safety glass or plastic face or shield and blowout back or plug.

**PART 3 EXECUTION****3.1 FIELD QUALITY CONTROL**

- A. Perform piping pressure test before cleaning or flushing to avoid possible discharge of chemicals due to pipe or joint failure during a pressure test.
- B. All examination records and pressure test plans must be complete and submitted prior to testing.
- C. Piping being tested shall remain exposed until WRPS has approved the test results.
- D. Trenches may be backfilled between joints before testing to prevent movement of pipe during testing. Ensure that thrust blocks are sufficiently hardened before testing.
- E. Piping being tested shall not leak nor show any change in test pressure for duration specified unless otherwise noted.
- F. Where portion of piping system is to be concealed before completion, the portion shall be tested separately as specified for the entire system.
- G. Ensure piping supports are in place.
- H. Isolate system gages, sensors, etc., from pressure tests so instruments and devices are not damaged. Test pressure shall not exceed the maximum allowable test pressure for any vessel, pump, valves, or other component in the system.
- I. Hydrostatic (Water) Testing:
  - 1. Use potable water as test medium. Do not fill system until the WRPS has approved the source of water supply.
  - 2. Provide vents at high points to release trapped air while filling system.
  - 3. Provide drains at low points for complete removal of test liquid.

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4. Follow ASTM E1003 for detecting leaks or use other enhanced detection methods like pressure decay or vacuum decay techniques.
  5. After the test duration reduce pressure to design pressure and visually examine the system for leaks.
  6. Drain system if there is a potential for freezing, e.g., no heat in building, coil in outside air stream, or other similar situations.
- J. Pneumatic (Air) Testing – ASME B31.3 345.1(c) pneumatic testing is only allowed by owner approval and is currently set at a maximum of 2 cubic feet (ft<sup>3</sup>).
1. Use clean dry air (Excluded from use with natural gas pipe testing) or inert gas as the test medium.
  2. Barricade the area around the system to be tested.
  3. Prior to application of full air test pressure, apply a preliminary test of not more than 10 psig to reveal possible major leaks.
  4. After preliminary test, raise pressure in stages not more than 25 percent up to full test pressure, allowing at least 10 minutes for equalization of strain and detection of major leaks at each intermediate stage. Hold final test pressure for time specified.
    - a. If test pressure is 25 psig or less, pressure can be raised in a single increment.
  5. Use ASTM E515 for detecting leaks or use other enhanced detection methods like pressure decay or vacuum decay techniques.
  6. After the test duration reduce pressure to design pressure and visually examine the system for leaks.
- K. If leaks are found, eliminate them by tightening, repair, or replacement, as appropriate and test repeated until no leakage is found.
- L. Where repairs or additions are made to piping system following the pressure test, test the affected piping. Testing is not required in cases where it does not include addition to, replacement, alteration or relocation of, any piping, or in any cases where piping is set up temporarily for exhibition purposes.

### 3.2 PRESSURE TESTING

- A. Fire Protection Lines:
1. Test with water in accordance with NFPA 13 at a minimum of 200 psig, or 50 psig in excess of the system working pressure, whichever is greater, for 2 hours and shall maintain that pressure without loss.



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2. For modifications to existing piping bring system up to operating pressure gradually. Visually examine the piping for leaks at one-half the system operating pressure. Perform a final examination at the system operating pressure. No leaking from the piping indicates that the system meets the requirement of the project.
- B. Compressed Air (Less than 150 psig design pressure)
1. Test with air at a maximum of 150 psig in accordance with ASME B31.9, paragraph 937.4 for 10 minutes.
- C. Instrument Air (Less than 150 psig design pressure)
1. Test with air at a maximum of 150 psig in accordance with ASME B31.9, paragraph 937.4 for 10 minutes.
- D. Process Piping (ASME B31.3):
1. Process piping shall be pneumatically leak tested at 165 psig, not to exceed 200 psig in accordance with ASME B31.3, 345.5 “Normal” Fluid Service after owner’s approval per paragraph 345.5. A leak test shall be maintained for at least 10 minutes, and all joints and connections shall be examined for leaks as required in paragraph 345.2.2 (a)
  2. Category D piping shall be tested in accordance with ASME B31.3, paragraph 345.7.

**3.3 RETESTING**

- A. If piping does not pass test, locate leak, safely vent pressure repair leaks and repeat testing procedure until satisfactory results are obtained.
- B. Make repairs to piping with new materials. Caulking on screwed joints, cracks, or holes is not acceptable.
- C. Notify TOC Construction Representative at least 24 hours (1 working day) in advance to arrange for onsite witnessing of the piping retesting (a hold/witness point) by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.

END OF SECTION 22 08 13

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**SECTION 22 15 13****BALANCE OF FACILITIES PAD GENERAL SERVICE COMPRESSED AIR PIPING AND TUBING****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Purchasing and installing tube, pipe, and components applicable to ASME B31.9. This includes compressed / instrument air piping and tubing and the associated fittings and adapters. This Section includes piping and tubing for general-service compressed / instrument air systems operating at 150 psig or less. The contents of this Section are to be adhered to unless specifically detailed otherwise on the design media.
- B. This Section does not include specialty gas and vacuum tubing.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. American Society of Mechanical Engineers (ASME)
- |              |   |
|--------------|---|
| ASME B1.20.1 | Pipe Threads, General Purpose, Inch   |
| ASME B16.3   | Malleable Iron Threaded Fittings: Classes 150 and 300   |
| ASME B16.5   | Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric-Inch Standard  |
| ASME B16.21  | Nonmetallic Flat Gaskets for Pipe Flanges   |
| ASME B16.39  | Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300  |
| ASME B18.2.1 | Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series) |
| ASME B31.9   | Building Services Piping  |
- B. American Welding Society (AWS)
- |                      |                                 |
|----------------------|---------------------------------|
| AWS D1.1/D1.1M, 2015 | Structural Welding Code – Steel |
|----------------------|---------------------------------|

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- C. ASTM International (ASTM)
- |               |  |
|---------------|--|
| ASTM A53/A53M | Standard Specification for Pipe, Steel, Black and Hot-Dipped Zinc-Coated, Welded and Seamless  |
| ASTM A106     | Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service   |
| ASTM A182     | Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service |
| ASTM A269     | Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service   |
| ASTM A403     | Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings  |
| ASTM A733     | Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples  |
- D. Hanford Documents
- |                     |  |
|---------------------|--|
| TFC-ENG-STD-12, E-2 | Tank Farm Equipment Identification Numbering and Labeling Standard |
|---------------------|--|

**1.3 SUBMITTALS**

- A. Product Data Sheets: Submit product data for components used in the compressed gas systems. Manufacturer's product data shall include component dimensions, equipment configuration, and connection details. Limits for operating pressure and temperature of each component and any related manufacturing standard shall be indicated.
- B. Welding certificates.
- C. Qualification Data: For Installers.
- D. Field quality - control test reports.

**1.4 QUALITY ASSURANCE**

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work.

- A. Source limitations: Obtain each type of pipe, tubing, fitting, and adapter through one source form a single manufacturer.
- B. The Seller shall submit to the Buyer a material handling plan. The material handling plan may include, but not limited to, the Seller's plan to maintain product cleanliness, protection from damage, and proper handling of components.

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- C. Piping, tubing, and fittings shall be fabricated, assembled, and inspected in accordance with ASME B31.9.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Cleaned components shall be packaged to protect them from general debris contamination and damage during shipping and storage.
- B. Exposed male threads are capped when necessary for protection during shipping and storage. Exposed female threads are plugged when necessary for protection during shipping and storage.
- C. Exposed tubing shall be protected during delivery, storage, and handling to ensure surface finish is maintained for proper sealing with the compression style tube connections.

**PART 2 PRODUCTS****2.1 PIPES, TUBES, AND FITTINGS**

- A. **Stainless Steel Tubing:** High quality fully annealed stainless steel hydraulic tubing, ASTM A269 seamless and welded tubing. Tubing to be free of scratches, suitable for bending and flaring.
1. **Flanges & Fittings:** ASTM A403, ASTM A182, or ASME B16.5. Unless dictated on design media compression tube fittings and adapter fittings shall be used.
  2. Tubing and fittings used in the compressed air system shall be cleaned to remove oil, grease, and loose particles that typically remain on products and components following industrial manufacturing processes. Lubricants and coatings are an exception and shall be applied to mating surfaces.
  3. The minimum nominal wall thickness for compressed air tubing shall comply with the following table:

**Table 1 – Tube Wall Minimum Thickness**

<b>Tubing Size (inches)</b>	<b>Minimum Wall Thickness (inches)</b>
1/4	0.028
3/8	0.035
1/2	0.049
3/4	0.065
1	0.083

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- B. Schedule 40, Steel Pipe: ASTM A53/A53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded according to ASME B1.20.1.
1. Steel Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106, Schedule 40, galvanized seamless steel pipe.
  2. Malleable-Iron Fittings: ASME B16.3, Class 150 or 300, threaded.
  3. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.
  4. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel, threaded.
  5. Piping and fittings used in the compressed air system shall be cleaned to remove oil, grease, and loose particles that typically remain on products and components following industrial manufacturing processes. Lubricants and coatings are an exception and shall remain applied to mating surfaces.

**2.2 JOINING MATERIALS**

- A. Pipe-Flange Gasket Materials: Suitable for compressed air system contents.
1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-in. maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Welding Filler Metals: Comply with AWS D1.1/D1.1M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

**2.3 FLEXIBLE CONNECTORS**

- A. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
1. Working-Pressure Rating: 200 psig minimum.
  2. End Connections, NPS 2 and Smaller: Threaded steel pipe nipple, compression tube connection.

**2.4 HOSE ASSEMBLIES**

- A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed air service, of nominal diameter indicated, and rated for 200 psig minimum working pressure, unless otherwise indicated.

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1. Hose: Reinforced single or double-wire-braid, CR-covered hose for compressed air service.
2. Hose Clamps: Stainless-steel clamps or bands.
3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.
4. Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with barbed ends for connecting two sections of hose.

**PART 3 EXECUTION****3.1 PIPING AND TUBING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed air piping and tubing. Indicated locations and arrangements were used to size pipe/tubing and perform ASME and pressure loss calculations, air compressor sizing, and other design considerations. Install piping/tubing as generally indicated. Minor deviations in layout to avoid general equipment and facility obstructions are acceptable.
- B. All piping/tubing supports shall be located with adherence to Section 22 05 29, "Hangers and Supports for Plumbing, Piping and Equipment," for maximum unsupported length.
- C. Install piping/tubing in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated. Installed piping/tubing shall not interfere with the operation or accessibility of doors; shall not encroach on aisles, passageways, or equipment; and shall not interfere with servicing or maintenance of equipment.
- D. Piping/tubing shall be cut accurately to measurements established at the construction site and shall be worked into place without forcing or springing, properly clearing all openings and equipment to avoid strain on joints.
- E. Exposed tubing shall be grouped, run parallel on the same plane and with minimal spacing. Just prior to connection to equipment or point of use, tubing shall be fanned out neatly.
- F. Multiple pipes/tubes following the same paths shall be evenly spaced, run parallel and have a professional appearance. Tubing shall be run parallel with the lines of the building unless otherwise noted on the drawings. Tubing connections to equipment shall be in accordance with details shown on the drawings.
- G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.

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- H. Equipment and Specialty Flanged Connections:
  - 1. For steel pipe, NPS 2 or smaller, use steel national pipe thread (NPT) connections per ASME B1.20.1.
  - 2. For tubing connections use compression style tube inlet/outlet connections.
- I. Install eccentric reducers where compressed air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- J. Install branch connections to compressed air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
- K. Install piping/tubing to permit valve servicing.
- L. Install piping/tubing free of sags and bends.
- M. Bend tubing in accordance with ASME B31.9, and meet tolerances given in ASME B31.9. Use methods and equipment that produce bends free of wrinkles, bulges, or kinks. Tubing must not be used if it kinks, flattens, or wrinkles.
- N. Identify compressed air lines during installation so that the chance for crossover of one service line to a different terminal unit is avoided.
- O. For pipe routing, install fittings for changes in direction and for branch connections.
- P. To remove potential particulate matter, a heavy, intermittent purging of each compressed air supply line shall be performed with oil-free nitrogen (Nigh Purity 99.99 percent or greater) at 50 psig after installation of the distribution system but before installation of station outlet/inlet assemblies and other system components (e.g., pressure indicators, relief valves, manifolds, etc.). The outlet shall be allowed to free flow until the purge produce no discoloration in a white cloth. Provide written documentation of purging of lines.

### 3.2 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe/tube and fittings before assembly.
- C. Compression Fittings: For tubing installation use compression fittings and follow the manufacturer's installation instructions for assembly of tubing and tube fittings. Ensure that the tubing is fully bottomed in the fitting before final tightening. After assembly, check that the fitting is properly tightened by using a Gap Inspection Gauge.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

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1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified. For compressed air threaded joint pipe, use either Swagelok SWAK or Swagelok polytetrafluoroethylene tape. For vacuum system with threaded joint pipe, use a non-outgassing thread sealant. Apply in accordance with manufacturer's instructions.
  2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Welded Joints for Steel Piping: Join according to ASME B31.9.
- F. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

**3.3 DIELECTRIC FITTING INSTALLATION**

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. NPS 2 and Smaller: Use dielectric unions.

**3.4 HANGER AND SUPPORT INSTALLATION**

- A. Comply with requirements in Section 22 05 29, "Hangers and Supports for Plumbing, Piping and Equipment," for pipe/tubing hanger and support devices.

**3.5 LABELING AND IDENTIFICATION**

- A. Install identifying labels and devices for general service compressed air pipe/tubing, valves, and specialties. Comply with requirements TFC-ENG-STD-12, "Tank Farm Equipment Identification Numbering and Labeling Standard."

**3.6 FIELD QUALITY CONTROL**

- A. Perform field tests and inspections.
- B. Tests and Inspections:
  1. Perform testing in accordance with Section 22 08 13, "Testing Piping Systems," and ASME B31.9.
  2. Repair leaks and retest until no leaks exist.
  3. Inspect installed equipment for proper operation.
- C. Prepare test reports.

END OF SECTION 22 15 13



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**SECTION 26 05 02****BASIC ELECTRICAL REQUIREMENTS****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. This section covers the Work required in conjunction with other Division 26 specifications necessary to procure, detail, manufacture, deliver to the jobsite, and install the electrical systems.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. National Electrical Contractors Association (NECA)  
National Electrical Installation Standards
- B. National Electrical Manufacturers Association (NEMA)  
NEMA Z535.4 Product Safety Signs and Labels
- C. National Fire Protection Association (NFPA)  
NFPA 70, 2017 National Electrical Code (NEC)
- D. Underwriters Laboratories (UL)

**1.3 SUBMITTALS**

- A. See Contract Statement of Work for submittal procedures.

**1.4 QUALITY ASSURANCE**

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

- A. Provide the Work in accordance with the NEC. Electrical material and equipment shall be accepted, certified, listed, labeled, or otherwise determined safe by a Nationally Recognized Testing Laboratory (NRTL) and indicated by an NRTL label applied by the manufacturer or labeled by an NRTL representative following an NRTL field evaluation to provide basis for approval under NEC.

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- B. Materials and equipment manufactured within the scope of standards published by UL, shall conform to those standards and shall have an applied UL listing mark or label.
- C. Provide materials and equipment acceptable to the Authority Having Jurisdiction for Class, Division, and Group of hazardous area indicated.
- D. Electrical inspection shall be performed by personnel that are certified to perform NEC inspections.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. See Statement of Work.
- B. All components, unless specified otherwise in this section or related sections, shall be compatible with being transported by public roadway to contract specified destination. Items shall either be self-supporting or provided with packing and dunnage to ensure their stability and protection from damage.

**PART 2 PRODUCTS****2.1 GENERAL**

- A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.
- B. Material and equipment installed in heated and air-conditioned areas shall be capable of continuous operation at their specified ratings within an ambient temperature range of 40°F to 104°F.
- C. Materials and equipment installed outdoors shall be capable of continuous operation at their specified rating within the ambient temperature range of -25°F to 115°F unless otherwise specified on Drawings.
- D. Electrical ratings of materials and equipment that are reduced by increased elevation shall be derated as required for Site elevation.

**2.2 EQUIPMENT FINISH**

- A. Manufacturer's standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment in accordance with light gray color finish as approved by the TOC Construction Representative.

**2.3 SIGNS AND LABELS**

- A. Sign size, lettering, and color shall be in accordance with NEMA Z535.4.

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**PART 3 EXECUTION****3.1 GENERAL**

- A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned. Contractor shall be responsible for actual location of equipment and devices and for proper routing and support of raceways, subject to approval of TOC Construction Representative.
- B. Check approximate locations of light fixtures, switches, electrical outlets, equipment, and other electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify TOC Construction Representative in writing.
- C. Install work in accordance with NECA National Electrical Installation Standards, unless otherwise specified.
- D. Keep openings in boxes and equipment closed during construction.
- E. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of TOC Construction Representative. Carefully perform cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces to original condition.

**3.2 COMBINING CIRCUITS INTO COMMON RACEWAY**

- A. Do not combine raceways where conduit numbers or wire run numbers are shown on the Drawings.
- B. Homerun circuits shown on Drawings indicate functional wiring requirements for power and control circuits. Circuits may be combined into common raceways in accordance with the following requirements:
  - 1. Analog control circuits from devices in same general area to same destination.
    - a. No power circuits shall be combined in same conduit with analog circuits.
    - b. No Class 2 or Class 3 circuits shall be combined with power or Class 1 circuits.
    - c. Analog circuits shall be continuous from source to destination. Do not splice or combine into a multi-pair cable without authorization of TOC Construction Representative.
    - d. Raceways shall be sized per General Circuit and Raceway Schedule and shall not exceed values specified in the NEC.
    - e. Changes shall be documented on record drawings.

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2. Discrete control circuits from devices in the same general area to the same destination.
  - a. No power circuits shall be combined in same conduit with discrete circuits.
  - b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, and paging system circuits shall be combined with power or Class 1 circuits.
  - c. Raceways shall be sized per the General Circuit and Raceway Schedule and shall not exceed values specified in the NEC.
  - d. Changes shall be documented on record drawings.
3. Power circuits from loads in same general area to same source location.
  - a. Lighting Circuits: Combine no more than three circuits to a single raceway. Provide a separate, identified neutral conductor for each 120-volt and 277-volt circuit. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
  - b. Receptacle Circuits, 120-Volt Only: Combine no more than three circuits to a single raceway. Provide a separate identified neutral conductor for each circuit. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
  - c. All Other Power Circuits: Do not combine power circuits without authorization of TOC Construction Representative.

### 3.3 NAMEPLATES, SIGNS, AND LABELS

- A. Arc Flash Protection Warning Signs:
  1. Field mark switchboards and panelboards to warn qualified persons of potential arc-flash hazards. Locate marking so to be clearly visible to persons before working on energized equipment.
  2. Use arc flash hazard boundary, energy level, shock hazard, bolted fault current, and equipment name from TOC Construction Representative as basis for warning signs.
- B. Equipment Nameplates:
  1. Provide a nameplate to label electrical equipment including tap cabinets, switchboards, panelboards, motor starters, adjustable speed drives, transformers, terminal junction boxes, disconnect switches, light switches, control stations, receptacles, and lights.
  2. Switchboards, panelboards, and motor control centers shall include equipment designation, service voltage, phases, power source, and circuit number.

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3. Transformer and disconnect switch shall include equipment designation, power source, and circuit number.
4. Motor starter and adjustable speed drive shall include equipment designation and power source. Include circuit number when power source is a switchboard or panelboard.
5. Lighting switch and receptacles shall include power source and circuit number.
6. Control station shall include controlled equipment designation.
7. Pad mount utility transformer shall include equipment designation, primary and secondary voltages, and power source.
8. Tap cabinet shall include equipment designation, service voltage, phases, and power source.
9. Provide a nameplate to label HVAC and plumbing equipment including electric heaters, heat pumps, air handling and makeup units, water heaters, exhaust fans, supply fans, and freeze-proof safety showers. Include equipment designation, power source, and circuit number.

**3.4 LOAD BALANCE**

- A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.
- B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, and other equipment where balancing is required.
- C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement. Obtain TOC Construction Representative approval prior to relocating or reconnecting loads.

**3.5 CLEANING AND TOUCHUP PAINTING**

- A. Cleaning: Throughout the Work, clean interior and exterior of devices and equipment by removing debris and vacuuming.
- B. Touchup Paint:
  1. Touchup scratches, scrapes, and chips on exterior and interior surfaces of devices and equipment with finish matching type, color, and consistency and type of surface of original finish.
  2. If extensive damage is done to equipment paint surfaces, refinish entire equipment in a manner that provides a finish equal to or better than factory finish, that meets requirements of Specification, and is acceptable to TOC Construction Representative.

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**3.6 PROTECTION FOLLOWING INSTALLATION**

- A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation and contact surfaces.
- B. When equipment intended for indoor installation is installed at Contractor's convenience in areas where subject to dampness, moisture, dirt or other adverse atmosphere until completion of construction, ensure adequate protection from these atmospheres is provided and acceptable to TOC Construction Representative.

END OF SECTION 26 05 02

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**SECTION 26 05 19****LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Building wire (600V)
- B. TC cable (2000V and 600V)
- C. Wire and cable connectors
- D. Insulating tape and tubing
- E. Wire pulling lubricant

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. ASTM International (ASTM)
  - ASTM B3 Standard Specification for Soft or Annealed Copper Wire
  - ASTM D3005 Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
- B. National Electrical Contractors Association (NECA)
  - NECA 1 Standard for Good Workmanship in Electrical Contracting
- C. National Fire Protection Association (NFPA)
  - NFPA 70, 2017 National Electrical Code (NEC)
- D. Institute of Electrical and Electronics Engineers (IEEE)
  - IEEE 422 IEEE Guide for the Design and Installation of Cable Systems in Power Generating Stations

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IEEE 1210 Standard Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable

E. Underwriters Laboratories (UL)

UL 44 Thermoset-Insulated Wires and Cables

UL 83 Thermoplastic-Insulated Wires and Cables

UL 486A-486B Wire Connectors

UL 486C Splicing Wire Connectors

UL 486D Sealed Wire Connector Systems

UL 510 Standard for Polyvinyl Chloride Polyethylene and Rubber Insulating Tape

UL 1277 Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members

### 1.3 SUBMITTALS

A. See the Contract Statement of Work for the submittal process.

B. Approval Required

1. Project Record Documents: Submit project record documents including specified certifications and all field test reports.

C. Approval Not Required

1. Catalog Data: Conductors/cables; compression connectors; indicate compression tools and dies that will be used.

### 1.4 QUALITY ASSURANCE

A. Comply with the NEC for components and installation.

B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application and environment in which installed.

### 1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect, and handle products according to manufacturer's instructions and NECA 1.



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**PART 2 PRODUCTS****2.1 PRODUCT OPTIONS AND SUBSTITUTIONS**

- A. Refer to the Contract Statement of Work.

**2.2 CONDUCTORS 600 VOLTS AND BELOW**

- A. General:

1. Description: Single conductor 600 V, 90°C insulated wire.
2. Conductor:
  - a. 98% conductivity, annealed, uncoated copper (per ASTM B3) solid or stranded as specified in Part 3 of this Section.
  - b. 120 V circuits, 10 AWG and smaller: Solid Copper.
  - c. All other circuits: Stranded Copper.
3. Insulation: The following types unless otherwise indicated on the Drawings.
  - a. 1 AWG and smaller, Type THHN/THWN-2 per UL 83.
  - b. 1/0 AWG and larger, Type XHHW per UL 44 or Type THHN/THWN-2 per UL 83.

- B. Color code conductors as follows:

1. Use colored insulation for color coding conductors 6 AWG and smaller.
2. Use water and oil resistant colored plastic adhesive tape, 3/4 in. minimum width, for color coding conductor 4 AWG and larger. Manufacturer: 3M "Scotch 35."
3. Provide black conductor insulation where colored tape is used for color coding.

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4. Use the following color codes for AC power system conductors:

Conductor Color Codes

System Voltage:	480Y/277V	120/240V	208Y/120V
Conductor:			
Phase A:	Red	Black	Black
Phase B:	Yellow	Brown	Purple
Phase C:	Blue	---	Brown
Grounded (Neutral):	White/Gray	White/Gray	White/Gray
Equipment Grounding:	Green	Green	Green
Isolated Ground:	---	---	---
Switched:	Purple	Blue	Black

5. Use the following color codes for DC power system conductors:

Positive: Red  
 Negative: Black

6. Provide color code for control conductors as indicated on equipment or control system manufacturer's drawings.

### 2.3 TC-ER CABLE

- A. Provide tray cable (Type TC-ER) that complies with UL 1277, the NEC, and this Section.
- B. TC-ER cable shall be rated 90°C, minimum of 600V insulation rating, UL listed, sunlight and weather resistant, rated for direct burial and rated for variable frequency drive (VFD) use where specified on the Drawings. TC cable rated for VFD use shall have a 2,000V insulation rating.
- C. Provide TC-ER cables with quantities and sizes (minimum 12 AWG for power) of conductors as indicated on the Drawings.
- D. TC-ER cable manufacturer: General Cable or equal.

### 2.4 CABLE PROTECTORS

- A. Cable Protectors: Where cables require protection from vehicle or pedestrian traffic, use a cable protector such as Yellow Jacket, Bumblebee, or Cable Guard. Cable Guard or other engineering approved protection shall be used at vehicle and crane crossings.

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**2.5 WIRING CONNECTORS**

- A. For splices and taps on copper wire, sizes 8 AWG and smaller, use pressure type, or spring type rated for use with copper conductors with insulating caps or covers rated for 600V and 105°C that are NRTL-listed to UL 486C. Thomas and Betts Corporation “Sta-Kon<sup>®21</sup>,” 3M Company “Scotchlok,” or approved substitute, where required by the NEC.
- B. For splices and taps on copper wire, sizes 6 AWG through 1 AWG, use the following materials:
1. Tin-plated copper split-bolt connectors that meet the requirements in UL 486A-486B; provide with matching 600V snap-on insulating cover. Manufacturer: FCI Burndy “Type KSA” with “Type SC” insulating cover.
  2. Multi-tap connectors that meet the requirements of UL 486A-486B that have two or more range-taking mechanical lugs and matching 600V insulated cover. Manufacturers: Burndy “POLYTAP” or “UNITAP,” IlSCO<sup>®22</sup> “Type PCT,” Blackburn<sup>®20</sup> “AMT.”
- C. For copper wire, sizes 1/0 AWG and larger, use UL 486A-486B listed circumferential or hexagonal crimp compression terminals, splices, or adapters.
1. Provide compression terminals and splices made from electro-tin plated seamless copper tubing and marked with wire size, die index/color code, and number/locations of crimps. Manufacturers: FCI Burndy Types “YA,” “YA-L,” “YA-L-NT,” “YS,” and “YC-C.” Thomas & Betts “Color-Keyed.”
  2. Provide straight and offset compression adapters made from electro-tin plated aluminum, NRTL-listed for use on copper conductors, and marked with wire size, die index / color code, and number / locations of crimps. Each adapter shall include a 600V, 90°C rated insulating cover. Manufacturer: FCI Burndy Types “AYP” and “AYPO.”
  3. Range-taking, die-less, or indenter-applied terminals are not acceptable for control wiring. Use nylon insulated crimp-on terminals with insulation grip that meet the requirements of UL 486A-486B. Manufacturer: 3M “Scotchlok MNG,” Thomas & Betts “Sta-Kon.”
  4. Use ring tongue terminals for nutted studs.
  5. Use flanged fork terminals for barrier terminal blocks.

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<sup>21</sup> Sta-Kon is a registered trademark of Thomas & Betts International, Inc., Wilmington, Delaware.

<sup>22</sup> IlSCO is a registered trademark of IlSCO Corporation, Cincinnati, Ohio.

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- D. Insulation-piercing type connectors are not acceptable for power or control wiring.

**2.6 INSULATING TAPE AND TUBING**

- A. For making re-enterable tape-insulated splices and connections, provide varnished cambric electrical insulating tape made of cotton cambric fabric that is oil primed and coated with electrical insulating varnish. Manufacturer: 3M “Scotch 2510” (no adhesive) and “Scotch 2520” (pressure-sensitive adhesive).
- B. Insulate taped splices and connections using ethylene propylene rubber tape that meets the requirements of UL 510 and is rated for 90°C continuous operation and 130°C short-term overload service. Manufacturer: 3M “Scotch 130C.”
- C. For the outer covering of tape-insulated splices and connections use vinyl plastic tape that meets the requirements of UL 510 and has the following characteristics:
1. 8.5 mil minimum thickness.
  2. ASTM D3005, Rated 600V and 105°C, suitable for indoor and outdoor applications.
  3. Retains flexibility, adhesion, and applicable at temperature ranges from 0 through 100°F without loss of physical or electrical properties.
  4. Resistant to abrasion, moisture, alkalis, acid, corrosion, and sunlight.
  5. Manufacturer: 3M “Scotch Super 88.”
- D. Provide heat shrinkable tubing that meets the requirements of UL 486D and has the following characteristics:
1. Rated 600V.
  2. Factory applied adhesive/sealant.
  3. Split resistant.
  4. Manufacturer: 3M “ITCSN.”
- E. Use motor lead splicing kits to insulate and seal connections to leads for motors rated 480V and less. Manufacturer: 3M “5300 Series.”

**2.7 WIRE PULLING LUBRICANT**

- A. Provide NRTL-listed wire pulling lubricant that is compatible with the conductor insulation or jacket, has a maximum coefficient of dynamic friction of 0.25, and leaves no flammable residue. For cold weather installations, provide wire pulling lubricant suitable for conduit temperature.

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- B. Manufacturer:
  - 1. For conduit temperature above freezing: American Polywater Corporation, "Polywater" "Lubricant J."
  - 2. For conduit temperature below freezing: American Polywater Corporation, "Polywater" "Lubricant WJ."

**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Verify that work of other trades has not damaged wires and cables.
- B. Verify raceway/conduit installation is complete and supported.
- C. Verify that field measurements are as shown on Drawings.
- D. Wire and cable routing shown on Drawings is approximate unless dimensioned.
  - 1. Route wire and cable as required meeting project conditions.
  - 2. Where cable routing is not shown, and destination only is indicated, determine exact routing and lengths required to meet field conditions.

**3.2 PREPARATION**

- A. Do not handle or pull cables that are colder than +15°F. Store cold cables for at least 24 hours in a heated building prior to installation.

**3.3 TYPE TC CABLE INSTALLATION**

- A. Install TC cables according to the NEC and requirements in this Section.
- B. Install and support Type TC cables as required in Article 336 of the NEC.

**3.4 CONNECTOR INSTALLATION**

- A. Install conductors in terminals, splices, adapters, and connectors in accordance with the manufacturer's instructions. Have the manufacturer's installation instructions available at the construction site.
- B. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise above the conductor temperature.
- C. Do not nick conductors when removing insulation.
- D. Do not cut conductor strands to fit into connectors, splices, adapters, or terminals.

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- E. Make connections using clean connection surfaces. Wire brush conductors immediately before installing lugs, terminals, splices, or adapters.
- F. Connect conductors 1/0 AWG and larger using compression terminals at the locations described below. Compression terminals shall be installed where there is adequate wire bending space to accommodate compression terminals. Select compression terminals suitable for the conductor sizes, materials, and termination point configurations. Install compression terminals using the manufacturer's recommended dies and minimum 12-ton force compression tools.
  - 1. Circuit breakers with frame size greater than 100 amperes that are NRTL-listed for use with compression terminals.
  - 2. Safety switches and fused switches rated more than 100 amperes.
  - 3. Transformers; refer to Section 26 22 13, "Low Voltage Distribution Transformers."
  - 4. Switchboards, panelboards, motor control centers, and similar service and distribution equipment.
  - 5. Utilization equipment connections that are NRTL-listed for use with compression terminals.
- G. For conductors sized 1/0 AWG and larger, and where compression lugs cannot be installed, connect using mechanical lugs, in the locations or conditions described below.
  - 1. Connection points not NRTL-listed for either compression terminals or compression adapters.
  - 2. Where there is insufficient wire bending space to accommodate either compression terminals or compression adapters.
- H. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals; including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors.

### 3.5 INSULATING TAPE AND TUBING INSTALLATION

- A. Install insulating tape and tubing in accordance with the manufacturer's instructions. Have the manufacturer's installation instructions available at the construction site.
- B. Insulate splices and taps of irregular shapes with manufactured insulating covers or insulating tape built up to not less than 150% of insulation rating of conductor.

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1. Apply varnished cambric tape over connections where re-entry is likely, such as motor lead connections.
  2. Use rubber insulating tape in half-lapped layers to develop the basic insulation over splices and taps.
  3. Use vinyl plastic tape in half-lapped layers to provide the outer protective covering over splices and taps.
- C. Insulate cylinder shaped splices and taps, connector barrels, and adapter barrels using heat shrinkable insulating tubing, insulating covers manufactured for the connector, or tape insulation as described above.

**3.6 IDENTIFICATION**

- A. Identify wire and cable under provisions of Section 26 05 53, "Identification for Electrical Systems."
- B. Identify each conductor with its circuit number or other designation indicated on Drawings.
- C. Apply color coding tape on conductors at each termination, splice, junction, and pull box.

**3.7 FIELD QUALITY CONTROL**

- A. Observe conductors and cables during the installation process.
  1. Reject and replace entire reels, rolls, or boxes containing conductors or cables with material or manufacturing defects.
  2. Reject and replace cable or conductor segments that have been kinked, dented, or otherwise damaged during handling or installation.
- B. Perform the following inspections:
  1. Inspect exposed conductors and cables for:
    - a. Material defect and physical damage.
    - b. Correct conductor size, material, and insulation type.
    - c. Correct color coding and identification.
    - d. Proper connections in accordance with the Drawings.
  2. Inspect connections for:
    - a. Correct connector size and type according to the Specifications and Drawings.

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- b. The use of the correct compression dies and the correct number of crimps on compression connectors in accordance with the connector manufacturer's instructions.
- C. Perform the following tests:
  - 1. Before connecting conductors to equipment, use a megohmmeter in a 1-minute test to verify the insulation integrity of each service conductor and feeder conductor, and all conductors in 480 V circuits, with respect to ground and other conductors in the same raceway.
    - a. Use 1000VDC to test conductors rated 600 and 2000V and 500VDC for conductors rated 300V or less.
    - b. Insulation test values shall be in accordance with the following:
      - i. Conductors with 300V insulation rating and insulation resistances over 25 megohms are acceptable.
      - ii. Conductors with 600V insulation rating and insulation resistances over 100 megohms are acceptable.
      - iii. Conductors with 2000V insulation rating and insulation resistances over 500 megohms are acceptable.
    - c. Conductors with insulation resistances less than indicated above shall be investigated.
  - 2. Prior to connecting conductors to equipment, test continuity to ensure proper circuit is identified to facilitate correct connection of each power circuit conductor and each control circuit conductor.
  - 3. Test the equipment and wiring for continuity and unintentional grounds, and verify proper phase sequence and voltage at equipment served before attempt is made to operate equipment.
  - 4. Perform insulation resistance testing on electric heat trace cable at installation, before and after insulation is installed, in accordance with manufacturer's instructions.
  - 5. Measure and record the tightness of not less than 10% of each size and type of mechanical or bolted connection using a calibrated torque wrench or torque screwdriver. Additionally, verify proper crimping method, as applicable.
    - a. Compare measured torque with torque recommended by the connector manufacturer or as shown in Attachment 1, "Recommended Tightening Torque per UL 486A-486B."



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- b. If any connection is found to be less than 90% of the recommended torque, notify the Buyer's Technical Representative and re-torque all bolted connections on the Project.
- D. Remove and replace defective, incorrect, or improperly installed conductors and connectors. Re-inspect and re-test replacement conductors and connectors.
- E. Submit test and inspection records to the Buyer's Technical Representative.
- F. Verify inspections and tests required by other Sections are completed before conductors may be energized.

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## SECTION 26 05 19 – ATTACHMENT 1

## RECOMMENDED TIGHTENING TORQUE PER UL 486A-486B

Table 21 - Tightening torque for screws

Conductor Size installed in Connector		Tightening Torque, N•m (lbf-in)			
		Slotted Head No. 10 and Larger*		Hexagonal Head – External Drive Socket Wrench	
		Slot Width – 1.2mm (.047 in.) or Less and Slot Length – 6.4mm (1/4 in.) or less	Slot Width – Over 1.2mm (.047 in.) or Slot Length – Over 6.4mm (1/4 in.) or less		
AWG or kcmil	mm <sup>2</sup>				
30 - 10	.05 - 5.3	2.3 (20)	4.0 (35)	9.0 (80)	8.5 (75)
8	8.4	2.8 (25)	4.5 (40)	9.0 (80)	8.5 (75)
6 - 4	13.2 - 21.2	4.0 (35)	5.1 (45)	18.6 (165)	12.4 (110)
3	26.7	4.0 (35)	5.6 (50)	31.1 (275)	16.9 (150)
2	33.6	4.5 (40)	5.6 (50)	31.1 (275)	16.9 (150)
1	42.4	-	5.6 (50)	31.1 (275)	16.9 (150)
1/0 - 2/0	53.5 - 67.4	-	5.6 (50)	43.5 (385)	20.3 (180)
3/0 - 4/0	85.0 - 107.2	-	5.6 (50)	56.5 (500)	28.2 (250)
250 - 350	127 - 177	-	5.6 (50)	73.4 (650)	36.7 (325)
400	203	-	5.6 (50)	93.2 (825)	36.7 (325)
500	253	-	5.6 (50)	93.2 (825)	42.4 (375)
600 - 750	304 - 380	-	5.6 (50)	113.0 (1000)	42.4 (375)
800 - 1000	406 - 508	-	5.6 (50)	124.3 (1100)	56.5 (500)
1250 - 2000	635 - 1000	-	-	124.3 (1100)	67.8 (600)

\* For values of slot width or length not corresponding to those specified, select the largest torque value associated with the conductor size. Slot width is the nominal design value. Slot length shall be measured at the bottom of the slot.

Table 22 - Tightening torque for slotted head screws smaller than No. 10 intended for use with 8 AWG (8.4 mm<sup>2</sup>) or smaller conductors

Slot Length of Screw*		Tightening Torque, N•m (lbf-in)	
		Slot Width of Screw Smaller than 1.2mm (.047 in.)	Slot Width of Screw 1.2mm (.047 in.) and larger**
mm	inch		
Less than 4	Less than 5/32	0.79 (7)	1.0 (9)
4	5/32	0.79 (7)	1.4 (12)
4.8	3/16	0.79 (7)	1.4 (12)
5.6	7/32	0.79 (7)	1.4 (12)
6.4	1/4	1.0 (9)	1.4 (12)
7.1	9/32	-	1.7 (15)
Above 7.1	Above 9/32	-	2.3 (20)

\* For slot lengths of intermediate values, select torques pertaining to next shorter slot length. Also see Table 21 for screws with multiple tightening means.

Slot length shall be measured at the bottom of the slot.

\*\* Slot width is the nominal design value

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Table 23 - Tightening torque for screws with recessed Allen or Square drives

Socket Width Across Flats*		Tightening Torque, N•m (lbf-in)
mm	inch	
3.2	1/8	5.1 (45)
4.0	5/32	11.3 (100)
4.8	3/16	13.6 (120)
5.6	7/32	16.9 (150)
6.4	1/4	25.4 (225)
7.9	5/16	33.9 (300)
9.5	3/8	45.2 (400)
12.7	1/2	56.6 (500)
14.3	9/16	67.8 (600)

\* See Table 21 for screws with multiple tightening means

END OF SECTION 26 05 19

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**SECTION 26 05 26****GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Connection to Grounding Electrode System.
- B. Circuit and System Grounding.
- C. Enclosure and Equipment Grounding System.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. ASTM International (ASTM)
  - ASTM B8                                      Standard Specification for Concentric-Lay Stranded Copper Conductors
- B. Institute of Electrical and Electronics Engineers (IEEE)
  - IEEE 81                                      Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System
  - IEEE 837                                      IEEE Standard for Qualifying Permanent Connections used in Substation Grounding
- C. National Fire Protection Association (NFPA)
  - NFPA 70, 2017                              National Electrical Code (NEC)
- D. Underwriters Laboratories (UL)
  - UL 486A-486B                              Wire Connectors and Soldering Lugs for Use with Copper Conductors
  - UL 486C                                      Splicing Wire Connectors

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**1.3 SUBMITTALS**

- A. See the Contract Statement of Work for the submittal process.
- B. Approval Required
  - 1. None.
- C. Approval Not Required
  - 1. Test Reports.

**1.4 QUALITY ASSURANCE**

- A. Comply with the NEC for components and installation.
- B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application and environment in which installed.

**1.5 RECEIVING, STORING, AND PROTECTING**

- A. Receive, store, protect, and handle products according to manufacturer's instructions.

**PART 2 PRODUCTS****2.1 PRODUCT OPTIONS AND SUBSTITUTIONS**

- A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work.

**2.2 GROUNDING ELECTRODE CONDUCTOR**

- A. Provide bare stranded, soft temper copper cable that conforms to ASTM B8.
- B. Provide ground electrode conductor for separately derived systems and equipment in the Tank Farm and bond to nearest tank riser.

**2.3 EQUIPMENT GROUNDING CONDUCTORS**

- A. Provide NRTL-listed THHN/THWN insulated copper wire.
- B. Use solid grounding conductors 12 AWG and smaller where not subject to vibration or repeated flexing.
- C. Use stranded grounding conductors for 10 AWG and larger.
- D. Use stranded grounding conductors where subject to vibration or repeated flexing.

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- E. Color code grounding conductors as follows:
  - 1. Equipment ground:
    - a. Conductors 6 AWG and smaller: Green colored insulation.
    - b. Conductors 4 AWG and larger: Green colored insulation or black colored insulation with 3/4 in. wide band of water and oil-resistant green plastic adhesive tape.

**2.4 GROUND PLATES**

- A. Provide ground plates designed for flush mounting in concrete.
- B. Furnish copper alloy castings with four 1/2 in. x 13 in. threaded holes at 1.75 in. x 1.75 in. NEMA spacing and a welding stud or compression connection suitable for 2 AWG to 250 kcmil copper conductor.
- C. Manufacturer: Burndy “YGF.”

**2.5 CONDUIT GROUNDING BUSHINGS**

- A. Provide NRTL-listed, galvanized malleable iron, 150°C rated insulated throat grounding bushings with lay-in type ground cable lugs.
- B. Manufacturers: O-Z/Gedney<sup>23</sup>® Type “BLG.”

**2.6 COMPRESSION GROUNDING CONNECTIONS**

- A. Provide wrought copper connectors, terminals, taps, and splices for making irreversible compression grounding connections.
- B. Furnish NRTL-listed grounding connectors that are suitable for direct burial and have been tested successfully according to the requirements of IEEE 837.
- C. Provide connector manufacturer’s hydraulic compression tools and dies that match the connectors.
- D. Match connector and die size to material shapes and conductor sizes to be joined.
- E. Use two-hole heavy-duty compression lugs for bolted connections to ground bars, ground plates, and equipment ground pads.
- F. Manufacturer: Burndy “Hyground®<sup>16</sup>.”

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<sup>23</sup> Gedney is a registered trademark of Appleton GRP LLC, Rosemont, Illinois.

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**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Verify that work of other trades has not damaged grounding or bonding connections.
- B. Verify that field measurements are as shown on Drawings.
- C. Grounding cable routing shown on Drawings is approximate unless dimensioned.
  - 1. Install and route cable as required meeting project conditions.
  - 2. Where cable routing is not shown, and destination only is indicated, determine exact locations, routing, and lengths required to meet project conditions.

**3.2 PREPARATION**

- A. Examine equipment that is to receive grounding and bonding material for compliance with installation tolerances and other conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.

**3.3 GENERAL**

- A. Comply with the requirements of the NEC, this Section, and the Drawings.
- B. Install grounding and bonding material according to manufacturer's instructions. Have the manufacturer's installation instructions available at the construction site.
- C. Use the following connection methods unless otherwise specified or indicated on the Drawings. Use compression or bolted grounding connection methods in the Tank Farm areas:
  - 1. Make bolted connections using bolts, nuts, flat washers, and toothed lock washers suitable for the connector and the installation environment; acceptable materials include high strength silicon bronze and 18-8 alloy stainless steel.
  - 2. Make irreversible bolted connections using 18-8 alloy stainless steel tamper-resistant bolts and tamper-resistant nuts along with flat washers, and toothed lock washers. Tamper-resistant nuts and bolts must resist loosening with common tools; acceptable tamper-resistant fasteners include penta-head, break-away, and oval designs.
- D. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in Section 26 05 19, "Low Voltage Electrical Power Conductors and Cables," Attachment 1, "Recommended Tightening Torque per UL 486A-486B." Use a calibrated torque wrench.

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- E. Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Follow connector manufacturer's installation instructions and use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed.
- F. Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
  - 1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.
  - 2. Make connections with clean bare metal at points of contact.
  - 3. Make aluminum to steel connections with stainless steel separators and mechanical clamps.
  - 4. Make aluminum to galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
  - 5. Coat and seal connections involving dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

### 3.4 GROUNDING ELECTRODE SYSTEM

- A. Install in accordance with the NEC and the Drawings.
- B. Concrete-encased grounding electrodes
  - 1. Install a concrete-encased grounding electrode in lower part of perimeter footing or grade beam to form a complete and continuous loop around the structure. Encase electrode with at least 2 in. of concrete from the bottom of foundation or footing. Use one of the following materials for the electrode:
    - a. Bare or zinc galvanized or other electrically conductive coated steel reinforcing bars, minimum 1/2-in. diameter. Bond reinforcing rods together using steel wire ties or other effective means.
    - b. Bare 4/0 copper conductor unless otherwise shown on the Drawings. Space cable from the bottom and sides of the grade beam so it has at least 2 in. of concrete coverage. Bond to rebar in one place.
    - c. Perform NEC inspection of grounding electrode prior to concrete placement.
- C. Install ground plates flush with top of concrete. Locate ground plates adjacent to electrical equipment as shown on the Drawings. Bond grounding electrode to ground plates with UL-listed compression fittings.



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**3.5 CIRCUIT AND SYSTEM GROUNDING**

- A. Bond service entrance equipment ground bus to grounding electrode system; use ground cable as indicated on the Drawings, or not smaller than the grounding electrode conductor required by the NEC and not smaller than 4 AWG.
- B. In the service entrance equipment, connect the neutral bus to the ground bus using a bonding jumper not smaller than the grounding electrode conductor required by the NEC; do not use a bonding screw for this purpose. Make no other neutral-to-ground connections on the load side of the service entrance disconnect.
- C. Separately Derived Systems:
  - 1. Connect ground bus of first disconnecting means for separately derived systems (e.g., dry type transformers) to the nearest ground plate (preferred) or building structural steel column; use grounding conductor sized as shown on the Drawings or as required by the NEC.
  - 2. At the first system overcurrent device or disconnecting means, connect the neutral bus to the ground bus using a bonding jumper sized as required by the NEC. For systems in the Tank Farm, provide grounding electrode conductor to nearest tank riser. Sized grounding electrode conductor in accordance with the NEC and use UL Listed pipe grounding clamp or to an existing ground tap on riser with the approval of the TOC Construction Representative.

**3.6 ENCLOSURE AND EQUIPMENT GROUNDING**

- A. Provide permanent and effective equipment, enclosure, and raceway grounding in accordance with NEC requirements, and as further specified or shown on the Drawings.
- B. Provide an equipment ground bar, separate from any neutral bar, in all switchgear, switchboards, panelboards, transformers, motor control centers, starters, disconnect switches, cabinets, etc., for grounding the enclosure and for connecting other equipment and raceway ground conductors. Make connections to the ground bar using mechanical lugs or compression lugs.
- C. Make connections and couplings on metallic conduit systems wrench tight.
- D. Grounding Bushings:
  - 1. Install grounding bushings on metallic conduit containing circuits rated 480 VAC or 100 amperes and higher.
  - 2. Install grounding bushings on metallic conduits entering enclosures through concentric, eccentric, or oversize knockouts.
  - 3. Install grounding bushings on metallic conduits that terminate to a metallic enclosure without effective electrical connection such as locknuts or threaded bushings.

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4. Bond conduit grounding bushing lug to the equipment ground bar or ground lug in switchboard, panelboards, transformers, starters, disconnect switches, cabinets, etc. Size bonding jumpers in accordance with the NEC.
- E. Provide an insulated equipment grounding conductor for each feeder and branch circuit.
  1. Install the grounding conductor within the common conduit or raceway with the related phase and neutral conductors and connect to the grounding terminal or grounding bus in each box or cabinet.
  2. Size equipment ground conductor in accordance with the NEC or as shown on the Drawings.
- F. In each 15 or 20 ampere branch circuit outlet box and junction box, install a green colored washer head grounding screw with a 12 AWG equipment grounding conductor pigtail.
- G. Connect receptacle grounding terminals to the equipment ground system using minimum 12 AWG equipment grounding conductor. Do not use a "self-grounding" receptacle strap as the only equipment grounding path.

**3.7 FIELD QUALITY CONTROL**

- A. General: Perform on-site verification and acceptance testing of the grounding installation during construction.
- B. Notify the TOC Construction Representative ten working days in advance of the expected completion of a concrete-encased grounding electrode system installation. Verification and testing can be scheduled in parts or by area depending on the system and construction schedule.
- C. Before work is concealed, verify and certify that the following grounding installations have been made correctly:
  1. Grounding electrode system
  2. Ground plates and grounding bars
  3. All other underground grounding installations
- D. Acceptance Testing: Perform acceptance testing for grounding electrode system and submit written reports to the TOC Construction Representative.
  1. Measure resistance between grounding electrode and each ground plate prior to concrete placement. Use the "Two-Point Direct Method" of IEEE 81. Investigate and correct equipment ground resistances that exceed 0.5 ohm.
  2. Prepare test reports of the ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe any measures taken to improve test results.

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- E. Perform the following inspections and tests of grounding systems.
1. Visual and Mechanical Inspection:
    - a. Equipment and circuit grounds in panelboard for proper connection and tightness.
    - b. Ground bus connections in panelboard for proper termination and tightness.
    - c. Effective dry-type transformer equipment grounding.
    - d. Accessible connections to grounding electrodes for proper fit and tightness.
    - e. Accessible compression connections grounding connections to verify that proper bonding was obtained.
  2. Electrical Tests:
    - a. Measure resistance between equipment ground system, equipment frames, and system neutral and derived neutral points. Use the “Two-Point Direct Method of IEEE 81.
    - b. Equipment ground resistance shall not exceed main ground system resistance by 0.5 ohm.
  3. Neutral Bus Isolation:
    - a. Test each neutral bus individually with neutral bonding jumper removed at separately derived system.
    - b. Evaluate ohmic values by measuring resistance between ground bus and neutral bus.
    - c. Investigate values less than 50 megohms.

END OF SECTION 26 05 26

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**SECTION 26 05 29****HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Furnish and install, hangers, supports, anchors, concrete bases, and other positive fastenings for non-structural electrical components such that gravity loads are safely transferred to the structure.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. Code of Federal Regulations (CFR)  
29 CFR 1910 Occupational Safety and Health Standards (OSHA)
- B. International Code Council (ICC)  
IBC, 2015 International Building Code
- C. Metal Framing Manufacturers Association (MFMA)  
MFMA-4 Metal Framing Standards Publication  
MFMA-103 Guidelines for the Use of Metal Framing
- D. National Fire Protection Association (NFPA)  
NFPA 70, 2017 National Electrical Code (NEC)

**1.3 SUBMITTALS**

- A. See the Contract Statement of Work for the submittal process.
- B. Approval Required: None.

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**1.4 QUALITY ASSURANCE**

- A. Furnish and install hangers and supports that conform to the Drawings and requirements of the following codes and standards:
  - 1. NEC.
  - 2. IBC, 2015.
  - 3. MFMA-4.
  - 4. MFMA-103.
- B. Where a Nationally Recognized Testing Laboratory (NRTL) has requirements for such products, provide products that are NRTL-listed and labeled for the application, installation condition, and the environment in which installed.
- C. Suspect and Misrepresented Products: See Contract Statement of Work for required measures to prevent use of misrepresented products.

**1.5 RECEIVING, STORING AND PROTECTING**

- A. Receive, store, protect, and handle products according to manufacturer's instructions.

**PART 2 PRODUCTS****2.1 SUBSTITUTIONS**

- A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work. Any substitution must be submitted to the TOC Construction Representative for approval before procurement of alternate products.

**2.2 COATINGS AND MATERIALS**

- A. Furnish products for use indoors protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic.
- B. Furnish products for use outdoors or in damp or corrosive indoor locations with hot-dip galvanized coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or material such as stainless steel with inherent corrosion resistant characteristics.

**2.3 RACEWAY SUPPORTING DEVICES**

- A. Furnish supports as described below for the installation of raceway systems.
- B. Use pressed steel, hot-dipped galvanized, single bolt hangers to support individual conduits from threaded rods or beam clamps. Manufacturer: Steel City "6H Series"

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**2.4 FASTENERS****A. Post-Installed Concrete Anchors:**

1. Furnish post-installed concrete anchors per Section 03 15 00, "Post-Installed Concrete Anchors (Non-Safety Related)" and as shown on the Drawings.
2. Each post-installed anchor shall have an ICC-ES evaluation report stating that the product is compliant with the current edition of the IBC and the intended conditions of use.
3. For applications in outdoor, damp, or corrosive locations, furnish stainless steel post-installed anchors.
4. Furnish post-installed expansion, adhesive, and undercut anchors specified on the Drawings.

**2.5 FRAMING CHANNEL SYSTEMS**

- A. Furnish U-channel framing systems that conform to MFMA-4 and are fabricated using minimum 12-gage steel.
- B. Furnish fittings and accessories that mate and match with U-channel and are of the same manufacturer.
- C. Manufacturers: B-Line or Unistrut.

**2.6 FABRICATED SUPPORTING DEVICES**

- A. Furnish shop or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Furnish steel brackets fabricated from angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

**PART 3 EXECUTION****3.1 GENERAL**

- A. Install hangers and supports according to the NEC, the requirements in this Section, and specific supporting requirements in other Sections and drawings.
- B. Conform to manufacturer's instructions and recommendations for selection and installation of hangers and supports.
- C. Do not use wire or perforated strap for permanent supports.
- D. Use appropriate, calibrated, special tools when installing devices for which special installation tools are recommended by the manufacturer.

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**3.2 EXAMINATION**

- A. Examine surfaces to receive supports for compliance with installation tolerances and other conditions affecting performance of the system. Do not proceed with installation until unsatisfactory conditions have been corrected.

**3.3 FASTENERS**

- A. Post-installed concrete expansion anchors: Install in accordance with Section 03 15 00, "Post-Installed Concrete Anchors (Non-Safety Related)," and the product's ICC-ES report conditions of use.
- B. Use machine bolts, nuts, and washers for fastening to metal.
- C. Fasten equipment to concrete or masonry with expansion anchors.
- D. The use of lead-cinch drop in anchors is not allowed.
- E. Torque threaded fasteners as recommended by the manufacturer's instructions.

**3.4 RACEWAY SUPPORTS**

- A. Support individual horizontal raceways by separate pipe hangers.

**3.5 BOXES AND CABINETS**

- A. Support sheet metal boxes by approved brackets or bar hangers, as shown on the Drawings or as required. Where bar hangers are used, attach the bar to structure on opposite sides of the box.
- B. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support.
- C. Install surface-mounted cabinets and panelboards as shown on the Drawings or as required.

**3.6 FRAMING CHANNEL SYSTEMS**

- A. Select and install framing channel systems in accordance with MFMA-103.
- B. Use framing channel to support electrical equipment that is mounted free of walls.

END OF SECTION 26 05 29

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**SECTION 26 05 33****RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Conduits and fittings.
- B. Outlet boxes and handholes.
- C. Pull and junction boxes.
- D. Wireway.
- E. Handholes.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. National Electrical Contractors Association (NECA)
 

NECA 1	Standard for Good Workmanship in Electrical Construction
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- B. National Electrical Manufacturers Association (NEMA)
 

NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA C80.1	Electrical Rigid Steel Conduit (ERSC)
NEMA FB1	Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing (EMT) and Cable
NEMA ICS 6, R2011	Industrial Control and Systems: Enclosures
NEMA RN 1	Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA OS 1	Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports



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NEMA OS 3	Selection and Installation Guidelines for Electrical Outlet Boxes
NEMA TC 2	Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
NEMA TC 3	Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing
NEMA TC 6 and 8	Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations
NEMA TC 7	Smooth Wall Coilable Electrical Polyethylene Conduit
NEMA TC 9	Fitting for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation
C.	National Fire Protection Association (NFPA)
NFPA 70, 2017	National Electrical Code (NEC)
D.	Society of Cable Telecommunications Engineers (SCTE)
SCTE 77	Specification for Underground Enclosure Integrity
E.	Underwriters Laboratories (UL)
	Electrical Appliance and Utilization Equipment Directory
	Electrical Construction Materials Directory
UL 1	Standard for Flexible Metal Electrical Conduit
UL 6	Electrical Rigid Metal Conduit-Steel
UL 50	Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 360	Standard for Liquid-Tight Flexible Metal Conduit
UL 467	Grounding and Bonding Equipment
UL 498	Standard for Attachment Plugs and Receptacles
UL 508A, 2013	Standard for Industrial Control Panels
UL 510	Standard for Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	Metallic Outlet Boxes
UL 514B	Conduit, Tubing, and Cable Fittings

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UL 514C	Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 651A	Schedule 40 & 80 High Density Polyethylene (HDPE) Conduit

**1.3 SUBMITTALS**

- A. See the Contract Statement of Work for the submittal process.
- B. Approval Required.
  - 1. Handholes.

**1.4 QUALITY ASSURANCE**

- A. The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:
- B. Comply with the NEC for components and installation.
- C. Rigid steel conduit. Verify the following:
  - 1. Each length is marked with manufacturer's name, UL label, and "Rigid Metal Conduit" or "Rigid Steel Conduit."
- D. Conduit fittings/metallic outlet boxes/terminal boxes (rigid, stainless steel). Verify the following:
  - 1. Check one lot or container and verify each item has, at a minimum, the UL symbol and that the shipping label or the container for which the items are shipped contains the manufacturers name, the UL listing, and the type of items shipped. If the item is not marked with the UL symbol or manufacturer's name, visually inspect the shipping carton of the item to ensure it is in accordance with the UL and manufacturer's published data.
  - 2. Check one lot or container and verify item size is in accordance with product description.
  - 3. Verify external coating for each item is uniform (rigid steel only) and no damage exists.
  - 4. Verify material used is ferrous metal (rigid or malleable iron only) by performing magnetic test.

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- E. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.
- F. Cabinets containing assembled control systems shall be designed, constructed, and listed or labeled to the UL 508A Standard, as applicable.

**1.5 RECEIVING, STORING, AND PROTECTING**

- A. Receive, store, protect, and handle products according to manufacturer's instructions and NECA 1.

**PART 2 PRODUCTS****2.1 SUBSTITUTIONS**

- A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work.

**2.2 COATINGS**

- A. Provide products with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic that is suitable for the environment in which the product will be installed and used.

**2.3 RIGID METAL CONDUIT (RMC) AND FITTINGS**

- A. Furnish RMC that meets the requirements of UL 6 and NEMA C80.1.
- A. Material: Hot-dip galvanized, with chromated protective layer.
- B. Furnish zinc-plated, threaded, malleable iron fittings and conduit bodies that meet the requirements of UL 514B and NEMA FB1.

**2.4 PLASTIC-COATED STEEL CONDUIT AND FITTINGS**

- A. Furnish polyvinyl chloride (PVC) exterior coated, urethane interior coated, RMC that meets the requirements of NEMA RN 1.
- B. Use factory-fabricated elbows.
- C. Furnish 40 mils PVC exterior coated, urethane interior coated, zinc-plated, threaded, malleable iron fittings and conduit bodies meeting the requirements of UL 514B.
- D. Interior finish: Urethane coating, 2 mils nominal thickness.
- E. Threads: Hot-dipped galvanized and factory coated with urethane.
- F. Bendable without damage to either interior or exterior coating.

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**2.5 RIGID NON-METALLIC CONDUIT (RNC) AND FITTINGS**

- A. Furnish RNC that conforms to UL 651, UL 651A, NEMA TC2, NEMA TC 3, NEMA TC 6 & 8, and NEMA TC 7.
- B. Furnish non-metallic, solvent-welded socket fittings that meet the requirements of UL 651, NEMA TC 3, and NEMA TC 9.

**2.6 FLEXIBLE METAL CONDUIT AND FITTINGS**

- A. Furnish galvanized steel flexible metal conduit that meets the requirements of UL 1 and UL 360 for 105°C insulated conductors.
- B. Material: Galvanized steel, with an extruded PVC jacket.
- C. Furnish zinc-plated malleable iron fittings that meet the requirements of UL 514B and NEMA FB1. Furnish insulated throat connectors.

**2.7 LIQUID-TIGHT FLEXIBLE METAL CONDUIT AND FITTINGS**

- A. Furnish liquid-tight flexible metal conduit that meets the requirements of UL 360.
- B. Furnish zinc-plated malleable iron or zinc-plated steel liquid-tight fittings that meet the requirements of UL 514B and NEMA FB1. Furnish insulated throat connectors.
- C. Furnish galvanized steel flexible metal conduit that meets the requirements of UL 1 and the NEC.

**2.8 INSULATING BUSHINGS**

- A. Provide NRTL-listed insulating bushings with 105°C rated insulation.
- B. Manufacturer: O-Z/Gedney, Type B or SB.

**2.9 GROUNDING BUSHINGS**

- A. Provide NRTL-listed, galvanized malleable iron, 150°C rated insulated throat grounding bushings with lay-in type ground cable lugs.
- B. Manufacturer: O-Z/Gedney, Type BLG.

**2.10 EXPANSION FITTINGS**

- A. Furnish NRTL-listed expansion fittings with hot dipped galvanized malleable iron body, factory-installed packing and a bonding jumper.
- B. Manufacturer: O-Z/Gedney, Type AX, TX, or EXE with Type BJ bonding jumper.

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- C. Lubricant and Sealant.
  - 1. Lubricant and Sealant for Conduit Thread: Conductive compound providing anti-seize and corrosion protection. Thomas and Betts Corporation “KOPR-SHIELD<sup>®24</sup>,” or approved substitute.

**2.11 PROTECTION TAPE AND CONDUIT SEALANT**

- A. Furnish pressure-sensitive, 10 mil thick, PVC-based tape for corrosion protection of metal conduit and fittings. Manufacturer: 3M, Type 50.
- B. Furnish plastic insulating tape that complies with UL 510.
- C. Furnish electrical color-coding tape that complies with UL 510.
- D. Furnish sealing compound for conduit: “Sealex” by Porcelain Products Company or “Duct Seal” by Gardner-Bender.

**2.12 RACEWAY MEASURING TAPE**

- A. Furnish raceway measuring tape with permanently printed measurements in 1-ft increments and minimum 1200 lb average breaking strength.

**2.13 WIREWAY**

- A. Provide NRTL-listed, wireway with covers, elbows, tees, hangers, and fittings required for a complete system. Wireway shall be rated for environment to be installed.

**2.14 OUTLET BOXES**

- A. Provide outlet boxes selected for specific installations using the guidance in NEMA OS 3 and the requirements of this Section.
- B. Exterior Mounted Enclosures (terminal boxes) shall be: NEMA ICS 6, NEMA Type 4 unless shown otherwise on the Drawings.
- C. For dry locations provide galvanized steel outlet boxes that comply with UL 514A.
  - 1. For luminaire outlets use 4 in. x 1 1/2-in. deep (min.) boxes with fixture stud attachment as required to support luminaires.
  - 2. For surface outlet boxes in EMT raceway systems, use 4 in. x 2 1/8-in. deep square boxes. Provide deeper boxes or multiple gang boxes as required to fit devices. Provide square surface covers that match the installed device and have not less than two holes for securing the device to the cover.

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<sup>24</sup> KOPR-SHIELD is a registered trademark of Jet-Lube, Inc., Houston, Texas.

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- D. For damp or wet locations and for surface-mounted RMC or IMC raceway systems, provide outlet boxes that comply with UL 498, UL 514A, UL 514B, UL 514C, and NEMA FB1.
1. For lighting fixture outlets use 4 in. x 2 1/16-in. deep (min.) round cast malleable iron boxes with threaded hubs.
  2. For surface wall-mounted outlets, use 4 11/16 square, 2 11/16-in. deep cast malleable iron boxes with threaded hubs. Provide multiple gang boxes as required to fit devices. Provide gasketed cast malleable iron or cast copper-free aluminum covers that match the installed device and have not less than two holes for securing the device to the cover.
- E. For all entries into NEMA ICS 6, Type 4 enclosures: Type CGB for exposed cable, and Myers type watertight fittings or sealing-type locknuts for conduits.

**2.15 PULL AND JUNCTION BOXES**

- A. Metallic boxes (terminal boxes) shall be NEMA 250 or UL 50, Type 4, 16 or 14 gage steel.
- B. For dry locations in clean, non-contamination environments, use galvanized sheet steel pull and junction boxes that comply with UL 50 Type 1 and the NEC as to size and construction. Use boxes not less than 4-in. square x 1 1/2-in. deep with screw-secured covers. Provide larger boxes as required by the number and size of conduits and conductors.
- C. For dry locations in dusty environments, use galvanized steel pull and junction boxes that comply with UL 50 Type 12 and the NEC as to size and construction. Use boxes not less than 6-in. square x 4-in. deep with gasketed covers. Provide larger boxes as required by the number and size of conduits and conductors.
- D. For damp or wet, non-corrosive locations, in conduit runs up to 3/4 in. trade size, provide 4 11/16-in. square, 2 11/16-in. deep (min.) cast malleable iron pull and junction boxes with threaded hubs and gasketed cast malleable iron or cast copper-free aluminum covers.
- E. For damp or wet, non-corrosive locations, in conduit runs 1 in. trade size and larger, provide galvanized sheet-steel pull and junction boxes and covers that comply with UL 50 Type 4.
- F. For damp or wet, non-corrosive locations that are subject to hose-directed water, provide pull and junction boxes and covers that comply with UL 50 Type 4.
- G. For in-ground, non-metallic handholes, provide products that are NRTL-listed to SCTE 77.
1. Material: Polymer concrete.
  2. Minimum SCTE 77 load rating:

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- a. Located in sidewalks: Tier 8.
  - b. Located in driveways, parking lots, and off-roadway locations: Tier 22.
  3. Size: As shown on drawings.
  4. Cover: Non-skid cover with stainless steel cover bolts.
  5. Identification: Permanent mark or logo on cover prominently identifying the function of the enclosure in accordance with NEC requirements.
  6. Manufacturer: Quazite®<sup>25</sup> “Style PC, PG, or PT.” or as shown on drawings.
- H. Provide connection points for equipment grounding conductors in each box.
- I. For all entries into NEMA ICS 6, Type 4 enclosures: Type CGB for exposed cable, and Myers type watertight fittings or sealing-type locknuts for conduits.

**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Examine surfaces to receive raceways and boxes for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected.

**3.2 PREPARATION**

- A. Scale dimensions on the Drawings show desired and approximate locations of equipment. Actual locations, distances, and levels shall be governed by field conditions.

**3.3 GENERAL**

- A. Perform work in accordance with NFPA 70, the Specifications, and the Drawings. Fasten equipment to structural members or metal supports attached to structure or to concrete surfaces
- B. Install complete systems of raceways and boxes for wiring systems.
- C. Install raceways and boxes according to the NEC, the manufacturer’s instructions, and requirements in this Section.
- D. Raceway termination points and box locations shown on the Drawings are in approximate locations unless dimensioned.

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<sup>25</sup> Quazite is a registered trademark of Hubbell Incorporated, Shelton, Connecticut.

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- E. Raceway routing is shown on the Drawings in approximate locations unless dimensioned. Coordinate routing with structure and with work of other trades. Route as required for a complete wiring system.
- F. Ground and bond raceways and boxes as required in Section 26 05 26, "Grounding and Bonding for Electrical Systems," and UL 467.
- G. Support raceways and boxes in accordance with the requirements the National Electrical Code, Section 26 05 29, "Hangers and Supports for Electrical Systems," and NEMA OS 1.
- H. Identify raceways and boxes as required in Section 26 05 53, "Identification for Electrical Systems."
- I. Arrange raceway and boxes to maintain headroom and present neat appearance.
- J. Install knockout closures in unused openings in boxes or raceways.

**3.4 CONDUIT INSTALLATION**

- A. For low-voltage wiring systems (less than 1000 volts) use conduit materials according to the NEC and the following:
  - 1. Outdoors – in Tank Farm:
    - a. Direct buried: Use plastic-coated RMC, minimum 1 in. diameter. Install with 12-in. minimum cover from top of conduit to finished grade for in-farm traffic areas or a minimum depth of 6 in. in non-traffic areas.
    - b. Outdoors - exposed: Use RMC or liquid-tight flexible metal conduit where subject to vibration or flexibility is required.
    - c. Outdoors - concealed: Use RMC for concealed outdoor work. Do not use bare RMC or IMC in direct contact with earth.
  - 2. Outdoors – underground not in Tank Farm:
    - a. Direct buried: Use plastic-coated RMC listed and marked for direct burial, 18-in. minimum cover from top of conduit to finished grade.
    - b. All 90° Bends shall be PVC coated RMC or tape wrapped RMC.
  - 3. Connection to vibrating equipment (including hydraulic, pneumatic, or electric solenoid or motor-driven equipment) - Use a minimum of 24 in.; maximum length as determined by the NEC:
    - a. Outdoors: Use liquidtight flexible metal conduit.
- B. Use 3/4-in. above ground or larger conduit to enclose multiple conductors larger than 12 AWG.



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- C. Install conduits with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions.
- D. Use specified fitting for conduit except that threaded hubs and sealing type locknuts shall be used outdoors and locations where moisture is present. Use couplings where required. Do not use running threads.
- E. Use conduit hubs to fasten conduit to boxes in damp and wet locations.
- F. Use galvanized steel locknuts and insulated bushings for attachment to enclosures, except threaded hubs or sealing type locknuts shall be used outdoors or where moisture is present. Use watertight fittings for entries into NEMA 4 enclosures. Use sealing locknuts into bottoms of NEMA 4 enclosures.
- G. Install insulating bushings or connectors with an insulated throat to protect conductors or cables at conduit terminations.
- H. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduits dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- I. Install plastic-coated RMC and fittings according to the NEC and manufacturer's instructions. Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
- J. Make elbows, offsets, and bends uniform and symmetrical. Bend conduit with approved bending devices.
- K. Do not use RNC 90 degree elbows larger than 2 in. trade size; use plastic-coated RMC, tape-wrapped RMC.
- L. Maintain the following minimum clearances between conduit and surfaces with temperatures exceeding 104°F (40°C):
  - 1. 6 in. at perpendicular crossings.
  - 2. 12 in. between parallel runs.
- M. Cut ends square, ream, and remove burrs. Conduit shall be clean, dry, and free of debris. Immediately after installation, plug or cap exposed ends with standard accessories until wires are installed.
- N. Avoid moisture traps in conduit system; provide junction boxes with drain fitting at low points in conduit system.
- O. Install corrosion protection tape on metal conduits and fittings in contact with soil using half-lapped wrappings.

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- P. Install grounding bushings at the following locations:
1. At every entry to enclosures on metallic conduits containing circuits rated 100 amperes and higher.
  2. On metallic conduits entering enclosures through concentric, eccentric, or oversize knockouts.
  3. On metallic conduits that terminate to a metallic enclosure without effective electrical connection such as locknuts or threaded bushings.
- Q. Install conduit measuring tape in empty raceways. Leave not less than 12 in. of slack at each end of the tape. Secure each end of tape.

**3.5 FIRESTOPPING**

- A. Install an NRTL approved firestop system at each electrical penetration in a fire-rated wall, floor, or partition.
- B. At least two days prior to firestopping installation, notify TOC Construction Representative so that arrangements can be made for inspection during installation.

**3.6 PULL AND JUNCTION BOX INSTALLATION**

- A. Install pull and junction boxes as shown on the Drawings and as required for splices, taps, wire pulling, and compliance with regulatory requirements.
- B. Install pull boxes as required to comply with limits on conduit bends and distance between pull points in Paragraph 3.4, "Conduit Installation."
- C. Install bedding material for in-ground handholes in accordance with manufacturer's installation instructions. Place top of handholes flush with top of finished grade.

**3.7 WIREWAY INSTALLATION**

- A. Install wireways at locations indicated on the Drawings.
- B. Mount plumb and level.

**3.8 CLEANING**

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
- C. Repair damage to paint finishes with matching touch-up coating recommended by the manufacturer.

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**3.9 FIELD QUALITY CONTROL**

- A. For conduits, junction boxes, associated fittings and supports, verify appropriate torque values are in accordance with manufacturer's recommendations.
- B. Provide final protection and maintain conditions to ensure that coatings and finishes are without damage or deterioration at final inspection.

END OF SECTION 26 05 33

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**SECTION 26 05 53****IDENTIFICATION FOR ELECTRICAL SYSTEMS****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Component identification tags.
- B. Equipment nameplates.
- C. Wire markers.
- D. Voltage markers.
- E. Warning signs.
- F. Working space labels.
- G. Underground warning tape.
- H. Arc Flash labels.
- I. Conduit labels.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. American National Standards Institute (ANSI)
  - ANSI Z535.1 Safety Colors
  - ANSI Z535.2 Environmental and Facility Safety Signs
  - ANSI Z535.3 Criteria for Safety Symbols
  - ANSI Z535.4 Product Safety Signs and Labels
  - ANSI Z535.5 Safety Tags and Barricade Tapes (for Temporary Hazards)

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- B. Code of Federal Regulations (CFR)
  - 29 CFR 1910.145 Danger and Caution Specifications
- C. Hanford Documents
  - TFC-ENG-STD-12, E-2 Tank Farm Equipment Identification Numbering and Labeling Standard
- D. International Standards Organization (ISO)
  - ISO 3864 Graphical Symbols Package
- E. National Fire Protection Association (NFPA)
  - NFPA 70, 2017 National Electrical Code (NEC)
  - NFPA 70E Standard for Electrical Safety in the Workplace
- F. Underwriters Laboratories (UL)
  - UL 969 Standard for Marking and Labeling Systems

**1.3 SUBMITTALS**

- A. See the Contract Statement of Work for the submittal process.
- B. Approval Required
  - 1. Catalog Data: Submit manufacturer's catalog literature for each product.
  - 2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.
  - 3. Samples:
    - a. Submit two samples of each type of printed identification products applicable to project.
    - b. Submit two nameplates illustrating materials and engraving quality.
  - 4. Manufacturer's Installation Instructions: Submit installation instructions, indicating special procedures and installation requirements.

**1.4 REGULATORY REQUIREMENTS**

- A. Conform to requirements of the NEC, NFPA 70E, and 29 CFR 1910.145.
- B. Conform to applicable requirements of ANSI Z535.1, Z535.2, Z535.3, Z535.4, and Z535.5.

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**1.5 COORDINATION**

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Subcontract Documents, Shop Drawings, and manufacturer's wiring diagrams, with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project

**PART 2 PRODUCTS****2.1 SUBSTITUTIONS**

- A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work

**2.2 COMPONENT IDENTIFICATION TAGS**

- A. Furnish component identification tags as specified and scheduled on the Drawings and consistent with the labeling format in TFC-ENG-STD-12.
- B. Provide tags made of materials shown on the Drawings, and consistent with the requirements in TFC-ENG-STD-12.

**2.3 EQUIPMENT NAMEPLATES**

- A. Furnish equipment nameplates at each switchboard, disconnect switches, distribution panel, and transformers as specified on the Drawings.
- B. Equipment nameplates: Laminated plastic, as shown on Drawings. Engraved nomenclature sharp and clear. Engraved manufacturer's standard nameplates may be used if equal in quality and legibility.
- C. Attachment:
  - 1. NEMA 4 and 4X Enclosures: One-Part Clear Room Temperature Vulcanizing adhesive.
  - 2. All Other Enclosures: Stainless steel screws unless otherwise noted on Drawings.
- D. Post conductor color code on each panelboard, switchboard, switchgear assembly, motor control center (MCC). Use type-written, adhesive-backed labels.
- E. Coordinate equipment nameplate schedule with equipment numbering scheme provided by TOC Construction Representative.

**2.4 WIRE MARKERS**

- A. Provide wire markers for power circuit wires.
- B. Furnish split sleeve or heat-shrinkable sleeve, wire markers.

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- C. Locate a wire marker on each conductor at each switchboard, disconnect switches, terminal box, distribution panel, transformer, pull boxes, junction boxes, and each load connection.
- D. Provide typewritten lettering on wire markers for as-built branch circuit or feeder circuit number.
- E. Manufacturer: LEM Products, Inc., Brady, Panduit.

**2.5 VOLTAGE MARKERS**

- A. Furnish voltage markers for each switchboard, disconnect switches, terminal box, distribution panel, transformer, and cabinets.
- B. Provide flexible pressure sensitive vinyl markers with minimum 1-in. x 4-in. orange background and black letters.
- C. Provide voltage markers with lettering indicating the highest voltage present:
  - 1. 480Y/277 and 480 V system: 480 V.
  - 2. 120/240V and 240V systems: 240V.
- D. Manufacturer: Electromark, LEM Products, Inc.

**2.6 WARNING SIGNS**

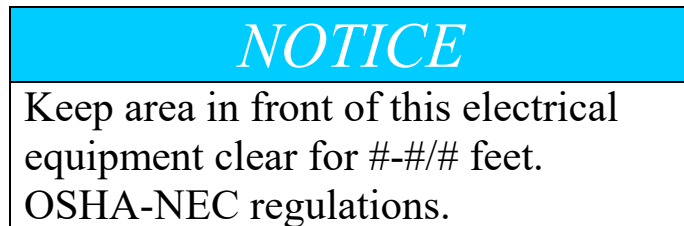
- A. Furnish warning signs for each switchboard, disconnect switches, terminal box, distribution panel, transformer, pull boxes, and cabinets.
- B. Use warning signs that conform to ANSI Z535.2, Z535.4 and 29 CFR 1910.145.
- C. Provide minimum 2-in. x 4-in. warning signs.
- D. Provide warning signs with format and lettering as follows:
  - 1. Signal word: DANGER
  - 2. Signal word panel color: red with safety alert symbol.
  - 3. Word message:
    - Keep Out!
    - Hazardous voltage inside
    - Will shock, burn, or cause death.
  - 4. Safety symbol: ISO 3864 "lightning bolt" in yellow triangle.
- E. Materials:
  - 1. Use flexible, pressure sensitive, polyester base with polyester overlamine.

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- F. Manufacturer: Seton Name Plate Co., Safety Label Solutions, Hazard Communication Systems, Electromark.

**2.7 WORKING SPACE LABELS**

- A. Provide labels indicating required working clearance at electrical equipment that is likely to require examination, adjustment, servicing, or maintenance while energized.
- B. Material:
1. Use polyester label stock that is NRTL-recognized to UL 969 and has a high-adhesion adhesive back.
  2. Use printing ribbon recommended by the label stock manufacturer.
  3. Use a suitable thermal transfer process label-printing machine to generate labels and enter the application-specific information.
  4. Outdoor labels shall be suitable for a high-UV environment.
- C. Minimum dimensions: 3 1/2 x 1 1/4 in.
- D. Use the following label design:



1. Signal word: "NOTICE" in 24-point minimum white italic letters on safety blue panel.
2. Word message: 16-point minimum black or safety blue letters on white background.
  - a. Word message for 151 to 600 Volt equipment with exposed live parts on one side of the working space and no live or grounded parts on the other side of the working space: "Keep area in front of this electrical equipment clear for 3 ft. OSHA-NEC regulations."
  - b. Word message for 151 to 600 Volt equipment with exposed live parts on one side of the working space and grounded parts on the other side of the working space: "Keep area in front of this electrical equipment clear for 3 1/2 ft. OSHA-NEC regulations."
  - c. Word message for 151 to 600 Volt equipment with exposed live parts on both sides of the working space: "Keep area in front of this electrical equipment clear for 4 ft. OSHA-NEC regulations."



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- d. Word message for 0 to 150 Volt equipment with exposed live parts on one side of the working space and live or grounded parts on the other side of the working space: "Keep area in front of this electrical equipment clear for 3 ft. OSHA-NEC regulations."

E. Manufacturer: Brother, Seton, Brady

## 2.8 UNDERGROUND WARNING TAPE

- A. Furnish underground warning tape for underground cables, conduits and duct banks.
- B. Use 6-in. wide, 0.004-in. thick, polyethylene detectable underground warning tape black lettering and the following background colors:
  1. Electric: Red
- C. Provide lettering that indicates the type service buried below.
  1. Electric: "CAUTION ELECTRIC LINE BURIED BELOW"
- D. Manufacturer: Utility Safeguard, LLC, Detectable Terra Tape, Reef Industries, Inc.

## 2.9 ARC FLASH LABELS

- A. Install arc flash labels on electrical equipment as required by NEC.

## 2.10 CONDUIT LABELING

- A. Conduit metal tags shall be affixed to all numbered conduit. Conduit numbers are shown on Drawings.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine surfaces to receive identification products for compliance with installation tolerances and other conditions affecting performance of the identification products. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION - GENERAL

- A. Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- B. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install electrical identification products only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

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- E. Clean surface where electrical identification product is to be placed.
- F. Use manufacturer's recommended adhesive for engraved tags and nameplates.
- G. Place electrical identification products centered and parallel to equipment lines.

**3.3 COMPONENT IDENTIFICATION TAGS**

- A. Install component identification tag as indicated on the Drawings on the front of each piece of electrical equipment including switchboards, MCCs, distribution panels, transformers, and variable frequency drives (VFDs).
- B. Position tags so they can be read from floor or ground.

**3.4 EQUIPMENT NAMEPLATES**

- A. Install equipment nameplate or nameplates as indicated on the Drawings on the front of each piece of electrical equipment including switchboards, MCCs, distribution panels, and transformers.
- B. Position nameplates so they can be read from floor or ground.

**3.5 WIRE MARKERS**

- A. Install wire markers on power conductors at each appearance in locations such as pull boxes, junction boxes, switchboards, MCCs, distribution panels, transformers, and load connections.
- B. Position markers so they can be read from the front of the enclosure.

**3.6 VOLTAGE MARKERS**

- A. Install voltage markers at the following locations and position markers so they can be read from floor or ground:
  - 1. Front of each free-standing low-voltage switchboard section.
  - 2. Front of each switchboard, MCC, distribution panel, and transformers.
  - 3. Cover of each pull box containing low-voltage conductors.

**3.7 WARNING SIGNS**

- A. Install warning signs at the following locations and position signs so they can be read from floor or ground:
  - 1. Front of each switchboard disconnect switches, terminal box, distribution panel, transformer, pull boxes, and cabinets.

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**3.8 WORKING SPACE LABELS**

- A. Install working space labels in front of switchboards, MCCs, distribution panels, and transformers.
- B. Any other equipment likely to require examination, adjustment, servicing, or maintenance while energized.

**3.9 UNDERGROUND WARNING TAPE**

- A. For trenches 12 in. or less from top of conduit to top of finished grade, install underground warning tape in trench, 6-in. above conduit.
- B. For trenches greater than 12 in. from top of conduit to top of finished grade, install underground warning tape in trench 12 in. minimum above conduit.
- C. Where conduits are 6-in. or less below grade, warning tape is not required.

END OF SECTION 26 05 53

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**SECTION 26 22 13****LOW VOLTAGE DISTRIBUTION TRANSFORMERS****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. General-purpose dry-type low-voltage transformers

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. National Electrical Manufacturers Association (NEMA)

NEMA TP 1	Guide for Determining Energy Efficiency for Distribution Transformers
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NEMA TP 2	Standard Test Method for Measuring the Energy Consumption of Distribution Transformers
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NEMA TP 3	Standard for the Labeling of Distribution Transformer Efficiency
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- B. National Fire Protection Association (NFPA)

NFPA 70, 2017	National Electrical Code (NEC)
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- C. Underwriters Laboratories (UL)

	Electrical Appliance and Utilization Equipment Directory
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UL 486A-486B	Wire Connectors
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UL 1561	Dry-Type General Purpose and Power Transformers
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**1.3 SUBMITTALS**

- A. See the Contract Statement of Work for the submittal process.
- B. Approval Required: None

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**1.4 QUALITY ASSURANCE**

- A. Comply with the NEC for components and installation.
- B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.
- C. Provide products that comply with the following industry standards:
  - 1. NEMA TP 1.
  - 2. NEMA TP 2.
  - 3. NEMA TP 3.
  - 4. UL 1561.

**1.5 RECEIVING, STORING AND PROTECTING**

- A. Receive, store, protect, and handle products according to manufacturer's instructions.

**PART 2 PRODUCTS****2.1 PRODUCT OPTIONS AND SUBSTITUTIONS**

- A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work

**2.2 GENERAL**

- A. Transformers shall be NRTL-listed to UL 1561 and shall be tested and labeled according to NEMA TP 1, NEMA TP 2, and NEMA TP 3.
- B. The efficiency of each transformer shall be NEMA TP 1 Class I when tested in accordance with NEMA TP 2. Transformer efficiency shall be indicated on a label that conforms to NEMA TP 3.
- C. Transformer coils may be aluminum or copper with continuous wound construction and shall be impregnated with non-hygroscopic, thermosetting varnish. Terminations shall be brazed or welded to the coil conductor.
- D. Transformer cores shall be constructed of a high grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities shall be kept well below the saturation point.
- E. The core and coil shall be bolted to the base of the enclosure, isolated by means of rubber vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and the enclosure. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.

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- F. The core of the transformer shall be visibly grounded to the enclosure by a flexible grounding conductor sized following applicable UL and NEC Standards.
- G. The transformer enclosure shall be ventilated and shall be fabricated of a heavy gauge, sheet steel construction. The entire enclosure shall be finished using a process consisting of degreasing, cleaning and phosphatizing followed by electrostatic deposition of polymer polyester powder and baking cycle to provide a uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use. The coating color shall be light or medium grey.
- H. Transformers shall be suitable for rack or floor mounting. Provide mounting accessories required for installation.
- I. Provide weather shields for transformers installed outdoors.
- J. Provide transformer manufacturer's transformer lug kits with compression type equipment lugs and hardware for connecting conductors to transformer terminals.
- K. Provide factory assembled and tested, energy-efficient, general-purpose, air cooled, two-winding, dry-type transformers with voltage and kVA ratings as indicated on the Drawings.
- L. General-purpose transformers 15 kVA and larger shall be 150°C temperature rise above 40°C ambient. The maximum temperature of the top of the enclosure shall not exceed 50°C rise above a 40°C ambient.
- M. Transformers 15 kVA and larger shall have a minimum of two 2.5 percent full capacity above normal and four 2.5 percent full capacity below normal primary taps.
- N. Manufacturers:
  - 1. Square D Class 7400 Type "EE."
  - 2. Eaton/Cutler-Hammer "DS-3" and "DT-3."

**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Examine surfaces to receive transformers for compliance with installation tolerances and other conditions affecting performance of the control system. Do not proceed with installation until unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

- A. Install dry-type transformers where indicated on the Drawings and according to manufacturer's instructions. Manufacturer's installation instructions shall be available at the construction site.

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- B. Arrange equipment to provide adequate spacing for access, replacement, and for cooling air circulation. Locate the front and rear of each ventilated transformer at least 6 in. from the wall or any obstruction to allow proper air circulation.
- C. Make conduit connections to transformer enclosure only at locations designated by the manufacturer's installation instructions.
- D. Connect conductors to transformer terminals using transformer manufacturer's lug kits. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not furnished, use those specified Section 26 05 19, "Low Voltage Electrical Power Conductors and Cables," Attachment 1, "Recommended Tightening Torque per UL 486A-486B."
- E. Bond transformers and ground systems served by transformers according to Section 26 05 26, "Grounding and Bonding for Electrical Systems."
- F. Identify transformers and install warning signs according to Section 26 05 53, "Identification for Electrical Systems."

**3.3 FIELD QUALITY CONTROL**

- A. Clean, inspect, test, adjust, and energize transformers in accordance with manufacturer's instructions.
  - 1. Inspect each transformer for physical damage, proper connection and grounding, and proper anchorage.
  - 2. Keep records of inspections, tests, and adjustments in the work package or fabrication document.
- B. Coordinate inspections and tests with those required by other Sections.
- C. After completing installation, cleaning, and testing, touch-up scratches and mars on finish to match original finish.
- D. Measure primary and secondary voltages and phase rotation, and make preliminary tap adjustments. After normal operating loads have been energized adjust taps to provide the following voltage at points of use; record voltages and tap settings.

<u>System Nominal Voltage</u>	<u>Minimum Load Voltage</u>
480Y/277	460Y/265
120/240	115/230

END OF SECTION 26 22 13

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**SECTION 26 24 16****PANELBOARDS****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Panelboards for feeder and branch circuit loads.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. National Electrical Manufacturer's Association (NEMA)

NEMA AB 3                      Molded Case Circuit Breakers and their Application

NEMA PB 1                      Panelboards

NEMA PB 1.1                      General Instructions for Proper Installation, Operation,  
and Maintenance of Panelboards Rated 600 volts or less

- B. National Fire Protection Association (NFPA)

NFPA 70, 2017                      National electrical Code (NEC)

- C. NSF International/American National Standards Institute (ANSI)

NSF/ANSI 49                      Biosafety Cabinetry: Design, Construction, Performance,  
and Field Certification

- D. Underwriters Laboratories (UL)

UL 50                              Enclosures for Electrical Equipment, Non-Environmental  
Considerations

UL 67                              Panelboards

UL 489                              Molded Case Circuit Breakers



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**1.3 SUBMITTALS**

- A. See the Contract Statement of Work for the submittal process.
- B. Approval Required: None

**1.4 QUALITY ASSURANCE**

- A. Comply with the NEC for components and installation.
- B. Furnish products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.
- C. Comply with NEMA PB 1, NEMA PB 1.1, and NEMA AB 3.
- D. Comply with UL 67, UL 50, and UL 489.

**1.5 RECEIVING, STORING AND PROTECTING**

- A. Receive, inspect, handle, and store panelboards according to manufacturer's instructions.

**1.6 EXTRA MATERIALS**

- A. Furnish spare keys of each type for panelboard cabinet locks.

**PART 2 PRODUCTS****2.1 SUBSTITUTIONS**

- A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work.

**2.2 DISTRIBUTION PANELBOARDS**

- A. Furnish panelboards as indicated on the Drawings and specified in this Section.
- B. Panelboards shall be UL 67 listed and shall conform to NEMA PB1.
- C. Furnish panelboard cabinets for surface mounting as indicated on the Drawings.
  - 1. Furnish outdoor enclosures as indicated below:
    - a. NEMA 4/4X or 3R: rated rain tight minimum.
  - 2. Cabinets shall be not less than 20-in. wide.
  - 3. Furnish steel cabinets constructed according to UL 50 requirements.
  - 4. NEMA 12 and NEMA 4 boxes shall have end walls welded and sealed.

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- D. Furnish trim fronts that meet the strength and rigidity requirements of UL 50.
1. Each panelboard trim front shall include a door.
  2. Fronts shall have NSF/ANSI 49 medium gray enamel electro-deposited over cleaned, phosphatized steel.
  3. Furnish a panelboard circuit directory card in a metal frame mounted inside the panelboard door. The directory card shall include spaces for circuit numbers and sufficient spaces to allow each circuit to be described in sufficient detail to be distinguished from all others.
    - a. Furnish cylindrical tumbler type locks for doors. Furnish sliding vault locks with 3-point latching for enclosures more than 48-in. high. Key all lock assemblies alike. Furnish two keys with each lock plus spares as required in Paragraph 1.6.
- E. Equip panelboards with mounting brackets, bus connections, and necessary appurtenances, for the future installation of circuit breakers as scheduled on the Drawings.
- F. Furnish panelboards having NRTL-listed short circuit current ratings not less than the available fault current indicated on the Drawings.
- G. Furnish thermal-magnetic circuit breakers that meet the requirements of UL 489 and NEMA AB 3.
1. Furnish circuit breakers of the type, rating, and features as indicated on the Drawings.
  2. Do not use tandem circuit breakers.
  3. Furnish multi-pole breakers with a common trip.
  4. Furnish bolt-on type circuit breakers or circuit breakers that connect to the panel bus through positive gripping connector jaws and are secured by an independent mechanical locking device.
  5. Furnish UL Class A ground fault interrupter circuit breakers or UL Class B equipment protection circuit breakers where scheduled on Drawings.
  6. Furnish circuit breakers with provisions for connecting the size and number of conductors indicated on the Drawings. Refer to Section 26 05 19, "Low Voltage Electrical Power Conductors and Cables," for conductor connection requirements.
- H. Furnish a permanently-installed handle lock-off device for each circuit breaker.
1. Furnish handle lock-off device that will accept a 1/4-in. padlock shackle.

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2. Securely attach the device to the circuit breaker case; the attachment shall not depending on a friction fit or the presence of the panelboard front for the handle lock-off device to remain in place and be functional.
- I. Manufacturers:
    1. Eaton:
      - a. 480Y/277 V: “PRL3a” and “PRL4”
      - b. 120/240 V: “PRL1a” and “PRL2a”
    2. Square D:
      - a. 480Y/277 V: “NF” and “I-LINE”
      - b. 120/240 V: “NQ” and “I-Line”

**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Examine surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance. Do not proceed with installation until unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

- A. Install panelboards where indicated on the Drawings and according to manufacturer’s instructions, NEMA PB 1.1, and the NEC. Have the manufacturer’s installation instructions available at the construction site.
- B. Furnish supports in accordance with the requirements of Section 26 05 29, “Hangers and Supports for Electrical Systems.”
- C. Position panelboards so the top circuit breaker handle is not more than 6 ft – 7 in. above the surface of the working space in front of the panelboard.
- D. Ground and bond panelboards as required in Section 26 05 26, “Grounding and Bonding for Electrical Systems.”

**3.3 IDENTIFICATION**

- A. Furnish typed circuit directories for each branch circuit panelboard.
  1. Install a plastic-laminated copy of the panel schedule drawing on the inner side of the panelboard door.
- B. Identify panelboards and install warning signs and arc-flash warning labels as required in Section 26 05 53, “Identification for Electrical Systems.”

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**3.4 FIELD QUALITY CONTROL**

- A. Clean, inspect, test, and energize panelboards in accordance with manufacturer's instructions. Exercise each circuit breaker three times to verify smooth mechanical operation.
- B. Coordinate inspections and tests with those required by other Sections.
- C. Visual and Mechanical Inspection: Include the following inspections and related work:
  - 1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of the Drawings and panelboard schedules.
  - 2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
  - 3. Check panelboard mounting, area clearances, and alignment and fit of components.
  - 4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for torque values and Section 26 05 19, "Low Voltage Electrical Power Conductors and Cables," Attachment 1, "Recommended Tightening Torque per UL 486A-486B."
  - 5. Perform visual and mechanical inspection for overcurrent protective devices.
- D. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:
  - 1. Ground continuity test ground bus to system ground.
- E. After completing installation, cleaning, and testing, touch-up scratches and mars on finish to match original finish.

END OF SECTION 26 24 16

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**SECTION 26 27 26****WIRING DEVICES****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Receptacles.
- B. Snap switches.
- C. Wall plates.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. ASTM International (ASTM)
  - ASTM A167 Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
- B. Federal Specifications (FS)
  - FS W-C-596 G/GEN Connector, Electrical, Power, General Specification for
  - FS W-P-455A Plate, Wall, Electrical
  - FS W-S-896 Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification)
- C. International Organization for Standardization (ISO)
  - ISO 9001 Quality Management Systems -- Requirements
- D. National Electrical Contractors Association (NECA)
  - NECA 1 Standard for Good Workmanship in Electrical Contracting
- E. National Electrical Manufacturers Association (NEMA)
  - NEMA ICS 4 Application Guideline for Terminal Blocks

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NEMA WD 1	General Requirements for Wiring Devices
NEMA WD 6	Wiring Devices—Dimensional Specifications
F.	National Fire Protection Association (NFPA)
NFPA 70, 2017	National Electrical Code (NEC)
G.	Underwriters Laboratories (UL)
UL 20	General Use Snap Switches
UL 498	Electrical Attachment Plugs and Receptacles
UL 508A, 2013	Standard for Safety for Industrial Control Equipment
UL 943	Ground Fault Circuit Interrupters
UL 1059	Standard for Terminal Blocks
UL 1449	Standard for Transient Voltage Surge Suppressors

**1.3 SUBMITTALS**

- A. See the Contract Statement of Work for the submittal process.
- B. Approval Required
  - 1. Not Used.

**1.4 QUALITY ASSURANCE**

- A. The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work.
- B. Comply with the NEC.
- C. Furnish products listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environments in which installed.

**1.5 RECEIVING, STORING, AND PROTECTING**

- A. Receive, store, protect, and handle products according to manufacturer's instructions and NECA 1.

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**PART 2 PRODUCTS****2.1 SUBSTITUTIONS**

- A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work.

**2.2 RECEPTACLES**

- A. Provide back and side wired, screw pressure terminal, straight-blade, and locking type, receptacles as indicated on the Drawings. Receptacles shall meet the performance and design requirements of FS W-C-596-G/GEN and UL 498. Receptacle configurations shall be in accordance with NEMA WD 6.
- B. For 120 volt receptacles connected to individual branch circuits provide straight-blade NEMA 5-20R, 20 amperes, 125 volts, grounding duplex receptacles. Receptacle mounting strap, ground terminal, and ground contacts shall be formed from one piece of brass alloy. Manufacturer: Hubbell "HBL5362" or equal.
- C. For GFCI receptacles connected to individual branch circuits provide straight-blade NEMA 5-20R, 20 amperes, 125 volts, grounding, "feed through" type, self-testing GFCI, duplex receptacle that meet the requirements of UL 943. Provide units that can be installed in a 2 3/4-in. deep outlet box without an adapter. Manufacturer: Hubbell "GFR5362ST" or equal.
- D. Provide straight-blade and twist lock receptacles for special applications as indicated on the Drawings.
- E. Provide 480 VAC, 3 wire, 4 pole, receptacles, amperage as shown on Drawings. Manufacturer: Crouse Hinds.

**2.3 SNAP SWITCHES**

- A. Provide single pole, double pole, three-way, four-way and illuminated handle snap switches as indicated on the Drawings.
- B. Switches shall be rated 20 amperes, 120-277 volts AC, back and side wired, screw pressure terminal, quiet type AC switch with yoke grounding screw. Switches shall meet the performance and design requirements of UL 20 and FS W-S-896.
- C. Manufacturer: Hubbell "HBL1220" series.

**2.4 WALL PLATES**

- A. For GFCI receptacles in damp or wet locations provide weatherproof, in use covers. Manufacturer: Hubbell "WP26E"
- B. Provide single, multi-gang, and combination type wall plates that mate and match with corresponding wiring devices.

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- C. Use metal plate-securing screws to match plate finish.
- D. Terminal Blocks
  - 1. Terminal Blocks shall meet the requirements of UL 1059 or NEMA ICS 4.

**PART 3 EXECUTION****3.1 PREPARATION**

- A. Verify outlet boxes are installed per Drawings.
- B. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- C. Clean debris from outlet boxes before installing devices.

**3.2 INSTALLATION**

- A. Install products following manufacturer's instructions. Have the manufacturer's installation instructions available at the construction site.
- B. Install devices plumb, level, and secure.
- C. Except as otherwise indicated on the Drawings, mount devices with long dimension vertical, and grounding point of receptacles on top. Group adjacent switches and receptacles under single, multi-gang wall plates.
- D. Do not use the duplex/split-wire break-off tabs in receptacles as circuit conductors for connecting downstream devices.
- E. Install galvanized steel plates on outlet boxes and junction boxes on surface mounted outlets.

**3.3 GROUNDING**

- A. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

**3.4 IDENTIFICATION**

- A. Identify wiring devices with circuit number as required in Section 26 05 53, "Identification for Electrical Systems."

**3.5 FIELD QUALITY CONTROL**

- A. Inspect each wiring device for defects before installing.
- B. Operate each operable device at least six times with circuit energized; verify proper operation.



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- C. Test 20 ampere receptacles for proper polarity and ground continuity using an NRTL-listed test device that impresses a momentary current of at least 15 amperes on the branch circuit conductors and equipment grounding path.
- D. Test ground-fault circuit interrupter receptacle operation according to manufacturer recommendations.
- E. Replace damaged or defective wiring devices.

**3.6 CLEANING AND ADJUSTING**

- A. Clean devices prior to and after installation. Replace stained or damaged wall plates or devices.
- B. Adjust devices and wall plates to be flush and level as required.

END OF SECTION 26 27 26

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**SECTION 26 28 16****ENCLOSED SWITCHES AND CIRCUIT BREAKERS****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Safety switches.
- B. Fuses and circuit breakers.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. National Electrical Manufacturers Association (NEMA)
 

NEMA FU 1	Low Voltage Cartridge Fuses
NEMA KS 1	Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
- B. National Fire Protection Association (NFPA)
 

NFPA 70, 2017	National Electrical Code (NEC)
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- C. Underwriters Laboratories (UL)
 

UL 50	Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 248	Low-Voltage Fuses

**1.3 SUBMITTALS**

- A. See the Contract Statement of Work for the submittal process.
- B. Approval Required.
  - 1. Not Used.

**1.4 QUALITY ASSURANCE**

- A. Comply with the NEC for componets and installation.

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- B. Provide safety switches that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environment in which installed.
- C. Comply with the following standards as applicable:
  - 1. NEMA KS 1
  - 2. UL 50
  - 3. NEMA FU 1
  - 4. UL 248

**1.5 RECEIVING, STORING AND PROTECTING**

- A. Receive, inspect, handle, and store safety switches, enclosed circuit breakers, and fuses according to the manufacturer's written instructions.

**1.6 EXTRA MATERIALS**

- A. Provide one spray can of touch-up paint that matches finish of switches.

**PART 2 PRODUCTS****2.1 SUBSTITUTIONS**

- A. Alternate products may be accepted. Follow the guidelines set forth in the Contract Statement of Work.

**2.2 SAFETY SWITCHES**

- A. Provide NRTL-listed, NEMA Type 1, 3R/12 or 4 Heavy Duty safety switches with ratings and number of poles as indicated on the Drawings or as required by the NEC suitable for the environment into which it is being installed.
- B. Each safety switch shall have an equipment ground bar.
- C. Each safety switch shall have provisions for padlocking in the OFF position.
- D. Manufacturer: Square D "Class 3110" or Cutler-Hammer "DH" Series.

**2.3 FUSES**

- A. Provide NEMA FU 1 and UL 248 fuses with type, voltage, and current ratings as indicated on Drawings.
- B. Manufacturer as shown on Drawings.

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**PART 3 EXECUTION****3.1 INSTALLATION**

- A. Install safety switches and fuses where indicated on the Drawings, according to manufacturer's instructions, and the NEC.
- B. Ground and bond safety switches as required in Section 26 05 26, "Grounding and Bonding for Electrical Systems."
- C. Install conduits as required in Section 26 05 33, "Raceways and Boxes for Electrical Systems."
- D. Install conductors as required in Section 26 05 19, "Low Voltage Electrical Power Conductors and Cables."
  - 1. Tighten electrical connectors and terminals to the manufacturer's published torque values.

**3.2 IDENTIFICATION**

- A. Identify safety switches and install warning signs and arc-flash warning labels as required in Section 26 05 53, "Identification for Electrical Systems."
- B. Mark floor in front of safety switches to show NEC required working space according to Section 26 05 53, "Identification for Electrical Systems."

**3.3 FIELD QUALITY CONTROL**

- A. Clean interior and exterior of safety switches.
- B. Verify proper torque of accessible bus connections and mechanical fasteners after installing safety switches; document in work package or fabrication document.
- C. Safety Switches, 600 Volts Maximum
  - 1. Visual and Mechanical Inspection:
    - a. Proper blade alignment.
    - b. Proper operation of switch operating handle.
    - c. Adequate mechanical support for each fuse.
    - d. Proper contact-to-contact tightness between fuse clip and fuse.
    - e. Manufacturer's phase barrier material installed and in place.
    - f. Verify fuse sizes and types correspond to the Drawings.



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**SECTION 26 56 00****EXTERIOR LIGHTING****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Exterior luminaires and accessories.
- B. Lighting controls.
- C. Lighting poles

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. American Society of Civil Engineers (ASCE)
  - ASCE 7, 2010                      Minimum Design Loads for Buildings and Other Structures
- B. Architectural Aluminum Manufacturers Association (AAMA)
  - AAMA 611                          Voluntary Specification for Anodized Architectural Aluminum
  - AAMA 2605                        Superior Performing Coatings
- C. ASTM International (ASTM)
  - ASTM A123/A123M                Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  - ASTM A500                         Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- D. Hanford Documents
  - TFC-ENG-STD-06, D-0          Design Loads for Tank Farm Facilities
- E. Illuminating Engineering Society of North America (IESNA)
  - Lighting Handbook

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- F. International Code Council (ICC)  
IBC, 2015 International Building Code
- G. National Fire Protection Association (NFPA)  
NFPA 70, 2017 National Electrical Code (NEC)
- H. Underwriters Laboratories (UL)  
UL 1598 Luminaires

**1.3 SUBMITTALS**

- A. See the Contract Statement of Work for the submittal process.
- B. Approval Required.
  - 1. Catalog Data: Lighting Fixtures, Light Poles, Prefabricated Pole Base
  - 2. Test Reports: Submit within 10 working days of successful test.

**1.4 QUALITY ASSURANCE**

- A. Comply with the following codes and standards:
  - 1. NEC for components and installation.
  - 2. International Building Code.
  - 3. ASCE 7.
- B. Provide luminaires listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application, installation condition, and the environments in which installed.
- C. Use manufacturers that are experienced in manufacturing, luminaires, lamps, similar to those indicated for this Project and have a record of successful in-service performance.

**1.5 SERVICE CONDITIONS**

- A. International Building Code and ASCE 7 and TFC-ENG-STD-06, Rev. D-0 design wind conditions:
  - 1. Exposure Category: C
  - 2. Basic Wind Speed: 110 mph (3-second gust at 33-ft above ground, mean recurrence interval of 50 years)
  - 3. Importance Factor: 1.0

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- B. Ambient temperature:
  - 1. -25°F to 115°F

**1.6 DEFINITIONS**

- A. Unless otherwise specified or indicated, terms used in this Section are as defined in the NEC or the IESNA Lighting Handbook.

**1.7 RECEIVING, STORING AND PROTECTING**

- A. Receive, inspect, handle, and store products according to the manufacturer's written instructions.
- B. Retain factory-applied pole wrappings on metal poles until right before installation.

**PART 2 PRODUCTS****2.1 PRODUCT OPTIONS AND SUBSTITUTIONS**

- A. Alternate products may be accepted in accordance with the requirements of the Contract Statement of Work.

**2.2 FINISHES**

- A. Furnish luminaires and accessories with finishes as scheduled that are resistant to fading, chalking, and other changes due to aging and exposure to heat and ultraviolet light. Acceptable finishes for metals are:
  - 1. Hot-dipped galvanized steel: ASTM A123/A123M.
  - 2. Brushed natural aluminum.
  - 3. Anodized aluminum: AAMA 611, Class I.
  - 4. Powder coated aluminum: Fluorocarbon polymer powder coating per AAMA 2605, over chrome phosphate conversion coated aluminum.
  - 5. Powder coated steel: Fluorocarbon polymer powder coating per AAMA 2605 over zinc phosphate conversion coated shot-blasted steel.
- B. Reject luminaires and accessories with finish having runs, streaks, stains, and defects.
- C. Replace luminaires and accessories showing evidence of yellowing, fading, chalking, and other changes indicating failure during warranty period.
- D. Use stainless steel for exposed hardware.



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**2.3 EXTERIOR LUMINAIRES**

- A. Furnish exterior luminaires that comply with requirements specified on the Drawings.
- B. Luminaires shall be NRTL-listed as conforming to UL 1598.
- C. Luminaire photometric characteristics shall be based on IESNA-approved methods for photometric measurements performed by a recognized photometric laboratory.
- D. Luminaire housing shall be primarily metal.
  - 1. Metal parts shall be free from burrs and sharp corners and edges.
  - 2. Sheet metal components shall be fabricated from corrosion-resistant aluminum, formed and supported to prevent sagging and warping.
  - 3. Exposed fasteners shall be stainless steel.
- E. Provide lenses, fabricated from materials that are UV stabilized to be resistant to yellowing and other changes due to aging or exposure to heat and ultraviolet radiation.
- F. Doors shall have resilient gaskets that are heat-resistant and aging-resistant to seal and cushion lens and refractor.

**2.4 LIGHTING CONTROL EQUIPMENT**

- A. Furnish photoelectric relays or timers to control exterior lighting as indicated on the Drawings.
- B. Furnish "HAND-OFF-AUTO" control switch and enclosure to facilitate lighting system testing.

**2.5 LIGHT POLES**

- A. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
- B. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
  - 1. Materials: Shall not cause galvanic action at contact points.
  - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
  - 3. Anchor-Bolt Template: Plywood or steel.
- C. Handhole: Minimum clear opening of 2 1/2 by 5 in. with cover secured by stainless-steel captive screws.

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## D. Concrete Pole Foundations:

1. Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Section 03 30 00, "Cast-in-Place Concrete (Non-Safety Related)."
2. Pre-cast; Pre-engineered concrete foundation. Adjustable bolt diameter and prepackaged bolts. Anti-rotation cavity. Embedded conduit sleeves.

## E. Poles:

1. Aluminum: Aluminum alloy type 6063 with T6 temper, one-piece construction up to 50 ft in height with access handhole in pole wall.
2. Steel: Comply with ASTM A500, Grade B, carbon steel with a minimum yield of 46,000 psig, one-piece construction up to 40 ft in height with access handhole in pole wall.
3. Mounting Provisions: Butt flange for bolted mounting on foundation.

## F. Steel Mast Arms: Continuously welded to pole attachment plate.

## G. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated on the Drawings, and securely fastened to pole top.

## H. Grounding and Bonding Lugs: Supplemental ground lug with tapped hole for 3/8-16 minimum ground bolt welded inside pole opposite or adjacent to handhole, complying with requirements in Section 26 05 26, "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors.

**2.6 LIGHT POLE ACCESSORIES**

- A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

**PART 3 EXECUTION****3.1 EXAMINATION**

- A. Examine areas, spaces, and surfaces to receive exterior luminaires and poles for compliance with installation tolerances and other conditions affecting performance of the product. Do not proceed with installation until unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions and the Drawings.
- B. Locations of luminaires and poles shown on the Drawings are diagrammatic unless coordinates, dimensions or angles are shown. Coordinate luminaire locations with

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building finishes and building structure. Obtain approval for location changes through TOC Construction Representative.

- C. Set luminaires plumb, square, level and secure.
- D. Install surface mounted luminaires directly to exterior wall, building structural steel, or an outlet box which is supported from structure.
- E. Install lamps in each luminaire.
- F. Fasten luminaire to indicated structural supports.
  - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- G. Adjust luminaires that require field adjustment or aiming in accordance with the Drawings.

### 3.3 LIGHTING CONTROL SYSTEM

- A. Install exterior lighting control system components in accordance with manufacturers' instructions.
- B. Install HAND-OFF-AUTO selector switch in control system to facilitate luminaire testing.

### 3.4 POLE INSTALLATION

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Cast-In-Place Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 03 30 00, "Cast-in-Place Concrete (Non-Safety Related)."
- C. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
  - 1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer
  - 2. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
  - 3. Install base covers unless otherwise indicated.
  - 4. Use a short piece of 1/2 in. diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

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- D. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6 in. wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 in. below top of concrete slab.

**3.5 FIELD QUALITY CONTROL**

- A. Inspect each installed lighting unit for damage. Replace damaged luminaires and components.
- B. Verify proper voltage at equipment served.
- C. Test installed luminaires for proper operation.
  - 1. Provide instruments to make and record test results.
  - 2. Replace or repair malfunctioning luminaires and components then re-test.
  - 3. Repeat procedure until all luminaires operate properly.
- D. Replace inoperative luminaires.
- E. Lighting Systems Testing
  - 1. Test lighting system after pole-mounted lighting fixtures are installed and Tank-Side Cesium Removal site work is substantially complete. Site work includes grading and concrete placement at the Ion Exchange Column (IXC) Storage Pad and Balance of Facilities (BOF) Pad, and fence fabric installation.
  - 2. Test illumination levels in units of foot-candles with calibrated light meter.
  - 3. Measure illumination level at top of concrete or at grade at the IXC Storage Pad and BOF Pad in the following locations:
    - a. Each corner of pad.
    - b. Every 10 to 20 feet along each edge of pad.
    - c. Every 10 to 20 feet along each fence line.
  - 4. Investigate measured values below an average of 3 foot-candles at IXC Storage Pad fence line and/or BOF Pad fence line. Adjust lighting fixture aiming as required and re-test.
  - 5. Prepare report of test results and submit in accordance with Paragraph 1.3, Submittals.

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**3.6 ADJUSTING AND CLEANING**

- A. Clean each luminaire inside and out, including plastics and glassware. Use methods and materials recommended by manufacturer.
- B. Aim adjustable luminaires as indicated on the Drawings to provide required light intensities or as directed by the TOC Construction Representative.
- C. Adjust exterior lighting controls to obtain the following performance unless otherwise indicated on the Drawings or directed by the TOC Construction Representative:
  - 1. “ON” at sunset, “OFF” at sunrise.

END OF SECTION 26 56 00

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**SECTION 31 20 00****EARTH MOVING****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Earthwork operations associated with construction of the Ion Exchange Column Storage Pad, Balance of Facilities Pad, and haul road improvements.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

## A. ASTM International (ASTM)

ASTM D653	Standard Terminology Relating to Soil, Rock, and Contained Fluids
ASTM D1557	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort
ASTM D2922	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

## B. Code of Federal Regulations (CFR)

29 CFR 1926	Safety and Health Regulations for Construction
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## C. Washington State Department of Transportation (WSDOT)

WSDOT M 41-10	Standard Specifications for Road, Bridge, and Municipal Construction
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## D. Washington Administrative Code

WAC 173-303-640 Dangerous Waste Regulations Washington State

**1.3 SUBMITTALS**

- A. See the Contract Statement of Work for submittal procedures.
- B. Approval Required
  - 1. Qualifications for Soils Technician (field inspector).
- C. Approval Not Required
  - 1. Competent person: Before excavation and in writing, submit identity of individual designated Competent Person as defined in 29 CFR 1926.650 and as required by the approved safety and health program.

**1.4 QUALITY ASSURANCE**

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work:

- A. Deliverable Documentation: The following documents and records, required by this Section, shall be delivered to TOC Construction Representative.

<u>Document</u>	<u>Paragraph</u>
In-Place Density Tests	3.8
Soil Compaction Test Report	3.8

**1.5 DELIVERY, STORAGE, AND HANDLING**

See Statement of Work.

**1.6 PROJECT CONDITIONS**

- A. Do not place backfill or fill on frozen ground.

**1.7 PERMITS**

- A. Obtain and conspicuously post the following permits before starting work under this Section.
  - 1. Backfill Permit: Use Attachment 1, "Backfill Permit Form" (A-6006-160).
  - 2. Excavation Permit: In accordance with Contract Statement of Work.

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**PART 2 PRODUCTS****2.1 MATERIALS**

- A. Use materials free of frozen particles, lumps, organic matter, and trash for backfill and fill, bedding, and stabilization.
- B. Backfill and Fill: Obtain from excavation or locations designated by the TOC Construction Representative.
  - 1. Backfill using excavation (in-situ) material or 5/8 minus crushed rock.
  - 2. Use of any other imported material will require TOC Construction Representative approval.
- C. Structural Fill: Obtain from excavation or locations designated by TOC Construction Representative. Well graded and uniformly mixed soil with largest particle being 2 in. in greatest dimension and constituting not more than 10% in volume.
- D. Bedding for Underground Piping, Tubing, Conduit, and Utility Lines: Sand as defined in ASTM D653 or excavated sandy material having less than 20% gravel particles. Gravel particles shall have a maximum dimension of 1/2 in.
- E. Location Marker: 3 in. wide, detectable plastic tape imprinted with warning such as "CAUTION - BURIED INSTALLATION BELOW" at maximum 4-ft intervals. "Terra Tape Sentry Line 620" with "Terra Clips," both by Reef Industries, or approved substitute.
- F. Stabilization: Crushed rock with maximum fragment size of 3/4 in.
- G. Geotextile Filter Fabric: Polypropylene, non-woven geotextile with grab tensile strength (ASTM D4632) of 90 lb/ft and water flow rate (ASTM D4491) of 150 gallons per minute per square foot. US Fabric Type US 90NW or similar.
- H. Slope Stabilization: Ballast in accordance with WSDOT M 41-10, Section 9-03.9(1) or Permeable Ballast in accordance with WSDOT M41-10, Section 9-03.9(2).

**PART 3 EXECUTION****3.1 EXCAVATION**

- A. Excavation includes any operation in which earth, rock, or other materials below original grade is moved, removed, or otherwise displaced by means of any hand tools, mechanical equipment, or explosives. These requirements constitute the need for an "Excavation Permit" (Form A-7400-373). If an excavation permit is not required, this section does not apply.
- B. Notify TOC Construction Representative before excavation.



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- C. Locate and expose underground utilities using subsurface scanning and hand tools, or other methods if approved by the TOC Construction Representative.
- D. If cultural properties (e.g., bones and artifacts) are encountered, stop excavation and notify the TOC Construction Representative. Obtain approval before resuming excavation.
- E. If unexpected debris is encountered, stop excavation, clear personnel to 30 ft from debris, and notify the TOC Construction Representative. Obtain approval before resuming excavation.
- F. Excavation of contaminated soil will be administered in accordance with contractor procedures and programs.
- G. Excavate earth and establish protective systems in accordance with the approved safety and health program.

**3.2 SECTIONS AND ELEVATIONS**

- A. Excavation for Utility Trenches: Excavate to section views and elevations shown on Drawings. Excavate deep enough to allow laying utility lines at line and grade shown on the Drawings after placement and compaction of bedding. If excavation will be in undisturbed sand or if utility lines will be encased in concrete, excavate to line and grade shown on the Drawings. Make trench wide enough to permit connection of utility lines. Excavate with near vertical sides from bottom of trench up to 12 in. above top of utility lines. Correct over-excavation by placing and compacting backfill and fill. Pare holes in trench bottoms for pipe couplings so pipe will bear full length of pipe barrel or pipe section.
- B. Excavation for foundations and slabs: Excavate to depth shown on the Drawings. Make excavation wide enough to permit construction of forms and bracing. Make excavation bottom compact, level, true and free of loose material. Correct over-excavation by extending concrete down to undisturbed earth at time of concrete placement or by placing and compacting backfill and fill.
- C. Excavation for Common Earthwork: Excavate as needed for general purpose, or as shown on Drawings.
- D. In-Situ Soils.
  - 1. Salvage excavated soil for use as backfill and fill material.
  - 2. Using nuclear density gauge, conduct in-place density tests or use existing testing laboratory reports (proctors) if backfill and compaction is to be completed via approved control procedure. Record results for use as standard density during backfill compaction (see Paragraph 3.6).
  - 3. Dispose of contaminated and excess soil in accordance with Contract Documents.

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4. If stabilization is required because of excavation, finish subgrade 3 in. below elevations shown on Drawings.

**3.3 BACKFILL AND FILL PREPARATION**

- A. Remove debris and organic material from area to be backfilled or filled.
- B. Do not backfill by sluicing or flooding unless written approval is obtained from TOC Construction Representative.
- C. HIHTL's and pipe-in-pipe transfer lines must be leak tested before being covered.
- D. Obtain TOC Construction Representative approval before proceeding with backfilling and filling. Backfill and fill activities shall be witnessed by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.

**3.4 BACKFILL AND FILL**

- A. Perform backfilling and filling in accordance with an approved soil compaction procedure (for example, Section 31 23 33, "Trenching and Backfilling," Attachment 2).
- B. Place specified common or native backfill in even, loose layers not more than 8 in. deep.
- C. Perform initial backfilling and filling in presence of TOC Construction Representative.
- D. Obtain test results (as applicable) and adjust compaction method, if required.

**3.5 STRUCTURAL FILL AND BACKFILL – FOUNDATIONS AND SLABS**

- A. Place loose layers of specified structural backfill and fill. Limit each layer to 8 in. depth.
- B. Compact each layer uniformly to 95% of maximum density as determined by specified compaction tests in Paragraph 3.8.

**3.6 BACKFILL AND FILL - UTILITY LINES**

- A. Before laying utility lines, place specified bedding in a 4 in. layer. Compact layer uniformly to 95% of maximum density as determined by specified compaction tests.
- B. Keep trenches free of standing water during laying of utility lines.
- C. After laying utility lines, ensure that lines have been pressure tested before backfilling and filling. Place loose, 8 in. layers of specified bedding under haunches, around sides and up to 12 in. above top of utility line. Compact each layer uniformly to 95% of maximum density as determined by specified compaction tests. Exercise care during compaction to avoid pipe misalignment and to provide uniform bearing along pipe barrel.

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- D. Place loose, 4 in. layers of backfill and fill in remaining trench depth. Use specified structural backfill and fill under foundations. Use specified common backfill and fill at other locations. Compact each layer uniformly to 95% of maximum density as determined by specified compaction tests.
- E. Place specified location marker continuously and directly over buried utility lines at depth of 12 in. below finish grade. Place marker continuously and directly over each outside line of multiple lines and if spacing between outside line markers exceeds 4 ft place sufficient intermediate markers to maintain 4 ft maximum spacing between adjacent markers.
- F. Prohibit passage of heavy construction equipment over buried utility lines until at least 24 in. of backfill and fill have been placed over lines and compacted or until bridging approved by Company has been placed across trenching.

**3.7 FINISH GRADING AND STABILIZATION**

- A. Grade each area disturbed by work to blend into existing contours. Slope area to drain away from structures.
- B. Rake each area to remove surface cobbles larger than 3 in. Dispose of excess material and debris as directed by the TOC Construction Representative.
- C. Stabilize area with minimum of 1 in. and maximum of a 3 in. course of specified stabilization material.
- D. After finish grading and stabilization, remove surface markers and flags.

**3.8 FIELD INSPECTIONS AND TESTS**

- A. Compaction Testing:
  - 1. Test compacted backfill and fill at the following intervals.
    - a. Backfill and fill: one test of each layer, each layer shall not exceed 8 in.
  - 2. Perform compaction testing in accordance with the following standards. Provide report required by each standard.
    - a. Compaction control: ASTM D1557.
      - i. In-place density: ASTM D6938. Each layer shall be as dense as the existing soil density and compacted uniformly to 95% of maximum density as established by compaction tests (per ASTM D1557).

Prior to completion of backfill, perform random surveillance to verify buried utility marker tape has been installed and record results.

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**SECTION 31 20 00 – ATTACHMENT 1****BACKFILL PERMIT FORM****Key to Backfill Permit Form**

<u>Item #</u>	<u>Description</u>
1.	Permit No. – Sequential number, developed by the Project; i.e., “5-0001.”
2.	Self-explanatory.
3.	Project title.
4.	Example – “22337 Release 5.”
5.	Describe location of the backfill; i.e. “Conduit run 001, between Handhole-005 and Handhole-006.”
6.	Enter the applicable drawings that show the backfill location.
7.	Enter any other reference documents.
8.	Discipline Foreman signature, signifying that their work in the excavation to be backfilled is complete. “N/A” will be entered if given discipline is not applicable to the specified backfill area.
9.	Quality Signature, signifying that all the quality requirements for the backfill area have been met prior to backfill and backfill may commence.
10.	Field Work Supervisor signature, signifying that the all contract requirements for the backfill area have been met and backfill may commence.
11.	Enter backfill requirements, typically construction specification reference.
12.	“Construction Representative,” this signature would be from the Construction Group, signifying that they agree that all of the requirements for the backfill area have been met and permission to proceed with backfill is granted.
13.	Date that “Construction Representative” signed off the form.
14.	Date that the applicable discipline foreman, Quality and Field Work Supervisor signed the form.

<b>BACKFILL PERMIT</b>		(1) No.:
(2) Project or Work Package No.:	(3) Title:	(4) Contract No.:
(5) Description of Backfill Work	Approvals	(14) Date
	(8) Electrical	
	(8) Piping	
	(8) Carpentry	
(6) Drawings:	(8) Concrete	
	(8) Layout	
	(8) Other	
(7) Reference	(8) Other	
	(9) Quality	
	(10) FWS	
(11) Backfill Requirements	Authorization to Proceed by	
	(12) WRPS Construction Representative	(13) Date

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END OF SECTION 31 20 00

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**SECTION 31 23 33****TRENCHING AND BACKFILLING****PART 1 GENERAL****1.1 SUMMARY OF WORK**

## A. Section Includes:

1. Trenching and backfilling for underground lines.
2. Excavation and backfilling for AP-108 Riser 15 containment Caisson.
3. Trenching and backfilling for piping and conduit.

**1.2 RELATED DOCUMENTS, CODES, AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

## A. American Concrete Institute (ACI)

ACI 301, 2010	Structural Concrete for Buildings
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## B. ASTM International (ASTM)

ASTM D653	Standard Terminology Relating to Soil, Rock, and Contained Fluids
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ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
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ASTM D2487	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
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ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
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## C. Code of Federal Regulations (CFR)

29 CFR 1926	Safety and Health Regulations for Construction
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- D. Hanford Documents
  - TFC-ENG-STD-06, D-0 Design Loads for Tank Farm Facilities
  - TFC-ESHQ-S-STD-30 Implementation of DOE-0344, Rev. 4-3, Excavating, Trenching, and Shoring
- E. Washington Administrative Code (WAC)
  - WAC 173-303-640 Tank Systems
- F. Washington State Department of Transportation (WSDOT)
  - WSDOT M 41-10 Standard Specifications for Road, Bridge, and Municipal Construction, Section 9-03.9(3), Crushed Surfacing

**1.3 DEFINITIONS**

- A. Backfill: Soil material used to fill an excavation.
  - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
  - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- C. Borrow Material: Material from required excavations or from designated borrow areas on or near site.
- D. Completed Course: A course or layer that is ready for next layer or next phase of Work.
- E. Fill: Soil materials used to raise existing grades.
- F. Lift: Loose (un-compacted) layer of material.
- G. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.
- H. Selected backfill material: Materials available on-site that TOC Construction Representative determines to be suitable for specific use.
- I. Controlled density fill: See Section 31 23 23.33, "Flowable Fill (Controlled Density Fill)."
- J. Structures: Buildings, footings, foundations, retaining walls, slabs, curbs, or other man-made stationary features constructed above or below the ground surface.
- K. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

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- L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

**1.4 SUBMITTALS**

- A. See the Contract Statement of Work for submittal procedures.
- B. Approval Required
  - 1. Qualifications for Soils Technician (field inspector).
  - 2. Shoring Plan (if required): Design of shoring shall be sealed by a professional engineer registered in the State of Washington.
- C. Approval Not Required
  - 1. Competent person: Before excavation and in writing, submit identity of individual designated Competent Person as defined in 29 CFR 1926.650 and as required by the approved safety and health program.

**1.5 QUALITY ASSURANCE**

- A. Provide survey control to avoid unauthorized over-excavation.
- B. Deliverable Documentation: The following documents and records, required by this Section, shall be delivered to Construction Document Control.

<u>Document</u>	<u>Paragraph</u>
Backfill Permit	1.6.A
Excavation Permit	1.6.A
In-Place Density Tests	3.11.C.2.b
Soil Compaction Test Report	3.11.C
Utility Location Marker Verification	3.11.C.3

**1.6 PERMITS**

- A. As required by TOC work control process.

**1.7 SITE CONDITIONS**

- A. Do not place backfill or fill on frozen ground.
- B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.



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**PART 2 PRODUCTS****2.1 MATERIALS**

- A. Use materials free of frozen particles, lumps, organic matter, and trash for backfill and fill, bedding, and stabilization.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487, or a combination of these groups; free of rock or gravel larger than 3 in. in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.
  - 1. Unsatisfactory soils also include satisfactory soils not maintained within two percent of optimum moisture content at time of compaction.
- D. Base Course: Top course conforming to WSDOT M 41-10, Section 9-03.9(3), Crushed Surfacing Base Course.
- E. Backfill and Fill: Obtain from excavation or locations designated by the TOC Construction Representative.
  - 1. Backfill within the Tank Farm using excavation (in-situ) material or 5/8 minus crushed rock.
  - 2. Use of any other imported material will require TOC Construction Representative approval.
  - 3. Controlled Density Fill (CDF): See Section 31 23 23.33 “Flowable Fill (Controlled Density Fill).”
  - 4. Bedding for Underground Piping, Tubing, Conduit, and Utility Lines: Sand as defined in ASTM D653 or excavated sandy material having less than 20% gravel particles. Gravel particles shall have a maximum dimension of 1/2 in.
- F. Location Marker: 3-in. wide, detectable plastic tape imprinted with warning such as “CAUTION - BURIED INSTALLATION BELOW” at maximum 4-ft intervals. “Terra Tape Sentry Line 620” with “Terra Clips,” both by Reef Industries, or approved substitute.
- G. General Stabilization: Crushed rock with maximum fragment size of 3/4 in.

**PART 3 EXECUTION****3.1 PREPARATION**

- A. The subcontractor shall prepare a “Backfill Permit” (see Attachment 1), and obtain approval from the TOC Construction Representative prior to commencing backfill.

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- B. Protect structures, utilities, sidewalks, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation and trenching.
- C. Protect and maintain erosion and sedimentation controls during excavation and trenching operations.
- D. Protect subgrades and foundation soils from freezing temperature and frost. Remove temporary protection before placing subsequent materials.

**3.2 EXCAVATION/TRENCHING**

- A. Excavation/Trenching work shall comply with TFC-ESHQ-S-STD-30.
- B. Excavation/Trenching shall be defined to mean any hand digging or machine digging below original grade. These requirements constitute the need for an "Excavation Permit" (Form A-7400-373). If an excavation permit is not required, this Section does not apply.
- C. Notify TOC Construction Representative before excavation.
- D. Locate and expose underground utilities using subsurface scanning and hand tools, or other methods if approved by the TOC Construction Representative.
- E. If cultural properties (e.g., bones and artifacts) are encountered, stop excavation and notify the TOC Construction Representative. Obtain approval before resuming excavation.
- F. If unexpected debris is encountered, stop excavation and notify the TOC Construction Representative. Obtain approval before resuming excavation.
- G. Excavation of contaminated soil will be administered in accordance with contractor procedures and programs.
- H. Excavate earth and establish protective systems in accordance with the approved safety and health program.

**3.3 SECTIONS AND ELEVATIONS**

- A. Excavation for Conduit Trenches: Excavate to section views and elevations shown on Drawings.
- B. Trench bottoms. Excavate and shape trench bottoms to be uniform and even. Remove projecting stones and sharp objects along trench subgrade. Allow for pipe or conduit bedding as indicated. Over excavation for conduit bedding is not required if soil is free of projecting stones and sharp objects.
- C. In-Situ Soils
  - 1. Salvage excavated soil for use as backfill and fill material.

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2. Using nuclear density gauge, conduct in-place density tests or use existing testing laboratory reports (proctors) if backfill and compaction is to be completed via approved control procedure. Record results for use as standard density during backfill compaction (see Paragraph 3.7).
  3. Dispose of contaminated and excess soil in accordance with Construction Waste Management Plan.
  4. If stabilization is required because of excavation, finish subgrade 3-in. below elevations shown on Drawings.
- D. Shoring
1. If conditions require shoring, a Shoring Plan shall be submitted to TOC for approval. Reference TFC-ESHQ-S-STD-30 for responsibilities and implementation requirements.
  2. Design of shoring shall be in accordance with TFC-ENG-STD-06, Section 3.7.

**3.4 SUBGRADE INSPECTION**

- A. Proof-roll subgrade below the building slab and pavements to identify soft pockets and areas of excess yielding. Do not proof-roll when subgrade is wet or saturated.
- B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by WRPS Construction Representative.
- C. Test or inspect subgrade materials as required for compaction requirements as applicable.

**3.5 STORAGE OF SOIL MATERIALS**

- A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.
- B. Stockpile borrowed soil materials and excavated soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water.
- C. Do not stockpile excavated soil materials adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.
- D. Do not stockpile excavated materials near or over existing facilities, adjacent property, if weight of stockpiled material could induce excessive settlement.

**3.6 BACKFILL AND FILL PREPARATION**

- A. The Subcontractor shall prepare a Backfill Permit (see Attachment 1) and obtain approval from the TOC Construction Representative.
- B. Remove debris and organic material from area to be backfilled or filled.

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- C. Do not backfill by sluicing or flooding unless written approval is obtained from TOC Construction Representative.
- D. Allow concrete to cure to full strength before placing backfill against concrete.
- E. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.
- F. Do not place fill or backfill, if fill or backfill material is frozen or if surface upon which fill or backfill is to be placed is frozen.
- G. Obtain TOC Construction Representative approval before proceeding with backfilling and filling. Backfill and fill activities shall be witnessed by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.
- H. HIHTL's and pipe-in-pipe transfer lines must be leak tested before being covered.

**3.7 BACKFILL AND FILL**

- A. Perform backfilling and filling in accordance with an approved soil/gravel compaction procedure (for example, Attachment 2 or Attachment 3).
- B. Place specified common or native backfill in even, loose layers not more than 8-in. deep if using Attachment 2, or not more than 6-in. deep if using Attachment 3, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.
- C. Perform initial backfilling and filling in presence of TOC Construction Representative.
- D. Obtain test results (as applicable) and adjust compaction method, if required.
- E. Obtain TOC Construction Representative approval before proceeding with backfilling and filling.

**3.8 CONTROLLED DENSITY FILL**

- A. The Controlled Density Fill (CDF, see Section 31 23 23.33, "Flowable Fill [Controlled Density Fill]") shall be placed in a uniform manner that will prevent voids or segregation of the bedding and filling materials. If required, the CDF shall be consolidated with internal vibrators.
- B. The CDF shall not be subjected to load and shall remain undisturbed by construction activities for a minimum of 24 hours after placement.

**3.9 BACKFILL AND FILL - FOUNDATIONS**

- A. Under Structures: A minimum of 6 in. of granular fill is required immediately below concrete footings, pipe anchors and other concrete structures.

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- B. Compact each layer uniformly to 95% of maximum density as determined by specified compaction tests in Paragraph 3.11.

**3.10 FINISH GRADING AND STABILIZATION**

- A. Grade each area disturbed by work to blend into existing contours. Slope area to drain away from structures. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
- B. Rake each area to remove surface cobbles larger than 6 in. Dispose of excess material and debris as directed by the Company.
- C. Stabilize disturbed areas with minimum of 1-in. and maximum of a 3-in. course of specified stabilization material.
- D. After finish grading and stabilization, remove surface markers and flags.

**3.11 FIELD INSPECTIONS AND TESTS**

- A. Testing Agency: Contractor shall engage a qualified geotechnical/soils engineering testing agency to perform tests and inspections.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill lift. Proceed with subsequent earth moving only after test results for previously complete work comply with requirements.
- C. Compaction Testing (not required if using Attachment 2, "Procedure for Backfill and Compaction of Existing Soils within Tank Farms" or Attachment 3, "Procedure for Backfill and Compaction of 5/8 Minus Crushed Rock")
  - 1. Test compacted backfill and fill at the following intervals.
    - a. Backfill and fill: one test of each layer, each layer shall not exceed 8 in.
  - 2. Perform compaction testing in accordance with the following standards. Provide report required by each standard.
    - a. Compaction control: ASTM D1557.
    - b. In-place density: ASTM D6938. Each layer shall be as dense as the existing soil density (Section 5) and compacted uniformly to 95% of maximum density as established by compaction tests (per ASTM D1557).
    - c. Prior to completion of backfill, perform random surveillance to verify buried utility marker tape has been installed and record results.
  - 3. Buried Pipe and Utility Location Marker Verification
    - a. Prior to completion of backfill, perform random surveillance to verify buried utility marker tape has been installed and record results.

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**SECTION 31 23 33 – ATTACHMENT 1****BACKFILL PERMIT FORM****Key to Backfill Permit Form**

<u>Item #</u>	<u>Description</u>
1.	Permit No. – Sequential number, developed by the Project; i.e., “5-0001.”
2.	Self-explanatory.
3.	Project title.
4.	Example – “22337 Release 5.”
5.	Describe location of the backfill; i.e. “W-211 Piping between Route Marker (or location) XX and XX or Conduit run 001, between Handhole-005 and Handhole-006.”
6.	Enter the applicable drawings that show the backfill location.
7.	Enter any other reference documents.
8.	Discipline Foreman signature, signifying that their work in the excavation to be backfilled is complete. “N/A” will be entered if given discipline is not applicable to the specified backfill area.
9.	Quality Signature, signifying that all the quality requirements for the backfill area have been met prior to backfill and backfill may commence.
10.	Field Work Supervisor signature, signifying that the all contract requirements for the backfill area have been met and backfill may commence.
11.	Enter backfill requirements, typically construction specification reference.
12.	“Construction Representative,” this signature would be from the Construction Group, signifying that they agree that all of the requirements for the backfill area have been met and permission to proceed with backfill is granted.
13.	Date that “Construction Representative” signed off the form.
14.	Initial and date that the applicable discipline foreman, Quality and Field Work Supervisor signed the form.

<b>BACKFILL PERMIT</b>		(1) No.:
(2) Project or Work Package No.:	(3) Title:	(4) Contract No.:
(5) Description of Backfill Work	Approvals	(14) Date
	(8) Electrical	
	(8) Piping	
	(8) Carpentry	
(6) Drawings:	(8) Concrete	
	(8) Layout	
	(8) Other	
(7) Reference	(8) Other	
	(9) Quality	
	(10) FWS	
(11) Backfill Requirements	Authorization to Proceed by	
	(12) WRPS Construction Representative	(13) Date

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**SECTION 31 23 33 – ATTACHMENT 2****PROCEDURE FOR BACKFILL AND COMPACTION OF  
EXISTING SOILS WITHIN TANK FARMS****PURPOSE**

This procedure identifies a process for placement and compaction of soil backfill by a controlled method. This procedure also defines the degree of compactive effort required to produce acceptable in-place densities as an alternative to performing density tests with a nuclear density gauge.

**SCOPE**

This procedure defines the requirements for placement and compaction of soil backfill including inspection methods to verify the acceptability of the compacted backfill within Tank Farm areas defined on project drawings. The compaction details in this were taken from Fluor Federal Services Job Bulletin No. JB-RPP-041, Rev. 1, which has been accepted standard practice in the Tank Farms.

In-place testing of compacted backfill including sand bedding by use of the nuclear density gauge is not required for this procedure. Random periodic visual observation and monitoring of the backfill operation and compactive effort shall be the basis for acceptance.

**PROCEDURE**

Compaction of backfill within the Tank Farms shall be controlled by adherence to this procedure and defined compactive effort within established variables as defined below. Determination of maximum standard density, from testing laboratory reports (proctors) or in situ values obtained from nuclear gauge testing of undisturbed ground is not covered by this procedure.

Only materials as defined by the project specifications will be used for backfill. Keep materials free of frozen particles, lumps, organic matter, and debris. Ensure that the area to be backfilled is not frozen and the backfill material does not contain frozen material.

If sand is encountered during excavation perform the following for installation and compaction.

- A. Excavate to proper installation depth. Use trench box if necessary.
- B. Install pipe on stone free earth. Rake native soil or sand bed if required.
- C. Cover pipe with 6 in. of 5/8 in. minus top course material.

Backfilling by means of sluicing or flooding with water is not permitted.

Backfill material shall be placed in loose uniform lifts not to exceed 8 in. in depth.

If needed, water shall be added and mixed with the backfill material before it is compacted to achieve optimum moisture content.

Optimum moisture content shall be approximately 8.5% and may vary as much as plus or minus 2.5% depending on different soil types and gradations. The addition of water to cohesive soil types shall be such that the material is easily compactable by mechanical manipulation as defined in this procedure.

Backfill shall be brought up in layers. Each layer shall be compacted full width and length by use of either pneumatic or gas powered compaction equipment such as a Wacker model BS-600 manufactured by Wacker Corporation or equivalent. Alternatively, a pneumatic "Pogo Stick" such as



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that manufactured by Jet Equipment or equivalent may be used. The use of “Pogo Stick” compaction equipment shall be limited to use in small confined areas such as that found in and around pipes and conduits and small excavations. Alternative compaction equipment may be used if acceptable to the TOC Construction Representative. All equipment used shall be in good working order capable of performing to manufacturer’s standards.

The compactive effort for each layer of backfill shall be as follows:

- If a Wacker or equivalent is used, a minimum of three complete passes shall be made.
- If a “Pogo Stick” type device is used, a minimum of eight complete passes is made.

One complete pass shall be defined as full rotation over the area being compacted. As a minimum, a rotation shall be once over and once back across the area being compacted. The rate of equipment travel shall be approximately 15 lineal feet per minute.

Water shall be added as necessary between individual passes to maintain the moisture content within the optimum range.

Bring up backfill material evenly on each side of walls, structures, and pipeline in order to avoid damaging or displacing them by unbalanced loading. Obtain written approval from the Tank Operations Contractor, Washington River Protections Solutions, LLC, for variations from this process that may result in uneven load distribution.

If backfill material is to be placed against or on top of newly poured concrete, ensure that the concrete curing period has been achieved and concrete design strength achieved as required by ACI 301.

Backfill material shall not be placed against foundation walls before the curing period is completed, unless written approval from the TOC Construction Representative is obtained on the Backfill Permit.

## **INSPECTION**

Control of backfill placement, optimum moisture content, and compactive effort shall be accomplished by visual surveillance. Surveillances shall be performed by a trained and qualified soils technician.

Personnel performing oversight and surveillance of the backfill operations shall possess a thorough working knowledge of earthwork and soils relative to material types and classification, excavation methods and procedures, material gradation, fill and backfill operations, compaction equipment and methods and moisture control. Oversight personnel shall have received training to perform visual surveillances of backfill operations.

Verification that soil moisture content is within the specified range shall be accomplished by visual and physical examination of the wetted material. Cohesive soil containing the correct optimum moisture content shall exhibit no evidence of saturation yet shall have enough moisture to maintain shape when deformed. Physical examination of soil cohesion and plasticity shall be the basis for determining proper moisture content.

The oversight person shall visually observe the backfill and compaction operation to verify adherence to this procedure. Type of compaction equipment, use of equipment, depth of lifts, number of passes and rate of travel shall be observed. Surveillances shall be documented on surveillance reports.

The frequency of surveillances for backfill operations shall as a minimum be at the beginning of backfilling for a project or job and at least daily thereafter while work is in progress.

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**SECTION 31 23 33 – ATTACHMENT 3****PROCEDURE FOR BACKFILL AND COMPACTION  
OF 5/8 MINUS CRUSHED ROCK****PURPOSE**

This procedure identifies a process for placement and compaction of 5/8 minus crushed rock backfill by a controlled method. This procedure also defines the degree of compactive effort required to produce acceptable in-place densities as an alternative to performing density tests with a nuclear density gauge.

**SCOPE**

This procedure defines the requirements for placement and compaction of 5/8 minus crushed rock backfill including inspection methods to verify the acceptability of the compacted backfill within Tank Farm areas defined on project drawings. The compaction details in this were taken from American Electric test plan 54891-006-TP-001.

In-place testing of compacted backfill by use of the nuclear density gauge is not required for this procedure. Random periodic visual observation and monitoring of the backfill operation and compactive effort shall be the basis for acceptance.

**PROCEDURE**

Compaction of 5/8 minus crushed rock backfill shall be controlled by adherence to this procedure and defined compactive effort within established variables as defined below.

Keep materials free of frozen particles, lumps, organic matter, and debris. Ensure that the area to be backfilled is not frozen and the backfill material does not contain frozen material.

Backfilling by means of sluicing or flooding with water is not permitted.

Backfill material shall be placed in loose uniform lifts not to exceed 6 in. in depth.

If needed, water shall be added and mixed with the backfill material before it is compacted to achieve optimum moisture content.

Optimum moisture content shall be approximately 9.5 percent and may vary as much as plus or minus 1.5 percent. The addition of water shall be such that the material is easily compactable by mechanical manipulation as defined in this procedure.

Backfill shall be brought up in layers. Each layer shall be compacted full width and length by use of a Wacker, model BS 50-2 or model WP 1550 AW manufactured by Wacker Corporation or equivalent. All equipment used shall be in good working order capable of performing to manufacturer's standards.

The compactive effort for each layer of backfill shall be as follows:

If a Wacker BS 50-2 or equivalent is used, a minimum of 4 complete passes shall be made.

If a Wacker WP 1550 or equivalent is used, a minimum of 2 complete passes shall be made.

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One complete pass shall be defined as full rotation over the area being compacted. As a minimum, a rotation shall be once over and once back across the area being compacted. The rate of equipment travel shall be approximately 15 lineal feet per minute.

Water shall be added as necessary between individual passes to maintain the moisture content within the optimum range.

Bring up backfill material evenly on each side of walls, structures, and pipeline in order to avoid damaging or displacing them by unbalanced loading. Obtain written approval from the TOC Construction Representative for variations from this process that may result in uneven load distribution.

If backfill material is to be placed against or on top of newly poured concrete, ensure that the concrete curing period has been achieved and concrete design strength achieved as required by ACI 301. Backfill material shall not be placed against foundation walls before the curing period is completed, unless written approval from the TOC Construction Representative is obtained on the Backfill Permit.

**INSPECTION**

Control of backfill placement, optimum moisture content and compactive effort shall be accomplished by visual surveillance. Surveillances shall be performed by a trained and qualified soils technician.

Personnel performing oversight and surveillance of the backfill operations shall possess a thorough working knowledge of earthwork and soils relative to material types and classification, excavation methods and procedures, material gradation, fill and backfill operations, compaction equipment and methods, and moisture control. Oversight personnel shall have received training to perform visual surveillances of backfill operations.

Verification that soil moisture content is within the specified range shall be accomplished by visual and physical examination of the wetted material.

The oversight person shall visually observe the backfill and compaction operation to verify adherence to this procedure. Type of compaction equipment, use of equipment, depth of lifts, number of passes, and rate of travel shall be observed. Surveillances shall be documented on surveillance reports.

The frequency of surveillances for backfill operations shall as a minimum be at the beginning of backfilling for a project or job and at least daily thereafter while work is in progress.

END OF SECTION 31 23 33

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**SECTION 31 23 23.33****FLOWABLE FILL (CONTROLLED DENSITY FILL)****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Controlled density fill for waste transfer piping bedding.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

A. American Concrete Institute (ACI)

ACI 301, 2010                      Structural Concrete for Buildings

ACI 306.1                          Cold Weather Concreting

B. ASTM International (ASTM)

ASTM C33                          Concrete Aggregates

ASTM C94                          Ready-Mixed Concrete

ASTM C150                         Portland Cement

ASTM C618                         Fly Ash and Raw or Calcined Natural Pozzolan for Use  
as a Mineral Admixture in Portland Cement Concrete

C. Washington Administrative Code (WAC)

WAC 173-303-640                 Dangerous Waste Regulations Washington State

D. Washington State Department of Transportation (WSDOT)

WSDOT M 41-10                    Standard Specifications for Road, Bridge, and  
Municipal Construction - English

**1.3 SUBMITTALS**

- A. See the Contract Statement of Work for the submittal process.

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## B. Approval Required

1. Controlled Density Fill (CDF): Before ordering, submit materials, mix design, and mix proportions. Identify each material to be used in fill, including amount (by weight) to be utilized in each cubic yard of plastic mix.
2. Test data: Before mixing, submit laboratory trial batches, or field trial data, to verify mix compressive strength
3. Cold Weather CDF Procedure: Before placement and if CDF will be placed during cold weather, submit procedures meeting requirements of ACI 301, Sections 4.2.2.7 and 5.3.2.1b, and ACI 306.1. If CDF will not be placed during cold weather, submit a statement to that effect.
4. Hot Weather CDF Procedures: Before placement and if CDF will be placed during hot weather, submit procedures meeting requirements of ACI 301, Sections 4.2.2.7 and 5.3.2.1c. If CDF will not be placed during hot weather, submit a statement to that effect.

## C. Approval Not Required: None

**1.4 QUALITY ASSURANCE**

- A. Deliverable Documentation: The following documents and records, required by this Section, shall be delivered to Company in accordance with contract documents.
  1. Pour Slip and Trip tickets. Paragraph 3.1.C.4

**PART 2 PRODUCTS****2.1 MATERIALS**

- A. Provide Controlled Density Fill containing, at a minimum, cementitious materials and water. Cementitious materials shall be Portland cement, pozzolanic materials, or other combinations thereof that will provide a nonsegregating, self-consolidating, free flowing material, which will result in a hardened, dense, nonsettling fill.
- B. Cement: ASTM C150, Type 11, Low alkali.
- C. Fly Ash: ASTM C618, Class F.
- D. Aggregates: ASTM C33, 3/8 in. maximum.
- E. Compressive Strength
  1. Minimum of 100 lb/in<sup>2</sup>.
  2. Maximum of 300 lb/in<sup>2</sup> at 28 days.

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## F. Mixes

1. Measure and mix specified materials and deliver mixture, in accordance with ASTM C94 or WSDOT M 41-10, Section 6-02.3.

**PART 3 EXECUTION****3.1 PLACEMENT**

- A. Deliver and place mixture in accordance with ASTM C94 or WSDOT M 41-10, Section 6-02.3. Discharge directly from truck by pumping or other methods approved by buyer.
- B. Place mixture on or against firm, damp surfaces that are free of frost, ice, and water. Obtain required compaction of earth subsurface before placement. Dampen earth surface to receive fresh fill.
- C. Start placement only when weather conditions are favorable. Do not place fill on frozen ground, or when it is raining.
  1. Ambient temperature shall be 34°F minimum and rising. Stop placing when the ambient temperature is 38°F and falling. Prior to placement at temperatures less than 34°F, submit a cold weather placement procedure.
  2. To maximum extent practicable, perform placement continuously.
  3. The mixture shall remain undisturbed by construction activities for 24 hours minimum after placement.
  4. Before placing:
    - a. HIHTL's and pipe-in-pipe transfer lines must be leak tested before being covered.
    - b. Notify TOC Construction Representative prior to placement of concrete supporting tank system components for witnessing of activities by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.
    - c. Approve "Pour Slip," including identification of location to be placed, maximum size of coarse aggregate, and design strength.
    - d. For each truck load, collect "Trip Ticket." Trip Tickets shall contain information listed in ASTM C94, paragraphs 14.1.1 through 14.1.10, and the water/cement ratio.
    - e. Identify location to discharge concrete rinsate with Company approval.

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**3.2 PROTECTION**

- A. After placement, protect mixture from construction activities for 24 hours minimum.

END OF SECTION 31 23 23.33

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**SECTION 32 11 23****AGGREGATE FOR GRAVEL BASE****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Aggregate base course under asphalt.
- B. Aggregate for ground surface.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. ASTM International (ASTM)
 

ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
ASTM D2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- B. Washington State Department of Transportation (WSDOT)
 

WSDOT M 41-10	Standard Specifications for Road, Bridge, and Municipal Construction
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**1.3 SUBMITTALS**

- A. See Contract Statement of Work for submittal procedures.

**1.4 QUALITY ASSURANCE**

- A. Deliverable Documentation: The following documents and records, required by this Section, shall be delivered to Document Control in accordance with Contract Documents.

<u>Document</u>	<u>Paragraph</u>
Aggregate grading results	3.1.C and 3.2.C
Product data for each type of product listed.	2.2
Field Inspections and Tests.	3.3



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**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. See the Contract Statement of Work for general requirements.

**PART 2 PRODUCTS****2.1 SUBSTITUTION**

- A. See the Contract Statement of Work for substitution approvals.

**2.2 MATERIALS**

- A. Aggregate for base and top courses under asphalt surface: WSDOT M 41.10, Section 9-03.9(3), "Crushed Surfacing" and 9-03.10, "Aggregate for Gravel Base."
- B. Aggregate for gravel-surfaced parking lots and general areas: WSDOT M 41.10, Section 9-03.9(4), "Maintenance Rock" (5/8 minus).

**PART 3 EXECUTION****3.1 AGGREGATE BASE COURSE**

- A. Hauling and Placing: Transport aggregate to the work site, add water to obtain proper moisture content, and place on prepared surface.
- B. Thickness and Number of Layers
1. Place each layer in spreads as wide as practical and to the full width of the course before a succeeding layer is placed.
  2. If the required compacted depth of the base course exceeds 6 in., construct in two or more layers of nearly equal thickness. The maximum compacted thickness of any one layer shall not exceed 6 in.
- C. Compacting and Shaping
1. Compact each layer of material placed in shoulder and base areas by rollers. Produce a uniform texture and firmly key the aggregates. Apply water over the materials for proper compaction. Continue compaction until there is no reaction or yielding observed under the compactor.
  2. Compact each lift to a minimum of 95 percent of maximum dry density as determined by ASTM D1557.
  3. Measure in-place density of compacted aggregate base course in accordance with ASTM D2922.
  4. Surface Tolerance: The finished top of base course, when tested with a Contractor-furnished 12 ft straightedge, must not vary from the testing edge by more than 0.08 ft at any point, and must be within 0.08 ft of specified grade.

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**3.2 GENERAL AREA GRAVEL**

- A. Hauling and Placing: Transport aggregate to the work site, add water to obtain proper moisture content, and place on prepared surface.
- B. Placing and Compacting
  - 1. Place each layer in spreads as wide as practical and to the full width of the course.
  - 2. Compact with rollers or tampers to produce a uniform surface at the specified grade and firmly key the aggregates. Apply water over the materials for proper compaction. Continue compaction until there is no reaction.
- C. Surface Tolerance: The finished top of base course, when tested with a Contractor-furnished 12 ft straightedge, must not vary from the testing edge by more than 0.08 ft at any point, and must be within 0.08 ft of specified grade.

**3.3 FIELD INSPECTIONS AND TESTS**

- A. Perform testing required by Paragraphs 3.1 and 3.2.

**3.4 PROTECTION**

- A. Traffic Control: Institute and maintain in accordance with Section 10 14 53 and WSDOT M 41-10, Section 1-07.23, Subsections (1) through (2).

END OF SECTION 32 11 23

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**SECTION 32 12 00****HOT MIX ASPHALT PAVING****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Asphalt roadways.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. ASTM International (ASTM)

ASTM D977                      Standard Specification for Emulsified Asphalt

ASTM D1751                    Standard Specification for Preformed Expansion Joint  
Fillers for Concrete Paving and Structural Construction  
(Nonextruding and Resilient Bituminous Types)

ASTM D2397                    Standard Specification for Cationic Emulsified Asphalt

ASTM D2950                    Standard Test Method for Density of Bituminous  
Concrete in Place by Nuclear Methods

- B. Washington State Department of Transportation (WSDOT)

WSDOT M 41-01                Construction Manual

WSDOT M 41-10                Standard Specifications for Road, Bridge, and Municipal  
Construction

**1.3 SUBMITTALS**

- A. See Contract Statement of Work for submittal procedures.

- B. Approval Required

1. Product data for each type of product listed in Paragraph 2.2.

2. Inspector qualifications: Before performance of any work, submit inspector qualifications in accordance with Paragraph 1.4.C of this Specification.

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3. Traffic control: Before use, submit sketches showing traffic control, including temporary signing and routing.

**1.4 QUALITY ASSURANCE**

- A. Deliverable Documentation: The following documents and records, required by this Section, shall be delivered to Document Control in accordance with Contract Documents.

<u>Document</u>	<u>Paragraph</u>
Pre-emergent herbicide	2.2.A
Mix design of asphalt mixture	2.2.B
Asphalt mix test reports	2.2.B and 2.3
Site Tests	3.2.A
Laboratory Tests	3.2.B

- B. Pre-emergent herbicide must be applied by applicator certified in the State of Washington.
- C. Qualification of Inspectors: A certified independent testing agency shall perform all required inspections and testing and shall meet the requirements set forth in the respective sections of WSDOT M 41-01 and M41-10.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. See the Contract Statement of Work for general requirements.

**PART 2 PRODUCTS****2.1 SUBSTITUTION**

- A. See the Contract Statement of Work for substitution approvals.

**2.2 MATERIALS**

- A. Pre-emergent herbicide: Selective-type control chemical meeting the requirements of WSDOT M 41-10, Section 5-04.3(5)D.
- B. Asphalt: In accordance with WSDOT M 41-10, Section 5-04 and Section 9-02. Grade of paving asphalt for use in asphaltic concrete paving (ACP) mixture shall be performance grade 70-28.
- C. Tack Material: Emulsified asphalt meeting requirements of ASTM D977, Grade SS-1h or ASTM D2397, Grade CSS-1h.

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- D. Aggregate: Hot mix asphalt, class 1/2 in., in accordance with WSDOT M 41-10, Section 9-03.8.
- E. Expansion joint filler (between concrete and asphalt): ASTM D1751; asphalt impregnated fiberboard or felt, 1/2 in. thick.

**2.3 MIXES**

- A. Mix Design: The contractor shall use a previously approved WSDOT mix design. The asphalt mix shall be in accordance with WSDOT M 41-10, Section 5-04.3(7)A.
- B. Proportioning of Materials: Hot mix asphalt, class 1/2 in., in accordance with WSDOT M 41-10, Section 9-03.8(6).

**PART 3 EXECUTION****3.1 APPLICATION**

- A. After obtaining submittal approvals, verify top course elevations and begin ACP placement. Perform work in accordance with the following sections of WSDOT M41-10.

Asphalt mixing plants:	Section 5-04.3(1)
Existing surface conditioning:	Section 5-04.3(5)
Asphalt material heating:	Section 5-04.3(6)
Aggregate preparation:	Section 5-04.3(7)
Mixing:	Section 5-04.3(8)
Spreading and finishing:	Section 5-04.3(9)
Compaction:	Section 5-04.3(10)
Joints:	Section 5-04.3(12)
Samples:	Section 5-04.3(11)
Surface smoothness:	Section 5-04.3(13)
Weather limitations:	Section 5-04.3(16)

**3.2 FIELD QUALITY CONTROL**

- A. Site tests:
  1. When tested with a 12 ft straightedge, surface of completed work shall not contain irregularities in excess of 1/4 in.
  2. Conduct in-place density testing using a nuclear gauge in accordance with ASTM D2950.
- B. Laboratory tests:
  1. Perform one test series for every 5,000 ft<sup>2</sup> of paving, unless otherwise directed by the TOC Construction Representative. Test reports will show compliance by examining depth and density of paving and materials used. Test procedures will be included with the test results.

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2. Replace and compact hot mix asphalt where core tests were taken.
3. Remove and replace or install additional hot mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

**3.3 PROTECTION**

- A. Traffic Control: Institute and maintain in accordance with WSDOT M 41-10, Section 1-07.23, Subsections (1) through (2).

END OF SECTION 32 12 00

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**SECTION 32 17 23****PAVEMENT MARKINGS****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Pavement markings.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. American National Standards Institute (ANSI)

ANSI D6.1	Manual on Uniform Traffic Control Devices for Streets and Highways
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- B. Washington State Department of Transportation (WSDOT)

WSDOT M 41-10	Standard Specifications for Road, Bridge, and Municipal Construction
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WSDOT QPL	Qualified Product List
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**1.3 SUBMITTALS**

- A. See contract Statement of Work for submittal procedures.

- B. Approval Required.

1. Pavement marking: Before delivery, submit complete list of materials, colors, and location to be used. List shall enumerate percentage of volatile and nonvolatile materials and percentage of component parts of each type of material.
2. Traffic control: Before use, submit sketches showing traffic control, including temporary signing and routing.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with the Contract Statement of Work.

- B. Store products in manufacturer's unopened packaging, with labels intact, until ready for installation.

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- C. Store materials in accordance with manufacturer's recommendations.

**PART 2 PRODUCTS****2.1 PRODUCT OPTIONS AND SUBSTITUTIONS**

- A. See the Contract Statement of Work for substitution approvals.

**2.2 MATERIALS**

- A. Pavement Marking: Low volatile organic compound solvent-based paint in accordance with WSDOT M 41-10, Section 9-34.2(4), or low volatile organic compound waterborne paint in accordance with WSDOT M 41-10, Section 9-34.2(5), using WSDOT QPL-listed manufacturer. Glass beads in accordance with WSDOT M 41-10, Section 9-34.4, using WSDOT QPL-listed manufacturer.

**PART 3 EXECUTION****3.1 APPLICATION**

- A. Pavement Marking: In accordance with ANSI D6.1, and WSDOT M 41-10, Section 8-22, and the Drawings.

**3.2 PROTECTION**

- A. Traffic Control: Institute and maintain in accordance with WSDOT M41-10, Section 1-07.23, Subsections (1) through (2).

END OF SECTION 32 17 23



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**SECTION 32 31 13****CHAIN LINK FENCES AND GATES****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Fence framework, fabric, and accessories.
- B. Gates.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. American National Standards Institute (ANSI) / Builders Hardware Manufacturers Association (BHMA)
  - ANSI/BHMA A156.3      American National Standard for Exit Devices
- B. ASTM International (ASTM)
  - ASTM A121              Standard Specification for Metallic-Coated Carbon Steel Barbed Wire
  - ASTM A123              Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products
  - ASTM A392              Standard Specification for Zinc-Coated Steel Chain Link Fence Fabric
  - ASTM F626              Standard Specification for Fence Fittings
  - ASTM F1083             Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
- C. Underwriters Laboratory (UL)
  - UL 305                  Standard for Panic Hardware

**1.3 SUBMITTALS**

- A. See the Contract Statement of Work for submittal procedures.

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- B. Approval Required
  - 1. Panic hardware: Data sheets.

**1.4 QUALITY ASSURANCE**

- A. The Seller is responsible for maintaining quality and shall perform in-process and final inspection of his work and all sub-tier contractors' work as required within this Specification.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle structural materials without damaging finish.
- B. Deliver manufactured materials in original unopened packages, containers, or bundles with manufacturer's label intact and legible.
- C. Store materials off ground, under cover, and away from damp surfaces.

**PART 2 PRODUCTS****2.1 MATERIALS**

- A. Fabric: ASTM A392, Class 1, zinc coated (1.2 oz), steel wire/fabric, 2-in. mesh size, 9-gage coated wire size, galvanized before weaving, with twisted barbed selvages top and bottom.
- B. Posts, Rails & Braces: ASTM F1083 galvanized steel pipe.
- C. Galvanizing: ASTM A123, unless otherwise indicated, provide hot-dipped, zinc-coated accessories of ferrous material with weight of zinc coating not less than 1.2 oz per sq. ft.
- D. Barbed Wire: ASTM A121 metallic coated steel, Type Z zinc coating strand wire, 2 1/2 gage (0.099 in.) steel wire, 4 barb points, 14 gage (0.080 in.) spaced on 5 in. centers.
- E. Fence Fittings: ASTM F626, Standard Specification for Fence Fittings, type and components as noted.
- F. Panic Hardware: Outdoor rated touchbar type with panic shield, key cylinder, key box, and lever style handle meeting the requirements of UL 305 and ANSI/BHMA A156.3.

**2.2 BASIC FENCE SYSTEM COMPONENTS**

- A. Terminal Posts (Angles, corners, ends, and pull posts): 2 1/2 in. Schedule 40 for fence height up to 8 ft and 3 in. Schedule 40 for fence height over 8 ft and equal to or under 16 ft.
- B. Line Posts: 2-in. Schedule 40 for fabric height up to 8 ft; 2 1/2 in. Schedule 40 for fabric height over 8 ft and equal to or under 16 ft.
- C. Braces at Terminal or Gateposts: 1 1/4 in. Schedule 40.

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- D. Tension Rods: 3/8 in. diameter galvanized steel with turnbuckle end-fitting-type tighteners.
- E. Tension Wire: 7-gage coil spring, hard tempered carbon steel wire.
- F. Tension Bars: 3/4 x 1/4 in. thick galvanized steel.
- G. Tension Bands: 3/4 x 1/10 in. (nominal) galvanized steel offset bands.
- H. Brace Bands: 3/4 x 1/10 in. (nominal) thick galvanized steel.
- I. Brace Ends: Cupped fittings of formed steel or cast iron with ears for attaching horizontal braces to brace bands and for connecting diagonal tension rods.
- J. Wire Ties: Galvanized steel with a diameter of at least 0.148 in.
- K. Post Caps: Formed steel, malleable cast iron, or aluminum, sized to post diameter, with set screw retainer.
- L. Barbed Wire Extension Arms: Galvanized pressed steel, type as specified.
- M. Gate Posts:
  - 1. Gate leaf-widths up to 6 ft: 2 1/2 in. Schedule 40.
  - 2. Gate leaf-widths up to 12 ft: 3 1/2 in. Schedule 40.
- N. Gate Frames:
  - 1. Gate leaf-widths less than 10 ft: 1 1/2 in. Schedule 40.
  - 2. Gate leaf-widths 10 ft to 16 ft: 2 in. Schedule 40.
- O. Provide non-lift-off type gate hinges sized for gate of adequate strength with large rearing surface for clamping in position so that hinges do not easily twist or turn with gate action.

**2.3 CONCRETE**

- A. Concrete: Concrete for fence posts shall have a minimum specified 28 day compressive strength of 3,000 psi. Testing is not required.

**PART 3 EXECUTION****3.1 PREPARATION**

- A. Notify TOC Construction Representative ten working days prior to start of construction to identify known utilities and stake and flag locations.
- B. Before installing chain-link fence, perform site clearing and grading as noted on Drawings.

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- C. Allow footings to cure minimum three days before installing fabric and other materials.

**3.2 POSTS**

- A. Space line posts equidistant at intervals not exceeding 9 ft 6 in. Measure interval parallel to grade of proposed fence and in line of fence from center to center of post.
- B. Set terminal posts (end, corner, and gate) at beginning and end of each continuous length of fence and at abrupt changes in vertical and horizontal alignments.
- C. Set fence and gate posts in concrete in holes of diameter and depth as follows:
  - 1. Minimum Diameter: Four times outside diameter of post.
  - 2. Minimum Depth: 36 in. plus an additional 3 in. for each 1 ft increase in fence height over 4 ft.
- D. Set posts in a vertical position, plumb and in line. Backfill concrete into excavation and extend 2 in. above grade. Crown concrete at top to shed water and extend minimum of 2 in. below bottom of post.
- E. Provide tension offset bands fitted around terminal posts at maximum 15 in. intervals to attach tension bars to posts.
- F. Provide brace center band to secure brace ends and tension rods to post.
- G. N-12 pipe or equivalent may be utilized to form post footings where post holes may not be excavated using an auger.

**3.3 FABRIC**

- A. Place chain-link fabric on outside of area enclosed. Locate posts, bracing, and other structural members on inside of secured perimeter.
- B. Place fabric by securing one end, applying sufficient tension to remove slack before making attachment elsewhere. Tighten fabric to provide smooth uniform appearance free from sag.
- C. Cut fabric by untwisting a picket and attach each span independently at terminal posts. Use stretcher bars with tension bands at maximum 15 in. intervals or any other approved method of attachment.
- D. Install fence fabric 2 in. maximum above ground level. Fasten fabric to line posts at intervals not exceeding 15 in. Fasten fabric to rail or tension wire at intervals not exceeding 24 in.
- E. Join rolls of wire fabric by weaving a single picket into ends of rolls to form continuous mesh.
- F. Provide continuous length tension bars equal to fence height and located wherever chain link fabric end attaches to terminal post. Thread bars through fabric ends for full height, and attach to posts by tension bands.

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- G. Provide wire ties for attaching chain link fabric to tension wires at maximum 18 in. centers and fence posts at maximum 24 in. centers.

**3.4 TENSION WIRE AND RAIL**

- A. Provide bottom tension wire and stretch wire from end to end of each stretch of fence at height that will enable it to be fastened to fabric.
- B. Stretch tension wire taut (not to exceed 6 in. sideway deflection) between terminal posts for securing fence fabric within 2 in. of bottom with hog rings at 18 in. on center, secure with wire ties to every third post minimum.
- C. Provide top rail and support at each post so that a continuous brace from end to end of each stretch of fence is formed. Securely fasten top rail to terminal posts and join with sleeves or coupling to allow for expansion and contraction. Secure fabric to top rail.

**3.5 BARBED WIRE**

- A. Fencing: Top fencing with three strands of barbed wire on each outrigger. Provide single 45-degree outriggers. Angle single outrigger away from secured area.
- B. Pull taut to remove sag, firmly install barbed wire in slots of extension arms, and secure to post or terminal arm.
- C. Gate: Install barbed wire strands at 6 in. on center between extended gate frame members above gate fabric.

**3.6 GATES**

- A. Install gates true to opening and plumb in closed position. Install gates to allow full opening without interference after concrete has hardened around gate posts. Adjust hardware for smooth operation.
- B. Gate posts shall be spaced according to the manufacturers' gate drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected. Type and quantity of gate hinges shall be based on the application, weight, height, and number of gate cycles. The manufacturers' gate drawings shall identify the necessary gate hardware required for the application. Gate hardware shall be provided by the manufacturer of the gate and shall be installed per manufacturer's recommendations.
- C. Hang gates so that bottom of gate is as close to ground as practical (2 in. max.) while allowing sufficient clearance for free operation through at least 90 degrees in one direction from closed position.
- D. Fasten gate fabric to vertical (end) gate frame members using tension bars and bands as for fence fabric. Fasten fabric to top and bottom gate frame members and to intermediate braces with 11-gage wire ties or clips at minimum spacing of 14 in. on center.
- E. Extend end frame members 18 in. vertically above top member of gate frame to support barbed wire.
- F. Provide tension rods as diagonal braces on gates and secure rods at gate corner only.

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**3.7 LATCHES**

- A. Single gates less than 10-ft wide may use forked type latches.
- B. Arrange plunger bars and rods so that they engage gate stops and cannot be raised when locked.
- C. Rigidly weld brackets for plunger bars holders to inactivate leaves.
- D. Arrange latching mechanisms at double gates so one padlock can lock both gate leaves at center latch integral to gate.
- E. Install keepers consisting of a mechanical device for securing free end of gate when in full open position.

**3.8 GENERAL REQUIREMENTS**

- A. Once in place, peen or spot-weld fence hardware to prevent easy removal.
- B. Coat damaged galvanized finish with zinc-enriched paint.
- C. Leave area of installation neat and free of debris caused by erection of fence.

**3.9 EXCAVATION, BACKFILL, AND COMPACTION**

- A. Refer to Section 31 20 00, "Earth Moving."

**3.10 SIGN INSTALLATION (GOVERNMENT-FURNISHED EQUIPMENT)**

- A. Install government-furnished equipment property signs or no trespassing signs in areas as indicated by the TOC Construction Representative.
- B. Signs will generally be 24 in. x 24 in. or smaller and shall be attached to the wire fabric by the use of, as specified, hog rings.
- C. General sign locations will be located on all gates, 25 ft each side of gates, trail crossings, and at visible distances along the fence line, not to exceed 300 ft.

**3.11 TESTING**

- A. The complete gate systems shall be adjusted to assure they are performing properly. Test gate through a minimum of ten full cycles and adjust to ensure operation without binding, scraping or uneven motion.

END OF SECTION 32 31 13

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**SECTION 33 10 00****WATER UTILITIES****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Raw/fire water.

**1.2 RELATED DOCUMENTS, CODES, AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. American National Standards Institute (ANSI)

ANSI Z535.1	American National Standard for Safety Colors
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- B. ASTM International (ASTM)

ASTM 53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
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ASTM A234	Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
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ASTM A865	Standard Specification for Threaded Couplings, Steel, Black or Zinc-Coated (Galvanized) Welded or Seamless, for use in Steel Pipe Joints
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- C. American Water Works Association (AWWA)

AWWA C104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
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AWWA C110	Ductile-Iron and Gray-Iron Fittings
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AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
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AWWA C151	American National Standard for Ductile-Iron Pipe, Centrifugally Cast
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AWWA C153	Ductile-Iron Compact Fittings
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- |           |  |
|-----------|--|
| AWWA C223 | Fabricated Steel and Stainless Steel Tapping Sleeves             |
| AWWA C502 | Dry-Barrel Fire Hydrants   |
| AWWA C509 | Resilient-Seated Gate Valves for Water Supply Service            |
| AWWA C600 | Installation of Ductile-Iron Water Mains and Their Appurtenances |
- D. Factory Mutual Engineering Corporation (FM)  
Approval Guide, 2010 Edition
- E. National Fire Protection Association (NFPA)
- |               |   |
|---------------|---|
| NFPA 24, 2016 | Standard for the Installation of Private Fire Service Mains and Their Appurtenances |
| NFPA 291      | Recommended Practice for Fire Flow Testing and Marking of Hydrants                  |
| NFPA 1963     | Standard for Fire Hose Connections  |

**1.3 SUBMITTALS**

- A. See the Contract Statement of Work for the submittal process.
- B. Approval Required
1. Catalog data for items in Paragraph 2.2.
  2. Flushing:
    - a. Procedure for pipe flushing required by Paragraph 3.3.B. Facility specific details required in this procedure are:
      - i. Water source.
      - ii. Flow outlets.
      - iii. How many hydrants will be opened to provide the flow capacity required by NFPA 24?
      - iv. Water disposal location.
    - b. Documentation of pipe flushing required by Paragraph 3.3.B.
  3. Pressure Testing:
    - a. Procedure for piping pressure testing required by Paragraph 3.4.B.
    - b. Documentation of pipe pressure testing required by Paragraph 3.4.B.



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4. Working plans prepared and submitted in accordance with NFPA 24, Section 4.1.3.
5. Manufacturer's installation instructions for any specially listed equipment, including descriptions, applications, and limitations for any devices, piping, or fittings.
6. Procedure for planned impairment to connecting water supplies.
7. Flow testing in accordance with NFPA 291, Chapter 4, and coordinated with Hanford Fire Marshal's Office.
8. Completion and signing of Contractors Materials and Test Certificates, per NFPA 24, Section 10.10.1.

**1.4 QUALITY ASSURANCE**

- A. See the Contract Statement of Work for general requirements.
- B. Misrepresented Products: See the Contract Statement of Work for required measures to prevent use of misrepresented products.
- C. Qualifications
  1. Contractor's Material and Test Certificate for Aboveground and Underground Piping in accordance with Paragraph 3.4.
  2. Qualification of Inspectors: A certified independent testing agency shall perform all required inspections and testing.
  3. Offsite contractors performing installation of underground fire mains shall be licensed fire protection contractors holding a State Level U license issued by the State of Washington.

**1.5 PERMITS**

- A. Obtain and conspicuously post the following permits before starting work under this Section. Permits are addressed by the TOC work control process.
  1. Excavation Permit: See the Contract Statement of Work and Section 31 20 00, "Earth Moving."
  2. A Hanford Fire Marshal permit shall be required for the installation of the water supply system and will be provided by WRPS.

**1.6 DELIVERY, STORAGE, AND HANDLING**

See the Contract Statement of Work for requirements.

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**PART 2 PRODUCTS****2.1 PRODUCT OPTIONS AND SUBSTITUTIONS**

See the Contract Statement of Work for substitution approvals.

**2.2 MATERIALS**

- A. All pipe, fittings, valves, and hydrants shall be UL Listed or FM Approved for fire protection service in accordance with NFPA 24.
- B. Raw/Fire Water Pipe and Fittings:
  - 1. Ductile Iron Pipe (3 in. diameter and greater): AWWA C151, Class 150.
    - a. Joints: Flanged per AWWA C110 or push-on joints, AWWA C111 rubber gaskets.
    - b. Fittings: AWWA C110, Ductile-Iron or Gray-Iron, Class 250 or AWWA C153, Ductile-Iron Compact Fittings, Class 250 or XTRA FLEX®<sup>26</sup> restrained joint high-deflection fittings.
    - c. Pipe and Fittings: Cement-mortar lining and asphalt seal coat in accordance with AWWA C104.
  - 2. Galvanized Steel Pipe and Fittings (3-in. and smaller): ASTM A53, type E or S, galvanized, standard weight, Schedule 40.
    - a. Joints: Threaded.
    - b. Fittings: ASTM A865, threaded and galvanized.
- C. Valves
  - 1. Tapping Valves: AWWA C509, UL listed or FM approved, Class 250, resilient wedge, non-rising stem, open left, 2-in.-square wrench nut.
  - 2. Gate Valves over 2 in.: AWWA C509, UL listed or FM approved, Class 250, non-rising stem, open left, mechanical joint inlet and outlet with mechanical joint unassembled accessories or Mueller AquaGrip®<sup>27</sup> System.
  - 3. Combination Air Valves: Combination air/vacuum and air release type, cast-iron or ductile iron body, single body or dual body type, APCO®<sup>28</sup> or Val-Matic®<sup>29</sup>.

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<sup>26</sup> XTRA FLEX is a registered trademark of United States Pipe and Foundry Company, LLC, Birmingham, Alabama.

<sup>27</sup> AquaGrip is a registered trademark of Mueller International, LLC, Atlanta, Georgia.

<sup>28</sup> APCO is a registered trademark of DeZurik, Inc., Sartell, Minnesota.

<sup>29</sup> Val-Matic is a registered trademark of Val-Matic Valve and Manufacturing Corporation, Elmhurst, Illinois.

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- D. Post Indicator Valve (PIV)
1. PIV Valve: See Paragraph 2.2.C, Gate Valves.
  2. PIV Indicator Post: Adjustable type, telescoping barrel type, open left, complete with lower barrel sized for appropriate bury depth. Locking handle, position indicator sign plates protected by non-breaking plastic windows, post assembly to match Gate Valve. PIV indicator posts shall be painted Red.
- E. Fire Hydrant: Dry barrel type in accordance with AWWA C502, with compression type main valve which opens against pressure, 6-in. inlet with minimum 5-in. valve opening. Outlet, one 4-1/2 in. pumper nozzle and two 2 1/2-in. hose nozzles, including caps and chains. Nozzle threads in accordance with National Standard fire hose coupling threads in accordance with NFPA 1963. Hydrant operating nut and cap nuts in accordance with National Standard Pentagon in accordance with AWWA C502 and open in counter-clockwise direction. Stem seals, O-ring type. Hydrant shall be Clow Medallion, M&H Model 929 or approved substitute. Hydrants shall be painted chrome yellow.
- F. Hydrant Valve: See Paragraph 2.2.C, Gate Valves.
- G. Valve Boxes: Cast-iron with top section and cover with lettering "WATER" cast on the cover, bottom section with base of size to fit over valve, barrel approximately 5 in. in diameter, adjustable cast-iron extension of length required.
- H. Flanges, Unions, and Couplings
1. Mechanical or Push-On Type Pipe, and Fittings Below Grade.
    - a. UL listed or FM approved.
    - b. Megalug malleable iron retainer/restraint gland with epoxy or bituminous outside coating and 1/2 in. minimum diameter asphalt coated tie rods.
- I. Pipe Casing
1. Raw/Fire Water: AWWA C151, Class 150, Ductile Iron Pipe.
    - a. Spacers: Calpico Inc., Model M-Series Casing Insulators or equivalent.
    - b. End Seals: Calpico Inc., Model W End Seals or equivalent.
- J. Gaskets: Gaskets containing asbestos are not permitted.
- K. Marker Tape: Non-detectable, Brady Identoline®<sup>30</sup> underground warning tape or similar.
- L. Tracer Wire: #10 AWG THHN/THWN-2, yellow, solid copper.

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<sup>30</sup> Identoline is a registered trademark of Brady Worldwide, Inc., Milwaukee, Wisconsin.

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- M. Threaded Pipe Joint Sealant: Permabond®<sup>31</sup> MH052 or approved substitute.
- N. Bitumastic®<sup>32</sup>: Koppers number 50 or Superservice Black.

**PART 3 EXECUTION****3.1 PREPARATION**

- A. Connection to existing fire main connections will require partial impairment to fire water supplies.
- B. No impairments to water supplies shall be executed without an approved Hanford Fire Marshal Permit.
- C. Water supply impairments shall be kept to the shortest time period through excavation, and pre-installation of piping, etc., to the extent practical.
- D. Keep piping systems clean during work. Cap open ends when installation is not in progress. Support pipe for full length of barrel.
- E. Refer to Drawings and Section 31 20 00, "Earth Moving," for earth cover, warning tape, documenting new or exposed existing utility location, etc., requirements.
- F. All underground utility locations shall be identified by means of marking tape and tracer wire. Place tape in backfill directly above the utility line at approximately 12 in. below grade.

**3.2 INSTALLATION**

- A. Raw/Fire Water Pipe and Fittings
  - 1. Install pipe and pipe accessories in accordance with AWWA C600 (Ductile Iron), ASTM A234 (Steel), manufacturer's instructions, NFPA 24, the drawings, and this Section.
  - 2. Install thrust restraint at all bends, tees, plugs, and caps in accordance with NFPA 24. If concrete thrust blocks are used, size in accordance with details shown on the contract drawings.
  - 3. Make joints in threaded piping system with specified joint sealant. Apply sealant sparingly to male threads only.
  - 4. Coat buried carbon steel accessories, such as tie-rods and clamps, with 16.0 mils of Bitumastic in one or two coats (10-24 hours between coats). Allow 8 hours for Bitumastic to dry before backfilling.

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<sup>31</sup> Permabond is a registered trademark of Loxeal Srl, Maderno, Italy.

<sup>32</sup> Bitumastic is a registered trademark of Koppers Company, Inc., Pittsburgh, Pennsylvania.

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5. Use galvanized steel pipe where heat tracing is required. Wrap heat tracing with insulation designed for the intended use (exterior, above or below grade as applicable).
6. Install post barricades around fire hydrant and post indicator valves in accordance with the drawings and this Section.
7. Install fire hydrants and hydrant connection valves in accordance with the drawing and this Section.
8. Painting and Markings: See Section 09 91 00, "Painting," for preparation and painting.

**B. Horizontal Directional Drilling**

1. Crossing of paved streets or roadways or other areas, if approved by TOC Construction Representative, may be accomplished by horizontal directional drilling (HDD) whenever practical. The HDD bore shall be kept to a maximum of 2 in. larger than the pipe. Care shall be exercised to ensure the paved surface is not damaged during the drilling operation.
2. Top of HDD shall have a minimum below grade bury depth of 42 in. and a minimum bury depth of 60 in. below any paved surface. Depth shall not exceed excavation by standard, conventional means and shall be approved by TOC Construction Representative.
3. When pulling in pipe the pulling force shall be monitored and kept below the Allowable Tensile Load (ATL) value of the pipe size and material per manufacturer's recommendation. Both pipe ends shall be monitored for continuous, smooth movement. Pulling load from the equipment shall be monitored and the pipe lead end shall be equipped with a weak link device to disengage at the ATL or below. Manufacturer's procedures and design parameters shall be followed regarding the installation of their pipe material by HDD.

**3.3 FIELD QUALITY CONTROL****A. Flushing/Testing Preparation**

1. Furnish equipment and instruments required to perform mechanical cleaning.
2. Obtain direction for disposal of flushing water from TOC Construction Representative. See the Contract Statement of Work.

**B. Raw/Fire Water Line Flushing**

1. Flush raw water in accordance with NFPA 24 for below ground piping.
  - a. The underground pipe trench shall be partially backfilled between joints before testing to prevent movement of pipe.

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- b. Notify TOC Construction Representative at least five working days before flushing of piping system for witnessing flush. Flushing to verify that new lines are clean and acceptable.
- c. Flush piping with water for five minutes minimum, and until effluent is clean and contains no visible particulate matter. Flushing pressure shall not exceed maximum operating pressure specified for the system. Flushing water supply shall have sufficient capacity to produce a full pipe (largest pipe size) flush.
- d. Document flushing of each piping system on NFPA Form, "Contractor's Material and Test Certificate for Aboveground and Underground Piping," in accordance with NFPA 24 and submit in accordance with Paragraph 1.3.

**3.4 FIELD INSPECTIONS AND TESTS**

- A. Coordinate with the Hanford Fire Marshal's office, Mission Support Alliance Water Utilities, and WRPS cognizant Fire Protection Engineer at least five working days in advance to:
  1. Witness inspection and testing prior to burial of piping.
  2. Conduct hydrant flow testing as directed.
- B. Raw/Fire Water Line Testing
  1. Furnish instruments, facilities, and labor required to conduct tests.
  2. Test gauges shall be calibrated and capable of measuring at least 1.5 times test pressure, but no more than four times test pressure.
  3. Document leak/pressure testing of each piping system on NFPA Form, "Contractor's Material and Test Certificate for Aboveground or Underground Piping," in accordance with NFPA 24 and submit in accordance with Paragraph 1.3.
  4. Perform tests after lines have been flushed and before joints have been backfilled for underground piping.
  5. Remove all air from piping and adequately restrain pipe prior to hydrostatic test for underground piping. The last thrust block poured shall have cured a minimum of seven days prior to test.
  6. Test mainline at 200 psi for two hours or at 50 psi in excess of the maximum static pressure, whichever is greater, and measure leakage of raw water lines in accordance with NFPA 24, Section 10.10.2.2, for underground piping. Repair any unsatisfactory joints and retest.
  7. Install a temporary relief valve during pressure test. Relief valve shall have a discharge capacity of at least 125 percent of the pressurizing device and be set to

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not more than 110 percent of the test pressure. Demonstrate proper operation of relief valve before relief valve is attached to system for leak test and whenever there is cause to question operating accuracy of valve.

END OF SECTION 33 10 00

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**SECTION 40 05 04****BALANCE OF FACILITIES PAD PROCESS PIPING****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. General requirements for tube, pipe, piping components, materials, fittings, valves, flanges, and installation of process piping systems applicable to ASME B31.3, Process Piping.
  - 1. Normal Fluid Service:
    - a. Reagent Liquid (water and caustic)

**1.2 RELATED SECTIONS**

- A. Section 22 05 29, "Balance of Facilities Pad Hangers and Supports for Plumbing, Piping and Equipment."
- B. Section 22 07 13, "Balance of Facility Pad Piping Insulation."
- C. Section 22 08 13, "Testing for Balance of Facilities Piping."

**1.3 RELATED DOCUMENTS/CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. American Society of Mechanical Engineers (ASME)
 

ASME B&PVC, 2017	Boiler and Pressure Vessel Code
Section V	Nondestructive Examination
Section IX	Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operations
ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	Pipe Threads, General Purpose (Inch)
ASME B31.3, 2016	Process Piping
- B. American Welding Society (AWS)



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AWS D1.1/D1.1M, 2015      Structural Welding Code – Steel

C.      ASTM International (ASTM)

ASTM A269/A269M      Standard Specification for Seamless and Welded  
Austenitic Stainless Steel Tubing for General Service

## 1.4      SUBMITTALS

A.      See contract Statement of Work for submittal procedures.

B.      Action Submittals - Materials

1.      Catalog Data: Include the Manufacturer's name, model number, parts list, and brief description of equipment and its basic operational features.
2.      Design Data, Evaluations, and Calculations: An item may be considered unlisted due to its component type or its material of construction. Such items shall adhere to the items below, respectively.
  - a.      Items that are unlisted due to component type shall be in accordance with ASME B31.3, paragraph 326.1.2 for metallic or A326.1 for non-metallic piping components.
  - b.      Items that are unlisted due to material of construction shall be in accordance with ASME B31.3, paragraph 323.1.2 for metallic or A323.1 for non-metallic piping components.

C.      Action Submittals - Fabrication

1.      Qualifications
  - a.      Manufacturer Qualifications are required when specified items are not supplied (see Submittals in Paragraph 1.4.B.2).
  - b.      Installer Qualifications.
  - c.      Test, Nondestructive Examination (NDE), and Inspection Qualifications Records - Subcontractor and Supplier inspectors are required to have certifications and experience commensurate with the examinations or inspections.
  - d.      Examiner Qualifications/Certifications.
2.      Welder and Bonding Qualifications
  - a.      Welder and Bonding Qualification Records.
  - b.      Welding and Bonding Procedure Specifications (WPS).
  - c.      Welding and Bonding Procedure Qualification Record (WPQR).

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3. Test and Inspection Plan
    - a. The Supplier shall provide an Inspection and Test Plan and Procedures for review and approval. All inspections and tests, including inspection and testing forms, logs shall be documented and submitted for review and approval.
    - b. Subcontractor shall provide a Field Test and Inspection Plan and Procedures for installed process plant piping and ancillary equipment.
  4. Test Reports
    - a. Factory Acceptance Test Report.
    - b. NDE Test Reports.
    - c. Field Test and Inspection Report.
  5. Certifications
    - a. Instrument Calibration Certificates for equipment used during the Factory Acceptance Test
    - b. Certified Material Test Reports for metallic piping and components required by the code of record specified below:
      - i. ASTM A269.
    - c. Certificate of Compliance to show compliance to the applicable codes and standards as identified in this specification.
- D. Closeout Submittals
1. Operation & Maintenance Manual

**1.5 QUALITY ASSURANCE**

- A. Material Control Procedure
1. Work shall be performed in accordance with an approved Material Control Procedure. This procedure shall describe the control methods and documentation used to handle and monitor the use of controlled materials (piping component, fasteners, and welding filler rod and other components).
  2. The procedure shall follow manufacturer's requirements for receiving, storage, handling, and preservation to minimize deterioration.
  3. Segregation of carbon steel and stainless steel material and tools shall be maintained throughout fabrication.

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4. The procedure shall also address procurement through processing and final assembly.
5. Subcontractor and Suppliers must provide protection against the weather, acceleration forces, airborne contamination, and physical damage for the equipment procured under this specification.

## B. Inspection, Testing, and NDE

1. The Supplier shall perform inspection and testing to verify the conformance of the item to the specified requirements defined in Part 2 of this section, as well as any Supplier requirements as defined as part of the Suppliers Quality Assurance (QA)/Quality Control program.
2. The Supplier shall provide an Inspection and Test Plan indicating all testing and inspection functions to be performed, including hold points during fabrication and assembly, as well as during the Factory Acceptance Testing.
3. All inspection and testing functions shall be performed by qualified personnel using qualified procedures in accordance with specified requirements.
4. Hold points are required during the fabrication process to allow inspection, verification, or approval by WRPS before the Supplier does further work. Hold points shall be identified within the Inspection and Test Plan, with provisions for WRPS review and acceptance. WRPS has the right to waive Hold Points at their discretion.
5. Inspection Records: The Supplier shall appropriately record, submit and maintain records documenting the inspection and/or test then submit the completed Inspection Record as part of the QA Document Package. The status of all planned and executed inspection and testing activities shall be logged and traceable to ensure that the required inspection and testing have been performed, and any items that have failed inspection or testing are not inadvertently installed or implemented.

## C. Qualifications

1. Welder Qualifications Subcontractor shall provide documentation that all personnel have passed relevant qualification tests per ASME B31.3 for joining processes involved and that certification is current.
  - a. Metallic Pipe: Welders and brazers shall be qualified in accordance with ASME B31.3 Section A328.2.
  - b. Steel Support Welding (not touching the pressure boundary): Qualify processes and operators to AWS D1.1/D1.1M.
2. Welding Procedures

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- a. Welding/Brazing procedures shall be qualified according to ASME B&PVC, Section IX.
3. Qualification of Examination Personnel:
  - a. Personnel performing other examination shall be certified in accordance with contractor's written practice. Personnel performing nondestructive examination to the requirements of ASME B31.3 shall be qualified and certified for the method to be utilized following a procedure as described in ASME B&PVC, Section V, Article 1, T-120 (e) or (f).
  - b. Certifications of examination personnel shall be maintained for the Owners Inspector's review.
  - c. Examination records including examiner's qualifications and procedures shall be retained for at least 5 years per ASME B31.3, Section 346.3.
4. Owner's Inspector shall be qualified in accordance with ASME B31.3 Section 340 and Construction Management – Field Engineering . WRPS shall act for DOE to designate Owner's Inspectors or Representatives.
5. Manufacturer Qualifications
  - a. Must have a minimum of five years of experience.
  - b. Must have maintenance service based within 200 miles radius of installation.

## 1.6 ENVIRONMENTAL REQUIREMENTS

- A. All tubing and piping shall be designed to operate in the environmental conditions specified project requirements documents.

## PART 2 PRODUCTS

### 2.1 THREADED JOINTS AND FASTENERS

- A. Threaded joints: Unless otherwise noted, all threaded joints shall be NPT (tapered threads) complying with ASME B1.20.1, Pipe Threads, General Purpose (Inch). The threaded joint assembly shall be in accordance with ASME B1.20.1, 3.1.9 "Wrench-Tight Engagement between External and Internal Taper Threads."
- B. Fasteners are to be in accordance with ASME B1.1 UNS Classes 1A (external) and 1B (internal) uncoated unless otherwise specified.

### 2.2 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. See contract Statement of Work for substitution procedures.
- B. Proposal of unlisted components is strongly discouraged and will be evaluated in accordance with the contract Statement of Work. Substitutions will be allowed only if

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the Subcontractor can demonstrate that the product can meet the same code requirements of the item specified in the design. Costs associated with evaluation of unlisted components shall be the responsibility of the Subcontractor.

- C. If an unlisted component alternate is proposed, the manufacturer must submit Design Data in accordance with Paragraph 1.4.B.2.

**2.3 SEISMIC PERFORMANCE REQUIREMENTS**

- A. The piping, tubing, and supports shall remain in place without separation of any parts when subjected to the design basis earthquake as represented by the seismic forces derived from the criteria indicated on the drawings.

**2.4 PIPING/TUBING/FITTINGS**

- A. Stainless Steel Tubing
  1. ASTM A269, Seamless.
  2. Fluid Service: Category Normal. Category D.
  3. System Application(s): Reagent less than 150 psig and between 65°F and 90°F.
  4. Location: Above grade.
  5. Assembly Methods: Welded, flanged, or compression fittings.
  6. Size: 3/4 in. to 1 in.

**PART 3 EXECUTION****3.1 GENERAL**

- A. Piping (and tubing) Systems: Fabricate, inspect, examine, and test in accordance with ASME B31.3.
- B. Piping systems include all piping components (including pressure retaining portions of instruments), pipe fixtures, clamps and supports, instrument mounting plates and their attachment to structural frame work.

**3.2 TAGGING & MARKING**

- A. To facilitate identification and assembly in the field, each pipe spool shall be conspicuously marked on the outside surface of each end with a spool piece identification number as identified in the isometric drawing, drawing, or line list.
- B. The identification numbers shall permanently attached barcode stickers are an acceptable alternative.
- C. For austenitic stainless steel and nonferrous alloys, the marking paint required for piece numbers or color coding shall contain no harmful metal or metal salts such as zinc, lead,

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or copper which cause corrosive attack upon heating. Marking materials shall contain no halides. Markings shall not be water soluble.

- D. Nameplates shall be attached by seal welding, permanent adhesive or stainless steel wire. Nameplates shall include:
1. Purchase order number.
  2. Manufacturer's name and address.
  3. Identification number.
  4. Size.
  5. Pressure class (if applicable).
  6. Fluid Service.
  7. System Application(s).

**3.3 PREPARATION****A. Pre-Assembly**

1. Verify materials are correct before assembly in accordance with the accepted Material Control Procedure.
2. Fastener materials shall be free of nicks, burrs, chips, dirt, and damage (inspect threads, shank, and nuts). All damaged fasteners must be replaced.

**3.4 FABRICATION**

A. Piping shall be fabricated in accordance with the provided drawings.

**B. Welded Joints**

1. Welding procedures, pre-weld cleaning, and weld dimensions, shall be per contract Statement of Work.
2. Unless noted otherwise on the isometric drawing, field fit-up welds shall include 6 in. of pipe beyond the length required.
3. Weld joints shall meet the approved WPS joint requirements.

**3.5 ERECTION**

A. Compression joints shall be per manufacturer's recommendations.

B. Install all piping shown on the construction drawings per manufacturer's recommended procedures and this Section.

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- C. Deviations from locations identified on the drawings must be approved by WRPS and documented for incorporation into as-built drawings.
- D. Route piping in an orderly manner and maintain gradient. Route parallel and perpendicular to walls and equipment to allow service and maintenance.
- E. Install piping to maintain headroom and ensure that it does not interfere with use of space or take more space than is necessary. Piping shall not block access to manholes, access covers, etc.
- F. Group piping whenever practical at common elevations.
- G. Wedges shall not be used to laterally contain or position pipe for closure fit-ups.
- H. Valves shall be placed to permit easy operation and access and be installed upright where possible. Valve stems shall be upright or horizontal, not inverted.
- I. Flanged dielectric connections shall be installed with dielectric bolt insulators.
- J. Identification and/or traceability marks of piping components shall not be removed or hidden by surface treatment, coating, or subdividing during installation unless other identification methods are implemented to ensure that all markings are properly transferred and traceability documentation is maintained for the components. Installer must verify that items are correct for the installation and have legible identification markings.
- K. Threaded Joints
  - 1. Compound or lubricant used on bolt threads shall be suitable for the service conditions and shall not react unfavorably with either the service fluid or the piping material. Reference manufacturer's recommendations for suitable compounds and lubricants. Lubricant for stainless steel shall contain no chloride.
  - 2. Provide non-conducting dielectric connections whenever joining dissimilar metals in liquid systems with corrosion potential.
  - 3. The threaded joint assembly shall be in accordance with ASME B1.20.1 3.1.9 "Wrench-Tight Engagement between External and Internal Taper Threads."
- L. Flare Joint 45 Degree (SAE J513)
  - 1. Cut tubing squarely and clean tube end thoroughly to remove burrs.
  - 2. Place nut onto tube. Place threaded end of nut toward end of tube.
  - 3. Flare tube end with flaring tool to provide 45° flare.
  - 4. No scratches, breaks, or other mars at sealing surface of flare shall be permitted.

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5. Clamp tube flare between nut and nose of fitting body by screwing nut on finger-tight. Tighten with a wrench an additional 1/4 turn for a metal-to-metal seal.

## M. Flare Joint 37 Degree (SAE J514)

1. Flaring of the tubing will meet the manufactures requirements.
2. Power flaring is quicker and produces more accurate and consistent flares compared to hand flaring. Therefore, it is a preferred method of flaring. Hand flaring should be limited to places where power flaring tools are not readily available.
3. Cut tubing squarely and clean tube end thoroughly to remove burrs.
4. Place nut and sleeve if used onto tube in the proper sequence. Place threaded end of nut toward end of tube.
5. Flare tube end with flaring tool to flare tubing. Flares will be within the minimum and maximum flare outside diameters. Inspect flare for surface quality.
6. No scratches, breaks, or other mars at sealing surface of flare shall be permitted.
7. Align the component and hand tighten fitting. With proper tube flare alignment with the nose of the fitting, tighten the nut to appropriate torque value shown in the manufacturer's literature.
8. Torque tolerances:
  - a. 2 ft-lbs if torque value is 50 ft-lbs or less.
  - b. 4 ft-lbs if torque value is greater than 50 but less than 100 ft-lbs.
  - c. 4% of torque value if greater than 100 ft-lbs.

## N. Final Assembly Cleaning

1. Subcontractor shall be responsible for the cleanliness and integrity of the system. Internal and external of pipe, tube, and components shall be free of loose scale, sand, dirt, paint, metal chips, filings, flux, slag, weld spatter, mill scale, rust, grease, oil, waxes, or other contaminants that are easily seen with the unaided eye.
2. Consult manufacturer's recommendation for the use of acids and cleaning agents to prevent damage. Cleaning agents used with stainless steel systems shall contain no more than 50 ppm halide content.
3. Ensure safeguards are taken to protect personnel from hazards of cleaning, which may include but not be limited to flying particulates, corrosive chemicals, and harmful vapors.



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4. A suitable chemical and/or mechanical cleaning method shall be used, if necessary, to clean all surfaces.

**3.6 HANGER AND SUPPORT INSTALLATION**

- A. Follow Section 22 05 29, "Balance of Facilities Pad Hangers and Supports for Plumbing, Piping and Equipment," as applicable.

**3.7 INSULATION INSTALLATION**

- A. Follow Section 22 07 13, "Balance of Facility Pad Piping Insulation," as applicable.

**3.8 EXAMINATION, TESTING, AND INSPECTION**

- A. For the purposes of this Section, the Subcontractor (constructor) is responsible for all tasks identified as examination and testing. CWI activities are considered examination. Owner's Inspector activities are considered inspection.
- B. Examination
  1. Pipe examinations shall be performed after fabrication, after required heat treatment, and before leak testing.
  2. Both the extent of examination and acceptance criteria shall be in accordance with ASME B31.3, paragraph 341 Examination and Section A341 Examination for non-metallic systems, as applicable.
  3. When pneumatic testing is planned 100% of all threaded, bolted, and other mechanical joints shall be examined.
  4. Any items rejected because of defects shall be repaired, replaced, and examined per this Section and ASME B31.3.
  5. Methods of examination shall be per ASME B31.3 Section 344.
  6. In-process examination of welds may replace radiographic or ultrasonic volumetric analysis for all welding per ASME B31.3, Section 344.7.
- C. Testing
  1. Pressure test piping system per Section 22 08 13, "Testing for Balance of Facilities Pad Piping."
- D. Inspection
  1. Owner's Inspector shall have access to any and all design, fabrication, manufacture, fabrication, heat treatment, assembly, erection, examination, testing, records, documentation or other project information or activities to verify that all required examinations and testing have been completed and to inspect the piping to the extent necessary to be satisfied that it conforms to all applicable examination requirements of the Code and of the engineering design and to perform the role defined in ASME B31.3.

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2. Owner's Inspector is the final authority on acceptance of the project examination, or test.

END OF SECTION 40 05 04

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**SECTION 40 05 22****HOSE-IN-HOSE TRANSFER LINE****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Installation of the Hose in Hose Transfer Line (HIHTL) piping will include connections in the AP-07F Pit, connections at AP-108 Riser 15, a connection at AP-106 Riser 2, and connections at the Tank-Side Cesium Removal (TSCR) enclosure. The HIHTLs are located within the 241-AP Tank Farm, the designated receiver TSCR unit is located just outside the tank farm fence. The furnished HIHTL assemblies will consist of a flexible primary hose installed within a secondary encasement hose. All HIHTL connections will be made as described in Paragraph 3.3. The secondary hose will be wrapped with heat tape and with insulation.

**1.2 RELATED DOCUMENTS/CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- |    |   |  |
|----|---|--|
| A. | American Society of Mechanical Engineers (ASME) |  |
|    | ASME B31.3, 2016                                | Process Piping   |
| B. | Hanford Documents                               |  |
|    | H-14-111331, Sh. 1                              | AP Farm TSCR Upgrades, HIHTL Layout General Arrangement            |
|    | H-14-111331, Shts. 2-3                          | AP Farm TSCR Upgrades, HIHTL Layout Sections                       |
|    | H-14-111331, Sh. 4                              | AP Farm TSCR Upgrades, HIHTL Layout Hose Chart                     |
|    | TFC-ENG-STD-12, E-2                             | Tank Farm Equipment Identification Numbering and Labeling Standard |
|    | TFC-ENG-STD-21, D-11                            | Hose-in-Hose Transfer Line   |
| C. | Washington Administrative Code (WAC)            |  |
|    | WAC 173-303-640                                 | Dangerous Waste Regulations Washington State                       |

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**1.3 SUBMITTALS**

- A. See Contract Statement of Work for the submittal process.
- B. Approval Required
  - 1. HIHTL assembly procedure as required by Paragraphs 3.3.G and 3.3.I.
  - 2. Documentation of inspections required by Paragraph 3.4.
  - 3. Leak test procedures required by Paragraph 1.4.C.
  - 4. Test results for Leak Testing performed for Paragraph 3.5.

**1.4 QUALITY ASSURANCE**

- A. The HIHTL system is classified as Safety Significant.
- B. Misrepresented Products: See Contract Statement of Work for required measures to prevent use of misrepresented products.
- C. Leak Testing Procedures: Leak testing procedures shall be in accordance with ASME B31.3 and this Specification. Maintain copies of procedures at jobsite

**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. See the Contract Statement of Work for general requirements.
- B. HIHTL materials shall be stored as follows and any additional manufacturer recommendations:
  - 1. Hose assembly shall be stored as shipped, on reel, in either vertical or horizontal position.
  - 2. Hose assembly should be stored in its original shipping/packing materials so that plastic wrapping and cardboard covering will provide some protection against possible deteriorating elements. Additionally, if stored outside, the material shall be covered with a tarpaulin or other protective covering.
  - 3. Hose ends shall be kept covered by wrapping in plastic and securing.
  - 4. Exposure to direct and reflected sunlight should be avoided. If the hose is exposed to the sun for a prolonged period, a section of hose should be inspected for deterioration every two years. Inspect hose for any damage to or holes in insulation and inspect fittings for visible damage.
  - 5. Optimum storage area is in a covered area that is cool and dark, and free of dampness and mildew.
  - 6. Maximum shelf life is seven years.

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**PART 2 PRODUCTS****2.1 MATERIALS AND EQUIPMENT**

- A. Unless otherwise noted on drawings, HIHTL system materials will be Government Furnished Equipment.
- B. Bolt thread lubricant (high stress compound, anti-seize).
- C. Calibrated torque wrenches.
- D. Shielding materials as indicated on Drawings.

**PART 3 EXECUTION****3.1 EXAMINATION**

Examine designated routing for the HIHTL systems and notify TOC Construction Representative in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been addressed and/or corrected.

**3.2 PREPARATION**

- A. Assigned personnel to perform work have reviewed and are familiar with the HIHTL system, associated handling recommendations, and the connection methods for HIHTL assemblies.
- B. Prepare routing path and tie-in connections for installation of HIHTL assemblies. Coordinate with TOC Construction Representative for delivery of materials to the site.
- C. Notify TOC Construction Representative prior to installation of HIHTL for witnessing of activities by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.

**3.3 INSTALLATION**

- A. Prior to final joining of secondary hose connections, verify heat tracing is spliced and/or heat trace lead is clear of the joint and available for termination.
- B. Install HIHTL assemblies, supports, anchors and insulation as shown on the Drawings.
- C. Use care in unwrapping plastic and cardboard to avoid damage to hose, fittings, and heat trace.
- D. If a spindle is used to unroll hose, provisions must be in place to slow the reel as it unwinds to control the roll off of the hose.
- E. Never pull on HIHTL assemblies by the ends alone. Use a choker strap at some point along the hose length.

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- F. If temperatures have been below 32°F, the hose may be stiff and require warming before installation. Notify Company for instructions if warming is required.
- G. Leave assembly connections covered and protected until in place to actually connect assembly to equipment.
- H. Connect primary hose joints using a qualified quality controlled procedure per manufacturer's directions.
  - 1. Primary hose connections are male to female ChemJoint.
  - 2. See H-14-111331.
  - 3. The male and female threads have been treated with Everlube®<sup>33</sup>, a dry film lubricant. No additional lubricant or anti-seize material should be applied.
  - 4. The o-ring should have one white and two yellow dots visible indicating it is the specified material, ethylene propylene diene monomer (EPDM).
  - 5. Verify cleanliness, correct o-ring, and then join the hose assembly.
  - 6. Torque for the ChemJoint fitting is 200 ft-lbs or hand tight plus 1 to 1 1/2 notches of the nut. Contact Company for clarification on turn of the nut torque method from vendor information.
  - 7. Apply set screws and tighten with 1/8-in. Allen wrench to the point that the ChemJoint nut cannot turn.
- I. Test primary hose in accordance with Paragraph 3.5.
- J. Prior to final joining of secondary hose connections, verify heat trace is spliced and/or heat trace lead is clear of the joint and available for termination.
- K. Connect secondary hose joints using a qualified quality controlled procedure per manufacturer's directions.
  - 1. Secondary hose connections will be one of two types. One joint will be flange connector consisting of 6 in., 150 lb raised face flange that would bolt directly to a mating flange on equipment/valve box. The other joint will be a threaded union end connector consisting of a 6 in., 150 lb raised face flange that would connect to another hose assembly and/or equipment.
  - 2. Make both of these connections in accordance with details shown on the Drawings.
  - 3. Verify cleanliness of the visible area of hose and connection.

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<sup>33</sup> Everlube is a registered trademark of Metal Improvement Company, LLC, Paramus, New Jersey.

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4. Apply approved lubricant to flange bolt threads and tighten in sequence that uniformly loads the gasket. For connections using raised face flanges with EPDM gaskets, final torque bolts to 40 ft-lbs.

### 3.4 CONSTRUCTION QUALITY CONTROL

- A. Notify TOC Construction Representative prior to installation of tank system components for witnessing of activities by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.
- B. TOC Construction Representative prior to installation of HIHTL for witnessing of activities by an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303.
- C. Perform visual inspection of encasement hose for damage. Minor cosmetic damage to the insulation is acceptable. If visible damage is present, inspect for potential leak paths and notify Company. If suspect, remove hose from service and retest.
- D. Inspect the HIHTL assembly connections are clean and free of debris.
- E. Inspect the hose assemblies and connections described in Paragraph 3.3. Verify final connections have been properly assembled and torqued.
- F. Refer to Section 40 41 00, "HIHTL Hose and Equipment Heat Tracing," for heat trace testing requirements.
- G. Perform visual inspection of equipment insulation for excessive damage. Minor cosmetic damage to the insulation is acceptable. Record results.
- H. Verify a minimum of 2 in. of soil cover is in place above the hose assembly prior to installation of cover plates.

### 3.5 FIELD INSPECTIONS AND TESTS

- A. Pressure and Leak Testing
  1. Install one temporary relief valve during testing to protect HIHTL against over-pressurization. Tag each relief valve used to show serial number, inspector, date, and pressure setting.
  2. Joints and connections to be tested shall be visible and accessible during tests.
  3. Isolate instruments and other items which could be damaged by test pressures.
  4. Perform leak test for primary hose connection per TFC-ENG-STD-21.

**Note:** Leak testing per this Section will be performed on components that have already been hydrostatically tested as subassemblies per ASME B31.3.

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- a. Leak testing of the HIHTL primary hose assembly connections shall be performed by visual observation. The connection leak testing shall be performed with water at the interfacing water system pressure except when (a) there is no waste transfer system valve downstream of the connection; or (b) closing the valve with water flowing causes a flow transient (water hammer) that could damage safety-significant waste transfer system structures, systems, or components. For this leak test, the interfacing water system pressure is maintained at the connection for at least ten min. If there is no valve downstream of the connection or closing the valve causes an unacceptable water hammer, leak testing is allowed with water flowing through the connection. This leak test requires a minimum water flow of 200 gal through the connection after flow is established in the line. If leak testing with water is not practical (i.e., no available water source), leak testing may be performed at the beginning of the initial waste transfer through the connection. This leak test also requires a minimum waste flow of 200 gal through the connection after flow is established in the line.

Leakage observed at the HIHTL primary hose assembly connections during the leak test shall be eliminated. Subsequent leak testing of HIHTL primary hose assembly connections is not required unless the connection is unmade and remade.

5. Secondary Hose

- a. Perform pneumatic pressure test of the encasement hose at 10 +/- 2 psig. Maintain pressure for ten minutes. Apply soap bubble solution to ensure no leakage at connections and any other location specified by the TOC Construction Representative. Where isolation of a connection is not possible, perform a final visual examination of the joint configuration/makeup to verify it conforms to the Drawings. Record results. The pressure relief valve shall be set at  $\leq 50$  psig. The secondary hoses have a minimum design pressure of 60 psig (or greater) and therefore a pressure relief valve setting of 50 psig does not pose a safety concern.

6. Document testing of each HIHTL system on Pressure Test Certification. Use separate forms to describe and record each system. Under "Description" describe HIHTL system in enough detail for correlation to Drawings, as applicable. For systems tested segmentally, indicate continuity in "Description" to ensure that entire systems have been tested.

- B. Notify TOC Construction Representative at least 24 hours (1 working day) in advance to arrange for onsite witnessing of the testing described in this section by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.



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**SECTION 40 05 22– ATTACHMENT 1****IDENTIFICATION OF PIPING SYSTEMS****GENERAL**

Identification of piping systems shall be in accordance with the American Standard Scheme for Identification of Piping Systems, ANSI/ASME A13.1, as supplemented herein, and with TFC-ENG-STD-12, “Tank Farm Equipment Identification Numbering and Labeling Standard.”

**LOCATION**

- Except as provided below, identification shall be located adjacent to outlets, valves, flanges, unions, changes-in-direction, where pipes through walls, floors, or ceilings, and along an uninterrupted length of pipe or hose at maximum intervals of 50 ft. Each line or branch in shall have a least one identification.
- Where a number of outlets, valves, flanges, unions, or changes of direction make identification at each item impracticable, they may be spaced at approximate 6-ft intervals, preferably adjacent to valves.
- Legend shall be located on pipe so that it can be read easily from operator’s normal viewing position. Labels shall be placed on readily visible lower quadrant of overhead pipes, an on an upper quadrant of pipes below normal eye level.

**LEGEND**

- Positive identification of piping system content shall be by lettered legend giving name of content in full or abbreviated form. Legends may also be as specified on the Drawings or in other specifications.
- Abbreviation of words in legend may be used only where unavoidable due to space limitations.
- Legend shall include nominal operating pressure and/or temperature when specified.
- An arrow indicating direction of flow shall be placed near legend on pipes normally having a flow in 1 direction only. Color and size of arrow shall be consistent with color and size of legend letters.
- Legend shall be located on or adjacent to classification color band.

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**APPROVED LABELS**

- Legend and color classification may be accomplished by use of approved labels that conform to this Standard and are suitable for temperature of surface to which they are applied. Approved labels include the following:
  - Stock System #4 Pipe Markers  
[www.pipemarker.com](http://www.pipemarker.com)  
  
Brimar Industries  
P.O. Box 467 / 64 Outwater Lane  
Garfield NJ 07026  
Ph: 800-274-6271  
  
High Performance Pipe Markers  
[www.bradyid.com](http://www.bradyid.com)  
  
Brady WORLDWIDE  
6555 W. Good Hope Rd  
Milwaukee, WI 53223
- Single-word labels may be combined to form complete legends. Individual-letter labels shall not be combined.
- Labels shall be installed after painting is complete.

**CLASSIFICATION COLOR shall conform to ANSI/ASME A13.1**

END OF SECTION 40 05 22

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**SECTION 40 05 28****OTHER METALS PROCESS PIPE  
(DOUBLE CONTAINMENT PIPING)****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Installation and testing of underground transfer piping, jumpers, and fittings.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

Note: Codes listed below that include the year-of-issue are prescribed by RPP-SPEC-62049. The current issue of a code shall be used when the code is listed without the year-of-issue.

- A. American National Standards Institute (ANSI) / American Society of Mechanical Engineers (ASME)

ANSI/ASME A13.1            Scheme for the Identification of Piping Systems

- B. American Society of Mechanical Engineers (ASME)

ASME B16.9                Factory Made Wrought Buttwelding Fittings

ASME B16.11              Forged Fittings, Socket-Welding and Threaded

ASME B31.3, 2016        Process Piping

- C. American Society for Nondestructive Testing (ASNT)

ASNT SNT-TC-1A, 2016   Personnel Qualification and Certification in  
Nondestructive Testing (Recommended Practice)

- D. ASTM International (ASTM)

ASTM A105                 Standard Specification for Carbon Steel Forgings for  
Piping Applications

ASTM A106/A106M        Standard Specification for Seamless Carbon Steel Pipe for  
High-Temperature Service

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ASTM A234/A234M	Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A312/A312M	Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A403	Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM D5162	Standard Practice for Discontinuity (Holiday) Testing of nonconductive Protective Coating on Metallic Substrates
E.	American Welding Society (AWS)
AWS A5.01M/A5.01	Welding Consumables—Procurement of Filler Metals and Fluxes
AWS D1.1/D1.1M, 2015	Structural Welding Code – Steel
AWS QC1	Standard for AWS Certification of Welding Inspectors
F.	Hanford Documents
24590-WTP-MG-01-030, Rev. 0	ICD 30 – Interface Control Document for Direct Feed LAW
RPP-SPEC-62049	Tank Farm System Infrastructure Upgrades Project Specification
RPP-SPEC-62666	Procurement Specification for Fabrication of a Double Containment Piping System for Tank Farm Upgrades/Waste Feed Delivery
G.	Washington Administrative Code (WAC)
WAC 173-303-640	Dangerous Waste Regulations Washington State

**1.3 SUBMITTALS**

- A. See the Statement of Work for the submittal process.
- B. Approval Required
  - 1. Certified Material Test Report (CMTR): Submit reports, certified by responsible manufacturer of weld filler metal. Reports shall present results of chemical analysis and physical tests required for Schedule I level testing in accordance with AWS A5.01. Submit separate reports for the following.
    - a. Primary (Stainless Steel).

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- b. Encasement (Carbon Steel).
  2. Commercial grade item documentation: Within five days of receipt inspection and testing, submit reports of commercial grade item inspections and tests specified in Paragraph 2.3, if applicable in accordance with Paragraph 2.3.A.
  3. Welding Personnel Qualifications: 15 days before start of fabrication, submit welder qualifications in accordance with Paragraph 1.4.B.1.
  4. Welding Procedure Specifications (WPSs), Standard Welding Procedure Specifications (SWPSs) with demonstration test results, and Weld Procedure Qualifications (PQRs): 15 days before start of fabrication, submit WPSs, SWPSs, demonstration test results, and PQRs in accordance with Paragraph 1.4.B.
  5. Examination Personnel Qualifications: 15 days before start of fabrication, submit examination personnel certifications in accordance with Paragraph 1.4.B.
  6. Examination Procedures: 15 days before start of fabrication, submit examination procedures in accordance with Paragraph 1.4.B.3.
  7. Survey results as required in accordance with Paragraph 3.2.B.2.
  8. Leak Pressure Testing: 15 days before pressure testing, submit testing procedure in accordance with Paragraph 3.3.C.
- C. Approval Not Required
1. None.

**1.4 QUALITY ASSURANCE**

- A. Misrepresented Products: See the Statement of Work for required measures to prevent use of misrepresented products.
- B. Qualifications
  1. Qualification of Welding Personnel: Personnel for welding pressure-retaining components along with attachments thereto, and pipe supports, shall be qualified in accordance with ASME B31.3, paragraph 328.2 before welding. Maintain copy of welder performance qualification test results and renewal of qualification documentation at jobsite.
  2. Qualification of Examination Personnel: Maintain copies of examination personnel certifications and written examination performance procedures at jobsite.
    - a. Personnel performing visual examinations shall be Certified Welding Inspectors (CWIs) who have received certification in accordance with AWS QC1. Certified Associate Welding Inspectors (CAWIs) certified

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in accordance with above standard may perform examinations when under immediate direction of CWIs.

- b. Personnel performing other nondestructive examinations (NDEs) shall be certified in accordance with approved procedure, which shall meet the requirements of ASNT SNT-TC-1A. Use Level II or III personnel to interpret results.
- 3. Examination Procedures: Examination procedures shall be in accordance with ASME B31.3 and this Section. Maintain copies of procedures at the jobsite.
- C. Leak Testing Procedures: Leak testing procedures shall be in accordance with ASME B31.3 and this Specification. Maintain copies of procedures at jobsite.
- D. Deliverable Documentation: The following documents and records, required by this Section, shall be delivered to Construction Document Control in accordance with the Contract Statement of Work.

<u>Document</u>	<u>Paragraph</u>
Welding Qualifications	1.4.B.1
Examination Personnel Qualification/Records	1.4.B.2
Weld Identification	3.2.D
Calibration Records	3.3.A.1
Examination Documentation	3.4.H
<b>Note: RT film shall be submitted in hard copy for approval.</b>	
Leak/Pressure Test Certification	3.3.C
Flushing/Mechanical Cleaning Verification	3.3.B

- 1. The safety classification of piping and piping components is shown in this specification as Safety Significant (SS) or General Service (GS). If no classification is shown, items are GS.

## 1.5 PERMITS

- A. All permits are: As required by TOC Work Control Process.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. See the Contract Statement of Work for general requirements.

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**1.7 FURNISHED EQUIPMENT**

- A. The following items are furnished for Contractor installation. Upon request, BUYER will furnish one copy of approved vendor submittal data. Submit equipment delivery requirements ten days before need.
1. Double Containment Piping System: Lines AP06A-WT-WTL-SN-637 and AP02D-WT-WTL-SN-700, see Procurement Specification RPP-SPEC-62666. The Vendor is the pipe spool fabricator who will provide pipe sections and elbows with the coating, insulation, and jacketing already installed. Field joints, as described in specification RPP-SPEC-62666, will then be used to make connections.

**PART 2 PRODUCTS****2.1 SUBSTITUTES**

- A. See the Statement of Work for substitution approvals.

**2.2 MATERIALS**

- A. Piping and Fittings: Piping and fittings will be supplied via Procurement Specification RPP-SPEC-62666, "Procurement Specification for Fabrication of Double Containment Piping System for Tank Farm Upgrades for Waste Feed Delivery," Section 3.2.
- B. Pipe Supports: As delineated in design drawings.
- C. Protective Coating System: See Procurement Specification, RPP-SPEC-62666, "Procurement Specification for Fabrication of Double Containment Piping System for Tank Farm Upgrades for Waste Feed Delivery," Section 3.2.
- D. Nonshrink Grout: See Section 03 30 53, "Miscellaneous Cast-in-Place Concrete."
- E. Pipe Insulation System: See Procurement Specification, RPP-SPEC-62666, "Procurement Specification for Fabrication of Double Containment Piping System for Tank Farm Upgrades for Waste Feed Delivery," Section 3.2.

**2.3 MATERIAL QUALITY ASSURANCE**

- A. Products in Paragraph 2.3.B shall be obtained from qualified suppliers, meeting NQA-1 program requirements, or be commercial grade items (CGI) meeting acceptance criteria specified in this Section. Commercial grade dedication will be performed by BUYER.
- B. CGIs Documentation: For SS items not purchased from qualified suppliers, acceptance testing shall be performed by qualified personnel. Testing agencies performing material test shall be qualified to do so in accordance with the Contractor's approved QA program. The following test and/or verifications shall be performed upon receipt of the products.
1. Weld filler metal (SS): For Primary and Encasement Pipe.

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Characteristics to be Verified	Action Party	Acceptable Value, Condition or Tolerance	Method of Verification	Sample Size
Identification	QC	Product description for weld filler material shall be in accordance with applicable AWS/ASME Specifications	Visual/receipt inspection	100%
Material Type	QC	Chemical analysis results shall meet the requirements of the applicable AWS/ASME Specifications	Special test – chemical analysis in accordance with applicable AWS/ASME (on receipt)	One coupon per heat of material
Strength	QC	Physical test results shall meet the requirements of the applicable AWS/ASME Specifications	Special test – physical test (on receipt)	One coupon per heat of material

**Note:** Independent chemical and physical test shall be performed before each heat or lot of material to prior fabrication to verify conformance to AWS specifications. Results shall be documented and submitted for approval before fabrication.

### PART 3 EXECUTION

#### 3.1 PREPARATION

- A. Maintain internal and external cleanliness of all piping prior to weld out.
- B. Surfaces to receive insulation shall be clean, free of moisture, oil, dirt, scale, rust, and other foreign material.
- C. Notify TOC Construction Representative prior to installation of tank system components for witnessing of activities by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.

#### 3.2 INSTALLATION

- A. General
  1. Install pipe in accordance with ASME B31.3 (Normal Fluid Service), the Drawings, and this Section.
  2. Maintain material traceability through fabrication and installation for materials requiring CMTRs (Paragraph 1.3.B.1) and CGI acceptance (Paragraph 2.3).
  3. Cut pipe using methods that result in clean, straight cuts.
  4. Ream pipe to nominal inside diameter after cutting.
  5. Tools marked for stainless steel shall be used on stainless steel only. Tools previously used on carbon steel shall not be used on stainless steel. Areas on



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stainless steel pipe that show signs of coming in contact with carbon steel (rust marks or streaks) shall be cleaned of all free iron.

6. Keep piping systems clean. Once fabrication has started, plug or cap ends of piping when installation is not in progress. Cap or plug openings in fabricated pipe spool assemblies until installation in piping system. Leave ends of spare lines capped or blind flanged when installation has been completed.
7. The adhesives of self-adhesive labels, tape, and marking materials used for temporary marking of stainless steel shall contain less than 200 ppm total halogens (free and chemically combined).
8. Install furnished double-containment piping, coatings, insulation, and jacketing in accordance with Pipe Vendor's instructions. Maintain piece mark numbers on WRPS/HiLine Engineering & Fabrication, Inc.-furnished spools and components for identification and orientation to facilitate proper location and orientation during installation.
9. Alignment: Distortion or cold springing of piping to bring it into alignment for joint assembly that introduces a strain in piping components is prohibited.

#### B. Underground Piping

1. Trenches: Excavate, bed, backfill, and compact in accordance with Section 31 23 33, "Trenching and Backfilling" and Drawings.
2. Place piping on construction support system at the elevations shown on Drawings.
3. Install piping spools according to fabrication drawings. Verify proper alignment of carrier pipe to encasement pipe prior to weld out. After final welding of the carrier pipe and encasement pipe, the carrier pipe shall be centered and in contact with or resting on the supports at bends.
4. Survey final pipe installation for elevation and location at all field joint locations. Elevation and location shall be in accordance with the Drawings. Piping (including all carrier and encasement pipes) shall slope as shown on the Drawings with no traps. Submit survey results for approval prior to insulation installation and backfilling.
5. Complete coating of encasement piping, insulation, jacket of piping at weld joints, and permanent end caps in accordance with drawings and insulation manufacturers' specifications.
6. Obtain approval from TOC Construction Representative prior to beginning backfill or covering piping.

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## C. Welding

1. Weld piping, attachments to pressure retaining components, and pipe supports in accordance with ASME B31.3, Normal Fluid Service.
2. Protect outdoor welding operation from rain and wind by using barriers to protect welder and weld joint.
3. Use of backing rings is not permitted.
4. Complete piping welds before tie-in welds to pits, or fixed items.
5. Gas tungsten arc welding (i.e., GTAW welding) shall be used on the encasement pipe for the root to hot pass. It is the manufacturer/fabricator's option whether to continue with GTAW or to fill/cap the encasement pipe joint with shielded metal arc welding.
6. Arc strikes on pressure boundary items shall be repaired and examined by liquid penetrant (dye penetrant) examination in accordance with Paragraph 3.4.C.1.
7. Seal welds may be used only to prevent leakage of threaded joints and shall not be considered as contributing any strength to the joints. (ASME B31.3, 311.2.7)

Seal welding shall be done by a qualified welder. Seal welds shall cover all exposed threads. (ASME B31.3, 328.5.3)

## D. Weld Identification

1. Prepare weld identification drawings, isometric or spool, or markup existing Drawings which show relative positions of pressure-containing welds and attachment welds to pressure-retaining components. Identify the piece mark number of the BUYER-furnished spools on weld identification drawings for field installation.

**Note: Weld maps shall be approved by Buyer prior to welding.**

2. Assign weld numbers to pressure containing welds and attachment welds to pressure-retaining components as made. Record weld numbers, and welder identification on weld identification drawings.
3. Do not reuse weld numbers. If a weld is completely replaced, assign a new number.
4. Show heat/lot numbers on weld identification drawings for materials requiring CMTRs.

## E. Exterior Protective Coating:

1. Before applying coating application over joints, perform NDE, flushing, and leak/pressure testing specified in this Section.

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2. Protect outer steel pipe and fittings with coating in accordance with RPP-SPEC-62666, Section 3.2.3, "Coating for Encasement Exterior."
  3. After installation, examine pipe, joints, and fittings with electrical holiday detector in accordance with manufacturer's instructions.
  4. Repair damage to coating in accordance with manufacturer's recommendations.
  5. Do not install underground insulation system in area of weld joints until coating has cured in accordance with manufacturer's recommendations.
- F. Piping Insulation System: Install insulation and jacketing at weld joints in accordance with drawings and manufacturer's instructions.

### 3.3 FIELD QUALITY CONTROL

A. Flushing/Testing Preparation

1. Furnish equipment and calibrated instruments required to perform flushing and testing. Submit calibration records in accordance with the Contract Statement of Work.
2. Obtain direction for disposal of flushing and testing water from Buyer. See the Statement of Work.

B. Cleaning and Flushing

**Note:** Additional detail on cleaning is found in the Pipe Specification, RPP-SPEC-62666, Section 3.4.

1. After examination is complete, clean primary piping internal surfaces by water flushing. Mechanical cleaning may be substituted for flushing if approved by the TOC Construction Representative.
2. Mechanical cleaning: Remove loose dirt, scale, and debris by brushing, wiping, high-pressure water jetting, or other mechanical method approved by the TOC Construction Representative until there is no visible dirt, scale, or debris.
  - a. When high-pressure water jetting or other mechanical cleaning method utilizing water is used, and leak/pressure testing will not be performed immediately after cleaning, remove all water.
3. Water flushing:
  - a. Flush piping with water for 1-minute minimum (once flow is obtained), and until effluent is clean and contains no visible particulate matter. Flushing pressure shall not exceed maximum design pressure specified in Pipe Codes. Flushing water supply shall have sufficient capacity to produce a flow velocity of 4 to 6 ft/s in largest pipe size, with pipe full. Provide flow measurement in flushing water supply line to be use as a basis for verification of flow velocities in piping system.

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- b. When leak/pressure testing will not be performed immediately after flushing, remove all water and either cap the lines or reconnect to the system.

## C. Leak/Pressure Testing

## 1. General:

- a. Perform leak/pressure testing of pipe in accordance with ASME B31.3, with a tolerance of +10%, -0, and this Section. Use calibrated gages with an accuracy of  $\pm 1$  psi.
- b. Document testing of each piping system on Pressure Test Certification. Use separate forms to describe and record each piping system. Under "Description" describe piping system in enough detail for correlation to weld identification drawings, shop fabrication drawings, and Project Drawings, as applicable. For systems tested in segments, indicate continuity in "Description" to ensure that entire systems have been tested.
- c. Pipe joints and connections to be tested shall be visible and accessible during tests.
- d. Install one temporary relief valve during testing.
  - i. For hydrostatic testing: Relief valve shall have a discharge capacity of 125% of capacity of pressurizing device, and a set pressure of  $1 \frac{1}{3}$  times the maximum test pressure.
  - ii. For pneumatic testing: Relief valve shall have a set pressure of the lessor of test pressure plus 50 psi or 110% of test pressure.
  - iii. Tag each relief valve used to show serial number, inspector, date, and pressure setting. Relief valve shall be set using a calibrated gauge.
- e. Install necessary restraining devices, before applying test pressure, to prevent distortion or displacement of piping.
- f. Isolate instruments and other items which could be damaged by test pressures.
- g. Continuously maintain test pressure for ten minutes minimum. Examine all joints and connections in accordance with ASME B31.3. Piping system shall show no visual evidence of weeping or leaking. Joints and connections previously tested in accordance with the Code do not require re-examination.
- h. Complete testing of encasement piping before application of exterior coating.
- i. Perform the testing for each Pipe Code listed in Paragraph 3.5.

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2. Hydrostatic pressure testing:
  - a. Perform in accordance with ASME B31.3, paragraph 345.4, to the test pressures identified in the Pipe Code.
  - b. Purge air from piping systems during filling, before applying pressure.
  - c. Remove water from piping systems when finished.
3. Pneumatic leak testing:
  - a. Perform in accordance with ASME B31.3, paragraph 345.5.
  - b. Perform testing with dry, oil-free air or nitrogen.
- D. Notify TOC Construction Representative at least 24 hours (1 working day) in advance to arrange for onsite witnessing of the testing described in this section by an Independent Qualified Installation Inspector, or an Independent Qualified Registered Professional Engineer (IQRPE), as required by WAC 173-303-640.
- E. The encasement interior surfaces shall be dried prior to sealing system. Condensation shall not be visually present in system prior to sealing system. If forced air is used to dry encasement, the encasement is considered dry when the dew point of inlet air to encasement is  $\pm 1^{\circ}\text{F}$  to the dew point of air being exhausted from the encasement.

### 3.4 FIELD INSPECTIONS AND TESTS

#### A. Examination

1. Perform examinations for each pipe code as listed in the table in paragraph 3.5 A of this document, in accordance with ASME B31.3 for "Normal Fluid Service." See Section 4.2 of RPP-SPEC-62666 for qualifications requirements.
2. In cases where volumetric examination is not possible (e.g., orientation of the weld), the subject welds shall have documented in-process examination in accordance with ASME B31.3, paragraph 344.7 with liquid penetrant or magnetic particle examination specified for the root pass [see paragraph 344.7.1(e)] and will be identified as such on the fabrication drawings. Individual items described in paragraph 344.7.1 shall be documented (e.g., checklist format) for each in-process examination. The in-process examinations shall not be used to meet the required representation of the welder's or the welding operator's work unless necessary to meet the required representation of work.

#### B. Visual Examination (VT)

1. Perform 100% visual examination of final weld joints in accordance with ASME B31.3, paragraph 344.2. Acceptance criteria shall be in accordance with Table 341.3.2, "Normal Fluid Service Criteria."

#### C. Liquid Penetrant Examination (PT)

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1. Perform in accordance with ASME B31.3, paragraph 344.4. Acceptance criteria in accordance with paragraph 344.4.2.
- D. Magnetic Particle Examination (MT)
1. Perform in accordance with ASME B31.3, paragraph 344.3. Acceptance criteria in accordance with ASME B31.3, paragraph 344.3.2.
- E. Radiographic Examination (RT)
1. Perform in accordance with ASME B31.3, Paragraph 344.5. Acceptance criteria for welds shall be in accordance with ASME B31.3, Table 341.3.2.
  2. Identify radiographic film with weld identification number, weld spool identification and project or work order number assigned to work covered by this Specification.
  3. Prepare radiographic examination reports as follows:
    - a. List each radiographic exposure location (0-1, 1-2...) individually on radiographic examination report.
    - b. Indicate location acceptance or rejection and note discontinuities whether rejected or not.
    - c. When report includes radiographs of welds that have been repaired, indicate which welds are repair welds and how many times each weld has been repaired.
  4. Radiographic examination results shall be independently reviewed by a qualified examiner. Differences must be resolved prior to submittal of final report.
  5. Additional welding performed on a weld in an area that has already been examined by radiography is a repair. Identify subsequent radiographs by "R-1, R-2," etc. Designate cutouts used for repair as "C-1," "C-2," etc.
- F. Ultrasonic examination (UT)
1. Perform in accordance with ASME B31.3, paragraph 344.6. Acceptance criteria in accordance with paragraph 344.6.2.
- G. Coating Examination
1. The coating shall be 100% inspected for holidays, pinholes, and discontinuities (such as runs, drips, and inclusions) with a holiday detector in accordance with ASTM D5162. All deficiencies and defects shall be corrected in accordance with the coating manufacturer's instructions. Any repaired areas shall be retested and allowed to cure before packaging and shipping.
- H. Examination Documentation

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1. Visual examination shall be performed and appropriate documentation prepared by a Certified Welding Inspector (CWI). A Certified Associate Welding Inspector (CAWI) may perform examination when under immediate direction of a CWI. Fabrication and welding-related examination documentation shall be signed or stamped by individuals performing examinations. Where a CAWI performs examinations, documentation shall be signed or stamped by both the CAWI and the CWI under whose direction examinations were performed. Required examinations and independent reviews shall be completed and documented before starting leak testing.
2. Documentation of coating inspections must be traceable to individual spools. Locations of areas requiring repairs and retesting must be documented.

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**3.5 SCHEDULES****A. Schedule of Pipe Weld NDE/Testing**

NDE/NDT Examination Methods	Pipe Codes	
	Primary	Secondary Encasement
Visual (VT)	H	H
Fit up		
Root pass		
Cover pass	100% (A, F, H)	100% (A, B, H, I)
Liquid Penetrant (PT)		
Root pass		
Cover pass		
Magnetic Particle (MT)		
Root pass		
Cover pass		
Radiographic (RT)		
Completed weld	100% (A) Note 1	20% (A, G, I) Note 1
Ultrasonic (UT)		
Completed weld	100% (A) Note 1	20% (A, I) Note 1
Leak/Pressure		
Completed weld	C or D	C or D
<p>Note:</p> <p>1. UT may be used in lieu of RT as approved by customer.</p>		
<p>Legend:</p> <p>A. Circumferential butt welds.</p> <p>B. Full penetration welds on branch connections.</p> <p>C. Pneumatic test.</p> <p>D. Hydrostatic test.</p> <p>E. Not used.</p> <p>F. Structural attachment welds to the pressure boundary for guides, supports, and anchors.</p> <p>G. In-Process examination may be substituted for all or part of the radiographic examination on a weld-for-weld basis upon Buyer approval of written request that provides the rationale (prior to welding). If in-process examination is used, the root pass shall be examined by the liquid penetrant or magnetic particle method and shall be documented in accordance with ASME B31.3, paragraph 344.7.</p> <p>H. Extent of visual examination shall be in accordance with ASME B31.3, Paragraph 341.4.1a. Each weld shall be represented in fulfilling the minimum requirements of ASME B31.3, Paragraph 341.4.1a.</p> <p>I. Longitudinal butt welds.</p>		



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## B. Primary Pipe Data Sheet

<b>Primary Pipe</b>			
<b>Line Number</b>	<b>Design Pressure lb/in<sup>2</sup> gage</b>	<b>Test Pressure lb/in<sup>2</sup> gage</b>	<b>Design Temperature °F<sup>2</sup></b>
AP06A-WT-WTL-SN-637	620	930 <sup>1</sup>	200°F
AP02D-WT-WTL-SN-700	620	930 <sup>1</sup>	200°F
Sizes	3 in.		
Pipe	ASTM A312, Grade TP 316/316L, SMLS		
Wall Thickness	Schedule 40S		
Fittings	Stainless Steel, ASTM A403, Grade WP 316/316L, SMLS, Butt-welding in accordance with ASME B16.9, Wall thickness to match pipe		
Bends	Bends shall be performed per ASME B31.3-2016, Section 332.2 (See RPP-SPEC-62666, Section 3.3.6 for minimum wall thickness.)		
1. Testing will be performed hydrostatically. (See RPP-SPEC-62666, Section 3.6.1.1 & ASME B31.3-345.4)			
2. Refer to 24590-WTP-MG-01-030 for design temperature and pressure.			

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## C. Encasement Pipe Data Sheet

<b>Encasement Pipe</b>			
<b>Line Number</b>	<b>Design Pressure lb/in<sup>2</sup> gage</b>	<b>Test Pressure lb/in<sup>2</sup> gage</b>	<b>Design Temperature °F<sup>3</sup></b>
Encasement for:			
AP06A-WT-WTL-SN-637	50	55 <sup>1</sup> -- 75 <sup>2</sup>	150°F
AP02D-WT-WTL-SN-700	50	55 <sup>1</sup> -- 75 <sup>2</sup>	150°F
1. When testing is performed pneumatically.			
2. When testing is performed hydrostatically.			
3. Refer to 24590-WTP-MG-01-030 for design temperature and pressure.			

<b>Encasement Pipe</b>	
	<b>Transfer Piping</b>
Sizes	6-in., Schedule 40
Pipe	ASTM A106, Grade B, SMLS, with an external epoxy coating in accordance with Pipe Specification, RPP-SPEC-62666, Section 3.2.3.
Wall Thickness	Standard Weight
Fittings	ASTM A234, Grade WPB, wrought steel, butt-welding in accordance with ASME B16.9. Wall thickness to match pipe.
Bends	Bends shall be performed per ASME B31.3-2016, Section 332.2. (See RPP-SPEC-62666, Section 3.3.6 for minimum wall thickness)

<b>Encasement Pipe</b>	
	<b>Test Risers</b>
Sizes	Less than 1 in.
Pipe	ASTM A106, Grade B with an external epoxy coating in accordance with Pipe Specification, RPP-SPEC-62666, Section 3.2.3.
Wall Thickness	Schedule 80
Fittings	ASTM A 105, 3000 lb ASME B16.11

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**SECTION 40 05 28– ATTACHMENT 1****IDENTIFICATION OF PIPING SYSTEMS****GENERAL**

Identification of piping systems shall be in accordance with the American Standard Scheme for Identification of Piping Systems, ANSI/ASME A13.1, as supplemented herein, and with TFC-ENG-STD-12, “Tank Farm Equipment Identification Numbering and Labeling Standard.”

**LOCATION**

- Except as provided below, identification shall be located adjacent to outlets, valves, flanges, unions, changes-in-direction, where pipes emerge from the ground, and along an uninterrupted length of exposed pipe at maximum intervals of 50 ft. Each line or branch in shall have a least one identification.
- Where a number of outlets, valves, flanges, unions, or changes of direction make identification at each item impracticable, they may be spaced at approximate 6-ft intervals, preferably adjacent to valves.
- Legend shall be located on pipe so that it can be read easily from operator’s normal viewing position. Labels shall be placed on readily visible lower quadrant of overhead pipes, an on an upper quadrant of pipes below normal eye level.

**LEGEND**

- Positive identification of piping system content shall be by lettered legend giving name of content in full or abbreviated form. Legends may also be as specified on the Drawings or in other specifications.
- Abbreviation of words in legend may be used only where unavoidable due to space limitations.
- Legend shall include nominal operating pressure and/or temperature when specified.
- An arrow indicating direction of flow shall be placed near legend on pipes normally having a flow in 1 direction only. Color and size of arrow shall be consistent with color and size of legend letters.
- Legend shall be located on or adjacent to classification color band.

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**APPROVED LABELS**

- Legend and color classification may be accomplished by use of approved labels that conform to this Standard and are suitable for temperature of surface to which they are applied. Approved labels include the following:
  - Stock System #4 Pipe Markers  
[www.pipemarker.com](http://www.pipemarker.com)  
  
Brimar Industries  
P.O. Box 467 / 64 Outwater Lane  
Garfield NJ 07026  
Ph: 800-274-6271  
  
High Performance Pipe Markers  
[www.bradyid.com](http://www.bradyid.com)  
  
Brady WORLDWIDE  
6555 W. Good Hope Rd  
Milwaukee, WI 53223
- Single-word labels may be combined to form complete legends. Individual-letter labels shall not be combined.
- Labels shall be installed after painting is complete.

**CLASSIFICATION COLOR shall conform to ANSI/ASME A13.1**

END OF SECTION 40 05 28

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**SECTION 40 41 00****HIHTL HOSE AND EQUIPMENT HEAT TRACING****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. Installation and testing of above ground, in trench, and in pit process Hose-in-Hose Transfer Line (HIHTL) heat tracing.

**1.2 RELATED DOCUMENTS /CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. American National Standards Institute (ANSI) / American Society of Mechanical Engineers (ASME)

ANSI/ASME A13.1                      Scheme for the Identification of Piping Systems

- B. Hanford Documents

RPP-14859, Rev. 14                      Specification for Hose-In-Hose Transfer Lines and Hose Jumpers

- C. National Electrical Contractors Association (NECA)

NECA 1                                      Standard Practices of Good Workmanship in Electrical Construction

NECA 202                                   Standard for Installing and Maintaining Industrial Heat Tracing Systems

- D. National Fire Protection Association (NFPA)

NFPA 70, 2017                              National Electrical Code (NEC)

**1.3 SUBMITTALS**

- A. See the statement of Work for the submittal process.

- B. Approval Required

1. Submit test procedures to be used with acceptance criteria prior to testing.

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2. Submit records of inspections, tests, and adjustments described in 3.4.
- C. Approval not required
1. Catalog Data: With delivery, submit five copies of catalog data for heater cable, thermostat, controls, fittings, indicator lights, and hose markers.
    - a. Includes rated capacities, operating characteristics, specialties, and accessories.
  2. Operation and Maintenance Data: With delivery, submit five copies of operation and maintenance instructions
  3. Warranty: Manufacturer agreement for replacement of electric heating cable due to failure in materials or workmanship.

**1.4 QUALITY ASSURANCE**

- A. Misrepresented Products: See the Statement of Work or required measures to prevent use of misrepresented products.
- B. Products shall be obtained from qualified suppliers, meeting NEC requirements, or be commercial grade items meeting acceptance criteria specified in this Section. Commercial grade dedication will be performed by Buyer.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- A. See the Contract Statement of Work for general requirements.
- B. Receive, store, protect, and handle products according to NECA 1, and NECA 202.

**PART 2 PRODUCTS****2.1 SUBSTITUTES**

- A. See the Statement of Work for substitution approvals.

**2.2 MATERIALS**

- A. General
  1. Furnish electric heat tracing system(s) as described in the procurement specification (RPP-14859), and on the Drawings with all components, controls, and accessories required for a complete and operating system.
- B. Self-Regulating, Parallel-Resistance Heating Cable System
  1. 5 W/ft Self-Regulating Heat Trace Cable, 120V. Raychem 5BTV1-CT.
  2. 8 W/ft Self-Regulating Heat Trace Cable, 120V. Raychem 8BTV1-CT.

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3. 5 W/ft Self-Regulating Heat Trace Cable, 240V. Raychem 5BTV2-CT.
4. 8 W/ft Self-Regulating Heat Trace Cable, 240V. Raychem 8BTV2-CT.
5. End Seal Kit. Raychem E-150.
6. Power Connection box with Red Indicating Light. Raychem JBM-100-L-A.
7. Splice Kit. Raychem S-150.
8. Tee, above grade. Raychem T-100.
9. Glass Tape. Raychem GS-54.
10. Markers: Furnish hose markers with the words "ELECTRIC TRACED" printed with UV-stable black ink on a durable yellow background. Meet the requirements of the ANSI/ASME A13.1, "Scheme for the Identification of Piping Systems." Provide materials and styles that are suitable for outdoor environments.

**PART 3 EXECUTION****3.1 PREPARATION**

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
  1. Surfaces to receive heat tracing shall be cleaned of all dirt, oil, scale, rust, and other foreign matter, and shall be dry and free of frost during installation of heat trace cable.
  2. Insure surfaces and hose in contact with electric heating cables are free of burrs and sharp protrusions
- B. Heat tracing cabling shall fit within the HIHTL insulation as described in the procurement specification.

**3.2 INSTALLATION**

- A. General
  1. Install electric heating cable according to the manufacturer's instructions, and in accordance with NECA 202, "Standard for Installing and Maintaining Industrial Heat Tracing Systems."
  2. Electric heating cables will be installed after hose has been tested and before insulation is installed.
  3. Waterproof all terminations and electrical connections.

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4. Heater cable will be attached directly to the hose using the heating cable manufacturer's adhesive backed glass fiber tape at intervals described in the procurement specification.
5. Connect wiring in accordance with Section 26 05 19, "Low Voltage Electrical Power Conductors and Cables."
6. Ground equipment in accordance with Section 26 05 26, "Grounding and Bonding for Electrical Systems."
7. Notify Buyer prior to backfilling or installing insulation on the hose. Obtain approval from Buyer prior to beginning backfill or covering hose.
8. Perform examination on connecting of heat tracing before application of insulation and jacketing over joints and other materials and components.
9. Insulation will be installed over hose with electric heating cables in accordance with RPP-14859, Rev. 14, "Specification for Hose-In-Hose Transfer Lines and Hose Jumpers."
10. Install signs at maximum 20 foot intervals along HIHTL insulation reading: "ELECTRIC TRACED." Install labels so they will be visible during normal operations.

**3.3 FIELD INSPECTIONS AND TESTS**

- A. Perform the following tests and inspections:
  1. Perform tests after heat trace cable installation before covering.
  2. Test cable for electrical continuity and insulation integrity before energizing.
  3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- B. Test for continuity, insulation resistance, and input power before backfilling or covering HIHTL mounted cables.
- C. Cables will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Remove and replace damaged heat trace cables and retest.
- F. Protect installed heat trace cables from damage during construction.

END OF SECTION 40 41 00



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**SECTION 40 70 00****INSTRUMENTATION****PART 1 GENERAL****1.1 SUMMARY OF WORK**

- A. This Section covers the work necessary to procure, install, adjust, document, test and start up instrumentation and hardware.

**1.2 RELATED DOCUMENTS / CODES AND STANDARDS**

Drawings and general provisions of the Contract Statement of Work, including Division 01 Specification Sections, apply to this Section.

The following documents and others referenced therein, form part of the Contract to the extent designated in this Section. Referenced documents are those current as of the date of this Section unless otherwise indicated.

- A. Factory Mutual Research (FM Global)  
Approval Guide, 2010 Edition
- B. Hanford Documents  
TFC-ENG-STD-12, E-2 Tank Farm Equipment Identification Numbering and Labeling Standard
- C. National Electrical Contractors Association, Inc. (NECA)  
NECA 1 Standard Practice of Good Workmanship in Electrical Construction (ANSI)
- D. National Fire Protection Association (NFPA)  
NFPA 70, 2017 National Electrical Code (NEC)
- E. Underwriters Laboratories (UL)  
UL 508A, 2013 Standard for Industrial Control Panels

**1.3 SUBMITTALS**

- A. Submit the following in accordance with the provisions of the Contract Statement of Work.
1. Catalog Data: Compression connectors; indicate installation tools and dies that will be used.

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2. Manufacturer's Installation Instructions: For each instrument, display and control, submit detailed installation, operations, and maintenance information.
  3. Certifications that items furnished are not counterfeit or misrepresented.
  4. Certificates of conformance for supplied items.
  5. NIST traceable Factory Certificate of Calibration for each instrument.
- B. In general, partial submittals will not be accepted. Where partial submittals are anticipated, coordinate these requirements with the Buyer's Technical Representative (BTR). Prior to submission of any submittals, provide a summary of the anticipated submittals to be provided. Examples of acceptable partial submittals are:
1. Early purchase of long lead items.
  2. Components and device data sheets and catalog cuts.
  3. Fabrication drawings.
- C. Project Record Documents: Submit project record documents including specified certifications, calibration reports, and all field test and inspection reports.

**1.4 QUALITY ASSURANCE**

The Seller shall comply with the following Quality Assurance requirements in addition to those of the Contract Statement of Work.

- A. Comply with the NEC for components and installation.
- B. Provide products that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for the application and environment in which installed.
  1. If a product is not listed by an NRTL (e.g., UL or FM) and if an NRTL is not available, submit vendor literature to Buyer for approval. Literature shall include product specification and description of intended application.
- C. All control panels/enclosures shall be UL 508A listed and labeled and fabricated per the design drawings.
- D. Certificates of Conformance (C of Cs) for all materials and equipment shall:
  1. Identify the purchased material or equipment.
  2. The quantity of purchased material or equipment.
  3. Identify the purchase order number.
  4. Identify the specific procurement requirements, such as codes, standards, and other specifications.

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5. Be signed or otherwise authenticated by a person who is responsible for the quality assurance function.
6. Each C of C shall be unique for each shipment.

**1.5 RECEIVING, STORING AND PROTECTING**

- A. Receive, store, protect, and handle products according to manufacturer's instructions.

**PART 2 PRODUCTS****2.1 GENERAL**

- A. Instrumentation and Controls, electrical components, terminals, wires, and enclosures shall be UL recognized or UL listed.
- B. Provide products that are listed and labeled by a NRTL for the application and environment in which installed.

**2.2 CLEANLINESS AND FOREIGN MATERIAL EXCLUSION**

- A. The Seller is responsible for ensuring items provided are free from foreign material during manufacturing, shipment, storage, and installation.
- B. The Seller shall demonstrate established Cleanliness and Foreign Material Exclusion practices to ensure that new, repaired, or refurbished parts and equipment delivered under this Order are free from oil or grease (not being used as a preservative or protective coating), machine tailings, dirt, mill scale, weld splatter, residue, broken or loose parts, contaminants, or other foreign material that may adversely affect the operation of the item(s) provided or may be introduced into connecting equipment and systems. Other examples of foreign material include loose fasteners, debris resulting from machining or other manufacturing processes, and tags or labels used in the manufacturing process.
- C. Seller is responsible for ensuring via inspection or other means that no foreign material or contaminants are present, including internal surfaces and cavities of the equipment.
- D. Additional measures shall be taken by the Seller to prevent foreign material from entering the equipment, including protective devices such as caps, plugs, or covers. Protective devices shall ensure material compatibility with the protected item (e.g., protective devices containing halogens or heavy metals should not be used on stainless steel items).
- E. Protective devices such as caps and plugs shall be clearly visible. Protective devices made of clear materials are prohibited. Protective devices that have been painted over during production processes shall be replaced or otherwise made clearly visible. Seller shall provide any protective devices needed for routine maintenance such as dust covers, end caps, plugs, or blanking flanges.
- F. Precautions shall also be taken to ensure foreign material is not introduced during packaging and shipping. If the equipment is shipped with other parts (such as seals,

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gaskets, lubricants, mounting hardware), precautions should be taken to ensure smaller items cannot be introduced into openings or cavities of larger parts and equipment. Where appropriate, every item included with shipment should be identified in the packing list or by other means. If desiccants or other preservatives are used to protect the item(s), the affected part of equipment shall be clearly labeled or tagged with information including the type of preservative, its location, and any special instructions pertaining to its removal prior to installation or other applicable information such as quantity of desiccant packages.

**2.3 PRODUCT OPTIONS AND SUBSTITUTES**

- A. Refer to the Contract Statement of Work.

**2.4 ENCLOSURES**

- A. Fabricate/modify enclosures per the Drawings.
- B. Connections to enclosures (e.g., conduit) shall maintain the enclosure NEMA rating.

**2.5 RACEWAYS**

- A. Conduit and Boxes per the Drawings and Section 26 05 33, "Raceways and Boxes for Electrical Systems."

**2.6 INSTRUMENTATION**

- A. Instrumentation shall be per the Drawings.

**2.7 INSTRUMENTATION WIRE**

- A. Provide NRTL-listed instrumentation wiring as shown on the Drawings.

**2.8 IDENTIFICATION PRODUCTS/LABELING**

- A. Comply with requirements of TFC-ENG-STD-12.
- B. The nominal label size is NH (1.5 x 3 inches). Labels may be larger or smaller when warranted by installation requirements.
  - 1. Tags shall show the following:
    - a. Equipment Identification Number
  - 2. Tag attachment wire: Tags shall be attached using a 0.063 inch 7 x 7 strand cable or other approved method.
- C. For on-site fabricated labels, unless otherwise specified, laser-engraved stainless steel shall be used. See TFC-ENG-STD-12 for additional details.

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**PART 3 EXECUTION****3.1 GENERAL**

- A. Ensure installation Lockout/Tagout in place where required prior to installation.
- B. Procure and install new instruments, displays, indicators enclosures, and associated components, conduit, cables, and accessories in accordance with the Drawings and manufacturer's instructions.
- C. Install Government Furnished Equipment in accordance with the Drawings.
- D. Remove/modify/relocate existing instruments, enclosures, and associated components, conduit, cables, and accessories in accordance with the Drawings.
- E. Attach identification tags or nameplates to instruments with wire or as shown on the Drawings. Cable and conductor labels shall be installed per design drawings.
- F. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- G. Install and terminate cables to the instruments, terminal boxes, enclosures, and panels as shown on the Drawings.
- H. Receive, store, protect, and handle products according to NECA 1.
- I. At the end of each workday, remove materials, scraps, and debris from interior and exterior of equipment, the worksite, and the facility.

**3.2 INSTALLATION OF INSTRUMENTS & CONTROLS**

- A. Install instruments per the Drawings and the manufacturers' directions.
- B. Instruments shall be grounded in accordance with the NEC and as shown on the Drawings.
- C. Tubing shall be continuously supported by an aluminum tubing raceway system.
- D. Before formal testing, performs inspections and informal testing to ensure that items being tested will respond correctly, e.g., valve control switch opens and closes a valve as expected.

**3.3 INSTALLATION OF CONDUCTORS AND CABLES**

- A. Install in accordance with the NEC, the Drawings, this Section, and Division 26.
- B. Comply with NECA 1.

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- C. General Requirements for Instrumentation Wiring and Cabling:
1. Terminate all conductors; no cable shall contain un-terminated elements unless shown on the Drawings. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
  2. Cables/wires may not be spliced.
  3. Route and train conductors to terminal points without exceeding manufacturer's limitations on bending radii.
  4. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
  5. Do not nick conductors when removing insulation.
  6. Do not cut conductor strands to fit into connectors, splices, adapters, or terminals.
  7. Make connections using clean connection surfaces.
  8. Cold-Weather Installation: Install only if temperature is within manufacturer's operating temperature range.
  9. Pulling Cable: Hand pull all instrumentation cables.
- D. Separation from electromagnetic interference sources: Do not run instrumentation cables/wiring with power or control wiring except as shown on the Drawings.

**3.4 INSTALLATION OF TUBING**

- A. Tubing Support: Continuously supported by aluminum tubing raceway system.
- B. Install tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
- C. Tubing and Conduit Bends:
1. Tool-formed without flattening, and of same radius.
  2. Bend Radius: Equal to or larger than conduit and tubing manufacturer's recommended minimum bend radius.
  3. Slope instrument connection tubing in accordance with installation details.
  4. Do not run liquid-filled instrument tubing immediately over or within a 3-ft plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
  5. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.

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6. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
7. Blow debris from inside of tubing.
8. Make up and install fittings in accordance with manufacturer's recommendations. Verify make up of tube fittings with manufacturer's inspection gauge.
9. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.
10. Run tubing in a workmanship like manner to allow but not be limited to clear access to doors, controls and control panels; and to allow for easy removal of equipment.
11. Provide separate support for components in tubing runs.
12. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.
13. Keep tubing and conduit runs at least 12 in. from hot pipes.
14. Locate and install tubing raceways in accordance with manufacturer's recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.
15. Securely attach tubing raceways to building structural members.

**3.5 ELECTRICAL**

- A. For low-voltage wiring and cabling, comply with requirements in Section 26 05 26, "Grounding and Bonding for Electrical Systems."
- B. Wiring connected to instrumentation, controls, enclosures and assemblies, including power wiring shall be in accordance with requirements in Section 26 05 19, "Low Voltage Electrical Power Conductors and Cables."
- C. Electrical Raceways: As specified in Section 26 05 33, "Raceway and Boxes for Electrical Systems."

**3.6 IDENTIFICATION**

- A. Identify system components, wiring, and cabling according to Section 26 05 19, "Low Voltage Electrical Power Conductors and Cables," and per the installation drawings. Individual wires in paired cables do not need individual labels.

**3.7 FIELD QUALITY CONTROL**

- A. Testing

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1. Perform testing per this Section.
  2. Furnish equipment and calibrated instruments required to perform testing.
  3. Participate in Construction Acceptance Test and Acceptance Test Procedure performance.
    - a. BTR may actively participate in many of the tests.
    - b. BTR reserves right to test or retest specified functions.
    - c. BTR's decision will be final regarding acceptability and completeness of testing.
- B. Perform tests and inspections.
- C. Tests and Inspections:
1. Visually inspect all installed items per Section 26 05 02, "Basic Electrical Requirements."
  2. Observe conductors and cables during the installation process.
    - a. Reject and replace entire reels, rolls, or boxes containing conductors or cables with material or manufacturing defects.
    - b. Reject and replace cable or conductor segments that have been kinked, dented, or otherwise damaged during handling or installation.
  3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
- D. After installation of wires and cables and before electrical circuit is energized, show product capability and compliance with requirements and verify by documented inspections and tests.
- E. Perform the following inspections:
1. Inspect and verify the enclosures are UL 508A labeled.
  2. Inspect conductors and cables for:
    - a. Freedom from material defect or physical damage.
    - b. Correct conductor size, material, and insulation type.
    - c. Correct color coding and identification.
  3. Inspect connections for:
    - a. Correct connector size and type according to the Specifications.



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- b. The use of the correct compression dies and the correct number of crimps on compression connectors in accordance with the connector manufacturer's instructions.
4. Inspect Shielded Instrumentation Cables for:
- a. Proper shield grounding.
  - b. Proper terminations.
  - c. Proper circuit identification.
5. Inspect Control Cables for:
- a. Proper termination.
  - b. Proper circuit identification.
- F. Perform the following tests:
1. Before connecting instrumentation wiring conductors, use a megohm meter in a 1-minute test to verify the insulation integrity of each conductor with respect to ground and other conductors in the same raceway.
    - a. Use 500-volts DC to test instrumentation wiring and conductors.
    - b. For shielded cables, leave shields connected to ground, measure and record resistances between each conductor and its related shield.
    - c. Insulation test values shall be in accordance with manufacturer's published test data. In absence of such data, insulation resistances over 10 megohms are acceptable.
  2. Prior to connecting conductors to equipment, test continuity to ensure proper circuit is identified to facilitate correct connection of each power circuit conductor and each control circuit conductor.
    - a. Verify continuity of every wire from end to end; continuity check of vendor-supplied cables is not required if received as pre-wired assembly. Resistance shall be 10 ohms maximum. Document test results.
    - b. Verify wires are connected after testing, in accordance with Drawings.
  3. Test the equipment and wiring for continuity and unintentional grounds, and verify proper phase sequence and voltage at equipment served before attempt is made to operate equipment.
- G. Document data for each measurement. Document tests data indicating wire/cable identity, time/date of test, witness name and test results, as a minimum. Print data for submittals in a summary report that is organized for easy retrieval of data.

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- H. Remove and replace defective, incorrect, or improperly-installed conductors and connectors. Re-inspect and re-test replacement conductors and connectors.
- I. Prepare test and inspection reports.
- J. Submit test and inspection records to the Buyer's Technical Representative.

END OF SECTION 40 70 00

END OF SPECIFICATION