CLAYTON COUNTY WATER AUTHORITY
MORROW, GA

TECHNICAL SPECIFICATIONS

FOR

BID NUMBER: 2023-WP-01

W.J. HOOPER WPP

CHEMICAL STORAGE SYSTEMS

MARCH 2023

CONFORMED DOCUMENTS

VOLUME 2 OF 3
DIVISIONS 02 – 16
TECHNICAL SPECIFICATIONS

SEALS

Specification Sections

Division 03	Division 05	Division 06
03313	05050 05095 05500	06600

Division 13

13122

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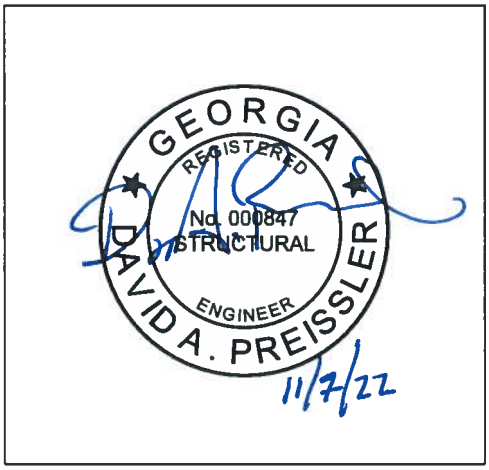

Georgia Certificate of Authorization
R2T, Inc.
License No.: PEF004653
Expiration Date: 6/30/2024

SEALS

Specification Sections

Division 09	Division 11	Division 13
09910	11308	13057

Division 15

15050
15094
15100
15200
15250

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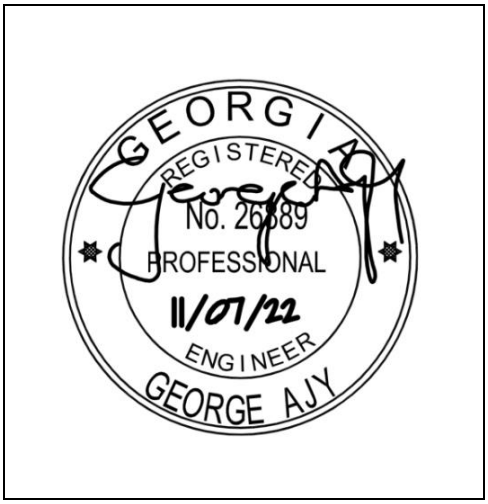

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SEALS

Specification Sections

Division 15

15050
15250
15400
15440

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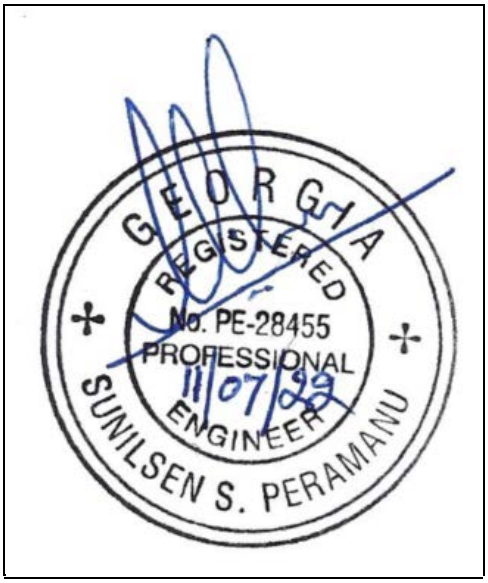

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Expiration Date: 6/30/2024

SEALS

Specification Sections

Division 16

16000
16060
16010
16111
16120
16141
16195

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Expiration Date: 6/30/2024

SECTION 02050

DEMOLITION

PART 1 - GENERAL

1.01 SCOPE

A. The work covered under this Section includes furnishing all labor, equipment and material required to demolish existing canopy system, transfer pumps, chemical storage tanks, and all associated accessories and appurtenances as shown on the Drawings, directed by the Engineer or required for the completion of the Work, including all necessary saw cutting, excavation and backfilling.

B. The work specified herein and shown on the Drawings is intended to show the extent of the scope of this work but must not be construed as covering it entirely. The Contractor shall visit the site and judge the amount of work required and the problems anticipated in the performance of the work.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions and Specification Section 01300, Submittal Procedures, of the Contract Documents. In addition, the following specific information shall be provided:

1. The Contractor shall submit for approval to the Engineer, prior to beginning work, a schedule of demolition and detail the methods to be used.

2. The Contractor shall develop and submit a demolition plan which includes a demolition schedule that covers:

    a. Stationing from and to with start and finish dates.

    b. Proposed method of demolition.

    c. Proposed method of disassembly, cataloguing, and reassembly of existing members to be retained.

    d. Approved haul routes and permit(s) to and from the site.

    e. Tank demolition (including safety and structural details)

PART 2 - PRODUCTS

2.01 MATERIALS

A. The Contractor shall provide all materials and equipment in suitable and adequate quantity as required to accomplish the work shown, specified herein, and as required to complete the project.

PART 3 - EXECUTION

3.01 GENERAL

A. Shutdown of Existing Operations and Utilities

1. The existing facilities are required to remain in service during construction with exceptions and additional requirements as noted in Specification 01011

B. Protection

1. Take care to prevent the spread of dust and flying particles. Sprinkle rubbish and debris with water to keep dust to a minimum. Install, operate, and maintain erosion control measures at all times.

2. Protect Owner and Contractor staff and surroundings from chemical solutions and residual. Neutralize chemical solutions as required to ensure staff are not exposed to chemical hazards throughout performance of demolition.

3. All work shall be performed in conformance with the laws and regulations pertaining to safety established by Federal, State, and local governments and other authorities having jurisdiction.Burning of demolition debris is prohibited.

PERSONNEL: Perform work by personnel experienced in this type work and in such a manner as to eliminate hazards to persons and property without interference with new work and with use of adjacent areas, public rights-of-way, utilities and structures.

3.02 CONCRETE DEMOLITION

A. According to drawings

3.03 MASONRY DEMOLITION (NOT USED)

3.04 REMOVAL OF EXISTING EQUIPMENT AND PIPING

A. Removal of existing equipment, piping and appurtenances as shown on the Contract Drawings. As noted in Drawings, existing piping is to be retained where feasible in completing the scope of the Work.

B. Chemical storage tanks and transfer pumps shall be demolished as noted in and in accordance with these Specifications and in Drawings. Contractor shall be responsible for safe storage, handling, and disposal of chemical solutions and residual as needed to perform the demolition included in the Work.

C. Owner shall be responsible for the drawdown of chemical solution contained within the tanks to be demolished to within 1 foot of the tank bottom. Contractor shall be responsible for storage, handling, disposal,

and/or neutralization of remaining chemical solution as needed to complete the Work in accordance with all Local, State, and Federal regulations. See Specification 01011 – Unique Requirements for project specific requirements relating to demolition of chemical storage tanks.

3.05 PROTECTION OF WORK AND EXISTING FACILITY

A. Perform the work in a manner that will not damage parts of the site, or systems not intended to be removed. If in the opinion of the Engineer, the method of demolition or cutting may endanger or damage parts of the structure(s) or affect the operation of the facilities, promptly change the method when so notified by the Engineer. Perform all cutting required regardless whether such cutting is specifically indicated. Examine the existing structures, evaluate conditions to be encountered in accomplishing the work, and accommodate such requirements accordingly in the Bid Proposal.

B. The Contractor shall exercise full care and shall use such methods and equipment during removal as will maintain the usefulness of vehicular access to telecommunications and antennas at the site at all times.

C. Any damage done to structures or equipment during removal and any patching, plugging of holes or repairs necessitated because of removal of equipment and piping shall be repaired to the satisfaction of the Engineer and the cost thereof shall be included in the Contract Price.

3.06 DISASSEMBLY AND REASSEMBLY OF MATERIALS

A. Prior to disassembly of materials, identify any damaged materials requiring replacement, and provide calculations for all materials. Include cost breakdown for Engineer’s review.

B. Catalogue and store materials intended for disassembly and reassembly as indicated on the Drawings.

C. Replace all damaged and non-catalogued materials and provide calculations for all materials intended for reassembly as indicated on the Drawings.

D. Items identified to be removed during construction that are damaged prior to reassembly by Contractor shall be replaced at no cost to Owner.

E. See Drawings for site-specific disassembly and reassembly requirements.

F. Prior to reassembly, Engineer and Contractor shall inspect materials to determine condition. Engineer may direct Contractor to replace materials deemed unsuitable for reassembly.

3.07 DISPOSAL

A. Disposal: All rubble and waste material shall be hauled off site as it is removed. Stockpiling is not permitted at any time. The Contractor shall be fully responsible for proper disposal of waste materials in accordance with all federal, state and local laws at no additional cost to the County.

B. Contractor shall not dispose of any trash, material, equipment, or litter on the site. Contractor shall be responsible for any damage to any facilities, tanks or equipment which is damaged by any such foreign material.

3.08 DISPOSITION OF SALVAGEABLE MATERIALS

The Owner has identified the following salvage items that the Contractor shall recover and protect during the demolition operation:

A. Existing bulk storage tank instrumentation (ultrasonic and pressure sensing level indicators and associated control boxes)

B. Heat tracing components

C. Existing transfer pumps

D. All safety showers that are removed and replaced

3.09 (NOT USED)

END OF SECTION 02050

SECTION 03313

MISCELLANEOUS STRUCTURAL CONCRETE

PART 1 GENERAL

1.01 SCOPE

A. Furnish and install concrete as shown on the Drawings and as specified herein. Design and detail components, where specified herein.

B. Furnish labor, material, equipment and incidental items necessary to complete Work.

C. ACI 301-20 shall be the base specifications in conjunction with additions and modifications as noted herein. ACI 301 requirements related to the Work shall apply whether or not they are referenced herein. In case of conflict, the more stringent requirement shall apply.

1.02 RELATED SPECIFICATION SECTIONS

A. The following list is intended to direct Contractor to specification sections related to the Work herein, but it shall not be considered an exhaustive list. The Contract Documents shall be an inclusive package whether or not individual sections are directly referenced.

1. 01400 Contractor Quality Control.
2. 01450 Special Inspections and Testing and Observation.

1.03 REFERENCES

A. Where referenced by the governing code, the adopted edition shall apply. Otherwise, the latest edition of the reference shall apply, unless otherwise noted.

B. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 301, Specifications for Concrete Construction.

2. ASTM International (ASTM):
   a. ASTM A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   b. ASTM A1064/A1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

1.04 ABBREVIATIONS

A. PSI: Pounds per square inch.

1.05 SUBMITTALS

A. Submit documents in accordance with Division 01 requirements.

B. Prior to other submittal requirements herein, submit a copy of ACI 301-20 for documentation of complete specifications for cast-in-place concrete.

1. A hard copy of the document shall be kept with the project specifications at the Project site at all times.

C. Action Submittals:

1. All submittal requirements identified in ACI 301, unless otherwise determined by Engineer.

D. Informational Submittals:

1. Any Action Submittals deemed by Engineer to be Informational Submittals at time of submittal.

1.06 SITE CONDITIONS

A. Prior to installation, visit and examine the work site and take into consideration conditions that may affect the work including, but not limited to:

1. Existing conditions of adjoining properties, river embankment, underground utilities and/or structures, streets, buildings and plant operations.
2. Conditions of public thoroughfares and roads for availability, clearances, loads, restrictions, and other limitations affecting transportation to and ingress/egress from the project site.

B. Conform to state and local regulations.

1.07 DELIVERY, STORAGE AND HANDLING

A. To the extent it is practical, factory assemble items provided hereunder.

B. In preparation for shipment, package and clearly tag parts and assemblies that are shipped unassembled of necessity in a manner that will protect materials from damage and that will facilitate identification and final assembly in field.

C. Store and handle products in accordance with manufacturer's recommendations and in such a manner as to prevent damage of any kind, including overexposure to sunlight.

PART 2 PRODUCTS

2.01 FORMWORK AND FORMWORK ACCESSORIES

A. Comply with ACI 301 Section 2.2 except as modified herein.

B. Form ties in buried, exterior, wet or humid environments shall have a setback or break-back distance of 1.5 inches.

2.02 REINFORCEMENT AND REINFORCEMENT SUPPORTS

A. Comply with ACI 301 Section 3.2 except as modified herein.

B. Steel reinforcing bars shall meet ASTM A615/A615M Grade 60.

C. Weld wire reinforcement shall be fabricated, shipped, stored and installed in flat sheets. Do not use rolls.

D. Reinforcement supports in buried, exterior, wet or humid environments shall be precast concrete or plastic.

2.03 CONCRETE MIXTURES

A. Comply with ACI 301 Section 4.2 except as modified herein.

B. Concrete mix design(s) shall meet the 28-day design compressive strength and the requirements in ACI 301 based on the following exposure categories and limits:

1. Minimum 28-day design compressive strength: 5,000 psi
2. Exposure categories: F1, S1, W1, C2
3. Maximum water-cementitious material ratio (w/cm): 0.40
4. Cement type: II or I/II
5. Maximum water-soluble chloride ion (Cl^-) content: 0.10 (percent by weight of total cementitious materials)
6. Calcium chloride admixtures are not permitted.

2.04 HANDLING, PLACING AND CONSTRUCTING

A. Comply with ACI 301 Section 5.2.

PART 3 EXECUTION

3.01 FORMWORK AND FORMWORK ACCESSORIES

A. Comply with ACI 301 Section 2.3.

3.02 REINFORCEMENT AND REINFORCEMENT SUPPORTS

A. Comply with ACI 301 Section 3.3.

3.03 CONCRETE MIXTURES

A. Comply with ACI 301 Section 4.3.

3.04 HANDLING, PLACING AND CONSTRUCTING

A. Comply with ACI 301 Section 5.3 except as modified herein.

B. Finished Formed Surfaces: Finish formed surfaces in accordance with ACI Section 5.3.3.1, except as modified herein:

1. Surfaces exposed to view, unless otherwise specified: Rubbed finish.
2. Edges of equipment pads with exposed sides less than 12 inches: Surface finish SF-1.

3.05 FIELD QUALITY ASSURANCE AND QUALIT CONTROL

A. General: Comply with ACI 301 Section 1.7 in addition to the requirements herein.

B. Owner-Furnished Quality Assurance will be provided in accordance with the Statement of Special Inspections. Refer to Section 01450 Special Inspection and Testing and Observation.

C. Contractor-Furnished Quality Control: Comply with:

1. Section 01400 Contractor Quality Control.
2. ACI 301 Section 2.3.5.

END OF SECTION

SECTION 05050

WELDING

PART 1 GENERAL

1.01 References

A. The following is a list of standards which may be referenced in this section:

1. American Society of Mechanical Engineers (ASME):

   a. BPVC SEC V, Nondestructive Examination.

   b. BPVC SEC IX, Welding and Brazing Qualifications.

2. American Society of Nondestructive Testing (ASNT): SNT TC 1A, Personnel Qualification and Certification in Nondestructive Testing.

3. ASTM International (ASTM): A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.

4. American Welding Society (AWS):

   a. A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.

   b. A3.0, Standard Welding Terms and Definitions.

   c. D1.1/D1.1M, Structural Welding Code - Steel.

   d. D1.8/D1.8M, Structural Welding Code - Seismic Supplement.

   e. D1.2/D1.2M, Structural Welding Code - Aluminum.

   f. D1.3/D1.3M, Structural Welding Code - Sheet Steel.

   g. D1.4/D1.4M, Structural Welding Code - Reinforcing Steel.

   h. D1.6/D1.6M, Structural Welding Code - Stainless Steel.

   i. QC1, Standard for AWS Certification of Welding Inspectors.

1.02 Definitions

A. CJP: Complete Joint Penetration.

B. CWI: Certified Welding Inspector.

1. Contractor's Welding Inspector: Contractor's CWI acts for, and on behalf of, the Contractor for all inspection and quality matters within the scope of the Contract Documents. Contractor is required to provide a welding inspector to oversee welding operations and be responsible for visual inspection and necessary correction of all deficiencies in materials and workmanship required to meet referenced welding codes. This type of Quality Control Inspection is not classified as Special Inspection.

2. Verification Inspector: CWI who acts on behalf of the Owner. This type of independent inspection and testing is the prerogative of the Owner, who may perform this function, or waive independent verification inspection if it is not required by the building official and building code.

C. MT: Magnetic Particle Testing.

D. NDE: Nondestructive Examination.

E. NDT: Nondestructive Testing.

F. PJP: Partial Joint Penetration.

G. PQR: Procedure Qualification Record.

H. PT: Liquid Penetrant Testing.

I. Special Inspection: Non-destructive examination exclusive of VT. Special inspection includes NDE such as MT, PT, UT, RT and Verification Inspection. Special Inspection personnel report to and are retained by the Owner. See additional requirements in Section 01450, Special Inspection and Testing and Observation.

J. RT: Radiographic Testing.

K. UT: Ultrasonic Testing.

L. VT: Visual Inspection/Testing.

M. WPQ: Welder/Welding Operator Performance Qualification Record.

N. WPS: Welding Procedure Specification.

1.03 Submittals

A. Action Submittals:

1. Shop Drawings:

a. Shop and field WPSs and PQRs.

b. NDT procedure specifications prepared in accordance with ASME BPVC SEC V.

c. Welding Data (Shop and Field): Submit welding data together with Shop Drawings as a complete package.

1) Show on Shop Drawings, or on a weld map, complete information regarding base metal specification designation, location, type, size, and extent of welds with reference called out for WPS and NDE numbers in tails of combined welding and NDE symbols as indicated in AWS A2.4.

2) Clearly distinguish between shop and field welds.

3) Indicate, by welding symbols or sketches, details of welded joints and preparation of base metal. Provide complete joint welding details showing bevels, groove angles, and root openings for welds.

4) Welding and NDE Symbols: In accordance with AWS A2.4.

5) Welding Terms and Definitions: In accordance with AWS A3.0.

B. Informational Submittals:

1. WPQs.

2. CWI credentials.

3. Testing agency personnel credentials.

4. CWI visual inspection (VT) reports.

5. Welding Documentation: Submit on forms in referenced welding codes.

1.04 Quality Assurance

A. WPSs: In accordance with AWS D1.1/D1.1M (Annex M Forms) for shop or field welding; or ASME BPVC SEC IX (Forms QW 482 and QW 483) for shop welding only.

B. WPQs: In accordance with AWS D1.1/D1.1M (Annex M Forms); or ASME BPVC SEC IX (Form QW 484).

C. CWI: Certified in accordance with AWS QC1, and having prior experience with specified welding codes. Alternate welding inspector qualifications require prior approval by Engineer.

D. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT TC 1A.

1.05 Sequence and Scheduling

A. Unless otherwise specified, Submittals required in this section shall be submitted and approved prior to commencement of welding operations.

Part 2 Products

2.01 Source Quality Control

A. Contractor's CWI shall be present whenever shop welding is performed. CWI shall perform inspection at suitable intervals, prior to assembly, during assembly, during welding, and after welding. CWI shall perform inspections as required in AWS D1.1/D1.1M or referenced welding code and as follows:

1. Verifying conformance of specified job material and proper storage.

2. Monitoring conformance with approved WPS.

3. Monitoring conformance of WPQ.

4. Inspecting weld joint fit-up and performing in-process inspection.

5. Providing 100 percent visual inspection of welds.

6. Coordinating with nondestructive testing personnel and reviewing NDE test results.

7. Maintaining records and preparing reports documenting that results of CWI VT and subsequent NDE testing comply with the Work and referenced welding codes.

Part 3 Execution

3.01 General

A. Welding and Fabrication by Welding: Conform to governing welding codes referenced in attached Welding and Nondestructive Testing Table.

3.02 Nondestructive Weld Testing Requirements

A. Quality Control Inspection:

1. All Welds: 100 percent VT by Contractor's CWI.

2. Acceptance Criteria:

a. Structural Pipe and Tubing: AWS D1.1/D1.1M, Paragraph 9.25.

b. All Other Structural Steel: AWS D1.1/D1.1M, Paragraph 6.9, Visual Inspection, Statically Loaded Nontubular Connections.

c. Stud Connections: AWS D1.1/D1.1M, Paragraph 7.8.1.

B. Nondestructive Testing Requirements:

1. NDT frequency shall be as specified below, as required by referenced welding codes, or as specified in the attached table. In case there is a conflict, the higher frequency level of NDT shall apply.

a. Nontubular Connections:

1) CJP Butt Joint Groove Welds: 10 percent random RT. Use UT for CJP butt joint groove welds that cannot be readily radiographed.

2) All Other CJP Groove Welds: 10 percent random UT.

3) Fillet Welds and PJP Groove Welds: 10 percent random PT or MT.

b. Tubular Connections:

1) CJP butt joint groove welds made from one side without backing: 100 percent RT or UT in accordance with AWS D1.1/D1.1M, Paragraph 9.26.2 requirements.

2) CJP Butt Joint Groove Welds made without backing or back-gouging: 10 percent random RT. Use UT for CJP butt joint groove welds that cannot be readily radiographed.

3) All Other CJP Groove Welds: 10 percent random UT.

4) Fillet Welds and PJP Groove Welds: 10 percent random PT or MT.

2. NDT Procedures and Acceptance Criteria:

a. Nontubular Connections:

1) RT: Perform in accordance with AWS D1.1/D1.1M, Clause 6, Part E. Acceptance criteria per AWS D1.1/D1.1M, Paragraph 6.12.1.

2) UT: Perform in accordance with AWS D1.1/D1.1M, Clause 6, Part F. Acceptance criteria per AWS D1.1/D1.1M, Paragraph 6.13.1.

3) PT and MT:

a) Perform on fillet and PJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 6.14.4 and Paragraph 6.14.5.

b) Acceptance criteria per AWS D1.1/D1.1M, Paragraph 6.9, Visual Inspection, Statically Loaded Nontubular Connections.

b. Tubular Connections:

1) RT: Comply with requirements for Nontubular Connections and additional requirements of AWS D1.1/D1.1M, Clause 9, Paragraph 9.28 and Paragraph 9.29.

2) UT: Comply with requirements for Nontubular Connections and additional requirements of AWS D1.1/D1.1M, Clause 9, Paragraph 9.27.

a) PT and MT:

b) Perform on fillet and PJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 6.14.4 and Paragraph 6.14.5.

c) Acceptance criteria per AWS D1.1/D1.1M, Paragraph 9.25.

3.03 Field Quality Assurance and Quality Control

A. Contractor's CWI shall be present whenever field welding is performed. CWI shall perform inspection, at suitable intervals, prior to assembly, during assembly, during welding, and after welding. CWI shall perform inspections as required in AWS D1.1/D1.1M or referenced welding code and as follows:

1. Verify conformance of specified job material and proper storage.

2. Monitor conformance with approved WPS.

3. Monitor conformance of WPQ.

4. Inspect weld joint fit-up and perform in-process inspection.

5. Provide 100 percent visual inspection of all welds in accordance with Subparagraph Quality Control Inspection.

6. Supervise nondestructive testing personnel and evaluating test results.

7. Maintain records and prepare report confirming results of inspection and testing comply with the Work

3.04 Weld Defect Repair

A. Repair and retest rejectable weld defects until sound weld metal has been deposited in accordance with appropriate welding codes.

3.05 Welding And Non Destructive Testing Table

Welding and Nondestructive Testing						
Specification Section	Governing Welding Codes or Standards	Submit WPS	Submit WPQ	Onsite CWI Req'd	Submit Written NDT Procedure Specifications	NDT Requirements
05500 Metal Fabrications	AWS D1.1/D1.1M, Structural Welding Code–Steel or AWS D1.2/D1.2M, Structural Welding Code - Aluminum or AWS D1.6/D1.6M, Structural Welding Code - Stainless Steel	Yes	Yes	Yes	Yes	100% VT; also see Section 05500
13122 Metal Building Systems	AWS D1.1/D1.1M, Structural Welding Code - Steel	Yes	Yes	Yes	Yes	100% VT; also see Section 13122

Welding and Nondestructive Testing						
Specification Section	Governing Welding Codes or Standards	Submit WPS	Submit WPQ	Onsite CWI Req'd	Submit Written NDT Procedure Specifications	NDT Requirements
15050 Basic Mechanical Materials and Methods	ASME B31.3 Process Piping	Yes	Yes	Yes	Yes	100% VT; also see Section 15050

END OF SECTION

SECTION 05095

POST-INSTALLED ANCHORS

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 318, Building Code Requirements for Structural Concrete.
   b. 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
   c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
2. American Iron and Steel Institute (AISI): Stainless Steel Type 316.
3. American National Standards Institute (ANSI).
4. ASTM International (ASTM):
   a. A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A143, Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   c. A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   d. A193/A193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   e. A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
   f. A380, Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   g. A385, Practice for Providing High-Quality Zinc Coatings (Hot Dip).
   h. A563, Specification for Carbon and Alloy Steel Nuts.
   i. A780, Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   j. A967, Specification for Chemical Passivation Treatments for Stainless Steel Parts.
   k. E488, Standard Test Methods for Strength of Anchors in Concrete Elements.
   l. F436, Specification for Hardened Steel Washers.
   m. F468, Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
   n. F568M, Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners.
   o. F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   p. F594, Specification for Stainless Steel Nuts.

q. F1554, Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength.

5. International Association of Plumbing and Mechanical Officials Uniform ES (IAPMO UES): Evaluation Reports for Concrete and Masonry Anchors.
6. International Code Council Evaluation Service (ICC-ES):
   a. Evaluation Reports for Concrete and Masonry Anchors.
   b. AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
   c. AC70, Acceptance Criteria for Fasteners Power-driven into Concrete, Steel and Masonry Elements.
   d. AC106, Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.
   e. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
   f. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements. Evaluation Reports for Concrete and Masonry Anchors.
7. Specialty Steel Industry of North America (SSINA):
   a. Specifications for Stainless Steel.
   b. Design Guidelines for the Selection and Use of Stainless Steel.
   c. Stainless Steel Fabrication.
   d. Stainless Steel Fasteners.

1.02 DEFINITIONS

A. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

B. Exterior Area: Location not protected from weather by a building or other enclosed structure to include buried roof structures.

C. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or wash down, and where wall or roof slab is not common to a water-holding or earth-retaining structure.

D. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or wash down, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

E. Submerged: Location at or below top of wall of open water-holding structure, such as a basin or channel, or wall, ceiling, or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Specific instructions for concrete anchor installation, including drilled hole size and depth, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

B. Informational Submittals:

1. Concrete Anchors:
   a. Manufacturer's product description and installation instructions.
   b. Current ICC-ES or IAPMO-UES Report for each type of post-installed anchor to be used.
   c. Adhesive Anchor Installer Certification.
2. Passivation method for stainless steel members.
3. Hot-Dip Galvanizing: Certificate of Compliance signed by galvanizer, with description of material processed and ASTM standard used for coating.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Installers of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Installer Certification Program or equivalent.
2. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 DELIVERY AND STORAGE

A. Package stainless steel items in a manner to provide protection from carbon impregnation.

B. Protect hot-dip galvanized finishes from damage as a result of metal banding and rough handling.

PART 2 - PRODUCTS

2.01 GENERAL

A. Unless otherwise indicated, meet the following requirements:

1. Stainless Steel Threaded Rods: F593, AISI Type 316, Condition CW.
2. Stainless Steel Nuts: F594, AISI Type 316, Condition CW.
3. Carbon Steel Threaded Rods: F1554, Grade 36.

4. Carbon Steel Nuts: F436.
5. Carbon Steel Flat and Beveled Washers (Hardened): A194/A194M, Grade 2H.
6. Galvanized Steel Threaded Rods, Nuts and Washers: ASTM A153/A153M.

B. Use stainless steel unless otherwise indicated.

2.02 POST-INSTALLED CONCRETE ANCHORS

A. General:

1. AISI Type 316 stainless, hot-dip galvanized or zinc-plated steel, as indicated on Drawings.
2. Post-installed anchor systems used in concrete shall be approved by ICC Evaluation Services Report or equivalent for use in cracked concrete and for short-term and long-term loads including wind and earthquake.
3. Mechanical Anchors: Comply with the requirements of ICC ES AC193 or ACI 355.2.
4. Adhesive Anchors: Comply with the requirements of ICC ES AC308 or ACI 355.4.

B. Torque-Controlled Expansion Anchors (Wedge Anchors):

1. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; Kwik-Bolt –TZ (KB-TZ) Anchors (ESR-1917).
   b. DeWalt Anchors & Fasteners, Brewster, NY; Power-Stud +SD1 , +SD2, +SD4, or +SD6 Anchors (ESR-2502 and ESR-2818).
   c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt 2 Anchors (ESR-1771 and ESR-3037).

C. Self-Tapping Concrete Screw Anchors:

1. Manufacturers and Products:
   a. DeWalt Anchors & Fasteners, Brewster, NY; Wedge-Bolt+ (ESR 2526).
   b. DeWalt Anchors & Fasteners, Brewster, NY; Vertigo+ Rod Hanger Screw Anchor (ESR 2989).
   c. DeWalt Anchors & Fasteners, Brewster, NY; Snake+ Flush Mount Screw Anchor (ESR 2272).
   d. Hilti, Inc., Tulsa, OK; HUS-EZ Screw Anchor (ESR-3027).
   e. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Titen HD Screw Anchor (ESR 2713 and IAPMO UES-493).

D. Adhesive Anchors:

1. Threaded Rod:
   a. Diameter as shown on Drawings.

b. Length as required to provide minimum depth of embedment indicated and thread projection required.
c. Clean and free of grease, oil, or other deleterious material.

2. Adhesive:
   a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
   b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
3. Packaging and Storage:
   a. Disposable, self-contained system capable of dispensing both components in proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.
   b. Store adhesive on pallets or shelving in a covered storage area.
   c. Package Markings: Include manufacturer's name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
   d. Dispose of When:
      1) Shelf life has expired.
      2) Stored other than in accordance with manufacturer's instructions.
4. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT RE 500 V3 (ESR 3814), or HIT HY 200 (ESR 3187).
   b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-3G Epoxy Adhesive Anchors. (ESR-4057).
   c. DeWalt Anchors & Fasteners, Brewster NY; Pure 110+ Epoxy adhesive anchor system (ESR 3298).
5. Adhesive Threaded Inserts:
   a. Type 316 stainless steel, internally threaded inserts.
   b. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIS RN Insert with HIT-RE 500 V3 or HIT HY 200 adhesive.

PART 3 - EXECUTION

3.01 CONCRETE ANCHORS

A. Begin installation only after concrete or masonry to receive anchors has attained design strength.

B. Locate existing reinforcing with Ground Penetrating Radar or other method approved by Engineer prior to drilling. Coordinate with Engineer to adjust anchor locations where installation would result in hitting reinforcing.

C. Install in accordance with written manufacturer's instructions.

D. Provide minimum embedment, edge distance, and spacing as indicated on Drawings.

E. Use only drill type and bit type and diameter recommended by anchor manufacturer.

F. Clean hole of debris and dust per manufacturer's requirements.

G. When unidentified embedded steel, rebar, or other obstruction is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than indicated in manufacturer's installation instructions to clear obstruction, notify Engineer for direction on how to proceed.

H. Adhesive Anchors:

1. Unless otherwise approved by Engineer and adhesive manufacturer:
   a. Do not install adhesive anchors when temperature of concrete or masonry is below 40 degrees F or above 100 degrees F.
   b. Do not install prior to concrete attaining an age of 21 days.
   c. Remove any standing water from hole with oil-free compressed air. Inside surface of hole shall be dry.
   d. Do not disturb anchor during recommended curing time. Do not exceed maximum torque as specified in manufacturer's instructions.

I. Antiseizing Lubricant: Use on all stainless steel threads.

J. Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Selected Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections in Section 01450, Special Inspection and Testing and Observation.

B. Contractor responsibilities and related information are included in Section 01450, Special Inspection and Testing and Observation.

3.03 MANUFACTURER'S SERVICES

A. Adhesive and Mechanical Anchors: Conduct Site training of installation personnel for proper installation, handling, and storage of adhesive anchor system. Notify Engineer of time and place for sessions.

END OF SECTION 05095

SECTION 05500

METAL FABRICATIONS

PART 1 - GENERAL

1.01 SCOPE

A. Furnish and install metal fabrications as shown on the Drawings and as specified.

B. Furnish labor, materials, equipment and incidentals necessary to fabricate and install metals fabrications and complete the Work.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. The Aluminum Association, Inc. (AA): The Aluminum Design Manual
2. American Institute of Steel Construction (AISC):
   a. 360, Specification for Structural Steel Buildings.
   b. Steel Construction Manual, 14th Edition.
3. American Iron and Steel Institute (AISI): Stainless Steel Types.
4. American Welding Society (AWS):
   a. D1.1/D1.1M, Structural Welding Code - Steel.
   b. D1.2/D1.2M, Structural Welding Code - Aluminum.
   c. D1.3/D1.3M, Structural Welding Code - Sheet Steel.
   d. D1.4/D1.4M, Structural Welding Code - Reinforcing Steel.
   e. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
5. International Code Council (ICC): 2018 International Building Code (IBC).
6. American Society for Testing and Materials International (ASTM).
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48/A48M, Specification for Gray Iron Castings.
   c. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   d. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   e. A143/A143M, Standard for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   f. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   g. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   h. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.

i. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
j. A276, Standard Specification for Stainless Steel Bars and Shapes.
k. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
l. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
m. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
n. A384/A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
o. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
p. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
q. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
r. A563, Standard Specification for Carbon and Alloy Steel Nuts.
s. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
t. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
u. A780/A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
v. A786/A786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
w. A793, Standard Specification for Rolled Floor Plate, Stainless Steel.
x. A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
y. A992/A992M, Standard Specification for Structural Steel Shapes.
z. A1069, Standard Specification for Laser-Fused Stainless Steel Bars, Plates, and Shapes.
aa. A1085, Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS).
bb. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
cc. B308/B308M, Standard Specification for Aluminum-Alloy 6061 T6 Standard Structural Profiles.
dd. B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
ee. B632/B632M, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
ff. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

gg. D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
hh. F436, Standard Specification for Hardened Steel Washers.
ii. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
jj. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
kk. F594, Standard Specification for Stainless Steel Nuts.
ll. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
mm. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength.
nn. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

7. The Society for Protective Coatings (SSPC):
   a. SP 1, Solvent Cleaning.
   b. SP 6, Commercial Blast Cleaning.
8. Specialty Steel Industry of North America (SSINA):
   a. Designer Handbook: Specifications for Stainless Steel.
   b. Designer Handbook: Stainless Steel Fabrication.
   c. Designer Handbook: Stainless Steel Fasteners.

1.03 SUBMITTALS

A. Manufacturers data on all materials listed in Part 2 of this Section.

B. Detail drawings, as provided for in the General Conditions, showing sizes of members, method of assembly, anchorage, and connection other members shall be submitted to the Engineer for review before fabrication. Drawings shall include vault and watertight door test results.

C. Passivation method for stainless steel members.

D. Galvanized coating applicator qualifications.

E. Hot-Dip Galvanizing: Certificate of compliance signed by galvanizer, with description of material processed and ASTM standard used for coating.

1.04 QUALITY ASSURANCE

A. Galvanized Coating Applicator Qualifications: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

B. Field verify dimensions, elevations and conditions prior to shop drawing submittal and fabrication.

C. Coordination:

1. The work of this Section shall be completely coordinated with the work of other Sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.
2. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

1.05 DELIVERY, STORAGE AND HANDLING

A. Preparation for Shipment:

1. Package and clearly tag parts and assemblies that are of necessity shipped unassembled in a manner that will protect materials from damage, and facilitate identification and final assembly in field.
2. Insofar as is practical, factory assemble items provided hereunder.
3. Package stainless steel items to provide protection from carbon impregnation.
4. Protect painted coatings and hot-dip galvanized finishes from damage as a result of metal banding and rough handling. Use padded slings and straps.

B. Storage and Handling:

1. In accordance with manufacturer's recommendations and in such a manner as to prevent damage of any kind, including overexposure to sunlight.
2. Store fabricated items in dry area, not in direct contact with ground.

PART 2 - PRODUCTS

2.01 STEEL ITEMS

A. Unless otherwise indicated, meet the following requirements:

1. Steel wide flange shapes: ASTM A992.
2. Angles, Channels, Plates and Other Shapes: ASTM A36; ASTM 572, Grade 50; or ASTM A992.
3. Pipe: ASTM A53, Grade B.
4. Hollow Structural Sections (HSS): ASTM A500, Grade C or ASTM A1085.
5. Machine Bolts: ASTM A307.
6. High-Strength Bolts and Nuts: ASTM F3125, Type 1.
7. Anchor Rods: ASTM F1554, Grade 36 with weldability supplement S1.
8. Threaded Rods: ASTM A36.
9. Nuts: ASTM A563.
10. Flat Washers (Unhardened): ASTM F844.
11. Flat and Beveled Washers (Hardened): F436.

12. Thrust Ties for Steel Pipe:
    a. Threaded Rods: ASTM A193, Grade B7.
    b. Nuts: ASTM A194, Grade 2H.
    c. Plates: ASTM A283, Grade D.

2.02 STAINLESS STEEL ITEMS

A. Unless otherwise indicated, meet the following requirements:

1. Angles and Bars: ASTM A276, AISI Type 316 (316L for welded components and connections).
2. Plates, Sheets and Strips: ASTM A240, AISI Type 316 (316L for welded components and connections).
3. Built-Up Shapes: ASTM A276, AISI Type 304 (304L for welded components and connections) and ASTM A1069 for the laser fusing process.
4. Rolled Shapes: ASTM A276, AISI Type 304 (304L for welded components and connections).
5. Bolts: ASTM F593, AISI Type 316, Group 2, Condition CW.
6. Anchor Rods: ASTM F593, AISI Type 316, Group 2, Condition CW.
7. Threaded Rods: ASTM F593, AISI Type 316, Group 2, Condition CW.
8. Nuts: ASTM F594, AISI Type 316, Condition CW.

2.03 ALUMINUM ITEMS:

A. Unless otherwise indicated, meet the following requirements:

1. Plates: ASTM B209, Alloy 6061-T6.
2. Shapes: ASTM B308, Alloy 6061-T6
3. Bolts: ASTM F593, AISI Type 316, Group 2, Condition CW.
4. Anchor Rods: ASTM F593, AISI Type 316, Group 2, Condition CW.
5. Threaded Rods: ASTM F593, AISI Type 316, Group 2, Condition CW.
6. Nuts: ASTM F594, AISI Type 316, Condition CW.

2.04 CAST IRON ITEMS:

A. Unless otherwise indicated, meet the following requirements:

1. Cast Iron: ASTM A48, Class 35.

2.05 BOLTS, AND FASTENERS

A. Furnish bolts and fasteners as necessary for installation of the work of this Section.

B. Use stainless steel bolts, nuts and washers, unless otherwise indicated.

C. Use stainless steel bolts, nuts and washers in connections with aluminum and

stainless items.

D. The bolts used to attach the various members to the anchors shall be the sizes shown or required. Aluminum and stainless steel shall be attached to concrete by means of stainless-steel machine bolts and iron or steel shall be attached with steel machine bolts unless otherwise specifically noted.

2.06 ANCHORS, ANCHOR RODS AND SLEEVES

A. Cast-in-Place Anchor Rods:

1. Headed type, unless otherwise shown on Drawings.
2. Material type and protective coating as shown in Fastener Schedule at end of this section.

B. Anchor Bolt Sleeves:

1. Plastic:
   a. Single unit construction with corrugated sleeve.
   b. Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.
   c. Material: High-density polyethylene.
2. Fabricated Steel: ASTM A36.

C. Post-Installed Concrete and Masonry Anchors

1. See Section 05095, Post-Installed Anchcors.

2.07 ACCESSORIES

A. Antiseizing Lubricant for Stainless Steel Threaded Connections:

1. Suitable for potable water supply.
2. Resists washout.
3. Manufacturers and Products:
   a. Bostik, Middleton, MA; Neverseez.
   b. Saf-T-Eze Div., STL Corp., Lombard, IL; Anti-Seize.

2.08 FABRICATION

A. General:

1. Form and finish true to detail, with clean, straight, well-defined lines and profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability.
2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.

3. Conceal fastenings where practical; where exposed, flush countersink.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.
6. Fit and assemble in largest practical sections for delivery to Site.
7. Provide connections and accessories of sufficient strength to safely withstand stresses and strains to which they will be subjected.
8. Provide steel accessories and connections to steel or cast iron, unless otherwise specified.
9. Make threaded connections such that the threads are concealed by fitting.

B. Welds:

1. Welded joints shall be rigid and continuously welded or spot welded as specified or shown. The face of welds shall be dressed flush and smooth. Exposed joints shall be close fitting and jointed where least conspicuous.
2. Welding of aluminum work shall be on the unexposed side as much as possible in order to prevent pitting or discoloration.
3. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.
4. Welded fabrications shall be free from twisting or distortion caused by improper welding techniques.
5. Steel: Meet fabrication requirements of AWS D1.1/D1.1M, Section 5.
6. Aluminum: Meet requirements of AWS D1.2/D1.2M.
7. Stainless Steel: Meet requirements of AWS D1.6/D1.6M.
8. Complete welding before applying finish.

C. Steel Items:

1. Use steel shapes, unless otherwise noted.
2. Hot-dip galvanized: Limit silicon content to less than 0.04 percent or to between 0.15 percent and 0.25 percent.

D. Stainless Steel Items: Fabricate built-up shapes in accordance with ASTM A1069.

E. Aluminum:

1. Fabricate aluminum in accordance with AA Specifications for Aluminum Structures–Allowable Stress Design.
2. Finish exposed surfaces, except as specified below, with manufacturer's standard mill finish. A coating of methacrylate lacquer shall be applied to all aluminum before shipment from the factory.

F. Castings:

1. Castings shall be smooth, free from scale, lumps, blisters, sand holes, and defects of any kind which render them unfit for the service for which they are intended. Castings shall be thoroughly cleaned and will be subjected to a hammer inspection in the field by the Engineer. Finished surfaces shown on the Drawings and/or specified shall be machined to a true plane surface and shall be true and seat at all points without rocking. Allowances shall be made in the patterns so that the thickness specified or shown shall not be reduced in obtaining finished surfaces. Castings will not be acceptable if the actual weight is less than 95 percent of the theoretical weight computed from the dimensions shown. The Contractor shall provide facilities for weighing castings in the presence of the Engineer showing true weights, certified by the supplier.

G. Painting:

1. Shop prime steel with 1 coat (2 mils minimum dry film thickness) rust-inhibitive primer, unless otherwise indicated. Prepare surface to SP 6, Commercial Blast Cleaning.
2. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals with 1 coat (10 mils minimum dry film thickness) bituminous paint, unless indicated otherwise. Prepare surface to SP 1, Solvent Clean.
3. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.

H. Galvanizing:

1. Fabricate steel to be galvanized in accordance with ASTM A143, ASTM A384, and ASTM A385. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.
2. Provide venting and drain holes for tubular members and fabricated assemblies in accordance with ASTM A385.
3. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.
4. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.
5. Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123.
6. Hot-dip galvanize bolts, nuts, washers, and hardware components in accordance with ASTM A153. Oversize holes to allow for zinc alloy growth. Shop assemble bolts and nuts.
7. Galvanized steel sheets in accordance with ASTM A653.
8. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.

I. Electrolytic Protection: Coat surfaces of galvanized steel and aluminum

fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals with 1 coat (10 mils minimum dry film thickness) bituminous paint, unless indicated otherwise. Prepare surface to SP 1, Solvent Clean.

J. Fitting: Where movement of fabrications is required or shown, cut, fit, and align items for smooth operation. Make corners square and opposite sides parallel.

K. Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

2.09 SOURCE QUALITY CONTROL

A. Visually inspect all fabrication welds and correct deficiencies.

1. Steel: AWS D1.1, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. Aluminum: AWS D1.2.
3. Stainless Steel: AWS D1.6.

B. Hot-Dip Galvanizing:

1. An independent testing agency shall be retained by Contractor and approved by Engineer to inspect and test hot-dip galvanized fabricated items in accordance with ASTM A123 and ASTM A153.
2. Visually inspect and test for thickness and adhesion of zinc coating for minimum of three test samples from each lot in accordance with ASTM A123 and ASTM A153.
3. Reject and retest nonconforming articles in accordance with ASTM A123 and ASTM A153.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Install metal fabrications plumb and level, accurately fitted, free from distortion or defects.
2. Install rigid, substantial, and neat in appearance.
3. Install manufactured products in accordance with manufacturer’s recommendations.
4. Obtain Engineer approval prior to field cutting steel members or making adjustments not scheduled.
5. Do not remove mill markings from concealed surfaces.
6. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.
7. Snug-tighten bolts, unless otherwise specified.

8. Field assembly and erection shall be bolted or fastened. Field weld where indicated. Field welding aluminum is not permitted.

B. Steel:

1. Fabrication, erection, connections, bolted and welded construction shall be in accordance with AISC Steel Construction Manual and AWS D1.1.

C. Stainless Steel:

1. Fabrication, erection, connections, bolted and welded construction shall be in accordance with AWS D1.6 and the following SSINA standards:
   a. Specifications for Stainless Steel.
   b. Stainless Steel Fabrication.
   c. Stainless Steel Fasteners.
2. Do not field weld unless approved by Engineer in writing.

D. Aluminum:

1. Do not remove mill markings from concealed surfaces.
2. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.
3. Fabrication, mechanical connections, and bolted construction shall be in accordance with the AA Aluminum Design Manual.
4. Do not embed aluminum into concrete or grout.

3.02 CAST-IN-PLACE ANCHORS

A. Locate and hold anchor bolts in place with templates at time concrete is placed.

B. Use anchor bolt sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt.

C. Minimum Bolt Size: 1/2-inch diameter by 12 inches long, unless otherwise shown.

3.03 ELECTROLYTIC PROTECTION

A. Aluminum and Galvanized Steel:

1. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals with 1 coat (10 mils minimum dry film thickness) bituminous paint, unless indicated otherwise. Prepare surface to SP 1, Solvent Clean.
2. Do not apply protective coating to galvanized steel anchor bolts or

galvanized steel welded anchor studs, unless indicated otherwise.
3. Allow coating to dry before installation of the material.
4. Protect coated surfaces during installation.
5. Should coating become marred, prepare and touch up in accordance with paint manufacturer's written instructions.

B. Stainless Steel:

1. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.
2. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.
3. Remove contamination using cleaning and passivation methods in accordance with requirements of ASTM A380 and ASTM A967.
4. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles. After treatment, visually inspect surfaces for compliance.

3.04 PAINTING

A. Painted Galvanized Surfaces (not used)

B. Repair of Damaged Hot-Dip Galvanized Coating:

1. Conform to ASTM A780.
2. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780.
3. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780.
4. Use magnetic gauge to determine thickness is equal to or greater than base galvanized coating.

C. Field Painting of Shop Primed Surfaces: Prepare surfaces to SP 6 Commercial Blast Cleaning and field finish with 2 coats (4 mils minimum dry film thickness) alkyd enamel, unless indicated otherwise.

3.05 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Selected Quality Assurance:

1. In accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections in Section 01450, Special Inspection and Testing and Observation.
2. Contractor responsibilities and related information on special inspection, observation, and testing are included in Section 01450, Special Inspection and Testing and Observation.

END OF SECTION 05500

SECTION 06600
FIBERGLASS REINFORCED PLASTIC FABRICATIONS

PART 1 - GENERAL

1.01 SCOPE

A. Design, detail, furnish and install fiberglass reinforced plastic (FRP) fabrications as shown on the Drawings and as specified.

B. Furnish labor, materials, equipment, and incidentals necessary to fabricate and install FRP fabrications and complete the Work.

C. Contract Drawings show only functional features, minimum requirements and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Supply parts, devices and equipment necessary to meet the requirements of the Contract Documents, and make dimensional adjustments particular to the fabrications being furnished. Costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. International Code Council (ICC):
   a. 2018 International Building Code (IBC).
   b. Evaluation Services Reports.
2. American Iron and Steel Institute (AISI).
3. Occupational Safety and Health Administration (OSHA): Standard 29 CFR 1910, Occupational Safety and Health Standards.
4. State of Georgia: 2020 and 2022 Amendments to the 2018 IBC.

1.03 DEFINITIONS

A. ICC Evaluation Services Report: ICC report on evaluation of manufactured concrete anchor systems.

1.04 DESIGN REQUIREMENTS

A. Structural Performance of FRP fabrications: Design, analyze, test, detail, fabricate and install FRP fabrications including components, connections and anchorage and embedment depth in accordance with the design requirements provided on the Drawings and herein. FRP fabrications including components,

connections and anchorage and embedment depth shall be designed and detailed by a qualified professional engineer licensed in the state where Project will be constructed.

B. Design Criteria:

1. Governing Codes: Comply with the IBC, amendments and referenced codes and standards therein and OSHA.
2. Load: 100 psf minimum uniform load or concentrated load of 300 pounds on an area of 4 square inches, whichever produces the greater stress, unless otherwise shown.
3. Maximum Deflection Under a uniform load of 100 psf: 1/4 inch for spans up to 48-inches and 3/8-inch for spans exceeding 48-inches, unless otherwise shown.

1.05 DEFERRED DESIGN DOCUMENT REQUIREMENTS

A. Deferred design is that portion of the design which is delegated to the Contractor's qualified professional engineer to be the engineer-of-record for the specified Work.

B. The following is a list of deferred design documents for the FRP fabrications that shall be prepared and sealed, signed and dated by a qualified professional engineer licensed in the state where Project will be constructed:

1. Shop Drawings

C. Submit deferred documents, sealed, signed and dated by a qualified professional engineer licensed in the state where Project will be constructed, for review and acceptance by the Engineer prior to fabrication and installation.

D. Submit deferred documents for approval to the appropriate permitting agency, where applicable, prior to installation.

1.06 SUBMITTALS

A. Product Data:

1. Catalog information and catalog cuts showing materials, design tasks, and showing load, span, and deflection. Identify load, span and deflection selected from catalog as the basis for the components provided.
2. Manufacturer's specifications.
3. Special handling and storage requirements.
4. Installation instructions.

B. Shop Drawings:

1. Grating: Show dimensions, weight, and size, and location of connections to adjacent grating, supports, and other work.
2. Grating Anchorage: Show structural calculations and details of anchorage to supports to prevent displacement from traffic impact.
3. Grating Supports: Show dimensions, weight, size, location, and anchorage to supporting structure.

C. Certified Test Reports.

1.07 QUALITY ASSURANCE

A. Professional Engineer Qualifications: Civil or Structural Engineer, who is:

1. Licensed in the state where Project will be constructed.
2. Experienced in the design of FRP fabrications having designed a minimum of 5 projects with similar conditions, size and scope within the past 3 years.

B. Fabricator: Minimum of 5 years of experience in manufacturing products meeting these specifications.

C. Manufacturer: Minimum of 5 years of experience in manufacturing products meeting these specifications.

D. Field verify dimensions, elevations and conditions prior to shop drawing submittal and fabrication.

1.08 DELIVERY, STORAGE AND HANDLING

A. Preparation for Shipment:

1. Package and clearly tag parts and assemblies that are of necessity shipped unassembled in a manner that will protect materials from damage, and facilitate identification and final assembly in field.
2. Insofar as is practical, factory assemble items provided hereunder.

B. Storage and Handling: In accordance with manufacturer's recommendations and in such a manner as to prevent damage of any kind, including overexposure to sunlight.

PART 2 - PRODUCTS

2.01 GENERAL

A. Like items of materials: Provide end products of one manufacturer in order to achieve standardization for appearance, maintenance and replacement.

Unless otherwise indicated, provide items, including support items, of the same material composition for uniformity.

B. Unless otherwise specified, manufacture products by a pultruded process using vinyl ester resin with ultra-violet (UV) inhibitor additives.

   1. Molded products may be furnished as an option where included in Specifications below.

C. Color and Pigment:

   1. Gray, unless otherwise specified.
   2. Provide color pigment dispersed in resin system.

D. Provide a synthetic surface veil covering on exterior surfaces.

E. The FRP material shall be tested for conformance with the specified standards. Certified copies of tests by independent laboratories.

F. Structural Shapes; fabricate structural shapes, columns, studs and nuts for the grating support systems from pultruded fiberglass.

G. Fabricate FRP products exposed to outdoor conditions with an additional 1-mil thick UV coating to shield product from UV light.

H. Seal cut ends, holes, and abrasions of FRP shapes with resin to prevent moisture intrusion.

2.02 GRATING

A. Pultruded Type:

   1. Main bars joined by cross bars secured in holes drilled in main bars.
   2. Cross bars with 6-inch maximum spacing shall mechanically lock main bars in position such that they prevent movement.
   3. Intersections: Bond using adhesive as corrosive-resistant as pultrusion resin.
   4. Main Bar Ends: Minimum bearing support width of 1 inch.
   5. Skid-Resistant Surface: Grit adhesively bonded, manufacturer’s standard.
   6. Provide extra stiffness around openings.

B. Molded Type:

   1. Nonskid grit affixed to top of bar surface or a concave, meniscus top to all bars, providing skid resistance.
   2. Load bars in both directions with equal stiffness.

3. Bearing: Minimum bearing support width of 1 inch.
4. Rectangular mesh minimum opening sizes of 1 inch x 4 inch.

C. Hold-Down Clamps: Same material as grating or AISI Type 316 stainless steel.

D. Bolts and Connectors:

1. Corrosion-resistant FRP or Type 316 stainless steel.
2. Size and strength to meet load requirements.

E. Fabrications:

1. Field measure areas to receive grating. Verify dimensions of new fabricated supports, and fabricate to dimension required for specified clearances.
2. Section Length: Sufficient to prevent it falling through clear opening when oriented in span direction when one end is touching either concrete or vertical leg of grating support.

F. Manufacturers:

1. Fibergrate Composite Structures, Inc., Addison, TX.
2. IKG/Borden, Clark, NJ.
3. Strongwell Corp., Bristol Division, Bristol, VA or Chatfield Division, Chatfield, MN.
4. International Grating, Inc., Houston, TX.

PART 3 - EXECUTION

3.01 GENERAL

A. Install in accordance with manufacturer’s written instructions.

B. Install plumb or level, rigid and neat, as applicable in locations shown.

C. Furnish fasteners and anchorages for complete installation.

D. Anchor grating securely to supports to prevent displacement from traffic impact.

E. Seal field cut holes, edges, and abrasions with catalyzed resin compatible with original resin in accordance with manufacturer’s instructions.

F. Replace items not meeting the specified or detailed dimensional requirements.

3.02 GRATING

A. Confirm that grating sections have a solid bearing on supports at both ends,

and that grating sections will not rock or wobble under design loads.

B. Anchor grating securely to supports to prevent displacement.

C. Install each grating section such that it is easily removable.

D. Locate joints between grating sections at pipe penetrations where applicable so that grating removal will not require pipe removal.

E. Minimum Clearance (Grating to Vertical Surfaces): 1/4 inch for spans up to 48-inches and 3/8-inch for spans exceeding 48-inches (plus or minus 1/8-inch tolerance).

F. If any section of grating does not meet requirements or does not fit, replace the section or obtain Engineer's approval of field modifications. Field modification acceptance will be based on both function and appearance.

3.03 PROTECTION

A. After installation, protect work from damage during subsequent construction activities.

3.04 CLEANING

A. Cleaning shall be as recommended by the FRP manufacturer.

END OF SECTION 06600

SECTION 09910

HIGH PERFORANCE COATING

PART 1 - GENERAL

1.01 SCOPE

A. The work covered by this section includes furnishing all labor, materials, and equipment required to accomplish all painting as specified herein and shown on the Drawings.

B. In general, work included under this section shall include the surface preparation, shop priming, field priming, and/or field painting of all exposed items and surfaces throughout the project, unless otherwise indicated.

C. All exposed items and surfaces shall be painted using the appropriate paint system as specified herein. Coating system schedules and finish schedules may be provided herein and/or on the Drawings, which identify specific paint systems and paint colors to be used on specific items and surfaces. However, these schedules do not necessarily cover all items to be painted. Where the selection of a specific painting system for a particular application is not clear, it shall be the responsibility of the Contractor to request clarification from the Engineer.

D. Surface preparation, priming, and coats of paint specified are in addition to shop priming and surface pretreatment specified in other sections, unless otherwise indicated.

E. All exposed surfaces associated with work performed shall be painted except where the natural finish of the material is obviously intended to be the finished surface or if the surface is specifically noted not to be painted.

F. In general, items to be painted include:

1. New concrete equipment pads.

2. All locations within chemical containment areas where existing coating has become compromised as a result of completion of the Work.

1.02 DEFINITIONS

A. Definitions of Painting Terms: ASTM D16, unless otherwise specified.

B. Dry Film Thickness (DFT): Thickness of a coat of paint in fully cured state measured in mils (1/1000 inch).

1.03 SUBMITTALS

A. The Contractor shall submit shop drawings and product data to the Engineer in accordance with the requirements of the General Conditions of the Contract Documents.

B. At a minimum, the submittals shall contain, but not be limited to, the following information to establish compliance with these specifications:

1. Product Data

   Submit Manufacturer's product data for each coating, including generic description, complete technical data, surface preparation, and application instructions.

2. Color Samples

   Submit Manufacturer's color samples showing full range of standard colors.

3. Configuration details for the following:

   a. Expansion joints and structural isolation joints.

   b. Construction joints.

   c. Cracks.

   d. Wall base details.

   e. Equipment bolts (when installed before or after coating application).

   f. Metal angle frames at trenches, grating, or hatches.

   g. Transition and termination detail at edge of coating system.

   h. Pipe penetrations (vertical and horizontal).

   i. Other details specific to the structure being coated.

C. Manufacturer's Quality Assurance

   Submit Manufacturer's certification that coatings comply with specified requirements and are suitable for intended application.

D. Warranty

   Submit a complete description of the warranty to be provided.

E. Painting Schedule

Contractor shall submit a schedule of all items (structures, equipment, pipe, etc.) to be painted prior to beginning painting operations. Schedule shall include, but not be limited to, items to be painted, surface preparation, paint system, and color. The schedule shall be submitted to the Engineer for approval at which time the Engineer will select the colors to be used that are not specified herein or on the Drawings.

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications

1. Specialize in manufacture of coatings with a minimum of 10 years successful experience.

2. Able to demonstrate successful performance on comparable projects.

3. Single Source Responsibility

   Coatings and coating application accessories shall be products of a single manufacturer.

B. Applicator's Qualifications

1. Experienced in application of specified coatings for a minimum of 5 years on projects of similar size and complexity to this work.

2. Applicator's Personnel

   Employ persons trained for application of specified coatings.

C. Pre-application Meeting

1. Convene a pre-application meeting two weeks before start of application of coating systems. Attendance of parties directly affecting work of this section, including Contractor, Engineer, Applicator, and Manufacturer's representative, is required. The meeting shall cover, but not be limited to, the following:

   a. Environmental requirements.

   b. Protection of surfaces not scheduled to be coated.

   c. Surface preparation.

   d. Application.

   e. Repair.

   f. Field quality control.

g. Cleaning.

h. Protection of coating systems.

i. One-year inspection.

j. Coordination with other work.

k. Application at joint, cracks and unique conditions.

D. Manufacturer's Representative During Painting Operations

An authorized Manufacturer's representative shall be present at the start-up and weekly during painting operations. Such representative shall instruct and observe the Contractor's and Applicator's work and shall, at the completion of work, certify in writing to the Engineer that the Manufacturer's application recommendations have been adhered to. The cost of this work shall be borne by the Contractor.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery

1. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying:

a. Coating or material name.

b. Manufacturer.

c. Color name and number.

d. Batch or lot number.

e. Date of manufacture.

f. Mixing and thinning instructions.

B. Storage

1. Store materials in a clean dry area and within temperature range in accordance with Manufacturer's instructions.

2. Keep containers sealed until ready for use.

3. Do not use materials beyond Manufacturer's shelf life limits.

C. Handling

Protect materials during handling and application to prevent damage or contamination.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Weather

1. Air and Surface Temperatures

   Prepare surfaces and apply and cure coatings within air and surface temperature range in accordance with Manufacturer's instructions.

2. Surface Temperature

   Minimum of 5º F (3° C) above dew point.

3. Relative Humidity

   Prepare surfaces and apply and cure coatings within relative humidity range in accordance with Manufacturer's instructions.

4. Precipitation

   Do not prepare surfaces or apply coatings in rain, snow, fog, or mist.

5. Wind

   Do not spray coatings if wind velocity is above manufacturer's limit.

B. Ventilation

Provide ventilation during coating evaporation stage in confined or enclosed areas in accordance with AWWA D 102.

C. Dust and Contaminants

1. Schedule coating work to avoid excessive dust and airborne contaminants.

2. Protect work areas from excessive dust and airborne contaminants during coating application and curing.

1.07 TESTING EQUIPMENT

A. The Contractor shall furnish and make available to the Engineer the following items of testing equipment for use in determining if requirements of this section are being satisfied. Specified items of equipment shall be available for the Engineer's use at all times when field painting or surface preparation is in progress.

1. Wet film gauge.

2. Surface thermometer.

3. Keane-Tator surface profile comparator.

4. Set of National Association of Corrosion Engineers (NACE) visual standards.

5. Holiday (pin hole) detector (low voltage).

6. Sling-psychrometer.

7. Magnetic dry film gauge.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Approved manufacturers include:

1. Tnemec.

2. Induron.

3. Carboline.

B. Unless otherwise indicated, product names and numbers specified herein are manufactured by Tnemec. Equivalent materials produced by approved Manufacturer's shall be acceptable subject to prior review by the Engineer.

2.02 PAINTING SCHEDULE

A. General: The Painting Schedule presented below summarizes the painting systems to be applied to the various surfaces.

B. Exposure terms refer to the environmental conditions to which different surfaces may be exposed. A surface may exist in more than one exposure, e.g. an exterior wall can be categorized not only as "Exposed", but also as "Buried", where the exposure is below the grade line.

C. In addition to the major items listed in the Painting Schedule, the Contractor shall paint safety warnings and notices as outlined in these specifications.

PAINTING SCHEDULE

INTERIOR CONCRETE CONTAINMENT FLOORS AND WALLS

Exposure:	Severe Chemical/ Functional
System Type:	Novolac Epoxy
Surface Prep:	Grind Floor, SSPC-SP 13/ NACE No. 6 , ICRI-CSP 4-5
Prime Coat:	Tnemec Series 201 applied @ 4.0 to 12.0 mils DFT
Base Coat:	Series 239SC applied @ 6.0 to 12.0 mils DFT
Fiberglass Reinforcement:	¾ oz. chopped strand fiberglass mat
Saturant Coat:	Series 239SC applied @ 6.0 to 12.0 mils DFT
Topcoat:	Tnemec Series 282-33GR applied @ 4.0-8.0 mils DFT
Total DFT:	65.0 to 75.0 mils DFT

EXTERIOR CONCRETE CONTAINMENT FLOORS AND WALLS

Exposure:	Severe Chemical/ Truck Containment Area
System Type:	Novolac Epoxy
Surface Prep:	Grind Floor, SSPC-SP 13/NACE 6, ICRI-CSP 4-5
Base Coat:	Tnemec Series 241 with 30/50 mesh dry silica sand applied @ 1/8”
Grout Coat:	Series 239SC applied @ 10.0 to 12.0 mils DFT
Topcoat:	Tnemec Series 290-33GR applied @ 6.0-8.0 mils DFT
Total DFT:	131.0 .0 to 145.0 mils DFT

CONCRETE MASONRY UNITS:

Exposure:	Interior Walls Exposed to View
System Type:	Novolac Epoxy
Surface Prep:	Level protrusions and mortar spatter. Clean and dry.
Prime Coat:	Tnemec Series 130-6602 masonry filler 60 to 100 sq ft/gal (20-25 Mils DFT)

Intermediate Coat:	Tnemec Series 282-33GR applied @ 4.0 to 6.0 mils DFT
Finish Coat:	Tnemec Series 282-33GR applied @ 4.0 to 6.0 mils DFT
Total DFT:	28 to 37 mils DFT
EXTERIOR PUMPS:	
Exposure:	Exterior Exposed
System Type:	Epoxy
Surface Prep:	SSPC-SP2 or SSPC-SP3
Prime Coat:	Tnemec Series 135- Color applied @ 3 to 4 mils DFT
Finish Coat:	Tnemec Series N69 – Color applied @ 2 to 3 mils DFT
Total DFT:	5.0 to 7.0 mils DFT
Exposure:	Exterior Exposed
System Type:	Epoxy/Polyurethane
Surface Prep:	SSPC-SP2 or SSPC-SP3
Prime Coat:	Tnemec Series 135 applied @ 3.0-4.0 mils DFT
Finish Coat:	Tnemec Series 72 applied @ 2.0-3.0 mils DFT
Total DFT:	5.0-7.0 mils DFT

2.03 COLORS

A. Building Walls and Floors: Selected by Owner from standard color chart

B. Chemical Piping and Pumps: Selected by Owner from standard color chart

2.04 ACCESSORIES

A. Coating Application Accessories

1. Accessories required for application of specified coatings in accordance with manufacturer's instructions, including thinners.

2. Products of coating manufacturer.

B. Chemical Resistant Joint Sealant System: Use high performance Polysulfide joint sealant system for all joints in the chemical storage and dispensing area meeting the following standards:

1. Certified NSF Standard 61, Sec. 6.

2. MIL TT-S-00227, Type II, non-sag.

3. ASTM C-920, Type M, Grade NS, Class25, Use NT, M, G, A and O.

4. ANSI A116.1

5. Contains no volatile solvents.

a. Basis of Design: Thiokol 2235M

b. Prime Coat: Thiokol 415 @ 3-5 mils DFT

c. Backer Rod: ¾” Closed Cell Backer Rod

d. Sealant: Thiokol 2235M

e. Install Fabric: Thiokol RLP 2378 Fabric

f. Bonding Agent: Thiokol 196 BA

g. Top Coat: Thiokol 196 SL

PART 3 - EXECUTION

3.01 EXAMINATION

Examine areas and conditions under which coating systems are to be applied. Notify Engineer of areas or conditions not acceptable. Do not begin surface preparation or application until unacceptable areas or conditions have been corrected.

3.02 PROTECTION OF SURFACES NOT SCHEDULED TO BE COATED

A. Protect surrounding areas and surfaces not scheduled to be coated from damage duringsurface preparation and application of coatings.

B. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

C. After resinous flooring is complete install ProplexBreathershield FR, vapor permeable membrane, flame retardant, fabric, followed by Proplex 1200 rigid flame-retardant twin-walled polypropolene. Contact www.entrypointusa.com .

3.03 SURFACE PREPARATION OF PVC

A. Prepare PVC surfaces in accordance with Manufacturer's instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Scarify PVC surfaces.

3.04 SURFACE PREPARATION OF CONCRETE FLOORS

A. Prepare concrete surfaces in accordance with Manufacturer's instructions, SSPC-SP13/NACE 6, and ICRI 03732.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Allow concrete to cure for a minimum of 28 days before coating.

D. Test concrete for moisture in accordance with ASTM D 4263 and F 1869.

3.05 SURFACE PREPARATION OF POROUS CONCRETE MASONRY UNITS

A. Prepare porous concrete masonry unit surfaces in accordance with Manufacturer's instructions and SSPC-SP 13/NACE 6.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Allow mortar to cure for a minimum of 28 days before coating.

D. Level protrusions and mortar spatter.

3.06 APPLICATION

A. Apply coatings in accordance with Manufacturer's instructions.

B. Mix and thin coatings, including Ulti-component materials, in accordance with manufacturer's instructions.

C. Keep containers closed when not in use to avoid contamination.

D. Do not use mixed coatings beyond pot life limits.

E. Use application equipment, tools, pressure settings, and techniques in accordance with Manufacturer's instructions.

F. Uniformly apply coatings at spreading rate required to achieve specified DFT.

G. Apply coatings to be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.

H. Stripe paint with brush critical locations on steel such as welds, corners, and edges using specified primer.

3.07 REPAIR

A. Materials and Surfaces Not Scheduled To Be Coated

Repair or replace damaged materials and surfaces not scheduled to be coated.

B. Damaged Coatings

Touch-up or repair damaged coatings. Touch-up of minor damage shall be acceptable where result is not visibly different from adjacent surfaces. Recoat entire surface where touch-up result is visibly different, either in sheen, texture, or color.

C. Coating Defects

Repair in accordance with manufacturer's instructions coatings that exhibit film characteristics or defects that would adversely affect performance or appearance of coating systems.

3.08 FIELD QUALITY CONTROL

A. Applicator's Services

1. Verify coatings and other materials are as specified.

2. Verify surface preparation and application is as specified.

3. Verify DFT of each coat and total DFT of each coating system is as specified using wet film and dry film gauges.

4. Coating Defects

a. Check coatings for film characteristics or defects that would adversely affect performance or appearance of coating systems.

b. Check for holidays on interior steel immersion surfaces using holiday detector.

5. Report

a. Submit daily written reports describing work performed, inspections made, and actions taken to correct nonconforming work. Daily reports shall contain, but no tbe limited to, the following information:

i. Start date and time of work in each area.

ii. Weather conditions.

iii. Date and time of application for each following coat.

iv. Moisture content of substrate prior to each coat.

v. Provisions utilized to maintain temperature and humidity of work area with Manufacturer's recommended ranges.

b. Report nonconforming work not corrected.

c. Submit copies of report to Engineer and Contractor.

B. Manufacturer's Field Services

Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating systems and shall be available .

3.09 CLEANING

Remove temporary coverings and protection of surrounding areas and surfaces.

3.10 PROTECTION OF COATING SYSTEMS

Protect surfaces of coating systems from damage during construction.

3.11 ONE-YEAR INSPECTION

A. Owner will set date for one-year inspection of coating systems.

B. Inspection shall be attended by Owner, Contractor, Engineer, and Manufacturer's representative.

C. Repair deficiencies in coating systems as determined by Engineer in accordance with Manufacturer’s instructions.

3.12 PIPE LABELS

A. After painting of pipe work is completed, all pipe work shall have stenciled labels indicating the contents of the pipe (" i.e"."FERROUS CHLORIDE").

B. Labels shall be placed on each side of the pipe (180 degrees from each other) and spaced at maximum 20 feet on center. Labels shall be placed such that they are in direct line of sight. For pipe runs less than 20 feet, label shall be placed at the center of the run or the most visible location. Label may be omitted from one side of pipe if view is obstructed from that side.

C. When the flow in a pipe is in one direction at all times, flow direction arrows shall be placed in front of each label on the pipe.

D. The width of each letter shall be 80% of the height of each letter. The height of each letter shall be as follows:

1. For pipes 3/4" to 1 1/2" in diameter: ½” in height

2. For pipes 2" in diameter: 3/4” in height

3. For pipes 2 ½” to 6" in diameter: 1 1/4” in height

4. For pipes 6" to 10" in diameter: 2 1/2” in height

5. For pipes greater than 10" in diameter: 31/2 in height.

E. For pipes smaller than %" in outside diameter, use a laminated plastic or aluminum tag with the lettering etched or stamped and filled in with black or contrasting enamel.

F. Labels shall be black or white in color such that it is contrasting with the primary pipe color.

3.13 EQUIPMENT LABELS

Where specified or directed by the Engineer, the Contractor shall label, in the same manner as the pipe, the individual units of equipment such as blowers, pumps, collector drives, compressors, silencers, etc. All push buttons, starters, switches, etc., when remote from the equipment, shall have labels of the engraved plastic type affixed to or adjacent to the remote switch, push button, starter, etc.

+ + + END OF SECTION 09910 + + +

SECTION 11308

SEAL-LESS MAGNETIC DRIVE PUMPS

PART 1 -GENERAL

1.01 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

B. (Not used).

1.02 EQUIPMENT AND COMPONENT NUMBERS

A. 532P1, 532P2: Aluminum Chlorohydrate Transfer Pumps.

B. 542P1, 542P2: Phosphoric Acid Transfer Pumps.

C. 592P1, 592P2: Sulfuric Acid Transfer Pumps.

D. 602P1, 602P2: Purate Transfer Pumps.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with the requirements of Section 01300 of these Specifications.

B. Additional shop drawing information required:

1. Provide make, model, weight, and horsepower of each equipment assembly.

2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction. Seal, coupling, and bearing literature shall be included with the pump information.

3. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity at the specified specific gravity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and NPSHR required at the guarantee point for the specific gravity and viscosity required.

4. Detailed mechanical and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.

5. Power and control wiring diagrams, including terminals and numbers.

6. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
7. Information, including technical catalog literature and specifications, on factory prime and finish coating systems in accordance with Section 09910, High Performance Coating.

    a. Where manufacturer proposes paint system different from that specified, manufacturer shall submit complete technical literature showing that the proposed paint system is equivalent or better than the paint system specified for the intended environmental conditions.

    b. (Not used.)

C. Quality Control Submittals:

1. Special shipping, storage and protection, and handling instructions.

2. Manufacturer's printed installation instructions.

3. Manufacturer's Certification of Compliance that the factory finish system is identical to requirements specified herein.

4. Manufacturer's Certificate of Proper Installation.

5. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

6. List all special tools, materials, and supplies which will be furnished with equipment for use, prior to and during start-up, or for future maintenance.

7. Operation and Maintenance Manual.

8. Service records for maintenance performed during construction.

9. Field Test Reports.

1.04 EXTRA MATERIALS

A. Furnish for each set of pumps.

1. Complete set gaskets and O-ring seals for each pump.

2. All constituent components comprising the entirety of a single pump head assembly shall be provided in fully assembled form, allowing for rapid pump replacement, for each pair of pumps. [ADD NO.1]

3. All constituent components comprising the entirety of a single pump head assembly shall be provided in disassembled form for each pair of pumps. [ADD NO.1]

2. ~~Complete set keys, dowels, pins, etc.~~ [ADD NO.1]

3. ~~One drive shaft for each pair of pumps.~~ [ADD NO.1]

4. ~~One impeller for each pair of pumps.~~ [ADD NO.1]

4. Any additional spare parts as recommended by pump manufacturer to maintain pump in operation for duration of pump warranty period (for each pump).

5. One complete set of any special tools required to dismantle or reassemble the pump.

B. (Not used).

1.05 STORAGE AND PROTECTION

1. Pumps shall be stored and protected in accordance with the requirements of Section 01611 of these Specifications.

2. (Not used).

PART 2 - PRODUCTS

2.01 GENERAL

A. Coordinate pump requirements with drive and motor manufacturer and be responsible for pump, drive, and motor requirements.

B. Pump design shall be single-stage, end suction close-coupled, frame mounted, leak-proof, seal-less magnetic drive design.

C. All specified performance is required at the specific gravity noted in the Data Sheets.

2.02 MANUFACTURERS

A. Iwaki Pump or March Pump. Pumps shall meet all pertinent design capabilities as the following specified Iwaki Pump pumps:

1. 532P1, 532P2, 542P1, 542P2, 592P1, 592P2, 602P1, 602P2:
Iwaki Model MX-400F-AFV or March Pump Equivalent

2.03 PUMP DATA SHEETS

Aluminum Chlorohydrate – 532P1, 532P2:	
Design Flow Rate (gpm; design points A & B)	A: 2.5 B: 38.6
Total Dynamic Head (ft)	A: 30.5 B: 22.5
Horsepower (hp)	0.75
Impeller Diameter (inch)	2.91
NPSHR (ft)	9
Chemical Strength (%)	50
Fluid Specific Gravity	1.34

Phosphoric Acid - 542P1, 542P2:	
Design Flow Rate (gpm; design points A & B)	A: 2.5 B: 38.6
Total Dynamic Head (ft)	A: 30.5 B: 22.5
Horsepower (hp)	0.75
Impeller Diameter (inch)	2.91
NPSHR (ft)	9
Chemical Strength (%)	36
Fluid Specific Gravity	1.22

Sulfuric Acid - 592P1, 592P2:	
Design Flow Rate (gpm; design points A & B)	A: 2.5 B: 38.6
Total Dynamic Head (ft)	A: 30.5 B: 22.5
Horsepower (hp)	0.75
Impeller Diameter (inch)	2.91
NPSHR (ft)	9
Chemical Strength (%)	78
Fluid Specific Gravity	1.71

Purate - 602P1, 602P2:	
Design Flow Rate	A: 2.5 B: 38.6

(gpm; design points A & B)	
Total Dynamic Head (ft)	A: 30.5 B: 22.5
Horsepower (hp)	0.75
Impeller Diameter (inch)	2.91
NPSHR (ft)	9
Chemical Strength (%)	40 (Sodium Chlorate)
Fluid Specific Gravity	1.37

2.03 PUMP CONSTRUCTION AND DESIGN

A. Casing:

1. Vertically split, with back pull-out arrangement to maintain impeller without disconnection of piping.

2. Provide thrust washer and mounting for impeller spindle in casing.

3. All wetted parts (casing, impeller, O-rings, bushing, etc.), shall be constructed of the materials specified on the Pump Data Sheet and suitable for intended application.

4. Gauge Connections: Provide tapped and plugged suction and discharge gauge connections on the adjacent piping immediately upstream and downstream of the pumps (prior to any valves or fittings).

5. Pumps with constant speed drives shall be capable of at least a 5 percent head increase at rated conditions by installing a new impeller.

6. Pump suction and discharge shall provide female NPT connections with a minimum diameter of 1-inch. [ADD NO.1]

B. Drive:

1. Provide pump coupled to motor through a seal-less magnetic drive.

2. Drive to consist of drive magnet, impeller magnet, impeller magnet housing, and motor bracket.

3. Provide O-ring seal between impeller magnet housing and pump casing.

4. Drive magnet to be completely isolated from pumped fluid.

~~5. Drive magnet to act as clutch to prevent motor overload.~~ [ADD NO.1]

6. Baseplate: Provide foot mounted baseplate suitable for supporting motor and close coupled pump. Each pump base plate shall be constructed of a chemically inert, non-metallic material that allows the pump baseplate to be leveled and grouted with a polymeric grout. [ADD NO.1]

C. Wetted Materials

1. All pump wetted materials shall be as recommended by pump manufacturer for the chemical solution transferred during normal pump duty.

2. ~~All pump wetted materials shall be NSF 61 approved.~~ [ADD NO.1]

2.04 MOTOR

A. The motor shall be designed and manufactured in accordance with the standards of NEMA and shall have the following characteristics:

1. Horsepower: 0.75

2. RPM: 3,600.

3. Enclosure: TEFC.

4. Insulation: Class F.

5. Voltage: 230 volt, 60 Hz, 3-phase.

6. Service Factor: 1.15.

B. (Not Used.)

2.05 ACCESSORIES

A. Equipment Identification Plate: 16-gauge, Type 316 stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location. Tag number may be laser etched rather than die-stamped. [ADD NO.1]

B. Lifting Lugs: Equipment weighing over 100 pounds (Not Applicable).

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05500, Metal Fabrications and Castings.

2.06 FACTORY FINISHING

A. Prepare, prime, and finish coat in accordance with Section 09910. Pump units constructed of corrosion resistant non-metallic materials shall not require coating in accordance with Specification 09910. Pump motors shall be designed and manufactured in accordance with the standards of NEMA 4X and meet the characteristics noted in 2.04.A.1-6. IEC frame units will not be allowed. [ADD NO.1]

B. (Not used).

2.07 SOURCE QUALITY CONTROL

A. Functional Test: ~~Perform manufacturer's standard test on equipment.~~ Perform manufacturer's standard test on equipment and demonstrate performance in accordance with manufacturer's pump curve that includes the duty points identified in Section 2.03 *Pump Data Sheets*. [ADD NO.1]

B. Hydrostatic Tests: Test pump casing(s) at 150 percent of shutoff head. Maintain test pressure for not less than 5 minutes.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4-inch per foot. Use double wedges to provide a level bearing surface for the pump and driver base. Accomplish wedging so that there is no change level or springing of the baseplate when the anchor bolts are tightened.

C. Adjust pump assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

D. After the pump and driver have been set in position, aligned, and shimmed to the proper elevation, grout the space between the bottom of the baseplate and the concrete foundation with a poured, nonshrinking grout of the proper category, as specified in Section 03313. Remove wedges after grout is set and pack void with grout.

E. Connect suction and discharge piping without imposing strain to pump flanges.

F. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05500, Metal Fabrications and Castings.

3.02 FIELD FINISHING

A. Touch up equipment as specified in Section 09910, High Performance Coatings.

B. (Not used).

3.03 FIELD QUALITY CONTROL

A. Provide field quality control as described herein.

B. Functional Tests: Conduct on each pump.

1. Alignment: Test complete assemblies for correct rotation, proper alignment connection (where appropriate), quiet operation, and minimal vibration (as approved by Engineer). [ADD NO. 1]

2. Flow Output: measured by plant instrumentation or storage volumes.

3. Fluid Tightness: Test complete assembly in operation to confirm no leakage is present during operation.

4. ~~Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.~~ [ADD NO.1]

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. Two person-days for completion of Manufacturer's Certificate of Proper Installation, functional testing, and training.

2. (Not used).

B. (Not used)

+++ END OF SECTION 11308 +++

SECTION 13057

POLYETHYLENE STORAGE TANKS

PART 1 GENERAL

1.01 SCOPE

A. This Specification covers the work necessary to furnish, install, and test complete, upright, cylindrical, flat bottom tanks molded in one-piece seamless construction by rotational molding and attachments (including but not limited to ladder and restraint system) to the tanks. The tanks are designed for service as indicated in this specification.

B. (Not used).

1.02 EQUIPMENT AND COMPONENTS NUMBER

A. 585T1 and 585T2 Sodium Hypochlorite Bulk Tanks.
(Minimum 12,000 gal.)

B. 601T Purate Bulk Tank.
(Minimum 6,000 gal.)

C. 541T Phosphoric Acid Bulk Tank.
(Minimum 6,000 gal.)

D. 591T Sulfuric Acid Bulk Tank.
(Minimum 6,000 gal.)

1.03 DEFINITIONS

A. Terms: ASTM D883, definition of terms relating to plastics.

B. XLPE: Cross-linked high density polyethylene

C. ACI 318-14, Building Code Requirements for Structural Concrete

D. ASCE 7-16, Minimum Design Loads for Buildings and Other Structures

1.04 DESIGN REQUIREMENTS

A. Design tank, including resin selection, wall thickness, methods and locations of support, and stiffener requirements, and when specified, insulation, and heat tracing. Design shall be prepared and sealed by designer meeting requirements of Paragraph QUALITY ASSURANCE.

B. Design tank restraint system including anchorage embedment depth. Design shall be prepared and sealed by structural designer meeting requirements of Paragraph QUALITY ASSURANCE.

C. Material in contact with chemicals shall be NSF approved.

1.05 SUBMITTALS

A. Shop Drawings:

1. Fabricator's catalog information, descriptive literature, specifications, and identification of materials of construction. Include complete resin system information.

2. Drawings: Orthographic drawings shall be scale drawings showing the relative size, configuration, location, materials of construction, and details of all equipment and materials to be furnished including the tanks, fittings, supports, ladder, and tank restraint and support systems. Both plan and elevation views shall be provided. All necessary clearances required for maintenance and operation shall be clearly shown and fully dimensioned.

3. Barlow wall thickness calculations shall be stamped and signed by a registered professional engineer provided by the Manufacturer.

4. Tank restraint system and anchorage calculations shall be stamped and signed by a registered structural engineer in the State of Georgia provided by the Manufacturer.

    a. Show flotation, seismic and wind criteria per requirements in paragraphs SERVICE CONDITIONS and STRUCTURAL DESIGN REQUIREMENTS.

5. Tank data indicating equipment number, diameter, straight shell lengths, overall lengths, wall thickness, and details of nozzle designs and appurtenances such as pipe supports, and level indicators.

6. Tank capacity chart indicating gallons for each inch of depth and cumulative total from bottom.

7. Manufacturer’s recommended anchor bolt, 5-ring.

8. Recommended bolt torques for all bolted connections.

9. Recommendations for tank material selection and fabrication methods for services indicated on the Tank Data Sheet included at the end of this section.

10. Factory Test Results: Provide a certified copy of all factory test results including gel tests, impact tests, and hydrostatic tests.

11. Installation Instructions: Installation instructions shall be completed, detailed, and sequenced instructions for original installation. Recommended methods for assembly and adjustment including all bolt torques shall be provided along with special precautions and the sequence of work. Rigging and lifting details shall also be included for all factory-fabricated assemblies and individual components weighing over 100 pounds.

12. All tank signage including equipment tag and hazard signage.

13. All exceptions and any proposed revisions to the requirements of the Specifications shall be included with the submittals.

14. Drawings depicting accessory level indication equipment as required and detailed elsewhere in this specification.

15. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required". Failure to include all drawings applicable to the equipment specified in this section will result in rejection of the entire submittal with no further review.

B. Samples: Representative samples of high density cross-linked polyethylene with liner as appropriate shall be provided for each different tank/liner combination.

C. Quality Control Submittals:

1. Fabricator's Certificate of Compliance with fabrication requirements.

2. Qualifications of Fabricator's Quality Assurance Supervisor.

3. Copy of the Fabricator's Quality Assurance Program.

4. Quality Assurance Program:

   a. Initial QA Inspection Report.

   b. Certification of Factory Testing.

5. Qualifications of Tank Designer and Structural Engineer(s).

6. Special shipping, storage and protection, and handling instructions.

7. Fabricator's written/printed installation and tank support instructions.

8. Manufacturer's Certificate of Proper Installation.

9. Operation and Maintenance Manuals.

10. Manufacturer’s Certificates of Compliance for Ladder and Safety Harness.

D. Drawing Approval: Shop Drawings shall be approved by ENGINEER prior to manufacturing of the tanks. Approval of Drawings by the ENGINEER shall not release the CONTRACTOR of responsibility of compliance with these Specifications.

E. Contract Closeout Submittals: Service records for repairs preformed during construction.

1.06 QUALITY ASSURANCE

A. Fabricator's Quality Assurance Supervisor: Minimum of 3 years' experience in the fabrication of rotationally molded polyethylene tanks.

B. Tank Designer: Registered professional engineer.

C. Structural Designer: Structural Engineer (SE), registered in the State of Georgia. A registered professional engineer (PE) will not be accepted. The Structural Engineer shall be experienced in the design of tank restraints and anchorage having designed a minimum of 5 projects with similar conditions, size and scope within the past 5 years.

D. The tanks shall be furnished, coordinated, and tested by one manufacturer. The system shall be completely shop-assembled, and shop-tested prior to shipment.

E. Ladder Certificate of Compliance: Ladder including components, fasteners, anchorage, and anchorage embedment shall be certified to meet code and regulation requirements and as specified herein based on engineering design or testing.

F. Safety Harness Certificate of Compliance: Safety Harness shall be certified to meet code and regulation requirements and as specified herein based on engineering design or testing.

1.07 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01610 and 01611. In addition, prepare and protect the tanks for shipment as follows:

1. Mount and ship tanks in accordance with manufacturer's written shipping, handling, and installation instructions.

2. Remove flanged fitting adapters prior to shipping. Temporarily seal nozzle openings to prevent debris from entering the tank.

3. Do not ship components or other pieces loose inside the tanks.

4. Load tanks with at least 2-inch clearance between the tank (including fittings) and the bulkheads or bed of the vehicle.

5. Regardless of the mode of transportation, firmly fasten and pad all components to prevent shifting of the load or flexing of components while in transit.

6. Nozzles or other fittings shall not be used for lifting.

7. Protect all flanged nozzles with wooden blinds bolted to the flange and having a diameter of 2 inches greater than the outside diameter of the flange.

B. (Not Used).

1.08 SEQUENCING AND SCHEDULING

A. Tanks shall not be shipped from factory until ENGINEER's review of Certification of Factory Testing is completed.

B. Contractor shall sequence tank delivery in a manner that allows for adherence to all project sequencing and storage requirements as outlined in Contract Drawings and these Specifications.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Poly Processing Co.

B. Snyder Tanks.

2.02 SERVICE CONDITIONS

A. The proposed chemical service of the tanks is defined in the Tank Data Sheets.

B. Seismic conditions when tank is full or empty. Tank system including tank restraint system shall be seismically qualified in accordance with ASCE 7-16, Chapter 13.

C. Wind conditions when tank is full or empty. Shielding effects from adjacent walls, tanks, buildings or other structures is not permitted.

D. Flotation: Tank restraint system shall resist each tank (within containment areas shared by other tanks) for flotation when tank is empty and containment area is filled to top of containment wall with contents from adjacent tank(s) based on specific gravity of adjacent tanks.

E. Operating Pressure: Atmospheric.

2.03 TANK CONSTRUCTION

A. Tank specified herein shall be cross-linked high density polyethylene construction with interior anti-oxidant resistant HDPE resin as required by chemical service. Integrally mounted flanged outlet (IMFO or equal) and shall meet or exceed all requirements of ASTM D1998.

B. Tanks shall be vertical, flat bottom (except for IMFOR locations), dome top construction with translucent materials to allow observation of liquid level.

C. IMFO fittings (or equal) shall be constructed such that fitting components extending below the bottom of the tank shall be positioned no less than 9 inches from tank wall as measured perpendicularly from the tank along the fitting axis.

D. Tank manufacturer must be capable of issuing gel test results reading no less than 65 percent. Entire thickness must be at least 80 percent gelled.

E. The XLPE tanks shall be constructed using the rotational molding process.

F. Materials of Construction: The material used shall be virgin polyethylene resin as compounded and certified by the manufacturer. Tanks shall be made from high density cross-linked polyethylene resin as manufactured by Exxon Chemical, or resin of equal physical and chemical properties. All polyethylene resin material shall contain a UV stabilizer as compounded by the resin manufacturer. Pigments shall not exceed 0.25 percent (dry blended) of the total weight.

G. Mechanical Properties of Tank Material:

Property	ASTM	Value
Density (Resin)	D1505	0.938-0.944 glee
Tensile Strength (Yield)	0638	2,600 psi
Elongation at Break	0638	350 percent
ESCR (100 percent IGEPAL, Cond. A, F50)	01693	400 - 1,000 hours
ESCR (10 percent IGEPAL, Cond. A, F50)	01693	200 - 500 hours
Vicat Softening Temperature	D1525	235 degrees F
Flexural Modulus	D790	97,000 – 103,000 psi
Specific Gravity	--	1.9

H. Design Requirements:

1. The tanks shall be designed in accordance with ASTM DI998, Standard Specifications for polyethene upright storage tanks.

2. The minimum required wall thickness or the cylindrical shell at any fluid level shall be determined by the following equation, but shall not be less than 0.187-inch thick.

$$T = P \times (OD/2) \times (SD) = 0.433 \times S.G. \times H \times (OD/2) \times (SD)$$

T= wall thickness, inch
SD = hydrostatic design stress, psi
P = pressure (0.433 x S.G. x H), psi
H= fluid head, foot.
S.G.= specific gravity, g/cm3
OD = outside diameter, inches

a. The hydrostatic design stress shall be determined by multiplying the hydrostatic design basis, determined by ASTM D2837 using rotationally molded samples with a service factor selected for the application. The hydrostatic design stress for the tank material is 600 psi at 100 degrees F. In accordance with the formula above, the tank shall have a stratiform (tapered wall thickness) wall.

b. The hydrostatic design stress shall be derated for service above 100 degrees F and for mechanical loading of the tank.

3. Flat areas shall be provided to allow location of fittings on the cylinder straight shell larger than those specified for a curved surface in Article TANK

FITTINGS. The bottom knuckle radius of flat bottom tanks shall be a minimum of 2 inches.

4. On domed top tanks, the top head must be integrally molded with the cylinder shell. The minimum thickness of the top head shall be equal to the top of the straight wall. The top head of tanks with 2,000 or more gallons of capacity shall be designed to provide a minimum of 1,300 square inches of flat area for fitting locations.

I. Structural Design Requirements: Design, analyze and detail tank and ladder components and systems (including but not limited to tank restraint system, components, welds, connections, lugs, anchorage, anchorage embedment, etc.) in accordance with the design requirements provided on the Drawings and herein:

1. Governing codes and design criteria as indicated on Drawings including structural general notes sheets and structural floor plan.

2. OSHA Standard 29 CFR 1910, Occupational Safety and Health Standards

3. Service conditions per paragraph SERVICE CONDITIONS. Additional seismic, wind and operating conditions are indicated on Drawings.

4. Ladder

   a. Ladder shall comply with OSHA Standard 29 CFR 1910 and and American Ladder Institute Publication ANSI-ASC A14.3 – Fixed Ladders.

   b. Live Load:

      1) Concentrated Load at Each Step or Rung: 400 pounds, which includes impact load.

      2) Concentrated Load between Any Two Consecutive Attachments: 250 pounds.

      3) Loads shall be considered to be concentrated at such a point or points as will cause the maximum stress in the structural component in question.

      4) Safety harness system attachment load requirements.

5. Anchorage

   a. Anchorage design shall include anchor bolts and anchor embedment depth.

b. Anchorage design shall consider existing foundation conditions including tank pad edge distance and concrete compressive strength of 4,000 psi. In case existing conditions are not sufficient for anchorage design, CONTRACTOR and anchorage design engineer shall coordinate and develop alternative design solution to determine appropriate conditions for anchorage. Direct anchorage to base foundation shall be acceptable with coordination of existing and new components. Testing of existing materials is at cost to CONTRACTOR.

c. Anchorage design shall be in accordance with ACI 318-14, Chapter 17 and shall be based on “cracked” concrete conditions.

J. Openings and fittings shall be provided as shown on the Tank Data Sheet:

1. All dimensions will be taken with the tank in the vertical position, unfilled. Tank dimensions will represent the exterior measurements.

a. The tolerance for the outside diameter, including out of roundness, shall be per ASTM D1998.

b. The tolerance for fitting placements shall be plus or minus 0.5 inch in elevation and 2 degrees radial at ambient temperature. Appurtenances described herein and shown on the Drawings represent the minimum design standards.

2. (Not Used).

K. Like items of equipment provided hereunder, although for different services shall be the end products of one manufacturer.

2.04 TANK FITTINGS (NOZZLES)

A. Provide tank fittings (nozzles) for proper installation, operation, and as specified on the Tank Data Sheet. All materials used in tank fitting assemblies shall be resistant to the stored chemicals. No wetted fittings or appurtenances shall be metallic construction.

B. Fittings -Bolted Flange Fittings

1. 150-pound bolted double flange fittings are required for below liquid level installation for sizes 1inch and above depending on the diameter and the placement of the fittings in the tank. Fittings must be placed away from tank knuckle radius and flange lines. Allowable fitting sizes based on tank diameter for curved surfaces are shown below:

Tank Diameter	Maximum Bolted Fitting Size Allowable
48 in. - 86 in.	3 in.
90 in. - 102 in.	6 in.
120 in. - 142 in.	8 in.

2. The bolted double flange fitting shall allow tank wall thickness up to 2-1/2 inches

3. The bolted double flange fitting shall be constructed with two each, 150-pound flange; two each, 150-pound flange gasket, and the correct number and size of all thread bolts for the flanges specified by the tank manufacturer.

4. The bolted double flange fitting shall be constructed of material compatible with the fluid contained within the tank. Tank manufacturer shall submit information indicating the appropriateness of the selected material for Engineer approval.

5. Gasket material shall be constructed of a material rated for continuous exposure to the chemical solution stored in a given tank.

6. The bolts shall be constructed of material rated for continuous exposure to the chemical solution stored in a given tank. The boltheads shall be encapsulated in the polyethylene as the tank material. The encapsulated bolt shall be designed for metal exposure to the liquid in the tank and prevent bolt rotation during installation. The polyethylene shall fully cover the bolt head and a minimum of ¼ inch of the thread closest to the bolt head. The polyethylene shall be color coded to distinguish bolt material. Each encapsulated bolt shall have a gasket to provide a bolt sealing surface against the inner flange.

C. Fittings -Integrally Molded Flanged Outlet:

1. The fitting shall be an integral part of the tank and provide complete drainage of liquid through the side wall of a flat bottom container without the use of a special support structure or concrete pad. Fitting flange shall extend such that, in the position indicated in the Drawings, the flange will be beyond edge of concrete pad sufficient to make connection to piping. The tank pad shall not need to be modified to accommodate a flange extending below the tank bottom.

2. The fitting shall be a flanged molded from the same material as the tank and located flush with tank bottom.

3. Fitting shall be Poly Processing, IMFO™ or, Snyder, SUMO™.

D. Fittings - Siphon Tube Fittings: Provide siphon tubes to the suction fittings specified to allow tank drainage below the invert level of the suction fitting. Siphon tube material shall be the same as the bulkhead fitting.

E. Fittings - Self-Aligning Threaded Bulkhead:

1. Provide self-aligning fittings for installation above the liquid level on curved surfaces depending on the spherical dome radius and the placement of the fitting on the tank dome. Fittings shall be placed away from tank knuckle radius and flange lines. See the Tank Detail Sheet in the Drawings for fitting placement details.

2. The self-aligning fittings and gaskets shall be constructed of the same materials as the threaded bulkhead fitting.

F. Vents: Each tank must be properly vented for the type of material and flow rates specified herein. Vents must comply with OSHA 1910.106 (F) (iii)(2)(1V)(9) for normal venting for atmospheric tanks, or other accepted standard, or shall be as large as the filling or withdrawal connection, whichever is larger but in no case less than 1-inch nominal inside diameter.

2.05 TANK ATTACHMENTS

A. Provide tank attachments for proper installation, operation, and as specified as the Tank Data Sheet and in accordance with Contract Drawings.

1. Level Indication

a. Float Indication: The level indicator shall be assembled to the tank and shall consist of PVC float, indicator, polypropylene rope, perforated interior pipe, PVC roller guides, clear UV resistant PVC sight tube EnviroKing® by C.F. Harvel (or Engineer approved equal), and necessary pipe supports. The level indicator shall act inversely to the tank contents and shall not allow entrance of tank contents into the sight tube at any time. Indicator shall be neon orange color for visual ease for onsite operators.

B. Sealed Top Manway:

1. Provide sealed manways in sizes as specified on Tank Data Sheet

2. The sealed manway shall be constructed of polyethylene material. The bolts shall be polyethylene or other specified material.

3. The gaskets shall be closed cell, crosslinked polyethylene foam, Viton, or other specified material.

2.06 TANK ACCESSORIES

A. Provide tank accessories for proper installation, operation, and as specified on the Tank Data Sheet or as indicated below.

B. Tank Restraint System (including Anchorage to Foundation): Provide manufacturer's standard tank restraint system. Tank restraint system, including but not limited to tie-down lugs, cables, anchor bolts, etc., shall be designed to meet specifications herein and Section 05500, METAL FABRICATIONS. Metal components shall be Type 316 stainless steel, unless otherwise specified on Tank Data Sheet.

1. Anchor Bolts: Anchor bolts shall be Type 316 stainless steel unless otherwise specified on Tank Data Sheet and at least 5/8-inch minimum diameter. Anchor bolts including embedment depth shall be designed by the manufacturer (or his delegated third-party designer) and shall be designed to meet specifications herein and as specified in Section 05500, METAL FABRICATIONS and Section 05095, POST-INSTALLED ANCHORS.

C. Lifting Lugs: Tanks with 2,000 or more gallons of capacity shall have a minimum of 3 lifting lugs integrally molded into the top head. The lifting lugs shall be designed to allow erection of an empty tank.

D. Ladder: Access ladders made from fiberglass reinforced plastic and made with safety harness shall be provided with the polyethylene chemical storage tanks at locations as shown. Ladders must be secured to the tank and secured to the concrete to allow for tank expansion and contraction due to temperature and loading changes. Provide proper chemical resistant materials for anchoring to tank dome and sidewall. Secure to concrete with stainless steel type 316 anchors in accordance with Section 05095.

E. Safety Harness: Provide safety harness for all ladders conforming to OSHA 29 CFR Part 1910.29 and 1910.140. Acceptable manufacturer is North Safety Products Saf-T-Climb® or equivalent. Alternatives must be approved by Engineer.

1. Harnesses shall be provided as follows for this project:

a. Two extra-large harnesses

b. Two large harnesses

c. One Medium Harness

F. Tank Insulation and Heat Tracing:

1. Insulation used shall be polyurethane foam with a "R" value of 8.33 inches.

2. Polyurethane foam shall be applied with a nominal thickness of 2 inches to all external tank except the tank bottom shell.

3. Upon completion of application and curing of insulation, the polyurethane foam shall be coated with two full coverage coats of manufacturers' recommended latix mastic.

4. Heat tracing of tanks shall be provided with a delta T value of 60^{o}F and installed prior to application of tank insulation.

5. Manufacturer must provide guarantee of performance for tank heat tracing and insulation for approval by Owner and Engineer.

G. Permanent signage shall be provided for each tank in conformance with NFPA 704 for chemicals stored within tank.

2.07 EQUIPMENT IDENTIFICATION PLATES

A. Tank Identification: Identify each tank with the fabricator's name, capacity in gallons, design maximum temperature, design pressure, chemical service, specific gravity, minimum wall thickness, vessel "tag" number, vessel name and date of manufacture. Marking shall be permanent. Seal decals, labels, etc., on the tank exterior. Signage material, design, and position shall be submitted to Engineer for approval prior to manufacture.

B. (Not used).

2.08 SOURCE QUALITY CONTROL

A. Provide manufacturer's quality assurance supervisor to be present at the point of manufacture at the time fabrication is started, to perform the following:

1. Observe manufacturing methods, machinery, and techniques to assure compliance with industry standards and these Specifications.

2. Provide manufacturer’s warranty.

3. Observe initial fabrication to verify compliance with these Specifications.

4. Observe quality control methods for mixing resins and testing of completed equipment.

5. Prepare an Initial QA Inspection Report.

B. Provide manufacturer's quality assurance supervisor to be present at the point of manufacture, upon completion of fabrication and prior to shipment, to perform

or witness the items below. Tanks and appurtenances failing to pass inspection requirements shall not be shipped to the site.

C. Test Methods:

1. Test specimens shall be taken from fitting location areas or “piggyback” test molds.

2. Low Temperature Impact Test - ARM Standard:

a. Test specimens shall be conditioned at minus 40 degrees F for a minimum of 2 hours.

b. The test specimens shall be impacted in accordance with ARM Standard Test Method. The specimens less than 1/2 inch thickness shall be tested at 100 foot-pound. Test specimens greater than 1/2-inch thickness shall be tested at 200 foot-pound.

3. Hydrostatic Leak Test:

a. Perform on each tank.

b. Fill to top nozzle; allow to stand for 2 hours with no visible leakage.

D. The tank shall be visually inspected to determine workmanship as discussed hereinafter.

E. Notwithstanding the above, a clearance for shipment shall not relieve the fabricator of responsibility as to performance guarantees, quality of materials and workmanship, and dimensional conformity with the Drawings.

F. Repairs deemed acceptable by the fabricator's quality control supervisor must be approved by ENGINEER.

G. A factory leak test and Certificate of Compliance shall be provided for each tank prior to installation of casing and insulation.

H. Identify and retain all cutouts. ENGINEER may select certain nozzle or manway cutouts for testing for physical properties of the polyethylene.

I. Factory Test Reports: Certify, by signature, results of the following:

1. Inspections.

2. Results of hydrostatic testing.

3. Test reports of physical properties of standard polyethylene.

PART 3 - EXECUTION

3.01 GENERAL

A. Workmanship: The finished tank wall shall be free, as commercially practicable, of visual defects such as foreign inclusions, air bubbles, pinholes, pimples, grazing, cracking, as well as defects that will impair the serviceability of the tank.

B. All cut edges where openings are cut into the tanks shall be trimmed smooth

C. Installation, handling, and storage of the tanks shall be in strict accordance with the manufacturer's printed instructions.

1. Marking, Packing, and Packaging:

a. The tank shall be marked to identify the manufacturer date (and year) of manufacture, capacity, and serial number.

b. The proper caution or warning signs as prescribed by OSHA Standard 29 CFR 1910.106 shall be supplied by the tank manufacturer.

c. All packing, packaging, and marking provisions of ASTM Practice D3892 shall apply to this standard.

d. All fittings shall be installed, removed, and shipped separately.

2. Shipping:

a. Tanks shall be shipped per manufacturer's recommendations.

b. Tank loading and unloading shall be per manufacturer' s instructions

3.02 INSTALLATION

A. By the CONTRACTOR, in accordance with the fabricator's written instructions.

B. (Not used).

3.03 FIELD QUALITY CONTROL

A. Functional Test:

1. Conduct on each tank.

2. Hydrostatic leak test with the tank full of clean water. Allow water to stand for 24 hours to verify no leakage.

3. Any viable evidence of leakage after 24 hours shall require an investigation and correction by the CONTRACTOR to the OWNER'S satisfaction.

4. Following repairs of leaks, the tank shall be retested. The tank and wetted accessories shall be completely dried before being placed in service.

B. (Not Used).

3.04 MANUFACTURER’S SERVICES

A. Manufacturer's Representative: Present at site or c1assroom designated by OWNER for minimum person-days listed below, travel time exc1uded:

1. Two (2) person-days for installation assistance and inspection per tank.

2. One (1) person-day for functional testing and completion of Manufacturer’s Certificate of Proper Installation per tank.

B. See Section 01740, WARRANTIES

TANK DATA SHEET

Tank Number	585T1	585T2	601T	542T	591T
Chemical Stored	Sodium Hypochlorite	Sodium Hypochlorite	Purate	Phosphoric Acid	Sulfuric Acid
Chemical Purity (%)	12.5	12.5	40 (Sodium Chlorate) 8 (Hydrogen Peroxide)	36	78
Chemical S.G.	1.21	1.21	1.37	1.22	1.71
Chemical Density (lb/gal)	10.01	10.01	11.51	10.17	14.26
Chemical pH	14	14	1.7	<2	<1
Chemical Boiling Temperature (°F)	>212	>212	>212	>212	>212
Chemical Freezing Temperature (°F)	14 (at decayed % strength)	14 (at decayed % strength)	<0	<0	4
Tank Volume (Gal)	12,000 min.	12,000 min.	6,000 min.	6,000 min.	6,000 min.
Tank Material	XLPE	XLPE	XLPE	XLPE	XLPE
Heat Trace and Insulation	YES	YES	YES	YES	YES
Tank Diameter (maximum)	12’	12’	10’ 4”	10’ 4”	10’ 4”
Tank Fittings	Sizes				
Suction	2”	2”	2”	2”	2”
Fill	3”	3”	3”	3”	3”
Overflow	4”	4”	4”	4”	4”
Drain	4”	4”	4”	4”	4”
Vent	8”	8”	6”	6”	6”
Interconnection	2”	2”	N/A	N/A	N/A
Level Sensor	3”	3”	3”	3”	3”
Level Indicator	2”	2”	2”	2”	2”
Manway	24”	24”	24”	24”	24”

END OF SECTION 13057

SECTION 13122

METAL BUILDING SYSTEM REFURBISHMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. The existing canopies over the bulk chemical storage and chemical containment areas (including Northeast Area and South Area) are pre-engineered metal building systems constructed circa 2006. Over the life of the canopies (metal building systems), components of the structures have experienced weathering, wear and tear and degradation. Several of these components have been identified for replacement to extend the service life of the structures. In addition, it is anticipated that portions of the canopies will need to removed and re-installed to safely install several new bulk chemical tanks under the canopies.

B. The primary intent of the Work in this Section is to:

1. Enable Contractor to work under and around the canopies to safely install tanks and equipment in the Northeast and South Areas within the operating constraints of the Project requirements, and

2. Refurbish the existing canopies to extend the service life of the structures.

3. Match color and style of new materials with adjacent existing conditions.

C. This Section identifies the components that need to be replaced, the minimum components that shall be removed and re-installed, and the components that shall remain. Contractor shall determine the full extent of removal and replacement of canopy components necessary to remove existing tanks and to install new tanks and to perform all other Work, as required in the Contract Documents. Removal and replacement of canopy components beyond the minimum required herein and on the Drawings shall be included in the bid and shall be done at no additional cost or schedule to Owner.

1.02 SCOPE

A. Furnish and install all new metal building components on existing structures as shown on the Drawings and as specified.

B. Furnish or reinstall all existing metal building components intended for disassembly and reassembly as shown on the Drawings and as specified.

C. Furnish labor, materials, equipment and incidentals necessary to fabricate and

install metals building components and complete the Work.

D. Furnish labor, materials, equipment and incidentals necessary to maintain structural stability of the canopies against self-weight, environmental and construction loads and for squaring, plumbing, and securing the components and structural frames, during the complete duration from start of disassembly to completion of reassembly and installation. Remove all temporary guys, bracing, falsework, cribbing and other components immediately upon completion of erection.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Institute of Steel Construction (AISC):
   a. 360, Specification for Structural Steel Buildings.
   b. Steel Construction Manual, 14th Edition.
   c. Steel Design Guide 3, Serviceability Design Considerations for Steel Buildings.
2. American Iron and Steel Institute (AISI):
   a. AISI S100, North American Specification for the Design of Cold-Formed Steel Structural Members, Washington, D.C., 2016.
3. American Welding Society (AWS):
   a. A2.4, Standard Welding Symbols
   b. D1.1/D1.1M, Structural Welding Code - Steel.
   c. D1.3/D1.3M, Structural Welding Code – Sheet Steel.
4. International Code Council (ICC): 2018 International Building Code (IBC).
5. American Society for Testing and Materials International (ASTM).
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   c. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   d. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
   e. A325, Standard Practice for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
   f. A463/A463M, Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process.
   g. A475, Standard Specification for Zinc-Coated Steel Wire Strand.
   h. A490, Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
   i. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   j. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

k. A529/A529M, Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality.
l. A572/A572M, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
m. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
n. A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
o. A792/A792M, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
p. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
q. D2244, Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
r. D4214, Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.
s. E1514, Standard Specification for Structural Standing Seam Steel Roof Panel Systems.
t. E1592, Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
u. E1646, Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference.
v. E1680, Standard Test Method for Rate of Air Leakage through Exterior Metal Roof Panel Systems.
w. F3125/F3125M, Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 Mpa Minimum Tensile Strength.

6. Metal Building Manufacturers Association (MBMA): Metal Building Systems Manual.
7. Occupational Safety and Health Administration (OSHA): Standard 29 CFR 1910.
8. State of Georgia: 2020 and 2022 Amendments to IBC.
9. The Society for Protective Coatings (SSPC):
    a. SP 1, Solvent Cleaning.
    b. SP 2, Hand Tool Cleaning.
    c. SP 3, Power Tool Cleaning.
    d. SP 6, Commercial Blast Cleaning.
    e. Paint 20, Zinc Rich Primers Inorganic and Organic.
10. Underwriters' Laboratories (UL):
    a. UL 580, Tests for Uplift Resistance of Roof Assemblies.

1.04 SUBMITTALS

A. Product Data: Submit Metal Building System Manufacturer's product

information, specifications, and installation instructions for all building components, accessories, and materials listed in Part 2 of this Section.

B. Manufacturer's Installation Instructions: Indicate preparation requirements, disassembly sequence, cataloguing system and requirements, and assembly sequence.

C. Shop and Erection Drawings: Indicate assembly dimensions, locations of structural members, connections, attachments, roof system dimensions, panel layout, general construction details, anchorages and method of anchorage, installation, sizes, and locations, and indicate field welded connections.

D. Certifications:

1. Submit certification verifying that the metal roof system has been tested and approved by Underwriter's Laboratory as Class 90.
2. Submit certification verifying that the metal standing seam roof system has been tested in accordance with ASTM E1592 test protocols.
3. Submit certification of welder qualifications as required by Specification Section 05050 Welding.

E. Warranties.

F. Samples:

1. Color swatches.
2. Roofing sample with proposed color for approval by Owner.

G. Calculations: Provide calculations upon request by Engineer for any roof framing components not limited to primary framing members, secondary framing members, bracing and blocking members, connections, fasteners, or structural diaphragm systems that are to be installed and do not match existing fabricated or assembled conditions. Calculations shall be stamped by a Professional Engineer (PE) licensed in the State of Georgia.

1.05 QUALITY ASSURANCE

A. Fabricate structural steel members in accordance with MBMA Metal Building Systems Manual. For items not covered by MBMA, fabricate members in accordance with AISC Specification for Structural Steel Buildings.

B. Field verify dimensions, elevations, member sizes and grades, and existing conditions prior to shop drawing submittal and fabrication.

C. Coordination:

1. The Work of this Section shall be completely coordinated with the Work of

other Sections. Verify at the site both the dimensions and Work of other trades adjoining items of Work in this Section before fabrication and installation of items herein specified.
2. Furnish to the pertinent trades all items included under this Section that are to be built into the Work of other Sections.

1.06 QUALIFICATIONS

A. Manufacturer: The company manufacturing the products specified in this Section shall have a minimum of 5 years of experience in the manufacture of steel building systems. The metal building systems manufacturer shall be accredited under the International Accreditation Service, "Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems (AC472)."

1. American Buildings Company, Swansea, SC.
2. MBCI, Atlanta, GA.
3. Whirlwind Steel Buildings, Tallapoosa, GA.

B. Structural framing, roof diaphragm, and decking shall be designed upon request by Engineer by a licensed Professional Engineer (PE) in the state of the Project having specialized experience in the design of steel building systems with a minimum of 5 years of experience.

C. Erector shall be AISC-certified erector, or qualified by similar program, having specialized experience in the erection of steel building systems with a minimum of 5 buildings of similar size and scope within the past 5 years.

1. American Summit PEMB, LLC, GA.
2. Patriot Steel Buildings, Inc., Calhoun, GA.

1.07 DELIVERY, STORAGE AND HANDLING

A. Preparation for Shipment:

1. Package and clearly tag parts and assemblies that are of necessity shipped unassembled in a manner that will protect materials from damage, and facilitate identification and final assembly in field.
2. Insofar as is practical, factory assemble items provided hereunder.
3. Package stainless steel items to provide protection from carbon impregnation.
4. Protect painted coatings, Galvalume, and hot-dip galvanized finishes from damage as a result of metal banding and rough handling. Use padded slings and straps.

B. Storage and Handling:

1. In accordance with manufacturer's recommendations and in such a manner

as to prevent damage of any kind, including overexposure to sunlight.
2. Store fabricated items in dry area, not in direct contact with ground.
3. Store all metal building materials away from exposure to chemicals stored in containment areas.

1.08 WARRANTY

A. Standing Seam Roof Performance Warranty:

1. Furnish manufacturer's performance warranty for a minimum of 20 years for gravity and uplift load conditions.

B. Standing Seam Roof Weathertightness Warranty:

1. Furnish manufacturer's weathertightness warranty for a minimum of 20 years against leaks in standing seam roof panels caused by ordinary wear and tear under normal weather and atmospheric conditions.

C. Roof Paint Finish Warranty:

1. Furnish manufacturer's standard warranty for the metal panel paint system against chipping, peeling, blistering, fading more than 5 NBS Hunter units as detailed in ASTM D2244, and chalking more than 8 NBS Hunter units as detailed in ASTM D4214.
2. The warranty shall be for a minimum period of 20 years from the date of shipment of the paint systems.

1.09 DESIGN REQUIREMENTS

A. Where metal building components cannot be fabricated or installed to match existing assembled conditions, structural calculations shall be performed and provided by a Professional Engineer (PE) upon request by Engineer and shall meet the following design requirements.

B. Governing Codes: Meet 2018 International Building Code and referenced codes and standards therein, 2020 and 2022 State of Georgia Amendments and OSHA Standard 29 CFR 1910, Occupational Safety and Health Standards.

C. Design structural mill sections and built-up plate sections in accordance with AISC 360 "Specification for Structural Steel for Buildings".

D. Cold-Formed steel structural members and panels shall be designed in accordance with AISI S100 "North American Specifications for the Design of Cold-Formed Steel Structural Members".

E. Design structural welding per AWS D1.1/D1.1M "Structural Welding Code – Steel".

F. Design Loads:

1. Dead Load: Self-weight of the building systems as determined by manufacturer.
2. Roof Live Load: 20 psf minimum. Do not reduce live load.
3. Snow Load: As indicated on Drawings.
4. Wind Load: As indicated on Drawings. Full lateral analysis on existing primary framing not required. Design roof decking and associated framing members for uplift and diaphragm load transfer anchorage to existing framing members.
5. Seismic Load: As indicated on Drawings. Full lateral analysis on existing primary framing not required. Design roof decking and associated framing members for diaphragm load transfer anchorage to existing framing members.

G. Limit deflection of roof framing to the limits indicated on Drawings for roof secondary framing (Purlins).

PART 2 - PRODUCTS

2.01 MATERIALS AND CONSTRUCTION

A. The materials and construction of the specified metal building systems and the associated products listed herein are based on the assumed and estimated quantities for both new construction items and existing items intended for disassembly and reassembly as indicated in the Drawings. The assumed and estimated quantities to be used for bid cost are listed in the following tables.

B. Northeast Containment Area:

Metal Building Component:	**Quantity:**
Columns – Replacement Sections with Base Plates	20 LF
Columns – Sandblasting and Repainting of Columns	48 LF
Roof Decking (Including Flashing, Trim, Closures, and Soffits)	1600 SF
Zee Purlins – Existing to be Disassembled and Reassembled	460 LF
Zee Purlins – Existing to be Replaced	160 LF
C-Shape Blocking – Existing to be Disassembled and Reassembled	120 LF
C-Shape Blocking – Existing to be Replaced	0 LF
Strap Bracing – Existing to be Disassembled and Reassembled	0 LF
Strap Bracing – Existing to be Replaced	450 LF
Number of Vents Through Roof (VTR)	3
Gutters – Existing to be Replaced	110 LF
Downspouts – Existing to be Replaced	120 LF

C. South Containment Area:

Metal Building Component:	Quantity:
Columns – Replacement Sections with Base Plates	0 LF
Columns – Sandblasting and Repainting of Columns	0 LF
Roof Decking (Including Flashing, Trim, Closures, and Soffits)	4100 SF
Zee Purlins – Existing to be Disassembled and Reassembled	1500 LF
Zee Purlins – Existing to be Replaced	0 LF
C-Shape Blocking – Existing to be Disassembled and Reassembled	280 LF
C-Shape Blocking – Existing to be Replaced	0 LF
Strap Bracing – Existing to be Disassembled and Reassembled	0 LF
Strap Bracing – Existing to be Replaced	1050 LF
Number of Vents Through Roof (VTR)	6
Gutters – Existing to be Replaced	190 LF
Downspouts – Existing to be Replaced	120 LF

D. All fasteners, roof clips, purlin anchorage, blocking anchorage, and other typical anchorage systems shall be replaced with new fasteners/anchors for all new or reassembled components. Exact quantities of fasteners/anchors shall be determined and supplied by metal building manufacturer and have not been included for individual metal building components listed in tables above.

E. Quantities provided in above tables and on Drawings shall be field verified prior to construction and fabrication. Contractor shall notify Engineer in writing immediately of any discrepancies found. Refer to 'Unit Price Bid Schedule' as specified in Section 00300 Bid Form for additional quantities.

2.02 ROOF FRAMING

A. Panel Material and Finish:

1. Steel coated both sides with layer of acrylic-coated Galvalume aluminum-zinc alloy (approximately 55 percent aluminum, 45 percent zinc) applied by continuous hot-dip method.
2. Minimum 0.55-ounce coated weight per square foot as determined by triple-spot test, ASTM A792.

B. Standing Seam Roofing:

1. Minimum 24 gauge.
2. 16-inch vertical standing seam roof panels, uninsulated.
3. Standing ribs shall be 2-1/2 inch high minimum with two intermediate ribs 3/8 inch high minimum.
4. Ridge cap 24 gauge minimum.
5. ASTM E1592 tested.
6. UL 580, Class 90 uplift rating.
7. Mechanical seam joining sides, with sealant and concealed anchors.
8. Individual panels shall be removable for replacement of damaged material.

C. Closures: Manufacturer's standard type, metal.

D. Sealants:

1. Sidelaps: Factory applied non-skinning Butyl mastic.
2. Endlaps, Eave, and Ridge Assembly: Field applied 100% solids butyl-based elastomeric tape sealant, furnished in pre-cut lengths.

E. Color:

1. Exterior surfaces to match existing roof panels of adjacent structures as close as possible as selected from manufacturer's standard colors.
2. Interior surfaces to be precoated with wash coat of silicone polyester manufacturer's standard finish.

F. Panel Fasteners:

1. Manufacturer's standard type.
2. Size and design to maintain load and weather tightness requirements.
3. Fasteners to be stainless steel, head and shank, self-drilling and tapping.
4. Color of exposed fastener heads to match roof panel finish.

G. Roof Clips: Manufacturer's standard type with minimum requirements of factory applied mastic and designed so that movement between panel and clip does not occur.

2.03 PRIMARY FRAMING

A. Existing primary framing system to be retained unless otherwise specified, indicated on Drawings or determined by Contractor to be disassembled and reinstalled to accomplish Project Work.

B. Clean and prepare in accordance with SSPC-SP2 as a minimum, and coat with primer meeting or exceeding the minimum performance requirements of SSPC-Paint 15.

C. Structural steel members shall be fabricated in accordance with AISC Specification for pipe, tube, and rolled structural shapes and in accordance with Section 05500 Metal Fabrications.

1. Member thickness as indicated on Drawings or 3/16 inch minimum.
2. 50 ksi minimum yield strength.
3. Factory primer compatible with finish coating.

D. Fabricate built-up members in accordance with MBMA Metal Building Systems Manual, Chapter IV Common Industry Practices.

E. Color to match existing primary framing members.

2.04 SECONDARY FRAMING

A. Existing secondary framing members to be retained except where indicated on Drawings, or determined by Contractor to be disassembled and reinstalled to accomplish Project Work, or deemed structurally compromised during pre-installation inspections by Contractor.

B. For secondary framing members to be replaced, match existing shapes, profiles, and member thicknesses with minimum requirements as specified herein. Notify Engineer of any discrepancies prior to fabrication and installation.

C. Clean and prepare in accordance with SSPC-SP2 as a minimum. Members shall be formed from galvanized flat material.

D. Cold-formed structural shapes shall be fabricated in accordance with MBMA Metal Building Systems Manual, Chapter IV Common Industry Practices.

E. Purlins:

1. 9-inch Zee purlins.
2. 14 gauge minimum.
3. ASTM A572, Grade 50 ksi.
4. Minimum G60 galvanized coating.

F. Blocking Members:

1. 6-inch C-Shapes with 1-1/2 inch flanges.
2. 16 gauge minimum.
3. ASTM A572, Grade 50 ksi.
4. Minimum G60 galvanized coating.

G. Strap Bracing:
1. 3-inch wide sheet steel.
2. 16 gauge minimum.
3. ASTM A572, Grade 50 ksi.
4. Minimum G60 galvanized coating.

2.05 GUTTERS AND DOWNSPOUTS

A. Coatings and Finish:

1. Finish shall be factory baked on 70 percent Kynar 500 or Hylar 5000

fluoropolymer (PVDF) coating with a dry film thickness of 0.7 to 0.8 mil.

B. Gutters:

1. Fabricate gutters from manufacturer's standard to match existing gutter profiles, sizes, and material.
2. Form gutters to match existing gutter profiles and sizes to collect and remove water.
3. Aluminum.
4. 6-inch by 6-inch minimum.
5. 21 gauge minimum.
6. Provide connections, support straps and closure pieces.
7. Provide solid gutter guards with drip edge into gutter.
8. Color to match roof decking.

C. Downspouts:

1. Fabricate downspouts from manufacturer's standard to match existing downspout profiles, sizes, and material.
2. Furnish downspouts with elbows from manufacturer's standard shapes.
3. Aluminum.
4. 4-inch by 4-inch minimum.
5. 21 gauge minimum.
6. Provided connections, clips, and support straps.
7. Color to match roof decking.

2.06FLASHINGS AND TRIM

A. Coatings and Finish:

1. Finish shall be factory baked on 70 percent Kynar 500 or Hylar 5000 fluoropolymer (PVDF) coating with a dry film thickness of 0.7 to 0.8 mil.

B. Furnish flashings, internal and external corners, closure pieces, fascia, infills, caps, and trim of same material and finish as adjacent material.

C. Aluminum.

D. 21 gauge minimum thickness for all flashing and trim components.

E. Form flashing and trim sections in maximum possible lengths and hem exposed edges.

F. Profiles to be selected from manufacturer's standard to best match existing conditions.

G. Color to match new roof decking components.

2.07 FABRICATION

A. Shop-fabricate all framing members for field bolting assembly, unless otherwise noted. Surfaces of bolted connections must be smooth and free from burrs or distortions.

B. All framing members must be labeled with identifying mark.

C. Factory weld base plates, splice plates, and stiffeners into place on all structural members where possible. Field welding shall be limited to column splices to existing columns as indicated on the Drawings.

D. Fabricate purlins with cold-formed Zee sections with stiffened flanges. Bearing connection bolts shall be installed through the bottom flanges only. Splice connection bolts shall be installed through the webs, not the flanges. Connections and splices shall be centered at bearing support locations.

E. Roof decking panels shall be fabricated to span the full length from ridge to eave and shall span a minimum of three supports.

PART 3 - EXECUTION

3.01 ERECTION AND INSTALLATION

A. Erect new and reassembled framing in accordance with MBMA Metal Building Systems Manual, Chapter IV Common Industry Practices.

B. Field verify alignment and location of existing anchor rods prior to shop welding new base plates to new column bases. When required, level base plates with non-shrink, non-metallic grout pads.

C. Erect new building frame members true and level with vertical members plumb and bracing properly installed. Maintain structural stability of frame during erection.

D. Tighten bolts and nuts in accordance with “Specification for Structural Joints Using High-Strength Bolts”, using specified procedure. Snug tighten bolts unless otherwise specified.

E. The Contractor shall furnish temporary guys and bracing where needed for squaring, plumbing, and securing the structural frame during disassembly, reassembly, and replacement of structural members. Secure structural framing against loads, such as wind loads and seismic forces, as well as loads due to

erection operations. Remove all temporary guys, bracing, falseworks, and cribbing immediately upon completion of erection.

F. Do not field cut, drill, or modify structural members without approval of the Engineer.

G. After erection, Contractor shall prime welds, abrasions, and surfaces not shop-primed, galvanized, or needing touch-up.

H. Install roofing systems in accordance with manufacturer's instructions and details.

I. Exercise care when cutting prefinished material to ensure cuttings do not remain on finished surface.

J. Set purlins at right angle and bolt to appropriate clips. Attach to clips as required to satisfy design loads and as shown on drawings.

K. Place Standing Seam Roof panels at right angle to purlins. Attach with sliding concealed clip where expansion and contraction must be accounted for. Lap panel ends six inches minimum or as determined by manufacturer's standard. Place end laps above purlin with backup plate so panel end-lap fasteners do not penetrated purlin. Follow manufacturer's instructions for fastening and sealing end laps.

3.02 DISASSEMBLY AND REASSEMBLY OF MATERIALS

A. Prior to disassembly of materials, identify any damaged materials requiring replacement that have not been indicated on the Drawings, and notify Engineer in writing before proceeding with disassembly. Include cost breakdown for Engineer's review. Replace materials to match original materials after approval from Engineer.

B. Catalogue and store materials intended for disassembly and reassembly as indicated on the Drawings.

C. Replace all damaged and non-catalogued materials in kind and provide calculations upon request by Engineer for all materials intended for reassembly as indicated on the Drawings.

D. Items identified to be removed during construction that are damaged prior to reassembly by Contractor shall be replaced at no cost to Owner.

E. See Drawings for site-specific disassembly and reassembly requirements.

F. Prior to reassembly, Engineer and Contractor shall inspect materials to

determine condition. Engineer may direct Contractor to replace materials deemed unsuitable for reassembly.

3.03 PAINTING

A. For all new materials, color match to match existing materials.

B. Repair of Damaged Hot-Dip Galvanized Coating:

1. Conform to ASTM A780.
2. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780.
3. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780.
4. Use magnetic gauge to determine thickness is equal to or greater than base galvanized coating.

C. Field Painting of Shop Primed Surfaces: Prepare surfaces to SP 6 Commercial Blast Cleaning and field finish with 2 coats (4 mils minimum total dry film thickness) alkyd enamel, unless indicated otherwise.

3.04 TOLERANCES

A. Install framing in accordance with MBMA Metal Building Systems Manual, Chapter IV Common Industry Practices.

3.05 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Owner-Selected Quality Assurance:

1. In accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections in Section 01450, Special Inspection and Testing and Observation.
2. Contractor responsibilities and related information on special inspection, observation, and testing are included in Section 01450, Special Inspection and Testing and Observation.

END OF SECTION 13122

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SCOPE

A. The work described in this Section and/or indicated on the Drawings shall include, except where otherwise noted, the furnishing of all materials, equipment, appurtenances, accessories, connections, labor, etc. required and/or necessary to completely install, clean, inspect, adjust, test, balance and leave in safe and proper operating condition all plumbing systems.

B. Prior to the ordering or purchase of any equipment or materials or the layout or installation of any work, the Contractor shall visit and examine the site and shall examine and understand the work shown on the Drawings and described in these Specifications. If any work involves existing equipment, piping, buildings, etc., the Contractor shall first verify model numbers, electrical characteristics, sizes, dimensions, etc. to be compatible with the work shown on the Drawings.

C. Throughout the course of the Project, the Contractor shall schedule and coordinate work with the Engineer and other trades to optimize space utilization and avoid conflict or interference with the work of other trades, structural elements, doors, windows, lights, conduit and other equipment or systems.

D. All electrical items provided under Division 15 of the Specifications shall be provided in accordance with applicable sections of Division 16. Enclosures shall be the same NEMA type as specified in Division 16 or on the Electrical Drawings.

E. The Contractor will be held responsible for the satisfactory and complete execution of all work included. The Contractor shall produce complete finished operating systems and provide all incidental items required as part of the work, regardless of whether such item is particularly specified or indicated.

1.02 QUALITY ASSURANCE

A. Codes and Standards

1. All mechanical work shall be performed in accordance with all applicable codes, ordinances, rules and regulations of local, state, federal or other authorities having jurisdiction. As a minimum, this shall include:
   a. International Building Code 2018 with Georgia Amendments.
   b. International Plumbing Code 2018 with Georgia Amendments.
   c. International Mechanical Code 2018 with Georgia Amendments.
   d. International Energy Conservation Code 2015 with Georgia

Amendments.
e. International Fire Code 2018.
f. National Fire Protection Association Codes.
g. National Electrical Code 2020 with Georgia Amendments.
h. Unless otherwise specified on the Drawings, the latest edition of all codes, ordinances, etc. shall be followed. Where code or other requirements exceed the provisions shown on the Contract Documents, the Contractor shall notify the Engineer. Where provisions of the Contract Documents exceed code or other requirements, the Work shall be performed in accordance with the Contract Documents.

2. All equipment, products and materials used in mechanical work shall be listed by Underwriters Laboratories, ARI or AMCA as appropriate.
3. The Contractor shall schedule all required tests and inspections with a minimum of 72 hours prior notice to the Engineer.

B. Allowable Tolerances: Equipment shall be readily adaptable for installation and operation in the structures shown on the Drawings. No responsibility for alteration of a planned structure to accommodate other types of equipment will be assumed by the Owner. Equipment which requires alteration of the structures will be considered only if the Contractor assumes all responsibility for making and coordinating all necessary alterations. All such alterations shall be made at the Contractor's expense.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

B. Drawings and Specifications:

1. The Drawings are diagrammatic and, unless specifically dimensioned, are intended to show only the general arrangement of equipment and accessories, and the general routing of piping, etc. The Drawings do not specifically show every fitting, offset, contour, etc. required to accomplish the intended work or to avoid every interference that may be encountered. It shall be the responsibility of the Contractor to arrange all work to fit within the allowed space without modifying any building structure or property, and to make readily accessible all equipment and accessories requiring servicing or maintenance.
2. Should any changes be deemed necessary by the Contractor in items shown on the Contract Drawings, the Contractor shall submit shop drawings, descriptions, and the reason for the proposed changes to the Engineer for approval.
3. Exceptions and inconsistencies in Drawings and Specifications shall be brought to the Engineer's attention before bids are submitted.

C. Operation and Maintenance Instructions: Operation and maintenance instructions shall be provided in accordance with the requirements of the General Conditions of the Contract Documents. The Contractor shall instruct the Owner’s

personnel during the adjustment and testing period. The Contractor shall also, in the presence of the Engineer, demonstrate the complete operation of each and every piece of apparatus.

1.04 QUALITY STANDARDS

A. All materials shall be furnished by manufacturers fully experienced, reputable and qualified in the manufacture of the particular material to be furnished. All material shall be designed, constructed and installed in accordance with standard practices and methods and shall comply with these Specifications as applicable.

B. The manufacturer shall provide written certification to the Engineer that all equipment furnished complies with all applicable requirements of these Specifications.

1.05 TRANSPORTATION AND DELIVERY

A. As part of the mechanical work, the Contractor shall provide and pay for all transportation, delivery and storage required for all equipment and materials.

B. The Contractor shall closely coordinate the ordering and delivery of all mechanical equipment with other trades to assure that equipment will be delivered in time to be installed in the building without requiring special or temporary access or building modifications. Certain equipment may have to be installed prior to the erection of the building walls or roofs.

1.06 STORAGE AND PROTECTION

A. Equipment and materials shall be properly stored to protect against vandalism, theft, the elements and other harm or damage. Any equipment or materials received in a damaged condition, or damaged after receipt, shall not be installed. Only new undamaged equipment in first-class operating condition shall be installed.

B. Provide protection covers, skids, plugs or caps to protect equipment and materials stored or otherwise exposed during construction.

1.07 WARRANTY

A. All mechanical work described in the Contract Documents shall be warranted in accordance with the General Conditions of the Contract Documents.

B. This warranty shall apply to all equipment, materials and workmanship.

C. During the warranty period, all defects in mechanical systems shall be corrected in an acceptable manner, consistent with the quality of materials and workmanship of original construction, at no expense to the Owner.

PART 2 - PRODUCTS

2.01 MATERIALS AND CONSTRUCTION

A. General

1. All equipment, materials, accessories, etc. used as part of the mechanical work shall be new, of the best grade and quality and of current production, unless specified otherwise. Equipment not specified in the Contract Documents shall be suitable for the intended use and shall be subject to approval by the Engineer.
2. All equipment, products and materials shall be free of defects and shall be constructed to operate in a safe manner without excessive noise, vibration, leakage or wear.

B. Piping: See appropriate sections of Division 15 for Specifications on various piping systems. See Part 3 of this Section for general stipulations on installation of piping systems.

D. Provide and install unions between each item of equipment and the valve controlling and/or the various piping connections to it.

F. Dielectric Isolation

1. Wherever dissimilar metals are used in piping systems, this connection shall be made with dielectric isolators. The dielectric isolators shall be so designed that non-ferrous piping materials shall be isolated by the use of Teflon or nylon isolating materials made up in the form of screwed type unions or insulating gaskets and bolt sleeves and washers for standard flanged connection. All dielectric isolators shall be selected for the pressure and contents of the system involved.
2. Dielectric isolators shall be Watts, Epco, Crane, Maloney, or Equal.

G. Anchor Bolts

1. All anchor bolts shall be ANSI type 316 stainless steel.

2. All anchor bolts are to be supplied by the manufacturer or fabricator of the specific material or equipment to be installed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. All equipment, materials, accessories, etc. used as part of the mechanical work shall be installed according to the manufacturer's recommendations and in accordance with the best practice and standards for the work.
2. All work shall be performed by competent personnel satisfactory to the Engineer. All work requiring particular skill shall be performed by persons that have had special training and past experience in that line of work.

B. Equipment Support

1. Major equipment supports (concrete foundations, framed structural openings, etc.) shall be furnished and installed under other Divisions of the Contract Documents as shown on the Drawings. The mechanical work shall include the furnishing and installation of all miscellaneous equipment supports, housekeeping pads, structural members, rods, clamps and hangers required to provide adequate support of all mechanical equipment.
2. Unless otherwise shown on the Drawings, all mechanical equipment, piping and accessories shall be installed level, square and plumb.

C. Pipe and Ductwork Penetrations

1. Sleeves or wall pipes shall be installed in all masonry or concrete walls, floors, roofs, etc. for pipe and ductwork penetrations. Sleeves for ductwork shall be 20-gauge galvanized steel. Sleeves shall be sized to provide a minimum of ¼-inch clearance between the sleeve and pipe or duct. For insulated pipes or ducts, the clearance shall be ¼-inch between the sleeve and the insulation.
2. As far as possible, all pipe and ductwork penetrations shall be made at the time of masonry or concrete construction. Where drilling is required, only core drills shall be used. Star drills shall not be used.

D. Welding

1. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc or gas welding process.
2. All welding operations shall conform to the latest recommendations of the American Welding Society or to the applicable provisions of the Code for Pressure Piping. The Contractor shall pay for all electrical energy and/or gas used in welding.

E. Cutting and Patching: Where cutting or patching becomes necessary to permit the installation of any work or should it become necessary to repair any defects that may appear in patching, the Contractor shall make the necessary repair at no cost to the Owner.

F. Cross Connection and Interconnections

1. No plumbing fixture, device or piping shall be installed which will provide a cross connection or interconnection between a distributing supply for drinking or domestic purposes and a polluted supply, such as drainage

system or a soil or waste pipe which will permit or make possible the backflow of sewage, polluted water or waste into the water supply system.

2. The Contractor shall verify location of all existing utilities and make all connections to existing facilities as required.

H. Thermal Expansion of Piping

1. The Contractor shall furnish and install all devices required to permit the expansion and contraction of all work installed by the Contractor, particularly in water supply and circulating systems. In the main water and circulating lines, Contractor shall employ expansion joints where required or directed by the Engineer. Swing joints, turns, expansion loops or long offsets shall be provided wherever shown on the Drawings or wherever necessary to allow for the expansion of piping within the building. Broken pipes or fittings broken due to rigid connections must be removed and replaced at the Contractor's expense.
2. Anchor all lines having expansion joints so that expansion and contraction effect is equally distributed. Verify exact locations of anchors with the Engineer prior to making installation. The lines having expansion joints shall be accurately guided on both sides of each joint. These guides shall consist of saddles and "U" clamps properly arranged and supported. Submit complete details for approval.
3. In installing expansion members, exercise care to preserve proper pitch on lines. Furnish and install all special fittings, connectors, etc., as required.

3.02 SURFACE PREPARATION, SHOP AND FIELD PAINTING

A. Unless otherwise indicated within the Specifications or shown on the Drawings, painting of mechanical equipment shall be in accordance with Section 09910, High Performance Coatings.

B. Touch-up painting of mechanical equipment shall be part of the mechanical work. All equipment and materials that are painted or coated by the manufacturer shall be touched-up prior to completion to conceal any and all scratches or other finish irregularities and to maintain the integrity of the paint or coating. All painting and coating shall match the original and shall conform to the requirements detailed in other sections of these specifications.

3.03 INSPECTION AND TESTING

A. The mechanical work shall include all materials and labor required to properly test and balance all mechanical systems as required by codes and as described herein.

B. Concealed, underground and insulated piping shall be tested in place before concealing, burying or covering. Tests shall be conducted in the presence of the Engineer or designated representative. Equipment, materials and instruments required for tests shall be furnished without incurring additions to the Contract. The Contractor shall schedule all required tests and inspections with a minimum

of 72 hours prior notice to the Engineer.

C. Unless otherwise specified herein, all mechanical piping shall be tested as required by Code to 1-1/2 times the rated system pressure or 100 psig (modify as needed), whichever is greater. Care shall be taken to isolate all equipment not suitable for this test pressure by installing pipe caps or blank flanges at the equipment connections. All valves and fittings shall be tested under pressure.

D. Soil, waste and vent piping shall be tested with water before installing fixtures. Water test shall be applied to the system either in its entirety or in sections. If the test is applied to the entire system, all openings in the piping shall be closed except to highest opening, and the system shall be filled with water to the point of overflow. If the system is tested in sections, each opening except the highest opening of the section under test shall be plugged and each section shall be filled with water and tested with at least a 10 foot head of water. Each joint or pipe in the building except the uppermost 10 feet of the system shall be submitted to a test with at least a 10 foot head of water. The water shall be kept in the system, or in the portion under test, for at least 1 hour before the inspection starts; no substantial drop in the water level will be acceptable.

3.04 CLEANING

A. At all times, the premises shall be kept reasonably clean and free of undue amounts of waste, trash and debris by periodic cleaning and removal. After completion, all foreign material, trash and other debris shall be removed from the site.

B. All equipment and piping shall be thoroughly cleaned both inside and out.

D. After testing and prior to Engineer review and acceptance, all systems shall be finally cleaned and shall be left ready for use.

E. All water piping shall be cleaned and disinfected.

END OF SECTION

SECTION 15094

PIPE HANGERS AND SUPPORTS

PART 1- GENERAL

1.01 SCOPE

A. Work specified in this Section is subject to the provisions of Division 1 and Section 15050.

B. Design, furnish and install pipe hangers, supports and brackets necessary to install piping furnished under these Contract Documents. Provide all foundations, shims, hangers, clamps, supplemental steel, fasteners, anchor bolts and other hardware required for the complete installation as shown on the Drawings and specified herein.

C. The Drawings do not show every pipe hanger or support location but are intended to provide a guide as to type and usage of pipe hangers and supports required by this Project. The Contractor shall provide all pipe hangers and supports required to securely support all piping in accordance with the referenced standards.

D. In general, pipe supports shall refer to items which support pipe from below and hangers refer to items which support pipe from above.

E. Pipe hangers and supports for all chemical piping shall be non-metallic as specified herein.

1.02 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 1 and Section 15050.

B. Submit pipe hangers and support materials, locations, structural steel connections, supplemental support steel, miscellaneous hardware and hot dip galvanizing procedure for materials not factory galvanized.

C. Submit pipe hanger and support assembly drawings including location drawings identifying member to which the hanger or support will be attached and a bill of materials for each assembly.

1.03 QUALITY ASSURANCE

A. Work shall be installed by workers experienced in the selection, fabrication and installation of pipe support systems.

B. Selection, fabrication and installation of pipe hangers and supports shall conform

to the requirements of ANSI/ASME B31.1, MSS SP-58, SP-69 and SP-89, except as supplemented or modified by the requirements of these Specifications.

C. Weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.

D. Pipe support system shall utilize standard manufactured hangers and supports wherever possible.

E. Pipe support materials in contact with piping shall be compatible with the piping materials such that neither shall have a deteriorating action on the other.

F. Supplemental steel shall be designed per AISC Steel Construction Manual and the governing codes listed on the structural drawings.

G. All supporting equipment shall be designed with a minimum safety factor of 5 based on the ultimate tensile strength of the material.

1.04 PROJECT CONDITIONS

A. The rehabilitation work associated with this project and referred to in other sections of this specification shall be essentially complete prior to erection of pipe supports.

B. The Contractor shall be responsible for coordinating shop drawings of all structural elements to which pipe hanger and support connections will be made with shop drawings for pipe hangers and supports. Where pipe hangers and supports are to be installed in existing structures, the Contractor shall be responsible for field verifying existing or as-built dimensions prior to fabrication of pipe hanger and support systems.

C. Per the Drawings, Contractor is to make a good faith effort to retain and reuse existing pipe supports deemed to be in satisfactory condition wherever possible within the scope of Work.

1.05 SEQUENCING AND SCHEDULING

The Contractor shall coordinate scheduling of pipe hanger and support installation with the piping system installation to prevent any damage to installed piping due lack of pipe supports.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Pipe hangers and supports shall be manufactured by Grinnell, B-Line Systems, Michigan Hanger Company, Aickenstrut, or Jove.

2.02 GENERAL MATERIALS AND CONSTRUCTION

A. Contact between ferrous supports and non-ferrous piping materials or between carbon steel and stainless steel shall not be permitted. Supports and clamps shall be rubber coated or copper-plated as necessary to prevent this condition. For hot stainless steel piping, the support shall also be stainless steel.

B. All supports and hangers shall meet the following material requirements:

1. All structural steel and hot rolled steel rod shall conform to ASTM A36.

2. All pipe support columns shall conform to ASTM A 53, Grade B.

3. All embedded anchor bolt materials shall conform to ASTM A 193, Grade B8 or IFI-104, Grade 304. Nuts shall be heavy hex nuts conforming to ASTM A 194, Grade 8 or IFI-104, Grade 304. Minimum anchor bolt size for pipe supports shall be 5/8-inch diameter.

4. All rod and bolting materials in contact with cold piping (less than -20 degrees F) shall conform to ASTM A 320, Grade B8. Nuts shall be heavy hex nuts conforming to ASTM A 194, Grade 8 or 8T.

5. All rod and bolting materials, unless specified otherwise, shall conform to ASTM A 307, Grade B. Nuts shall be heavy hex nuts conforming to ASTM A 307.

6. All carbon steel or malleable iron straps, hangers, clamps, U-bolts and other hardware in contact with the pipe shall be shop primed except where specified or shown on the Drawings to be galvanized.

7. Expansion type anchor bolts shall be stainless steel and as specified in Section 05095 of these Specifications.

8. Flat strap hangers shall not be permitted. Hangers relying on mastics or adhesives shall not be used.

9. All pipe support materials for chemical piping (where not retained) shall match existing materials, or otherwise be of non-metallic construction. Fasteners and other hardware may be of 316 Stainless Steel.

C. Steel or concrete pipe supports for all piping between undisturbed earth and face of structures shall be in accordance with the details shown on the Drawings.

D. All interior and exterior concrete piers shall meet the requirements of Section 03313 of these Specifications.

E. Rods for supporting suction bells or foot valves of pump intakes shall be stainless steel of the size shown on the Drawings. The rods shall be furnished complete with stainless steel turnbuckles and eyes or other approved means for connection to the suction bell and stainless steel eye bolt anchored in the concrete. Supports for other pump suction pipelines shall be as shown on the Drawings or as specified in this Section.

2.03 PIPE HANGERS FOR HORIZONTAL PIPING

A. Uninsulated Pipes: Steel, double bolt pipe clamp, equal to Grinnell Figure 295.

B. Insulated Pipes: Steel, adjustable clevis pipe hanger, equal to Grinnell Figure 260. Size hanger to wrap around insulation; provide galvanized steel insulation protection shield between insulation and hanger, equal to Grinnell Figure 167.

C. Long runs of pipe subject to expansion shall be hung by means of adjustable swivel pipe roll hangers equal to Grinnell, Figure 177.

D. Short runs of uninsulated pipe subject to expansion in sizes up to and including 3-1/2-inches as well as all pipe of those sizes not subject to expansion shall be hung by means of adjustable swivel, split pipe ring equal to Grinnell, Figure 104.

E. Insulated piping and tubing, short lengths of 4-inches and larger pipe subject to expansion, and pipe 4-inches and larger not subject to expansion shall be hung by means of adjustable steel clevis hangers equal to Grinnell, Figure 260. Corrosion resistant clevis hangers shall be constructed of fiber reinforced plastic (FRP) and shall be equal to Jove FPH Series.

F. Uninsulated copper tubing shall be hung by means of copper-plated, split ring hangers with copper-plated sockets equal to Grinnell Figure CT-109.

2.04 PIPE SUPPORTS FOR HORIZONTAL PIPING

A. Pipe supports shall be as indicated in Drawings wherever applicable. Where not indicated within Drawings, supports shall be as indicated below.

B. Pipe 2-inches and less in diameter (including any provided insulation and jacketing) and not subject to expansion may, when paralleling walls, be supported by single hook clamp hangers equal to Grinnell, Figure 126.

C. Pipe supported from underneath and subject to expansion shall have adjustable pipe roll stand supports equal to Grinnell, Figure 274. The pipe roll stand shall be supported by concrete piers, structural steel or steel brackets as required.

D. Pipe supported from underneath and not subject to expansion shall have cast-in-place concrete supports or adjustable pipe saddle supports on properly sized pipe stanchions and ample, properly grouted floor flanges. Saddle supports shall

be equal to Grinnell, Figure 264.

E. When supports are installed exterior to buildings, provide a 1/4-inch drain hole near the base.

2.05 PIPE RISER CLAMPS FOR VERTICAL PIPING

A. Steel riser clamps, equal to Grinnell Figure 261.

B. Provide insulation protection shields for insulated piping.

2.06 MISCELLANEOUS HARDWARE

A. C-Clamp with Locknut: Steel, equal to Grinnell Figure 86.

B. Hanger Rods: Continuously threaded, steel, equal to Grinnell Figure 146.

C. Welded Eye Hanger Rods: Steel, threaded at end, left or right hand thread as required, equal to Grinnell Figure 278 or 278L.

D. U-Bolts: Steel with four finished hex nuts, galvanized, special dimensions as required for installation, equal to Grinnell Figure 137 (137S for special dimensions).

E. Turnbuckle: Forged steel construction, equal to Grinnell Figure 230.

F. Threaded Rod Coupling: Malleable iron, equal to Grinnell Figure 136 (136R for reducing).

G. Hangers suspended from structural steel shall be supported on U.F.S. beam clamp equal to Grinnell, Figure 228L or 292L with links as required.

H. Hangers from concrete work shall be secured by universal, galvanized metal inserts equal to Grinnell, Figure 282, placed in the concrete at the time of pouring. Wooden plugs or other improvised means shall not be used for any form of hanger fastening.

I. Protection Saddles: Protection saddles shall be equal to Grinnell Figure 160 or 161.

J. Insulation Shields: Insulation shields shall be galvanized with a 180 degree contour equal to Grinnell Figure 167.

K. Shock absorbing devices for shock and sway suppression shall be equal to Grinnell Figure 200.

2.07 SUPPLEMENTAL STEEL

A. Utilize standard steel shapes fabricated in accordance with ASTM A 36.

B. Prime and paint supplemental steel support brackets and assemblies after all fabrication procedures (welding, drilling, cutting, etc.) are complete.

2.08 NON-METALLIC SUPPORTS

A. All glass fiber reinforced channel covered under this Section shall have a flame spread rating of 25 or less when tested per ASTM E 84.

B. Glass fiber reinforced channel framing shall have a minimum pull out resistance of1,000 pounds when a load is applied to the inside of the flanges over a 3/8-inch long section of the channel and shall not deflect more than 1/4-inch when a uniform load of 1,000 pounds is applied to a 24-inch beam. Framing shall have a surface veil over 100 percent of the surface which, along with a properly designed filler system will protect against degradation from ultraviolet light and shall be made from corrosion resistant grade polyester or vinylester resins. Framing shall be Aickenstrut Type P or V.

C. Polyvinyl chloride channel framing shall be manufactured by the extrusion process and shall have a minimum pull-out strength of 1,400 pounds when a load is applied to the inside of the flanges over a 3/8-inch long section of the channel. Framing shall be manufactured from a UV stabilized resin. Framing shall be Aickenstrut Type E.

D. Universal pipe clamps shall be made by the injection molding process using a polyurethane base resin, shall have full and interlocking contact with the interior area of channel flanges to maximize pull-out resistance, shall be adjustable to accommodate a minimum 3/4-inch variance in OD sizes of piping or conduit, and shall contain no metal materials. Pipe clamps shall be Aickenstrut "Aickenstrap".

E. All fasteners shall be manufactured from long glass fiber-reinforced polyurethane.

F. All threaded rods shall be made from vinylester resin.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Pipe hangers and supports shall be installed in complete conformance with the manufacturer's recommendations and the Contract Documents.

B. Pipe hangers and supports shall be capable of supporting the pipe in all conditions of operation. Hangers and supports shall allow free expansion and contraction of the piping, and prevent excessive stress resulting from transferred weight being induced into the pipe or connected equipment.

C. Intermediate pipe supports shall be provided between building structural

members so as not to exceed maximum support spacing specified shall be galvanized structural steel angles (minimum 2-1/2 x 2-1/2 x 1/4-inch).

D. If vibration is encountered after the piping system is in operation, appropriate vibration control equipment shall be installed at the direction of the Engineer.

E. Pipe hangers and supports for building plumbing shall be provided at intervals no greater than that specified by the governing plumbing code listed in Section 15050.

F. Pipe hangers and supports for fire protection piping shall be provided at intervals no greater than that specified by NFPA 13.

G. Pipe hangers and supports for gas piping shall be provided at intervals no greater than that specified by the governing fuel gas code listed in Section 15050.

H. All threaded connections installed loose, such as hanger rods and U-bolts, shall have a double nut installation.

I. Provide pipe hangers or supports within 18-inches of each elbow and within 24-inches of each equipment connection.

J. Pipes shall not be supported by non-loading bearing walls and partitions. Pipe hangers shall not be connected to roof decking, bar joists or ceiling suspension systems unless approved by the Engineer.

K. Unless otherwise shown, piping shall not be fastened to a support in such a manner than would prevent axial movement due to thermal expansion and contraction.

L. Supports, guides, and anchors shall be so designed that excessive heat will not be transmitted to the building steel. The temperature of supporting parts shall be based on a temperature gradient of 100 degrees F per inch distance from the outside surface of the pipe.

M. No pipe shall be supported from floor grating.

N. The Contractor shall size supports and hangers using actual field dimensions.

O. Corrosion resistant channels shall be attached to trench walls by rigid PVC base posts secured with 316 stainless steel hex head bolts, minimum 4-inch embedment.

3.02 INSTALLATION - HORIZONTAL PIPING

A. Spacing of hangers and supports for above ground horizontal piping shall be in accordance with ANSI/ASME B31.1 and MSS SP-69.

B. Carbon steel, alloy steel, stainless steel and hard-drawn copper pipe shall be supported on maximum intervals as follows:

Pipe Size	Maximum Interval for Steel		Maximum Interval For Copper
	Water	Steam, Air, Gas	
1/2"	5’	6’	4’
3/4"	6’	7'	5’
1"	7’	9’	6’
1-1/2"	9’	11’	8’
2"	10’	13’	9’
2-1/2"	11’	14’	10’
3"	12’	15’	10’
4"	13’	17’	-
6"	17’	21’	-
8"	19’	24’	-
10"	22’	27’	-
12"	23’	29’	-
14"	25’	32’	-
16"	27’	35’	-
18"	28’	37’	-
20"	30’	39’	-
24"	32’	42’	-

C. Annealed copper tubing and polyethylene tubing shall be supported on maximum intervals as follows:

Tubing Size	Maximum Interval for Copper	Maximum Interval For Polyethylene
3/8" and Smaller	-	2’
1/2" - 5/8"	6’	3’
3/4" - 1-1/8"	8’	4’
1-1/4" - 2"	10’	5’
2-1/2" - 5"	12’	-
6" - 8"	14’	-
10"	18’	-

D. PVC and CPVC piping shall be supported on maximum intervals as follows at design temperatures up to 80 degrees F

Pipe Size	Maximum Intervals	
	PVC Schedule 80	CPVC Schedule 80
1/2" - 3/4"	4’	4’
1"	4’	5’
1-1/4" - 1-1/2"	5’	6’
2"	5’	7’
2-1/2"	5’	8’
3"	6’	8’
4"	6’	9’
6"	6’	10’
8"	6’	10’

E. Pipe hangers and supports shall be installed at intervals recommended for a specific application by the piping system manufacturer.

F. Cast iron or ductile iron piping shall be supported as recommended by the pipe manufacturer, and at all valves and fittings larger than 4-inches in size. At least one support shall be provided per pipe section or at every other joint, whichever is closer. Supports shall be located next to hubs or bells.

G. Provide all necessary steel angles and other items required to maintain the

minimum hanger or support spacing.

H. Wherever possible, pipe attachments for uninsulated horizontal piping shall be pipe clamps.

I. Wherever possible, structural attachments shall be beam clamps.

J. Pipe Hangers

1. Pipe hangers, trapeze hangers, upper attachments and other supports shall be selected based on pipe material, size and service conditions. Provide all hangers and rods, turnbuckles, angles, channels and other structural supports to support the piping systems. The minimum rod diameter for single pipe rigid rod hangers shall be as follows:

Pipe Size	Minimum Hanger Rod Diameter For Steel, Ductile and Cast Iron Soil Pipe	Minimum Hanger Rod Diameter For Copper And Plastic Pipe
2" & smaller	3/8"	3/8"
2-1/2" and 3"	1/2"	1/2"
4" and 5"	5/8"	1/2"
6"	3/4"	5/8"
8", 10" and 12"	7/8"	3/4"
14"	1"	7/8"
16" and 18"	1"	-
20" and 24"	1-1/4"	-

2. Hangers shall permit a minimum of 1-1/2-inch vertical adjustment after installation.

3. Where the piping system is subject to shock loads, such as seismic disturbances or thrusts imposed by the actuation of safety valves, pipe hangers shall include shock absorbing devices.

4. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing. Where lateral or axial movement cannot be

tolerated, provide sway bracing for rods exceeding 10 feet.

5. Where horizontal piping movements are greater than 1/2-inch, or where the hanger rod angularity from the vertical is greater than 4 degrees from the cold to hot position of the pipe, the hanger pipe and structural attachments shall be offset in such a manner that the rod is vertical in the hot position.

6. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.

7. Hangers shall be sized to fit around insulation.

K. Additional hangers and supports shall be provided as required so that there is no movement or visible sagging between supports.

L. Where indicated on the Drawings or directed by the Engineer, exposed piping and tubing carrying liquid shall be sloped as necessary to permit complete draining. Pipe deflection between supports shall be considered when determining the slope required to permit complete drainage.

M. Pipe Supports for Floor Supported Horizontal Piping: Pipe supports for horizontal piping supported on concrete floors and on concrete bases shall be adjustable pipe saddle support with U-bolt and screwed floor flange and unless otherwise indicated in Drawings. Bolt floor flange to floor and bases utilizing all bolt holes. Use foam glass inserts at all saddles, sleeves, etc.

N. Open ends of pipe columns used for support shall be completely covered with 1/4-inch thick plate or angle leg welded in place.

3.03 INSTALLATION - VERTICAL PIPING

A. Supports for all pipes shall fit directly around the pipe, except that on insulated pipes, the support shall be insulated and provided with vapor barrier.

B. Vertical pipes passing through floors shall be provided with a riser clamp at each floor. Riser clamps shall have steel lugs, 1/3-inch thick x 2-inches high x 1-1/2-inches long, welded to the clamp arms so that clamp does not come in contact with the pipe sleeve.

C. Vertical piping shall be supported as shown or required to prevent buckling or swaying utilizing special brackets. Unless otherwise shown, vertical piping shall be supported at the bottom and at each floor. Vertical copper tubing 1-inch and smaller in size shall be supported at five foot intervals.

3.04 INSULATION SHIELDS AND SADDLES - HORIZONTAL PIPING

A. Minimum insulation shield requirements unless otherwise noted:

1. Pipes 2-Inches and Smaller: 18 gauge x 12-inches long.

2. Pipes 2-1/2-Inches and Larger: 16 gauge x 12-inches long.

B. Shields shall be 180 degree type at all pipe hangers, except that on trapeze hangers, pipe rack and on floor supported horizontal pipes shields shall be 360 degree type. Use foamglass inserts at all shields, hangers, sleeves, etc.

C. Galvanized pipe clamps, including bolts and nuts, shall be provided with the framing channels and shall be used for securing pipes to channels. Pipe clamps on insulated pipes shall fit around pipe, pipe insulation and pipe insulation protection shield.

D. Insulation on hot piping (carrying fluids above 70 degrees F) shall be protected at supports and hangers with a 12-inch long galvanized steel protection saddle with welded center support. Protection saddle shall be equal to Grinnell Figure 160 or 161.

E. Insulation on cold piping (carrying fluids at 70 degrees F or below) shall be protected at supports and hangers by galvanized steel insulation shields with a 180 degree contour. Insulation shields shall be equal to Grinnell Figure 167.

F. On insulation finished with an aluminum jacket, a 1/32-inch thick sheet of neoprene shall be provided between the jacket and the shield.

3.05 SUPPLEMENTAL STEEL

A. All supplemental steel shall be fabricated in accordance with the requirements of the AISC Manual of Steel Construction and the Standard Building Code. B. No flame cutting of galvanized steel members will be permitted.

C. All galvanized surfaces damaged or exposed by cutting or drilling shall be resurfaced in accordance with ASTM A 780.

3.06 SURFACE PREPARATION AND SHOP PAINTING

Fabricated pipe supports and accessories, except where shown on the Drawings to be galvanized, shall be cleaned and shop primed in accordance with the requirements of Section 09910.

3.07 FIELD PAINTING

Field painting all pipe hangers, supports and accessories shall be in accordance with the requirements of Section 09910.

3.08 CLEANING

Prior to acceptance of the work of this Section, thoroughly clean all installed

materials, equipment and related areas.

END OF SECTION 15094

SECTION 15100

VALVES AND APPURTENANCES

PART 1 GENERAL

1.01 Scope

A. Furnish all labor, materials, equipment and incidentals required to complete and make ready for operation, all valves and appurtenances as shown on the Drawings and as specified herein.

B. This Section does not include valves for combustible or flammable liquids or gases.

C. The equipment shall include, but is not limited to, the following:

1. Sch. 80 PVC Ball Valves

2. Sch. 80 CPVC Ball Valves

1.02 Submittals

A. Complete shop drawings of all valves and appurtenances shall be submitted to the Engineer for approval in accordance with Section 01300 of these Specifications. Clearly indicate make, model, location, type, size and pressure rating.

1.04 Quality Assurance

A. The manufacturer shall provide written certification to the Engineer that all equipment furnished complies with all applicable requirements of these Specifications.

PART 2 PRODUCTS

2.01 General

A. Provide valves of same manufacturer throughout where possible.

B. Provide valves with manufacturer's name and pressure rating clearly marked on the outside of the valve body

C. Provide PVC valves for all chemical service piping except for systems explicitly noted as requiring CPVC

D. Provide CPVC valves for all Sodium Hypochlorite and Sulfuric Acid system piping

E. All valves provided for Sodium Hypochlorite service shall be diaphragm

2.02 PVC Ball Valves

A. Schedule 80 PVC Ball Valve 2 Inches and Smaller:

1. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, quarter turn, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions.

2. Manufacturers and Products:

    a. Nibco; Chemtrol Tru-Bloc .

    b. ASAHI/America; Duo-Bloc.

B. Schedule 80 PVC Ball Valve (3 Inches to 4 Inches)

1. Rated 150 psi at 73 degrees F, with ASTM D1784 Type I, Grade l polyvinyl chloride full port body, quarter turn, Teflon seat, Viton O-ring stem, face and carrier seals, end entry design with single union ball valve with flanged ends drilled to ANSI Bl6.l.

2. Manufacturers and Products:

    a. Nibco; Chemtrol Tru-Bloc.

    b. ASAHI/America; Duo-Bloc.

2.03 CPVC Ball Valves

A. CPVC Ball Valve (2 Inches and Smaller)

1. Rated 150 psi at 100 degrees F, 80 psi at 140 degrees, with ASTM 01784, Type IV, Grade 1 chlorinated polyvinyl chloride (CPVC) body, ball, and stem, end entry, double union design, quarter turn operation, with solvent-weld socket ends, replaceable Teflon seat, Viton or Teflon O-ring stem seals, to block flow in both directions.

2. Manufacturers and Products:

    a. Nibco; Chemtrol Tru-BJoc.

b. ASAHI/America; Duo-Bloc.

B. CPVC Ball Valve (3 Inches to 4 Inches)

1. Rated 150 psi at 100 degrees F, 80 psi at 140 degrees, with ASTM 01784, Type IV, Grade 1 chlorinated polyvinyl chloride (CPVC) full port body, Teflon seat, Viton O-ring stem, face and carrier seals, end entry design, quarter turn operation, with single union ball valve with flanged ends drilled to ANSI Bl6.l

2. Manufacturers and Products:

a. Nibco; Chemtrol Tru-BJoc.

b. ASAHI/America; Duo-Bloc.

2.04 (NOT USED)

PART 3 EXECUTION

3.01 Installation

A. All valves and appurtenances shall be installed in the locations of existing valves being replaced as best as possible or otherwise shown on the Drawings, true to alignment and properly supported. Any damage to the above items shall be repaired to the satisfaction of the Engineer before they are installed.

3.03 Inspection and Testing

A. Following installation, operating tests will be performed to demonstrate to the Engineer that all equipment and accessories will function in a satisfactory manner. The Contractor shall make, at Contractor's own expense, all necessary changes, modifications and/or adjustments required to ensure satisfactory operation.

3.05 Cleaning

A. Prior to acceptance of the work of this Section, thoroughly clean all installed materials, equipment and related areas.

END OF SECTION

SECTION 15200

PROCESS PIPING

PART 1 GENERAL

1.01 Design Requirements

A. All replacement chemical piping shall be Schedule 80 PVC except for piping associated with Sodium Hypochlorite and Sulfuric Acid systems, which shall be CPVC with both PVC and CPVC in accordance with data sheet provided in this Specification.

B. All yard piping shall be installed with a minimum of 3 feet of cover unless otherwise indicated in the Drawings.

C. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

1. Process Piping: ASME B31.3, normal fluid service unless otherwise specified.
2. Building Service Piping: ASME B31.9, as applicable.
3. Sanitary Building Drainage and Vent Systems: Henry County Plumbing Code
4. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.

1.02 Submittals

A. Informational Submittals:

1. Manufacturer's Certification of Compliance:

   a. Pipe and fittings.
   b. Factory applied resins and coatings.

2. Test logs and reports.

PART 2 PRODUCTS

2.01 Piping

A. As specified on Drawings and Piping Data Sheets located at the end of this section.

B. Diameters Shown:

1. Standardized Products: Nominal size.

2.02 Joints

A. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.

PART 3 EXECUTION

3.01 Examination

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

3.02 Preparation

A. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

B. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer's instructions.

3.03 Installation—General

A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.

C. PVC & CPVC Piping:
1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
2. Use strap wrench for tightening threaded plastic joints. Do not over tighten fittings.

3. Do not thread Schedule 40 pipe

3.04 Installation—Exposed Piping

A. Piping Runs:
   1. Run piping to match existing condition configuration wherever possible. For instances where this is infeasible, refer to the subsequent instructions.
   2. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
   3. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

   4. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

C. Piping clearance, unless otherwise shown:

   1. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

   2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems (exceptions may be made when matching existing pipe configuration).

   3. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.

   4. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.

   5. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.

   6. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.05 (NOT USED)

3.06 Field Quality Control

A. Pressure Leakage Testing: in accordance with the International Plumbing Code.

3.07 Cleaning

A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines (except as stated below) with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

B. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

C. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.08 Piping Data Sheets

POLYVINYL CHLORIDE (PVC) & CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS		
Item	Size	Description
General	All	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC. Schedule 80 CPVC: Type IV, Grade I or Class 23447 conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 CPVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.

POLYVINYL CHLORIDE (PVC) & CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS		
Item	Size	Description
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub type PVC/CPC flat face flange in accordance with Fittings above, 150-pound ASME B16.1 drilling
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts. Use titanium bolts at Lime tank flange connections for Lime service. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts and ASTM A563 Grade A heavy hex head nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch-thick ethylene propylene (EPR) rubber. Use PTFE gaskets at Lime tank flange connections for Lime service Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656 and as recommended by pipe and fitting manufacturer for the fluid being conveyed.
Thread Lubricant	All	Teflon Tape.

3.09 (NOT USED)

END OF SECTION

SECTION 15250

INSULATION AND HEAT TRACING

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools, and incidentals required for a complete and operable installation of mechanical insulation. All equipment shall be installed, adjusted, tested, and placed in operation in accordance with these Specifications, the Contractor's recommendations and as shown on the drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any specific material. Contractor shall supply all parts, devices, and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the material being furnished. All costs associated with such changes and adjustments shall be included in the price bid for the Work shown and specified.

C. Related work specified elsewhere:

1. Section 15050, Basic Mechanical Materials and Methods.

2. Section 15200, Process Piping

3. Section 15400, Plumbing

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer's technical product data and installation instructions for each type of mechanical insulation:

a. Manufacturer's product number.

b. k-Value and thickness.

c. Accessories included for each mechanical system requiring insulation.

2. Maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

3. Submit manufacturer's installation instructions.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Flame/Smoke Rating: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics, and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84, NFPA 255 method.

C. Reference Standards: Comply with all Federal and State laws or ordinances, as well as the latest edition of all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ASTM, American Society for Testing Materials.

2. ASME, American Society of Mechanical Engineers.

3. OSHA, Occupational Safety and Health Act.

4. ANSI, American National Standards Institute.

5. AWWA, American Water Works Association.

6. NFPA, National Fire Protection Association.

7. FM, Factory Mutual Engineering Corporation.

8. UL, Underwriters Laboratories, Inc.

1.04 STORAGE AND PROTECTION

A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Insulation products shall be manufactured by CertainTeed, Knauf, Johns Manville, Owens Corning, IMCOA, Pittsburgh-Corning, or Armstrong.

2.02 PIPE INSULATION

A. Materials (Tepid Water, Non-potable Water, and Chemical Piping)

1. Piping insulation shall be pre-formed glass fiber molded to cover pipe in two pieces with longitudinal joints. The insulation shall be covered with factory applied, all-service jacket with self-sealing lap strip. Thermal conductivity shall not exceed 0.23 BTUin/hr/Ft^2/°F at 75 degrees F.

2. Valve and fitting insulation shall be pre-formed glass fiber, covered with preformed PVC fitting covers. Thermal conductivity shall not exceed 0.23 BTUin/hr/Ft^2/°F at 75 degrees F.

3. Furnish heavy duty Aluminum jacketing over insulation retained by bands of the same or thicker gauge. All jacketing seams shall be sealed weathertight with sealant suitable for outdoor installation.

B. Pipe Insulation Thickness: Insulation thickness shall be 1 inch for pipes below 1.5 inches in diameter, 1.5 inches for pipes 1.5 inches to 3 inches in diameter, and 2 inches for pipes 4 inches and above in diameter.

2.03 ELECTRIC HEAT TRACING FOR PIPING

A. Provide self-limiting heat trace cables where shown on the Drawings.

B. Cable shall have 16 AWG copper bus wire with self-regulating, semi-conductive core tinned copper braided shield over bus wire and core. Overjacket shall be modified polyolefin or fluoropolymer over shield. Cable shall provide temperature maintenance up to 150 degrees F. Cable shall be equal to Raychem Model BTV.

C. Provide all required electrical accessories, including power connection kits, splice kits, tee kits, lighted end seals, thermostats, aluminum or glass tape and other components required for a complete operating system for each heat trace service as scheduled herein. Cable and accessories shall be FM approved for insulation in NEC classified areas where indicated on the Heat Trace Schedule. Unless heat trace services are installed in NEC classified locations, all enclosures for electrical accessories shall be NEMA 4X rated. All components shall be UL-listed.

D. Thermostats shall be bulb type. Temperature range shall be adjustable from 25 to 150 degrees F.

E. Ambient-sensing thermostats shall be equal to Model AMC-1A and line-sensing thermostats shall be equal to Model AMC-1B as manufactured by Raychem.

F. Lighted end seals shall be equal to Raychem Model E-100-L-A. Splice or tee connection kit shall be equal to Raychem Model T-100. Single entry power connection kit shall be equal to Raychem, Model JBS-100. Multiple entry power/splice-tee connection kit shall be equal to Raychem Model JBM-100.

G. Outdoor design temperatures shall be 0° F.

H. Coordinate circuit sizing with available electrical circuits shown on the Electrical Drawings. All wiring and conduit from the junction boxes to the heat trace power connection kits shall be installed in accordance with Division 16.

I. Provide pipe markers cautioning “ELECTRIC HEAT TRACING – SHOCK HAZZARD”.

J. Acceptable Manufacturers: Raychem, Thermon, and Chromalox.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions under which mechanical insulation is to be installed. Work shall not proceed until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION OF PIPING INSULATION

A. Install insulation products in accordance with manufacturer's written instructions, these specifications and in accordance with recognized industry practices to ensure insulation serves its intended purpose.

1. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.

2. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

3. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

4. Install insulation on pipe systems subsequent to installation of heat tracing, testing and acceptance of tests.

5. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

6. Maintain integrity of vapor-barrier jackets on pipe insulation and protect to prevent puncture or other damage.

7. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.

B. Insulate all of the services listed below:

1. Tepid water piping serving emergency fixtures.

2. Non-potable water piping.

C. Insulate all piping, valves, and fittings that are heat traced in addition to those services specified herein.

3.03 ELECTRIC HEAT TRACING

A. Install heat tracing in accordance with the manufacturer's instructions prior to insulation.

B. Apply tracing cable around pipe, valves, and fittings as required to attain wattage densities specified herein. Do not spiral wrap pipe dimensions under 2-inches. Provide additional wattage for valves and fittings in accordance with the manufacturer's instructions.

C. Secure heat tracing cable to piping and components with glass tape. Provide aluminized Mylar heat transfer tape over and under heater and under insulation on plastic piping and valves.

D. Coordinate heat tracing installation with electrical and insulation work.

E. Where the multiple heat trace services are installed in a single area, each service shall be separately powered from an electrical junction box. Heat trace cable shall not be used as a means of power supply between separate heat trace services. Each heat trace service shall be provided with separate power connection kits, end seals, thermostats, and accessories as scheduled within this Specification.

F. Do not locate thermostats in the direct sun.

END OF SECTION

SECTION 15400

PLUMBING

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of all plumbing and associated appurtenances. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be included in the price bid for the work shown and specified.

C. Related work specified elsewhere:

1. Section 02050 Demolition
2. Section 15050 Basic Mechanical Materials and Methods
3. Section 15250 Insulation and Heat Tracing

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer's specifications, catalog data, descriptive matter, illustrations and diagrams.
2. Nameplates.
3. Foundations, installations and grouting.
4. Operating and maintenance instructions and parts lists.
5. Lubricants.
6. Special tools.
7. Bolts, anchor bolts and nuts.
8. Concrete inserts.
9. Sleeves.

B. Submit scaled plans and elevations of piping in areas of tight clearances for coordination of work by others subject to approval by the Engineer.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as the latest edition of all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ANSI, American National Standards Institute.
2. ASTM, American Society for Testing Materials.
3. AWS, American Welding Society.
4. AWWA, American Water works Association.
5. UL, Underwriters Laboratory.
6. NEC, National Electric Code.
7. OSHA, Occupational, Health and Safety Act.
8. NFPA, National Fire Protection Association.

1.04 QUALITY STANDARDS

A. Plumbing accessories of same type shall be furnished by a single manufacturer who shall assume sole responsibility for providing a complete and operable system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings.

B. Contractor shall provide written certification that the accessories provided under this specification have been designed in accordance with these specifications and is a suitable application for these service conditions. A certificate of unit responsibility shall be provided. Nothing in this provision, however, shall be construed as relieving the Contractor of his overall responsibility for this portion of the Work.

C. Unit responsibility certificates provided by suppliers, vendors, or other second party representatives of the plumbing accessories manufacturer shall not be accepted.

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 – PRODUCTS

2.01 PIPE AND FITTINGS:

A. Domestic Water (Copper Piping):

1. Copper piping shall be hard-drawn conforming to the requirements of ASTM B 88.
2. Type L for above ground piping and Type K for underground piping.
3. Fittings shall be hard-solder type. Hard solder fittings shall be wrought copper or cast brass conforming to the requirements of ASTM Designation B 62-74.

B. Domestic Water (CPVC Piping)

1. CPVC Pipe: Schedule 80 CPVC, ASTM D2846/D2846M, ASTM F441/F441M, or ASTM F442/F442M, chlorinated polyvinyl chloride (CPVC) material
2. Fittings: ASTM D2846/D2846M, ASTM F437, ASTM F438, ASTM F439, or ASTM F441/F441M, CPVC.
3. Joints: ASTM D2846/D2846M, solvent weld with ASTM F493 solvent cement.

C. Drain, waste, and vent:

1. Drain, waste and vent pipe shall be constructed of Schedule 80 PVC or cast-iron soil pipe where shown on the Drawings.

2.02 VALVES

A. Ball Valves

1. 2-inches and smaller shall be bronze body with full port, rated for a hydraulic working pressure of 150 psi.

B. Globe Valves

1. Globe valves 2-inches and smaller shall be bronze body with rising stem, screwed bonnet, integral bronze seat, renewable PTFE discs with screwed or solder joint ends. Valve shall be rated for a non-shock cold working pressure of 300 psi.

C. Acceptable Manufacturers: Crane, Nibco, Stockham, Milwaukee, Watts, Apollo, Kitz.

2.03 PRESSURE REDUCING VALVES (1/2 TO 2-INCH SIZE)

A. Provide bronze body, spring controlled, adjustable pressure reducing valve with threaded connections.

B. Provide valves with high temperature diaphragm and renewable nickel alloy seat.

C. Provide with thermal expansion bypass.

D. Provide with separate bronze strainer with 20 mesh stainless steel basket. Attach to valve with bronze nipple.

E. Rated for 300 psig maximum inlet water pressure with adjustable 25-75 psig outlet water pressure.

F. Tested and certified under ASSE 1003 and the International Plumbing Code.

G. Acceptable Manufacturers: Watts 223SB, Wilkins, Mueller.

2.04 PIPING ACCESSORIES:

A. Nipples: FS WW-N-351; be of same type material as piping on which installed.

B. Unions for Copper Tubing: Brass or bronze, have either treaded or solder joint ends and conform to FS WW-U-516.

C. Unions for Steel Piping: FS WW-U-531.

D. Escutcheons: Polished chromium-plated pressed steel, split-hinged, locking type held in-place by either an internal tension spring or a set-screw; encompass sleeve or opening.

E. Bolts and Nuts: Machined brass, stainless steel, or galvanized carbon steel, and not smaller than 1/4-inch; bolts shall have hexagonal heads and nuts shall be hexagonal.

F. Solder for Solder-Jointed Tubing: 95 percent tin and 5 percent antimony. Flux shall be non-corrosive type conforming to NSF 61.

G. Strainers

1. Strainers in water lines shall have standard pattern, stainless steel baskets with standard perforations. Bodies shall be bronze for sizes 2-inch and smaller and cast iron for sizes 2-1/2-inch and larger. Strainers shall be equal to Watts Series 77 unless otherwise specified.
2. All strainers shall be of the same size as the piping in which they are installed. Provide dielectric union, if necessary, to isolate strainer from pipe material.

2.05 INSULATION

A. Insulation shall be in accordance with Section 15250.

2.06 FLASHING

Either soft-temper or cold-rolled copper weighing not less than 16 ounces per square foot
or sheet lead weighing not less than four pounds per square foot.

2.07 ESCUTCHEON

Polished chromium-plated pressed steel, split-hinged, locking type held in place by either an internal tension spring or a set-screw and encompass sleeve or opening.

2.08 HOSE BIBB

A. Hose Bibb

1. Provide 3/4-inch size hose bibb, cast bronze construction, rough brass finish, with integral vacuum breaker-backflow preventer and 3/4-inch hose thread outlet.
2. The hose bibb shall be Zurn Z1241-BFP, or equal by J.R. Smith or Josam.

B. Where hose reels are called out on the Drawings, provide minimum of 50 feet long retractable, wall mounted hose reel, as manufactured by Zurn or equal.

2.09 PAINTING

A. Painting shall be in accordance with Division 9.

PART 3 - EXECUTION

3.01 PREPARATION

A. Early installation of buried drain piping may be required. All measurements shall be verified at the job site.

B. Avoid interferences with other trades.

3.02 WATER SUPPLY SYSTEM INSTALLATION

A. Install water systems in accordance with AWWA standards and local codes applicable to water system installation.

B. Earthwork and trenching shall be in accordance with Division 2 of these Specifications.

C. Cut pipe and tubing accurately to measurements established at worksite; work pipe into place without springing and forcing. Install pipe with a fall towards either shut-off valve or lowest fixture.

D. Remove fins and burrs from piping. Apply lubricant to male threads only; threads shall be full cut, and not more than three threads on pipe shall remain exposed after tightening. Coat installed and tested exposed ferrous threads with one coat of non-toxic primer and oil paint.

E. Cut end of copper tubing square and remove burrs. Clean ends of tubing and apply a rosin type flux to outside surface of tubing ends and on recess inside of fittings. Insert tubing to full depth of fitting; then solder joints before soldering valves.

F. Install piping true to line and grade, and support and guide in a manner which will ensure indicated alignment. Installed piping shall clear obstructions, preserve headroom, keep openings and passageways clear, and not be in same trenches as sewer lines. Water supply system drawings are schematic; do not scale. Install unions on pipe ends immediately adjacent to valves, equipment, and tanks.

G. Valves shall be accessible for operation and servicing. Stems of installed valves shall not be below horizontal position. Valves which will be in furred spaces shall be accessible.

H. Make-up soldered-to-threaded connections with male thread-to-solder adapters.

I. After pipes have been installed, either cap or plug ends of pipes. Neither bury, furr-in, nor conceal piping before piping has been inspected and tested.

J. Provide access panels in finished walls for access to concealed valves, water hammer arrestors, and other devices requiring periodic maintenance.

K. Install insulation in accordance with Section 15250 of these Specifications.

L. Dielectric Isolation

1. Wherever copper, brass, or bronze piping systems are connected to steel or iron piping systems, this connection shall be made with dielectric isolators. The dielectric isolators shall be so designed that non-ferrous piping materials shall be isolated by the use of Teflon or nylon isolating materials made up in the form of screwed type unions or insulating gaskets and bolt sleeves and washers for standard flanged connection. All dielectric isolators shall be selected for the pressure of the system involved.

2. Dielectric isolators shall be Watts, Epco, Crane, or Maloney.

3.03 WATER SUPPLY SYSTEM TESTING

A. Test installed building water supply system in accordance with the International Plumbing Code.

B. Test piping that will be buried prior to concealment.

3.04 WATER SUPPLY SYSTEM DISINFECTING

A. Disinfect water systems in accordance with AWWA C651 and local codes applicable to water system disinfecting.

B. Before disinfecting system, flush line in a manner which will remove all extraneous materials.

C. Disinfect each section of new line before seeking acceptance of water supply system.

D. Either directly apply chlorine or mix water with calcium hypochlorite, chlorine gas, or calcium chloride. Retain solution in pipe for not less than 24 hours, then measure residual chlorine at ends of section and at other representative points; residual chlorine content is similar to that obtained from the source.

END OF SECTION

SECTION 15440

EMERGENCY SHOWER AND EYEWASH FIXTURES

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all emergency shower and eyewash fixtures. All equipment shall be installed, adjusted and tested in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be included in the price bid for the Work shown and specified.

C. Related Work Specified Elsewhere:

1. Section 15050 Basic Mechanical Materials and Methods
2. Section 15250 Plumbing Insulation and Heat Tracing
3. Section 15400 Plumbing

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer's certification.
2. Manufacturer's data and installation instructions.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as the latest edition of all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ANSI, American National Standards Institute.

2. NEC, National Electric Code.
3. OSHA, Occupational Safety and Health Act.
4. NFPA, National Fire Protection Association.

1.04 QUALITY STANDARDS

A. The emergency shower and eyewash fixtures shall be furnished by a single manufacturer who shall assume sole responsibility for providing a complete, operating system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings.

B. Manufacturer shall provide written certification that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions. A certificate of unit responsibility shall be provided. Nothing in this provision, however, shall be construed as relieving the Contractor of his overall responsibility for this portion of the work.

C. Unit responsibility certificates provided by suppliers, vendors, or other second party representatives of the pump manufacturer shall not be accepted.

D. Acceptable Manufacturers:

1. Speakman, Bradley, Haws, and Guardian

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 EMERGENCY SHOWER AND EYEWASH FIXTURES

A. Drench Shower/Eyewash – Heat Traced and Insulated

1. Provide heat traced and insulated combination drench shower/eyewash units with 8-inch diameter plastic shower, 2 plastic spray outlets with automatic flow control and flip-top dust caps, stay-open shower valve with triangular pull rod, eye/face wash valve activation with push handle, 1-1/4 IPS inlet and drain, and floor flange.
2. Heat trace cable shall be self-regulating type with braided metal

shield, NEMA 4X water-tight and dust-tight junction box, 120 VAC.
3. The unit shall have closed cell rubber foam insulation.
4. ANSI/ISEA Z358.1 certified.
5. Provide the identification sign designed for wall mounting to read “EMERGENCY SHOWER AND EYE WASH”.
6. Shower/eyewash shall be equal to Speakman model SE-7000 for bottom supply and model SE-7001 for top supply.

2.02 EMERGENCY FIXTURE – FLOW SWITCH – THERMAL DISPERSION TYPE

A. Provide thermal dispersion type flow switch in the emergency fixture water supply loop.

B. The process connection shall be 3/4-inch MNPT with a standard “U” length suitable for mounting in a 3/4-inch threaded tee. The unit shall be designed to mount in horizontal piping in a side mounted configuration.

C. Contacts: SPDT 5 amp resistive at 120 VAC.

D. Response Time: Unit shall guarantee less than 10 seconds response time for the line sizes, flow rates, and other conditions as installed in this application.

E. Power: 120 VAC.

F. Materials of Construction

1. Wetted Parts: 316 stainless steel.
2. Electronics Enclosure: Cast aluminum with epoxy coating, suitable for outdoor service.

G. Calibrate the flow switches to generate alarm based on eyewash flow. See Divison 16 for remote reporting of flow activation alarm.

H. Acceptable Manufacturers: FCI (Series FLT) or Magnetrol (Thermatel Model TD2)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design and the referenced standards.

B. Examine rough-in for potable water and waste piping systems to verify

actual locations of piping connections prior to installation of fixtures.

C. Examine walls and floors for suitable conditions where fixtures are to be installed.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings, and the pertinent codes and regulations, the original design, and the referenced standards.

B. Fasten plumbing fixtures securely to the supports or building structure. Secure supplies behind or within wall construction to provide rigid installation.

C. Seal fixtures to floors using silicone sealant as specified in Division 7. Match sealant color to fixture color.

3.03 FIELD QUALITY CONTROL

A. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.

B. Inspect each installed unit for damage. Replace damaged fixtures.

3.04 ADJUSTING

A. Adjust water pressure at shower valves, and flush valves to provide proper flow and stream.

B. Clean fixtures using manufacturer's recommended cleaning methods and materials.

END OF SECTION

SECTION 16000

ELECTRICAL POWER AND SYSTEMS

PART 1 GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all electrical power and systems. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

1.02 DEFINITIONS

A. Provide: Furnish, install, and connect
B. Product Data: Catalog cuts and descriptive literature
C. Shop Drawings: Factory prepared specific to the installation
D. Indicated: Shown on the Contract Drawings
E. Noted: Indicated or specified elsewhere
F. Control Diagram: A control diagram shows by means of graphic symbols, the electric connections and functions of a specific circuit arrangement. The control diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.
G. One-Line Diagram: A one-line diagram shows by means of single lines and graphic symbols the course of an electric circuit or system of circuits and the components, devices, or parts used therein. Physical relationships are usually disregarded.
H. Block Diagram: A block diagram is a diagram of a system, instrument, computer, or program which selected portions are represented by annotated boxes and interconnecting lines.
I. Wiring Diagram: A wiring or connection diagram includes all the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. This diagram shall be a) in a form showing interconnecting wiring only by terminal designation (wireless diagram), or b) a panel layout drawing showing the physical location of devices plus the control diagram.

J. Interconnection Diagram: Interconnection diagrams shall show all external connections between terminals of equipment and outside points, such as motors and auxiliary devices. References shall be shown to all connection diagrams which interface to the interconnection diagram. Interconnection diagrams shall be of the continuous line type. Bundled wires shall be shown as a single line with the direction of entry/exit of the individual wires clearly shown. Wireless diagrams and wire lists are not acceptable. Each wire identification as actually installed shall be shown. The wire identification for each end of the same wire shall be identical. All devices and equipment shall be identified. Terminal blocks shall be shown as actually installed and identified. All jumpers, shielding and grounding terminations not shown elsewhere shall be shown here. Signal and DC circuit polarities shall be shown. Spare wires shall be shown.

K. Arrangement, Layout, or Outline Drawings: An arrangement, layout, or outline drawing is one which shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements or the location to which connections are to be made.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the Contract Documents. In addition, the following specific information shall be provided:

1. Information required "for reference" such as product samples, similar unit test reports, and time current curves is for the purpose of determining the suitability of a product, selecting breaker settings, etc. This information is to be submitted at the same time as approval data; however, this information will not be returned, and stamped approval is not required prior to installation.

2. Except as noted, installation instructions are not required to be submitted. However, it is the Contractor's responsibility to obtain installation information from the manufacturer for all equipment prior to installing the equipment.

3. Interconnecting diagrams depicting all cable requirements together with actual terminations as specified under paragraph 16000-1.02J.

1.04 QUALITY ASSURANCE

A. Provide complete electrical installation in accordance with the National Electrical Code (NFPA 70), Life Safety Code (NFPA 101), and in accordance with applicable local codes. Obtain all necessary permits and have all work inspected by appropriate authorities.

B. All products shall be designed, manufactured, and tested in accordance with industry standards. Where applicable, products shall be labeled or listed by third party certification agencies.

C. Industry Standards: Standards organizations and their abbreviations, as used herein, are as follows. Applicable date for industry standards is that in effect on the date of advertisement of the project.

1. American National Standards Institute (ANSI).
2. American Society for Testing and Materials (ASTM).
3. Federal Specifications (FS).
4. Institute of Electrical and Electronics Engineers (IEEE).
5. Insulated Cable Engineers Association (ICEA).
6. National Electrical Manufacturers Association (NEMA).
7. National Fire Protection Association (NFPA).
8. Underwriters Laboratories, Inc. (UL).
9. National Electrical Testing Association (NETA).

1.05 WORK INCLUDED IN DIVISION 16

A. Electrical power and systems.
B. Basic materials and methods.
C. Conduit.
D. Conductors.
F. Wiring devices.
G. Electric motors.
I. Instrument transformers and meters.

1.06 MATERIALS AND EQUIPMENT FURNISHED AND INSTALLED UNDER OTHER DIVISIONS WITH RACEWAY AND ELECTRICAL CONDUCTORS FURNISHED, INSTALLED, AND CONNECTED UNDER DIVISION 16

A. Equipment, Instrumentation and control system components indicated on the Drawings by filled circumscribed diamond symbol.

1.07 INTENT OF DRAWINGS

A. Electrical plan drawings show only general locations of equipment, devices, and raceway, unless specifically dimensioned. The Contractor shall be responsible for proper routing of raceway, subject to the approval of Engineer.

1.08 ELECTRICAL NUMBERING SYSTEM

A. Conductors which are in parallel or in series between equipment shall have the same conductor number. Neutral conductors shall have the same conductor number. Wherever possible, the conductor shall be the same as the terminal to which it connects.

B. When factory-wired equipment has terminal numbers different than the conductor number shown on the control diagram, both shall be shown on the interconnection diagram, and a copy of the interconnection diagram shall be fastened to the inside of the equipment cabinet.

C. Conductors shall be identified with the same numbers at both ends.

D. Approved conductor tags and wire labels shall be clearly legible, UV and weather

resistant, non-corroding and properly attached.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Ship products to the job site in their original packaging. Receive and store products in a suitable manner to prevent damage or deterioration. Keep equipment upright at all times.

B. Investigate the spaces through which equipment must pass to reach its final destination. Coordinate with the manufacturer to arrange delivery at the proper stage of construction and to provide shipping splits where necessary.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide only new products of the manufacturer's latest design.

B. Equipment shall be applied only within its rating. Equipment ratings shown are minimums. Voltage and current ratings shall be as required to adequately power the connected equipment. Fault current ratings shall be as shown for the particular item or for the next upstream device that has a fault current rating shown.

C. The following areas are classified hazardous:

1. Head works.
2. All sump pits.

D. The following areas are classified as corrosive:

1. Primary sludge pumping stations.
2. Mixed liquor channel.
3. Mixed liquor pumping station.
4. Aerated tanks.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Maintain continuity of electric service to all portions of the process or buildings at all times. Temporary outages will be permitted during cutover work at such times and places as can be prearranged with Engineer and the electric utility company providing service to the facility. Such outages shall be kept to a minimum number and minimum length of time. Make no outages without prior written authorization of the Engineer. Include all costs for temporary wiring and overtime work required in the Contract price. Remove all temporary wiring at the completion of the work.

B. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with these codes.

C. Unless otherwise indicated, all material required to be removed and salvaged shall become the property of the Owner.

D. Carefully modify existing electrical equipment, as necessary to carry out proposed changes. Rehabilitate and relocate items of equipment as required and as indicated or specified.

3.02 CERTIFICATION AND TESTS

A. Prior to request for final review, test all systems and repair or replace all defective work. Submit, with request for final review, written certification that all electrical systems are complete and operational.

B. At the time of final review of electrical work, demonstrate the operation of electrical systems. Furnish labor, apparatus and equipment for systems' demonstration.

C. After final review and acceptance, turn over to the Engineer all keys for electrical equipment locks. Present to the Owner's designated representatives, demonstrations and oral instructions for proper operation and maintenance of the electrical equipment and systems.

END OF SECTION

SECTION 16060

GROUNDING AND BONDING

PART 1 GENERAL

1.01 SCOPE

A. This Section includes grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.

B. Documents and general provisions of the Contract, including Division 1 Specification Sections, apply to this Section.

C. Related Sections include but are not limited to:
   1. Section 16120 – 600 Volt Conductors, Wire, and Cable

1.02 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. American Society for Testing and Materials (ASTM).
      a. ASTM B3 – Specification for Soft or Annealed Copper Wire.
      b. ASTM B8 – Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
      c. ASTM B33 – Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.
   2. National Electrical Code (NEC).
      a. NEC – National Electrical Code.
   3. Underwriters Laboratories Inc. (UL).
      a. UL 467 – Standard Grounding and Bonding Equipment.
      b. UL 486A and UL 486B – Standard Wire Connectors.
   4. National Fire Protection Association (NFPA).
      a. NFPA 70 – National Electrical Code.

1.03 SUBMITTALS

A. Product Data for grounding rods, connectors and connection materials, and grounding fittings.

B. Qualification data for firms and persons specified in the “Quality Assurance” Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

C. Field tests and observation reports certified by the testing organization and indicating and interpreting the test reports for compliance with performance requirements.

1.04 QUALITY ASSURANCE

A. Testing Agency Qualifications: A “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7, or a full member company of the international Electrical Testing Association (NETA).
   1. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3 of this Section.

B. Comply with NFPA 70.

C. Comply with UL 467.

D. Listing and Labeling: Provide products specified in this Section that are UL listed and labeled.
   1. The Terms “Listed” and “Labeled”: As defined in the National Electrical Code, Article 100.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Apache Grounding; Nashville Wire Products.
   2. Chance: A. B. Chance Co.
   3. Erico Products- Cadweld.
   4. Burndy Co.
   5. Fushi Int.- Copperweld
   6. Continental Industries – Thermoweld.
   7. Heary Brothers Lightning Protection Co.
   8. Ideal Industries, Inc.
   9. Kearney.
   10. Lightning Master Corp.
   11. O-Z/Gedney Co.
   12. Thomas & Betts, Electrical.
   13. Or approved equal.

2.02 GROUNDING AND BONDING PRODUCTS

A. Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirement and the greater size, rating, and quantity indications shown shall be adhered.

2.03 WIRE AND CABLE GROUNDING CONDUCTORS

A. Comply with Section 16120 - 600 Volt Conductors, Wire, and Cable. Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.

B. Equipment Grounding Conductors: Insulated with green color insulation.

C. Grounding-Electrode Conductors: Stranded copper cable.

D. Underground Conductors: Bare, tinned, stranded copper except as otherwise indicated.

E. Bare Copper Conductors: Conform to the following:
   1. Solid Conductors: ASTM B 3.
   2. Assembly of Stranded conductors: ASTM B 8.
   3. Tinned Conductors: ASTM B 33.

2.04 MISCELLANEOUS CONDUCTORS

A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.

B. Braided Bonding Jumpers: Copper tape, braided No. 3/0 AWG bare copper wire, terminated with copper ferrules.

C. Bonding straps: Soft copper, 0.05-inch thick and 2-inches wide, except as indicated.

2.05 GROUNDING PRODUCTS

A. Pressure connectors: High-conductivity-plated units.

B. Bolted Clamps: Heavy-duty type.

C. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer’s written instructions for specific types, sizes, and combination of conductors and connected items.

2.06 GROUNDING ELECTRODES AND TEST WELLS

A. Grounding Rods: Copper.
   1. Size: 3/4-inch by 120-inches.

B. Test Wells: Grounding rod, as above, driven through drilled hole in bottom of handhole. Handhole minimum size 12-inch x 1-inch x12-inch with cover. See 3.02 for details.

PART 3 - EXECUTION

3.01 APPLICATION

A. Equipment grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.
   1. Install equipment grounding conductor with circuit conductors for the items below in addition to those required by Code:
      a. Feeders and branch circuits.
      b. Lighting circuits.
      c. Receptacle circuits.
      d. Single-phase motor or appliance branch circuits.
      e. Three-phase motor or appliance branch circuits.
      f. Flexible raceway runs.
   2. Metallic Raceways: Raceways, conduits and cable trays, etc. shall be made electrically and mechanically continuous, and shall be bonded/ grounded to earth. Utilize jumpers, clamps, etc. as necessary to meet requirements for NEC. Install a grounding conductor in each metallic raceway, conduit and cable tray.
   3. Nonmetallic Raceways: Install a grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
   4. Air-Duct Equipment Circuits: Install a grounding conductor to duct mounted electrical devices operating at 120 V and above, including air cleaners and heaters. Bond conductor to each unit and to air duct.
   5. Water Heater, Heat-Tracing, and Antifrost Heater Circuits: Install a separate grounding conductor to each electric water heater, heat-tracing assembly, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

B. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide a No. 4 AWG minimum insulated grounding conductor in raceway from grounding-electrode system to each service location, backboard, terminal cabinet, wiring closet, and central equipment location.
   1. Service and Central Equipment Locations and wiring Closets: Terminate grounding conductor on a 1/4-inch x 2-inch x 12-inch grounding.
   2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

C. Separately Derived Systems: Where NEC requires grounding, ground according to NEC.

D. Metal Poles Supporting Exterior Lighting Fixtures: Ground pole to a grounding electrode in addition to separate equipment grounding conductor run with supply branch circuit.

E. Grounding and Bonding for Piping and Metallic Parts:
   1. Ground and bond piping to meet NEC and requirement of local Authority Having Jurisdiction.
   2. Ground and bond metallic structures, supports, fences, handrails, misc. metallic parts and similar items which are in proximity to electrical equipment, conduit and wiring and which are likely to become electrified upon fault or short of the electrical equipment, conduit or wiring.

F. Grounding and Bonding Metal Air Ducts: Ground and Bond metal air ducts to equipment grounding conductors of associated fans, blowers, heaters and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

3.02 INSTALLATION

A. General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.

B. Grounding Electrode System: Where available on the premises, at each building or structure served, a metal underground water pipe, the metal frame of the building or structure, concrete encased electrodes, any ground ring encircling the building or structure, and all made electrodes (ground rods, etc.) shall be bonded together to form the grounding electrode system. The main bonding jumper and the grounding electrode conductor shall be installed and sized per NEC except where larger sizes than required by NEC are indicated.

C. Electrical Room Grounding Bus: Space 1-inch from wall and support from wall 6-inches above finished floor, except as otherwise indicated.

D. Grounding Rods: A minimum of two (2) ground rods shall be installed where the ground rod serves as the grounding electrode per NEC. Locate a minimum of 1-rod length from each other and at least the same distance from any other grounding electrode.
   1. Drive until tops are 2-inches below finished floor or final grade, except as otherwise indicated.
   2. Interconnect with grounding-electrode conductors. Except at test wells and as otherwise indicated, use exothermic welds.

E. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

F. Underground Grounding Conductors: Use bare, soft-drawn copper wire: Bury at least 30-inches below ground.

G. Test Wells: Minimum of two at each building/ structure ground loop, except as otherwise indicated. Set top of well flush with finished grade or floor. Fill with 1-inch maximum-size crushed stone or gravel.

3.03 CONNECTIONS

A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or tin-coated materials to assure high conductivity and to 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 with tin-plated copper jumpers and mechanical clamps.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Non-contact metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at both entrances and exits with the grounding conductors, except as otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.04 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Manholes and Handholes: Install a driven grounding rod close to wall and set rod depth so 4-inches will extend above finished floor. Where necessary, install grounding rod before manhole is placed and provide a No. 1/0 AWG bare copper conductor from grounding rod in to manhole through a waterproof sleeve in manhole wall. Protect grounding rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2-inches above to 6-inches below concrete. Seal floor opening with waterproof, non-shrink grout.

B. Connections to Manhole Components: Connect exposed metal parts, such as inserts, cable racks pulling irons, ladders, and cable shields within each manhole or handhole, to grounding rod or grounding conductor. Make connections with minimum No. 4 AWG stranded, hard-drawn copper wire. Train conductors plumb or level around corners and support to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

C. Grounding System: Ground Pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Engage an electrical testing organization to perform tests described below.

B. Test: Subject the completed grounding system to a megger test at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than 2 full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the 2-point method according to IEEE 81

C. Maximum grounding to resistance values are as follows:
   1. Equipment rated 500 KVA and Less: 10 ohms.
   2. Unfenced Substations and Pad-Mounted Equipment: 5 ohms.
   3. Manhole Grounds: 10 ohms.

D. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify Owner promptly and include recommendations to reduce ground resistance and to accomplish recommended work.

E. Report: Prepare test reports, certified by the testing organization, or ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.06 ADJUSTING AND CLEANING

A. Restore surface features, including vegetation, at areas disturbed by work in this Section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include topsoil, fertilizer, lime, seed, sod, sprigs, and mulch. Maintain restored surface. Restore disturbed paving to the original condition.

END OF SECTION

SECTION 16110

RACEWAYS, BOXES, AND SUPPORTS

PART 1 - GENERAL

1.01 SCOPE

This section covers the furnishing and installation of electrical conduits, wireways, pull boxes, manholes, handholes, cable trays, fittings and supports. Raceways shall be provided for lighting, receptacles, power, control, instrumentation, signaling and grounding systems.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI	Rigid Steel Conduit-Zinc Coated
ANSI	Electrical Metallic Tubing-Zinc Coated
ASTM	Smooth-Wall Polyvinylchloride Conduit and Fittings for Underground Installation
FEDSPEC	Conduit, Metal, Rigid and Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit; Zinc Coated
FEDSPEC	Conduit and Conduit Fittings, Plastic, Rigid
NEMA	Industrial Control and Systems Enclosures
NEMA	Electrical Plastic Tubing (EPT) and Conduit (EPC 40 and EPC 80)
NEMA	PVC and ABS Plastic Utilities Duct for Underground Installation
NEMA	Cable Tray Systems

NEMA	Enclosures for Electrical Equipment (1000 volts maximum)
NFPA 70	National Electrical Code (NEC)
UL	Flexible Metal Electrical Conduit
UL	Rigid Metal Electrical Conduit
UL	Liquid Tight Flexible Electrical Conduit
UL	Rigid Nonmetal Electrical Conduit
UL	Electrical Metallic Tubing

1.03 SUBMITTALS

The following information shall be provided in accordance with the General Conditions:

1. Manufacturer's descriptive literature for all materials.

2. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (□) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

PART 2 - PRODUCTS

2.01 BOXES AND FITTINGS

A. PULL BOXES AND WIRING GUTTERS:

Indoor boxes larger than FD boxes shall be constructed of sheet steel and galvanized after fabrication. Similar enclosures outdoors shall be provided with neoprene gaskets on the hinged doors or removable covers. Box and gutter sizes, metal thickness, and grounding shall comply with the National Electrical Code. Bolt-on junction box covers 3 feet square or larger, or heavier than 25 pounds, shall have a rigid handle. Covers larger than 3 by 4 feet shall be split.

B. TERMINAL CABINETS:

Terminal cabinets located indoors shall be NEMA 12. Cabinets located outdoors and in corrosive areas shall be NEMA 4X. Cabinets shall be provided with hinged doors. Adjustable terminal strip mounting accessories shall be provided. Cabinets shall be provided with channel mounted terminal blocks.

C. MANHOLES:

Unless otherwise specified, manholes shall be precast concrete, 3000 psi strength at 28 days, with reinforcing and cover designed for H-20 bridge loading. Manhole dimensions shall be as indicated on the drawings. Necking and shaft shall have 36-inch minimum clear opening.

Manhole cover and frame shall be Class 30B grey cast iron per ASTM A48 with machine finished flat bearing surfaces. Manholes shall be watertight. Exterior walls of manholes shall be provided with 6 mils of waterproof membrane, Sonneborn HLM 5000 Series, or equal.

Duct entrees shall be no less than 14 inches above floor and below ceiling. Cables supports, clamps or racks shall be provided to support the cable at minimum 2-foot intervals. Concrete inserts shall be embedded in walls and ceiling. Floor shall slope 2 percent in all directions to a sump. Sump shall be a minimum of 18 by 18 by 12 inches deep.

Manhole walls shall be provided with boxouts with waterstops on all sides of each boxout. Waterstops shall be as specified in the Cast-in-Place Concrete section. Boxouts shall be sized to accommodate the penetrating underground duct banks.

D. HANDHOLES:

Handholes shall be precast concrete with checker plate, galvanized, traffic covers designed for H-20 loading. Dimensions shall be as specified on the drawings. Handholes shall be provided with precast solid concrete slab bottoms with sumps. Handholes shall be constructed of 3000 psi reinforced concrete. Handhole cover shall be engraved "ELECTRICAL" or "SIGNAL" as applicable.

Handhole walls shall be provided with boxouts, as specified for manholes.

2.02 RACEWAY SUPPORTS

A. CONDUIT SUPPORTS:

Hot-dip galvanized framing channel with end caps shall be provided to support groups of conduit. Individual conduit supports shall be one-hole galvanized malleable iron pipe straps used with galvanized clamp backs and nesting backs where required. Conduit supports for PVC coated rigid steel and PVC conduit systems shall be one-hole PVC coated rigid steel or clamps conduit wall hangers.

B. CEILING HANGERS:

Ceiling hangers shall be adjustable galvanized carbon steel rod hangers as specified. Straps or hangers of plumber's perforated tape are not acceptable. Unless otherwise specified, hanger rods shall be 1/2 inch all-thread rod and shall meet ASTM A193. Hanger rods in corrosive areas and those exposed to weather or moisture shall be stainless steel.

C. SUSPENDED RACEWAY SUPPORTS (RACKS):

Suspended raceway supports shall consist of concrete inserts, galvanized carbon steel rod hangers, and jamb nuts supporting hot-dip galvanized framing channel or lay-in pipe hangers as required. Hanger rods shall be 1/2 inch all-thread rod and shall meet ASTM A193, unless otherwise specified. All suspended raceway supports shall be braced at 30-foot intervals (alternating from one side to the other) to meet specified seismic requirements.

2.03 CONCRETE ENCASED DUCT BANKS

Concrete used for duct banks shall be Class E with red oxide added as specified in the Cast-in-Place Concrete section.

2.04 UNDERGROUND MARKING TAPE

Underground marking tape shall be for early warning protection of digging around reinforced concrete duct banks. Tape shall be low density polyethylene plastic, nominally 6 inches wide and 4-mil thickness. The plastic color shall be red. A warning shall be imprinted continuously along the length, with message reading similar to "CAUTION - STOP DIGGING - BURIED ELECTRIC LINE BELOW." Tape shall be Brady "Identoline"; Services and Materials "Buried Underground Tape"; Somerset (Thomas & Betts) "Protect-A-Line"; or equal.

Underground marking tape for directly buried cables and conduits shall be 6-inch-wide metallic lined tape with red polyethylene film on top and clear polyethylene film on the bottom. The message shall be clearly printed with black over red tape and shall read "CAUTION ELECTRIC LINE BURIED BELOW".

2.05 NAMEPLATES

Nameplates shall be provided for all boxes in accordance with the requirements of Section 16000. Nameplate wording shall be as indicated on the drawings. Where no wording is specified, the Contractor shall provide the functional description of the device on the nameplate.

2.06 FIRESTOPS

Firestops and seals shall be Flamemastic 77, Vimasco No. 1-A, or equal, and shall be applied in accordance with manufacturer's recommendations. Products which are affected by water are not acceptable.

2.07 RACEWAY IDENTIFICATION

Raceway number tags shall conform to the requirements of raceway markers, Section 16000.

PART 3 - EXECUTION

3.01 CONDUIT

A. GENERAL:

The number of directional changes of a conduit shall be limited to 270 degrees in any run between pull boxes.

Conduit runs shall be limited to a maximum of 400 feet between pull boxes, less 100 feet or fraction thereof, for every 90 degrees of change in direction.

B. INDOOR AND OUTDOOR CONDUIT SYSTEMS:

In general, conduit inside structures shall be concealed unless otherwise specified or indicated on the drawings. No conduit shall be exposed in water chambers unless so indicated on the drawings.

Unless otherwise indicated on the drawings, the Contractor shall be responsible for determining conduit routing that conforms to the installation requirements set forth herein.

Conduit installation shall conform to the following:

1. Exposed conduit shall be installed either parallel or perpendicular to structural members and surfaces.

2. Two or more exposed conduits in the same general routing shall be in parallel with symmetrical bends.

3. Exposed conduit shall be run on supports spaced not more than 10 feet apart.

4. Where three or more conduits are located in parallel run, they shall be spaced out from the wall using framing channel.

5. Conduits support systems shall comply with the requirements of Section 16000.

6. Conduit rack supports shall be secured to concrete walls and ceilings by means of cast-in-place anchors or framing channel concrete inserts.

7. Conduits shall be at least 6 inches from high temperature piping, ducts, and flues with temperatures higher than 90 degrees C.

8. Conduits shall be installed between the reinforcing steel in walls or slabs which have reinforcing in both faces. In slabs which have only a single layer of reinforcing steel, conduits shall be placed under the reinforcement.

9. Conduit shall be routed clear of structural openings and indicated future openings.

10. Conduits through roofs or metal walls shall be flashed and sealed watertight.

11. Conduit shall be neatly grouted into any openings cut into concrete and masonry structures.

12. Conduits shall be capped during construction to prevent entrance of dirt, trash, and water.

13. Exposed conduit stubs for future use shall be terminated with galvanized pipe caps.

14. Concealed conduit stub-up locations shall be determined from the manufacturer's shop drawings.

15. Concealed conduit for future use shall be terminated in equipment or by galvanized couplings plugged flush with structural surfaces.

16. Where the drawings indicate future duplication of equipment wired hereunder, concealed portions of conduits for future equipment shall be provided.

17. Conduit installed horizontally shall allow headroom of at least 7 feet except where it may be installed along structures, piping, and equipment, or in other areas where headroom cannot be maintained because of other considerations.

18. All conduits that enter enclosures shall be terminated by fittings which ensure that the NEMA rating of the enclosure is not affected or changed.

19. Underground metallic or nonmetallic conduit which turns out of concrete, masonry or earth shall be connected to a 90-degree elbow of PVC-coated rigid steel conduit before emergence.

20. Conduit across structural joints where structural movement is allowed shall have an O-Z "Type DX" or Crouse-Hinds "Type XD," bonded, weathertight expansion and deflection fitting of that conduit size.

C. UNDERGROUND CONDUIT SYSTEM:

All excavation, backfilling, and concrete work shall conform to respective sections of these specifications. Underground conduit shall conform to the following requirements:

1. All underground conduits not indicated otherwise on the drawings shall be concrete encased. All concrete encasement shall be reinforced.

2. Concrete encased conduit shall have minimum concrete thicknesses of 3 inches between conduits, 1 inch between conduit and reinforcing, and 3 inches over reinforcing.

3. Concrete encasement on exposed outdoor conduit risers shall continue to 3 inches above grade, with top crowned and edges chamfered.

4. Underground conduit bend radius shall be not less than 2 feet minimum at vertical risers nor less than 3 feet elsewhere.

5. Where conduit and concrete encasement are terminated underground, the conduit and reinforcing shall both extend at least 2 feet past the concrete. Conduits shall be capped and threads shall be protected. All steel surfaces shall be given two coats of thixotropic coal tar paint.

6. Underground conduits and conduit banks shall have 2 feet minimum earth cover except where indicated otherwise.

7. Underground conduit banks through building walls shall be cast in place or concreted into boxouts with waterstops on all sides of the boxout. Waterstops shall be as specified in the Cast-in-Place Concrete section.

8. Conduits not encased in concrete and passing through walls which have one side in contact with earth shall be sealed watertight with special rubber gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.

9. Conduits shall be thoroughly swabbed on the inside, immediately upon completion of pouring concrete. After the concrete has set, and before backfilling, a mandrel having a diameter equal to the nominal conduit inside diameter minus 1/2 inch, and not less than 4 inches long, shall be pulled through each conduit. If the mandrel showed signs of protrusions on the inside of the conduit, the conduit shall be repaired or replaced.

10. All spare raceways shall be provided with a nylon pull rope.

D. SEALING OF CONDUIT:

Conduits passing from a hazardous or corrosive area into a nonhazardous or noncorrosive area, or between Class 1, Division 1 area and Class 1, Division 2 area shall be provided with a sealing fitting which shall be located at the boundary in accordance with NEC.

Seal fittings for conduit systems in hazardous atmosphere locations shall be hot-dip galvanized cast ferrous alloy. Sealing compound shall be hard type, UL listed for explosion proof sealing fittings. Sealing compound shall be nonhardening type for corrosive areas. Seal fitting and sealing compound shall be as manufactured by Appleton, Crouse-Hinds, or equal.

3.02 MANHOLES AND HANDHOLES

Unless otherwise specified, manhole and handhole installation shall be as follows:

1. Manholes and handholes shall be set on a minimum of 6 inches of crushed rock on top of undisturbed or compacted earth.

2. Manholes and handholes shall be set plumb, so that water shall drain properly to the sump.

3. Manhole covers, unless otherwise specified, shall be set at 1 to 2 inches above finish grade with surrounding pavement sloping away from the manhole cover.

4. All metallic hardware inside manholes and handholes shall be grounded by connection to the ground plate. Connections shall be made using bolted connections, bonding jumpers and grounding bushings.

3.03 CABLE TRAY

Unless otherwise specified, cable tray installation shall be as follows:

1. Cable trays shall be supported at intervals not to exceed 5 feet.

2. Corners shall be supported by two supports installed as close as possible to the corner, with one support on each side of the corner.

3. All field cuts shall be treated with zinc rich paint.

4. Expansion joint splice plates shall be used to allow 1 1/2-inch free movement between adjacent trays when crossing building expansion joint.

5. Cable tray shall have minimum clearance of 3/4 inch from concrete surfaces and minimum spacing of 12 inches from other trays. The top of the tray shall be minimum 9 inches from the ceiling.

6. Signal cable trays shall be provided with covers. Covers shall be solid or louvered type.

7. Each cable tray shall be provided with No. 2/0 AWG minimum bare copper equipment ground conductor. The ground conductor shall be attached to the outside of each tray section using UL Listed bolted bronze or brass ground clamp.

8. Power cables shall be placed in cable trays not more than two layers deep.

9. Cables shall be arranged in trays so as to provide minimum cross-over.

3.04 RACEWAY NUMBERING

Each conduit shall be provided with a number tag at each end and in each manhole and/or pull box. Trays shall be identified by stencils at intervals not exceeding 50 feet, at intersections, and at each end.

3.05 RACEWAY SCHEDULE

A. GENERAL:

The Raceway Schedule is on the drawings.

B. UNSCHEDULED RACEWAY:

With the exception of lighting, communication, paging, fire alarm, security and receptacle circuits, the type and size of raceway shall be as specified on the drawings or schedules. Lighting and receptacle raceway are unscheduled and shall be sized by the Contractor in accordance with the NEC. Minimum size shall be 3/4 inch for exposed and 1 inch for embedded raceway.

The number and size of communication, paging, fire alarm, and security raceways shall be as required for the particular equipment provided subject to the minimum sizes specified above.

END OF SECTION 16110

SECTION 16111

CONDUIT

PART 1 - GENERAL

1.01 Scope

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of conduit, including rigid metal conduit and fittings, flexible metal conduit and fittings, liquid tight flexible metal conduit and fittings, non-metallic conduit and fittings, explosion proof flexible steel conduit, manholes, handholes and duct banks. All conduit shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

1.02 Submittals

A. Submittals shall be made in accordance with the requirements of the Contract Documents. In addition, the following specific information shall be provided:

1. Equipment data specified in this Section.

2. Catalog cuts.

1.03 Quality Assurance

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ANSI C80.1

2. ASTM F 512

3. Fed Spec WW-C-581E

4. Fed Spec WW-C-1094A
5. NEMA TC2
6. NEMA TC6
7. NFPA 70
8. UL 1
9. UL 6
10. UL 360
11. UL 651

1.04 Quality Standards

A. All products covered by these specifications shall be in conformance with NEMA standards and shall be UL approved.

B. Manufacturers offering products that comply with these specifications include:

1. Conduit: Allied, Republic, Triangle, Wheatland or equal.
2. PVC Coated Conduit: Permacote, Robroy or equal.
3. PVC Conduit: Amoco, Carlon, Certainteed or equal.
4. Flexible Conduit: Anamet, Columbia, Electrilex or equal.
5. Fittings: Appleton, Crouse-Hinds, Thomas & Betts or equal.

PART 2 - PRODUCTS

2.01 General

A. The type and size of raceway shall be as specified on the Drawings or schedules. Lighting and receptacle raceways are not scheduled and shall be sized by the Contractor in accordance with the NEC. Minimum size shall be ¾-inch for exposed and 1-inch for embedded raceway. The number and size of communication and security raceways shall be as required for the particular equipment provided, subject to the minimum sizes specified above.

2.02 Rigid Metal Conduit And Fittings

A. Rigid Steel Conduit: UL 6; ANSI C80.1; hot dip galvanized. Minimum size 3/4-inch, exposed, 1-inch embedded or inaccessible.

B. PVC Coated Conduit: NEMA RN-1; galvanized rigid steel conduit with factory applied external 40 mil PVC coating and 2 mil urethane interior coating. Prior to coating, treat conduit with a heat polymerizing adhesive so the bond between metal and coating is greater than the tensile strength of the coating. Minimum size ¾-inch.

C. Fittings and Conduit Bodies: NEMA FBI; zinc coated; taper-threaded type, material to match conduit. Where PVC coated conduits are indicated all couplings, fittings, conduit bodies, pipe straps, U bolts, beam clamps, and other accessories are to be PVC coated.

2.03 Flexible Metal Conduit And Fittings

A. Conduit: UL 1; FS WW-C-566; single steel continuous strip with galvanized coating. Minimum size ½-inch.

B. Fittings and Conduit Bodies: NEMA FB-1; malleable iron squeeze type.

2.04 Liquidtight Flexible Conduit And Fittings

A. Conduit: UL listed liquid tight consisting of an extruded thermoplastic cover over a galvanized steel core. Minimum size ¾-inch.

B. Fittings and Conduit Bodies: NEMA FB-1; galvanized steel compression type with 0-ring.

2.05 Rigid Nonmetallic Conduit And Fittings

A. Use rigid PVC Schedule 40 conduit, UL listed for concrete-encased, underground direct burial, concealed and direct sunlight exposed use, and UL listed and marked for use with conductors having 90 degrees C insulation. Use conduits, couplings, bushings, elbows, nipples, and other fittings meeting the requirements of NEMA TC 2 and TC 3, Federal Specification W-C-1094, UL, NEC, and ASTM specified tests for the intended use. Use only conduit with a factory formed bell on one end. Conduit that requires the use of couplings for straight runs will not be acceptable. Minimum size ¾-inch exposed, 1-inch embedded or encased.

B. Fittings for PVC conduit shall comply with Standard for PVC Fittings for use with Rigid Conduit and Tubing, NEMA TC3, and shall be NEMA Type IV.

2.06 Precast Handholes And Manholes

A. Install handholes and manholes with 28-day, 2,500 psi minimum compressive strength concrete and designed for AASHTO H-20 loading. Minimum dimensions for handholes and manholes are shown on the Drawings. Increase these as

required by use of extension sections to accommodate the several raceway entrances at their required elevations.

B. Slope floors toward drain points, leaving no pockets or other nondraining areas. Provide a drainage outlet at the low point of the floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and 4-inch minimum outlet and outlet pipe.

C. Provide raceway entrances on all four sides. For raceways installed under this Contract, knockout panels or precast individual raceway openings may be used. On sides where no raceways are installed under this Contract, provide 12-inch high by 24-inch wide (minimum) knockout panels for future raceway installation.

D. For manholes, utilize heavy-duty type frames and covers made of stainless steel, suitable for H-20 loading, and having machined bearing surfaces. Provide indented type covers, solid top design, with two drop handles each. On the upper side of each cover, cast or burn by welder, in integral letters not less than 2 inches high appropriate titles, ELECTRIC HV (for above 600 volts), ELECTRIC LV (for 600 volts and below), or COMMUNICATION. Field stamp covers with handhole and manhole numbers indicated on the Drawings.

E. For handholes, frames and covers shall conform to ASTM A48-83 and shall be slab type with letters as indicated above.

F. Provide heavy weight cable racks with adjustable arms and acceptable insulators for all cables in each handhole and manhole. Set adjustable inserts in the concrete walls for the attachment of racks. Do not use bolts or studs embedded in concrete for attaching racks. Set racks and inserts on not greater than 3-foot centers around the entire inside perimeter of the manhole, arranged so that all spare conduit ends are clear for future cable installation. Provide racks with a sufficient number of arms and insulators to accommodate cables for each conduit entering or leaving the handhole, including spares.

G. Provide pulling irons. Utilize ¾-inch round stock securely fastened to the overall steel reinforcement before concrete is poured.

H. Utilize handhole and manhole hardware of steel, hot-dip galvanized after fabrication.

I. Manufacturers: Brooks Products, Inc.; Penn-Cast Products, Inc.; Concrete Conduit Company; Associated Concrete Products, Inc.; or pre-approved equal.

2.08 Warning Tape

A. Provide heavy-gauge, yellow plastic tape of 6-inch minimum width for use in trenches containing electric circuits. Utilize tape made of material resistant to

corrosive soil. Use tape with printed warning that an electric circuit is located below the tape. Manufacturers and types: ITT Blackburn Type YT or RT; Griffolyn Co. Terra-Tape; or equal.

2.09 Raceway Identification

A. Raceways number tags shall be brass with stainless steel attachment wire. Raceway number shall be embossed on to the tag with ¼-inch letters.

PART 3 - EXECUTION

3.01 Conduit Schedule

A. Use rigid steel conduits for indoor clean area.

B. Use liquid tight flexible steel conduit for connections to motors, transformers, and other vibrating equipment.

C. Non-jacketed flexible steel conduit may be used for connections to lighting fixtures in suspended ceilings.

D. Use PVC coated conduits where conduits are in direct contact with earth, where conduits are installed in corrosive areas, or where conduits are outside (i.e. running to electrical panels). Exceptions: Use PVC coated rigid steel conduits inside and outside of the Residuals Building.

E. Use PVC conduits where conduits are embedded in concrete structures, encased in concrete duct bank or concealed in concrete block CMU.

F. Where PVC conduit is indicated, make a transition to PVC coated rigid steel below grade or slab and continue above with PVC coated rigid steel conduit.
Exception: PVC may enter switchboards, motor control centers or other floor standing electrical equipment enclosures.

3.02 Conduit Arrangement and Support

A. Arrange conduit to maintain headroom and present a neat appearance. Run exposed conduits parallel or perpendicular to building surfaces and adjacent piping. Group conduit in parallel runs where practical and provide rack space for 25 percent additional conduits.

B. Avoid sources of heat when possible. Where unavoidable, maintain 6-inch clearance when crossing hot pipes and 12-inch clearance between parallel hot pipes, flues, heating appliances, and other heat sources.

C. Support conduits to prevent distortion of alignment by wire pulling operations. Fasten single conduits with one-hole malleable iron straps. For multiple runs use galvanized steel channel and clamps. Wire, perforated pipe straps and the like are not acceptable support means.

D. Support conduit at a maximum of 7 feet on center and within 3 feet of each box, cabinet, or fitting. Hang trapeze assemblies with threaded rods not less than 3/8-inch diameter. Remove all temporary supports prior to pulling conductors.

3.03 Conduit Installation

A. Cut conduit square using a saw or pipe cutter and de-burr and ream cut ends. Paint threads with zinc compound. Bring conduit to the shoulder of fittings and couplings and fasten securely. All connections are to be wrench tightened and electrically continuous. No running threads are permitted.

B. Use conduit hubs for fastening conduit to boxes. Use conduit bodies to make sharp changes in direction. For sizes 2-inches and larger, use "LD" or similar fittings to permit a straight pull from either direction.

C. The maximum length between pull points is 400 feet. This length shall be reduced by 100 feet for each 90-degree of bend.

D. Use hydraulic one-shot shoe bender or factory elbows for bends in conduit larger than 2-inch size. Crushed or deformed conduits may not be installed.

E. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

F. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture. Install threaded PVC end caps on conduits stubbed up for future use.

G. Unless otherwise specified, conduit entering field equipment enclosures shall enter the bottom or side of the box.

H. Provide a 200-pound tensile strength polyolefin line pulled through and tied off at each end of all empty conduits.

I. Install expansion joints where conduit crosses building expansions joints and for straight runs in excess of 100 feet.

J. Where conduit penetrates fire-rated walls and floors, provide mechanical fire-stop fittings with UL listed fire rating equal to wall or floor rating.

K. Provide watertight seals, equal to OZ type WSK or FSK, where conduit penetrates

exterior walls and where conduit passes between spaces normally at different temperatures.

L. Provide clamp backs for conduits on exterior or damp surfaces to prevent the raceway from bearing directly on the damp surface.

M. Route conduits in slabs above the bottom reinforcing and below the top reinforcing. Maximum size for conduits in slabs above grade is 1-inch. Route so conduits in slabs above grade do not cross.

N. PVC conduit bends: Use PVC-coated rigid steel factory elbows.

O. PVC coated conduit: Exercise care not to damage the coating during cutting, threading, bending, and assembly. Follow the manufacturer's installation instructions. Use vise jaws, bending equipment, strap wrenches, and other tools which are specifically designed for coated conduits. Do not use chain vise, pipe wrench, channel locks or the like.

P. Provide sealing compound equal to Chico A or Chico B where conduit passes from hazardous or corrosive area in to a non-classified area.

Q. Each conduit shall be provided with a number tag at each end.

3.04 Underground Duct Bank Installation

A. Install top of duct bank minimum 24-inches below finished grade with plastic warning tape 12-inches below finished grade.

B. Install conduit with minimum grade of 4-inches per 100 feet.

C. Terminate conduit in end bell at manhole entries.

D. Provide minimum 3-inch concrete cover at bottom, top, and sides of duct bank. Use suitable separators and chairs installed not greater than 4 feet on centers to provide conduit spacing as indicated. Securely anchor conduit to prevent movement during concrete placement. Stagger conduit joints in concrete encasement 6-inches minimum.

E. Construct duct banks with 3,000 psi concrete. Provide reinforcing bars as indicated. Optionally, the top of freshly poured concrete may be sprinkled with the red dye (i.e. each 50 lb. bag of concrete should include 3 lbs. of red oxide).

F. Where duct bank passes beneath footings or slabs resting on grade excavate to provide a minimum of 6-inch clearance between the duct bank and the structure.

G. Thoroughly swab inside of conduits upon completion of pouring concrete. Before backfilling, a mandrel, ½-inch smaller than the conduit diameter, shall be pulled

through each conduit.

3.05 Handholes And Manholes

A. Install handholes and manholes where shown on the Drawings. Provide excavation, shoring, bracing, backfilling, grading, etc., in accordance with requirements specified in Division 2 of these Contract Documents.

B. Do not install handholes or manholes until final conduit grading, including field changes necessitated by underground interferences, has been determined. Set frames to final grades as required.

C. Install one ground rod in each handhole and/or manhole. Connect all noncurrent-carrying metal parts in the manhole or handhole and any metallic raceway grounding bushings to this ground rod with No. 6 AWG (minimum) copper conductor.

END OF SECTION 16111

SECTION 16120

600 VOLT CONDUCTORS, WIRE, AND CABLE

PART 1 GENERAL

1.01 Description

A. This section specifies stranded copper cables, conductors, and wire rated 600 volts insulation used for power; lighting, analog, digital, or pulse signals and control circuits.

1.02 References

A. This section contains references to the following documents. They are a part of this section. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to document shall mean the documents in effect at the time of Advertisement for bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM B3	Soft or Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Tinned Soft or Annealed Copper Wire for Electrical Purposes
ICEA S-68-516	Ethylene-Propylene-Rubber-Insulated Wire
NEMA WC7	Cross-Linked-Thermosetting Insulated Wire and Cable for the Transmission and Distribution of Electric Energy
NFPA 70	National Electrical Code (NEC)
UL 44	Rubber-Insulated Wires and Cables
UL 83	Thermoplastic-Insulated Wires and Cables

1.03 Submittals

A. The following information shall be provided in accordance with the Contract Documents:

1. Submittals specified in Section 16000.

2. Complete catalog cuts for all conductors, wire, and cable.

PART 2 PRODUCTS

2.01 General

A. Unscheduled Conductors and Cables:

1. Where not specified on the Drawings, conductors and cables shall be sized in accordance with the National Electrical Code for the particular equipment served with the minimum size as specified herein.

2. Unscheduled conductor with insulation shall be provided in accordance with the following:
   a. CABLESPEC "MEPR/CPE" multi-conductor power and control cable
   b. CABLESPEC “RHW” for single conductors
   c. CABLESPEC “XHHW or THWN” for indoor lighting and receptacles

B. Cable Specification Sheets (CABLESPEC): General requirements for conductors and cables specified in this Section are listed on CABLESPEC sheets in par. 16120-3.06.

2.02 Color Coding

A. Control Conductors: Single-conductor control conductors shall have the following colors for the indicated voltage:

Control Conductor	120V
Power (AC)	Black
Control (AC)	Red
Neutral	White
Ground	Green
Foreign Voltage (DC)	Blue/White
Foreign Voltage (AC)	Yellow
Power (DC)	Blue
Control (DC)	Violet

B. Power Conductors:

1. Power conductors shall have the following colors for the indicated voltage:

Power Conductor	480V	208/120V
Phase A	Brown	Black
Phase B	Orange	Red
Phase C	Yellow	Blue
Ground	Green	Green
Neutral	Gray	White

2. Cables may be black with colored 3/4-inch vinyl plastic tape applied at each cable termination. Tape shall be wrapped with 25 percent overlay to provide 3 inches minimum coverage.

C. Signal Conductors: Signal cable conductors shall be color coded black and white for pairs or black, white, and red for triads. Each conductor and each group of conductors shall be numbered.

2.03 Power and Control Conductors and Cable, 600 Volt

A. Single Conductor: Provide stranded conductors for all cable or wires. Provide minimum conductor size of 12 AWG for power and lighting circuits and minimum conductor size of 14 AWG for control circuits.

B. Multiconductor Cable: Provide multiconductor power cable and multiconductor control cable where identified on the drawings. Provide stranded conductors for all cable or wires.

2.04 Signal Cables

A. General:

1. Factory cable between manufactured instrument system components shall be provided in compliance with the instrument manufacturer's recommendations.

2. Signal cable shall be provided for instrument signal transmission. Single instrument cable (SIC) and multiple-circuit instrument cable (MIC) shall be provided in accordance with the following examples:

   a. CABLESPEC “SIC”:
   Cable designation: 1PR#16S shielded twisted pair (STP)
   Cable designation: 1TR#16S triad (STT)

   b. CABLESPEC “MIC":
   Cable designation example: 4PR#16S with individual shields for each of the four pair and an overall shield and jacket for the multiconductor instrument cable.

B. Communication, Paging, and Security System Cables: Voice communication, paging, and security system cables shall be specified in their respective specification sections.

2.05 Portable Cord

A. Portable cord shall be provided in accordance with CABLESPEC "CORD," unless otherwise specified. Cords shall contain an equipment grounding conductor.

2.06 Splicing and Terminating Materials

A. Connectors shall be tool applied compression type of correct size and UL listed for the specific application. Connectors shall be tin-plated high conductivity copper. Splicing is strictly prohibited.

B. Signal and control conductors shall be connected to terminal blocks and field devices and instruments shall be terminated with conductor terminals.

C. Connectors for wire sizes No. 8 AWG and larger shall be compression tool installed one-hole lugs up to size No. 3/0 AWG, and two-hole or four-hole lugs for size No. 4/0 and larger. Mechanical clamp, dimple, screw-type connectors are not acceptable. In-line splices and taps shall be used only by written consent of the Engineer and/or Owner.

D. Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and high dielectric strength mastic to seal the ends against ingress of moisture and contamination. Motor connections may use the Tyco Electronics removable boot product line.

E. Motor connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations. Connection kits shall be independent of cable manufacturer's tolerances.

F. Ethernet cable types shall be CAT 6 (green color cable used for SCADA controls and blue color cable used for computer network.

2.07 Cord Grips

A. Cord grips shall be provided where indicated on the Drawings to attach flexible cord to equipment enclosures. Cord grips shall consist of a threaded aluminum body and compression nut with a neoprene bushing and stainless-steel wire mesh for strain relief. Cord grip shall provide a watertight seal at enclosure interface and sized to accommodate the flexible cord.

PART 3 EXECUTION

3.01 General

A. Conductors shall be identified at each connection terminal. The identification marking system shall comply with Section 16000.

B. Pulling wire and cable into conduit or trays shall be completed without damaging or putting undue stress on the insulation or jacket. Manufacture recommended and UL Listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable.

C. Raceway construction shall be complete, cleaned, and protected from the weather before cable is installed. Where wire or cable exits a raceway, a wire or cable support shall be provided.

D. Provide tin-plated bus bar. Scratch-brush the contact areas and tin plate the connection where flat bus bar connections are made with un-plated bar. Bolts shall be torqued to the bus manufacturer's recommendations.

3.02 600 Volt Conductor and Cable

A. Conductors in panels and electrical equipment shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing shall be made up with plastic cable ties. Cable ties shall be tensioned and cut off by using a tool specifically designed for the purpose such as a Panduit GS2B. Other methods of cutting cable ties are unacceptable.

B. Conductors crossing hinges shall be bundled into groups not exceeding 10 to 15 conductors and protected using nylon spiral flexible covers to protect conductors. Provide oversized plastic panel wiring duct within panels and panelboards.

C. Slack shall be provided in junction and pull boxes, handholes and manholes. Slack shall be sufficient to allow cables or conductors to be routed along the walls. Amount of slack shall be equal to largest dimension of the enclosure. Provide dedicated electrical wireways and insulated cable holders mounted on Unistrut in manholes and handholes.

D. Raceway fill limitations shall be as defined by NEC and the following:

1. Lighting and receptacle circuits may be in the same conduit in accordance with de-rating requirements of the NEC. Lighting and receptacle circuits shall not be in conduits with power or control conductors. Signal conductors shall be in separate conduits from power conductors. Motor feeder circuits shall be in separate conduits including small fan circuit unless combination fan-light fixture.

2. Power conductors derived from uninterruptible power supply systems shall not be installed in raceways with conductors of other systems. Install in separate raceways.

3. Terminations are subject to inspection by the Engineer and/or Owner prior to and after insulating.

4. Motor terminations at 460-volt motors shall be made by bolt-connecting the lugged connectors.

5. Terminations at solenoid valves, 120-volt motors, and other devices furnished with pigtail leads shall be made using self-insulating tubular compression connectors within the termination box.

6. Terminations at valve and gate motor actuators shall be made directly into the actuator where possible. Power termination shall be made in the actuator power disconnect. Control and signal cable may be routed to a termination box near the actuator on 20-ampere rated terminal strips with label identification for the control and signal conductors. Single wire control conductors and analog cable (SIC or MIC) then installed in flexible conduit to the actuator control and signal termination compartments.

3.03 Signal Cable

A. Provide terminal blocks at instrument cable junctions within dedicated terminal boxes provided by the installer. Signal circuits shall be run without splices between instruments, terminal boxes, or panels.

B. Circuits shall not be made using conductors from different pairs or triads. Triads shall be used wherever 3 wire circuits are required.

C. Shields are not acceptable as a signal path, except for circuits operating at radio frequencies utilizing coaxial cables. Common ground return conductors for two or more circuits are not acceptable.

D. Shields shall be bonded to the signal ground bus at the control panel only and isolated from ground at the field instrument or analyzer and at other locations. Shields or drain wires for spare circuits shall not be grounded at either end of the cable run. Terminals shall be provided for running signal leads and shield drain wires through junction boxes.

E. Spare circuits and the shield drain wire shall be terminated on terminal blocks at both ends of the cable run and be electrically continuous through terminal boxes.

F. Where instrument cable splicing is required, provide an instrument stand with terminal box rated for the area and environment and mounted approximately 3 feet above grade for instrument cable splices with the circuits and individual conductors provided with label as specified in Section 16000.

G. Cable for paging, security, voice communication, and telephone systems shall be installed and terminated in compliance with the manufacturers and the Utilities recommendations.

3.04 Portable Cord

A. Portable power cords feeding permanent equipment, such as pendant cords feeding motors for pumps, cranes, hoists, and portable items shall have a wire mesh cord grip of flexible stainless-steel wire to relieve the tension from the cable termination. Connection of portable cords to permanent wiring shall be accomplished with dedicated boxes and terminals blocks.

3.05 Testing

A. The Contractor shall test conductors, wire, and cable..

3.06 Cable Specification Sheets (CABLESPEC)

A. General: Conductor, wire, and cable types for different locations, service conditions and raceway systems are specified on individual cable specification sheets. Scheduled and unscheduled conductors, wires, and cables shall be installed in accordance with the CABLESPEC SHEETS.

B. CABLESPEC Sheets: The following CABLESPEC sheets are included in this section:

Type	Volt	Product	Purpose
MIC	600	SP-OS: Multiple Pair PR#18 or 16SH With Overall Shield and Jacket	Cable Tray Rated Instrument Cable
SIC	600	P-OS: 1-PR#18 or 16SH or 1-TR#18 or 16SH	Cable Tray Rated Instrument Cable
THWN	600	PVC-insulated with nylon jacket building-grade conductor	Lights & receptacles
XHHW-2	600	XLP-insulated industrial-grade conductor	Power, control, lighting, & receptacles
MEPR / [XLP] [CPE]	600	Multi-conductor rubber insulated cable with jacket Examples: Power cable: 3/c #500 kcmil with factory ground conductor within cable Control cable: 19/C #14	Cable tray rated power & control
MXLPE / S / PVC	1000	Multiconductor shielded motor cable with PVC jacket	Flexible 3/C cable with NEC ground conductor. motor feeder range:16 AWG - 500KCMIL
CORD	600	Heavy Duty Cable: SJOOW	Portable Items

3.07 Cable Specification Sheet – (CABLESPEC)

Cable System Identification:	MIC
Description:	Multiple twisted, shielded pairs, 18 or 16 AWG, with overall shield instrumentation cable; Number of pairs as shown; UL listed, Cable Tray rated.
Voltage:	600 volts
Conductor Material:	Bare annealed copper; Class-B stranded per ASTM B-8
Insulation:	15 mil, Polyvinyl Chloride (PVC) with 4 mil nylon, 90-degree C temperature rated Color Code per ICEA Method-1: Pairs- Black and White with one conductor in each pair printed alpha-numerically for identification
Lay:	Twisted on a 2-inch lay
Shield:	100 percent, 1.35 mil aluminum/polyester or mylar tape with 7-strand tinned copper drain wire
Overall Shield:	2.35 mil aluminum-Mylar tape with 7-strand tinned copper drain wire
Jacket:	Flame-retardant, moisture and sunlight resistant 45 mil Polyvinyl Chloride (PVC)
Flame Resistance:	UL 1277 and UL 1581 vertical tray flame test
Manufacturer(s):	Okonite, Okoseal-N type SP-OS (Shielded Pairs with Overall Shield); or Cooper Industries-Belden; General Cable or approved equal
Execution:	
Installation:	Install in accordance with paragraph 16120-3.03.
Testing:	Test in accordance with paragraph 16999.

3.08 Cable Specification Sheet – (CABLESPEC)

Cable System Identification:	SIC
Description:	Single twisted, shielded pair or triad, 18 or 16 AWG, instrumentation and signal cable; UL listed; Cable Tray rated
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded per ASTM B8
Insulation:	15 mil, Polyvinyl Chloride (PVC) with 4 mil nylon, 90-degree C temperature rated Color Code per ICEA Method-1: Pairs- Black and White with one conductor in each pair printed alpha-numerically for identification
Lay:	Twisted on a 2-inch lay
Shield:	100 percent, 1.35 mil aluminum-Mylar tape with a 7-strand tinned copper drain wire
Jacket:	45 mil Polyvinyl Chloride (PVC)
Flame Resistance:	UL 1277
Manufacturer(s):	Okonite, Okoseal-N Type P-OS (Pair(s) Overall Shield) and Type TOS (Triad(s) Overall Shield); or Cooper Industries-Belden; General Cable or approved equal
Execution:	
Use:	Analog signal cable and RTD device Triad extension cable.
Installation:	Install in accordance with paragraph 16120-3.03.
Testing:	Test in accordance with paragraph 16999.

3.09 Cable Specification Sheet – (CABLESPEC)

Cable System Identification:	THWN
Description:	Single conductor lighting and receptacle type; Indoor branch circuit conductor.
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded per ASTM B8
Insulation:	THWN/THHN, 90-degree C dry, 75 degree C wet, Polyvinyl Chloride (PVC) per UL 83.
Jacket:	Nylon
Flame Resistance:	UL 83
Manufacturer(s):	Okonite, Okoseal-N, series 116-67-XXXX; or approved equal.
Uses Permitted:	Lighting, receptacle and appliance circuits
Execution:	
Installation:	Install in accordance with paragraph 16120-3.02.
Testing:	Test in accordance with paragraph 16999.

3.10 Cable Specification Sheet – (CABLESPEC)

Cable System Identification:	XHHW-2
Description:	Industrial grade single conductor Sizes: 14 AWG through 750 kcmil as shown
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded per ASTM B8
Insulation:	NEC Type XHHW-2; 90-degree C dry and C wet; Cross-Linked Polyethylene (XLP) per ICEA S-66-524 and UL-44; Color in sizes 14, 12 and 10 AWG: Black, Green, Yellow, White, Orange, Brown, Red, Blue
Jacket:	None
Flame Resistance:	UL 83
Manufacturer(s):	Okonite, X-Olene; Cablec, Durasheath XLP; or approved equal.
Uses Permitted:	Power, control, lighting and outlet circuits.
Execution:	
Installation:	Install in accordance with paragraph 16120-3.02.
Testing:	Test in accordance with paragraph 16999.

3.11 Cable Specification Sheet – (CABLESPEC)

Cable System Identification:	MEPR / CPE
Description:	Multiconductor Power Cable and Multiconductor Control Cable: 14 AWG stranded conductors; Cable tray rated.
Power Cable:	Insulated green grounding conductor sized per the NEC.
Ground Conductor Size:	Multiple sets of multiconductor power cable: Oversize the grounding conductor per NEC 250.
Control Cable Type:	ICEA Method 1, E-2, without white neutral conductor or green ground conductor
Control Cable Identification:	Conductors color coded per ICEA and conductors numbered
Voltage:	600 volts
Conductor Material:	Bare annealed copper; stranded per ASTM B8, coated per ASTM B33
Insulation:	RHW/RHH, 90-degree C dry, 75 degree C wet, ethylene propylene rubber (EPR) per ICEA 2-68-516 and UL 44.
Jacket:	Cross-linked Polyethylene (XLP)
Flame Resistance:	IEEE 383
Manufacturer(s):	Okonite, Okonite-Okolon-Okoseal series 202-11-3XXX; Cablec, Durasheath EP; or approved equal.
Execution:	
Installation:	Install in accordance with paragraph 16120-3.02.
Testing:	Test in accordance with paragraph 16999.

END OF SECTION

SECTION 16141

WIRING DEVICES

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of wall switches, receptacles, device plates and box covers. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the Contract Documents. In addition, the following specific information shall be provided:
   1. Catalog cuts.

1.03 QUALITY STANDARDS

A. All products covered by these specifications shall be in conformance with NEMA standards and shall be UL approved.

B. Manufacturers offering products that comply with these specifications include:

   1. Arrow Hart.
   2. Bryant.
   3. GE.
   4. Hubbell.
   5. Leviton Specmaster.
   6. Pass and Seymour.
   7. Sierra.
   8. Crouse Hinds.
   9. Appleton.

1.04 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.01 SWITCHES

A. General Purpose: NEMA WD-1; FS W-S-896; 20-amp, 120/277-volt, specification grade; horsepower rated; quiet type; back and side wiring provisions; toggle handle.

B. Hazardous Areas: Switches shall consist of a factory assembled and sealed combination general purpose switch in an explosion proof housing. The external operating mechanism shall consist of a wing-type handle having the on-off positions visible from front. The switch shall be rated in accordance with NEC for the area.

C. Corrosive and Outdoor Areas: Switches shall be 20 Amp pressure switch type with weatherproof/corrosion resistant neoprene plate. Switches shall be mounted in "FS" type copper-free aluminum or PVC mounting boxes.

D. Ground Fault Interrupter (GFI) Receptacles: Provide duplex specification grade GFI receptacles tripping at 5 milliamps; rated 20 amps, 120 volts, NEMA Configuration 5-20R. Use units meeting NEMA WD 1, fitting standard sized outlet boxes having provision for testing, and ivory in color. Use standard model where ground fault protection is needed. Do not use feed-thru model. Acceptable manufacturers: Square D, General Electric, or pre-approved equal.

E. Specific Use Receptacles: NEMA WD-1 or WD-5; type as indicated. For branch circuits serving a single device, match device rating to branch circuit rating.

F. Device Colors: Brown or black for specific use devices, otherwise as selected by the Engineer.

G. Plug Caps: Male plug caps for receptacles shall be of the cord grip armored type with heavy phenolic housing of the same manufacturer as the receptacle.

H. Three Phase Receptacles and Plugs: Receptacles shall be suitable for 480V, 3 phase, 4 wire service with ampere rating as specified. The grounding pole shall be permanently connected to the housing. The grounding pole shall make contact before the line poles are engaged when the plug is connected to the receptacle housing. The plug sleeve shall also make contact with the receptacle housing before the line and load poles make contact. Receptacles shall be provided complete with cast back box, angle adapter, gaskets, a gasketed screw-type, weathertight cap with chain fastener and one plug.

2.02 RECEPTACLES

A. General Purpose: Receptacles shall be NEMA WD-1; FS W-C-596, 20 AMP, 125 Volt, specification grade; impact resistant nylon face; back and side wiring provision; grounding screws; duplex.

B. Hazardous Areas: Receptacles shall be rated in accordance with NEC for the area and shall be factory sealed. Receptacle shall be designed so the plug must be inserted and turned before load is energized. Provide mounting box, sealing chamber and compatible plug.

C. Corrosive Areas: Receptacles shall be duplex; 20 Amp, NEMA 5-20R. Receptacle and plug shall be corrosion resistance; marine duty; polycarbonate with weatherproof lift cover.

2.03 WALL PLATES

A. Decorative Cover Plates: Unbreakable nylon, Lexan, or noryl, smooth finish, color to match devices.

B. Unfinished Area Device Plates: Type 302 stainless steel, 0.030-inch-thick minimum, satin finish.

C. Weatherproof Cover Plate: Gasketed cast metal with hinged, gasketed, spring loaded device covers.

2.04 PLUG STRIP

A. Plug strip shall be manufactured of sheet steel with the receptacles mounted on front cover. The front cover shall be removable.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Secure devices to outlet boxes without depending on device plates to pull them tight. Install a bonding jumper between all devices and outlet boxes.

B. Install switches with off position down; and receptacles with grounding pole on bottom.

C. For cord and plug connected equipment, coordinate receptacle configuration with equipment supplied.

D. Install device plates on switch, receptacle, and blank outlets. Use jumbo size plates for devices installed in masonry walls.

END OF SECTION

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SCOPE

A. This Section includes identification of electrical materials, equipment, and installations.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

C. Related Sections include but are not limited to:
   1. Section 01300 – Submittal Procedures.
   2. Section 16000 – Electrical Power and Systems.

1.02 REFERENCES

A. Publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by basic designations only.
   1. National Fire Protection Association (NFPA).
      a. NFPA 70 – National Electrical Code.
   2. American National Standards Institute (ANSI).
      a. ANSI A13.1 – Standard for Pipe Identification.

1.03 SUBMITTALS

A. General: Submit each item in this Section according to Section 01300 – Submittal Procedures.

B. Product Data for each type of product specified.

1.04 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.05 SEQUENCING AND SCHEDULING

A. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work:
   1. American Labelmark Co., Labelmaster Subsidiary.
   2. Brady USA Inc.; Industrial Products Div.
   3. Carlton Industries, Inc.
   4. Champion American, Inc.
   5. Cole-Flex Corp.
   6. Ideal Industries, Inc.
   7. Markal Corp.
   8. National Band & Tag Co.
   9. Panduit Corp.
   10. Seton Name Plate Co.
   11. Standard Signs, Inc.
   12. Or accepted equal.

2.02 ENGRAVED NAMEPLATES AND SIGNS

A. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.

B. Engraving stock, melamine Plastic laminate, 1/16-inch minimum thickness for signs up to 20 sq. in., 1/8-inch thick for larger sizes.
   1. Engraved Legend: White letters on black face.
   2. Punched for mechanical fasteners.

C. Metallic signs for Exterior Use: Preprinted brass or aluminum signs, punched for fasteners, with colors, legend, and size as indicated or as otherwise required for the application. 1/4-inch grommets in corners for mounting.

D. Laminated plastic signs for Interior Use: Engraved three layer laminated plastic, white letters on a black background. Use laminated phenolic engraving.

D. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.03 WIRE MARKERS

A. Each power and control conductor shall be identified at each terminal to which it is connected. Conductors size No. 10 AWG or smaller shall have identification

sleeves. The letters and numbers that identify each wire shall be machine printed on sleeves with permanent black ink. The figures shall be 1/8-inch high. Sleeves shall be yellow or white tubing, sized to fit the conductor insulation. The sleeves shall be shrunk to fit the conductor with hot air after installation. They shall be TMS Thermofit Marker System by Raychem Co., W. H. Brady Co., or accepted equal. Adhesive strips are not acceptable. Conductors No. 8 AWG and larger shall use cable markers of the locking tab type. Tabs shall be white plastic with conductor identification number permanently embossed.

2.04 RACEWAY MARKERS

A. Raceway markers shall be 0.036-inch minimum thickness, solid metal tags with raceway number stamped in 3/16-inch minimum height characters. Such tags shall be attached to the raceway with heavy duty tie wraps. Alternatively, aluminum wrapped bands, approved for the purpose, may be employed

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install identification devices according to manufacturer's written instructions.

B. Install labels at locations for best convenience of viewing without interference with operation and maintenance of equipment.

C. Lettering, colors, and Graphics: coordinate names, abbreviations, colors, and designations used for electrical identification with corresponding designations used in the Contract Documents or required by codes and standards. Use consistent designations throughout the Project.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

E. Self-Adhesive Identification Products: Clean surfaces of dust, loose material and oily films before applying.

F. Install circuit identification labels on faceplates of receptacles, outlet, telephone/data outlets, etc. Use pressure sensitive, self-adhesive plastic labels. Identify supply panel and circuit on the label.

G. Install Circuit Identification Labels on Boxes: Label externally as follows:
   1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
   2. Concealed Boxed: Plasticized card-stock tags.
   3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

H. Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communications lines, install

continuous underground plastic line marker located directly above line at 6-inch to 8-inch below finished grade. Where multiple lines installed in a common trench or concrete envelope do not exceed an overall width or 16-inches, use a single line marker.

I. The followingcolor codes shall be used for plastic line markers installed directly above underground lines:

Blue: Communications, Telephone, Data, Fire and Security

Red: 150V to 600V (lighting, power, controls)

Yellow: 601V to 15kV (medium and high voltage)

Note: Colors green, orange and white shall not be used for plastic line markers.

J. Color-Code Conductors: Primary service, secondary service, feeder, and branch circuit conductors throughout the electrical system.
   1. 208/120-V System: As follows:
      a. Phase A. Black.
      b. Phase B.: Red.
      c. Phase C: Blue
      d. Neutral: White.
      e. Ground: Green.
   2. 480/277-V System: As follows:
      a. Phase A: Yellow.
      b. Phase B: Brown.
      c. Phase C.: Orange.
      d. Neutral: Gray.
      e. Ground: Green.
   3. Medium Voltage System: Color code phases A, B and C to match Georgia Power recommendations.
   4. Factory-apply color the entire length of the conductors, except the following field-applied, color-coding methods may be used in lieu of factory-colored wire for sizes larger than No. 10 AWG. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6-inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply the last 2 turns of tape with no tension to prevent possible unwinding. Use 1-inch wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.

K. Power Circuit Identification: Use plastic laminated for cables, feeders, and power circuits in vaults, pull boxes junction boxes, manholes, and switchboard rooms.
   1. Legend: 1/4-inch letter and number with legend corresponding to indicated circuit designations.
   2. Fasten tags with nylon cable ties.
   3. Apply tags or bands such that all conductors in each circuit are included.

L. Apply identification to conductors as follows:
   1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
   2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.
   3. Multiple Control and Communications Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color coding, or cable marking tape.

M. Wire and Cable Identification
   1. Every power wire, power cable, control wire, control cable, instrumentation wire and cable shall be permanently identified at every termination point with a wire marker.
   2. Use wire marker as described in Paragraph 2.03 above. Mark with circuit wire number, control diagram number, loop number, equipment number, etc. as applicable.

N. Apply warning, caution, and instruction signs and stencils as follows:
   1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic-laminated instruction signs with accepted legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
   2. Emergency-Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

O. Nameplates:
   1. Apply equipment nameplates of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide a single line of text with 1/2-inch high lettering on 1 1/2-inch high label: where 2 lines of text are required, use lettering 2-inches high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment.
      a. Panelboards, electrical cabinets, and enclosures.
      b. Power transfer equipment.
      c. Contactors.
      d. Transformers.
      e. Fire-alarm master station or control panel.
      f. Telephone Backboard.
      g. Data Backboard.

2. Equipment nameplates shall also be applied for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.
3. Equipment nameplate shall include plant area identifier and specific equipment number as shown on power and MCC single line diagrams.

P. Identification Labels

1. Junction boxes shall includepermanent plastic labels, yellow with black text. Except as otherwise indicated, provide a single line of text with 1/2-inch high lettering on 1 1/2-inch high label: where 2 lines of text are required, use lettering 2-inches high. Identification labels shall include voltage class or services as follows:

   Comm – Communication/Data

   Tele – Telephone

   Control – 120V Control

   Inst – Instrumentation

   Motor – 600V motor branch circuit

   Power – 600V power and feeder circuit

   Note: lighting and receptacle junction boxes require no identification.

END OF SECTION 16195