Copy No.

CITY OF FLINT, MICHIGAN

WATER POLLUTION CONTROL

GRIT BAT "B" SYSTEM AND PRIMARY TANK IMPROVEMENTS

Contract Number 200-156238-21001

SRF No. 5709-01

Bidding Documents

Specifications

VOLUME 2 OF 2

Prepared by

East Lansing, Michigan

June 2021

CONTENTS

Section Number	Title	Pages
	VOLUME 1	
00100	ADVERTISEMENT FOR BIDS	00100 - 1 to 2
00110	CONTRACTOR'S QUALIFICATION STATEMENT	00110 - 1 to 8
00200	INSTRUCTION TO BIDDERS	00200 - 1 to 9
00400	BID FORM	00400 - 1 to 7
00430	BID BOND	00430 - 1 to 2
00450	REQUIRED CONTRACT LANGUAGE – SRF	00450 - 1 to 30
00458	AMERICAN IRON AND STEEL CONTRACT LANGUAGE	00458 - 1 to 1
00500	AGREEMENT	00500 - 1 to 8
00510	NOTICE OF AWARD	00510 - 1 to 2
00550	NOTICE TO PROCEED	00550 - 1 to 1
00613	PERFORMANCE BOND	00613 - 1 to 2
00614	PAYMENT BOND	00614 - 1 to 2
00615	ACT NO. 524, MICHIGAN P.A. 1980	00615 - 1 to 4
00620	APPLICATION FOR PAYMENT CERTIFICATE	00620 - 1 to 3
00623	CERTIFICATES OF INSURANCE	00623 - 1 to 1
00625	CERTIFICATE OF COMPONENT ACCEPTANCE	00625 - 1 to 1
00626	CERTIFICATE OF SUBSTANTIAL COMPLETION	00626 - 1 to 2
00627	CERTIFICATE OF FINAL COMPLETION	00627 - 1 to 2
00700	GENERAL CONDITIONS, EJCDC 1996 EDITION	00700 - 1 to 39
00800	SUPPLEMENTARY CONDITIONS	00800 - 1 to 13
	DIVISION 1 - GENERAL REQUIREMENTS	
01110	Summary of Work	01110 - 1 to 3
01210	Allowances	01210 - 1 to 3
01290	Applications for Payment	01290 - 1 to 3
01310	Project Coordination	01310 - 1 to 4
01330	Submittals	01330 - 1 to 7
01420	Definitions and Standards	01420 - 1 to 5
01450	Quality Control Services	01450 - 1 to 3
01500	Temporary Facilities	01500 - 1 to 16
01600	General Equipment Stipulations	01600 - 1 to 6
01730	Cutting and Patching	01730 - 1 to 3
01770	Contract Closeout	01770 - 1 to 5
	DIVISION 2 - SITE WORK	
02225	Selective Demolition	02225 - 1 to 7
02310	Earthwork	02310 - 1 to 9
02740	Hot Mix Asphalt Paving	02740 - 1 to 4

Section Number	Title	Pages
02805	Restoration Work	02805 - 1 to 9
	DIVISION 3 - CONCRETE	
03100	Concrete Formwork	03100 - 1 to 6
03200	Reinforcing Steel	03200 - 1 to 5
03250	Concrete Accessories	03250 - 1 to 6
03290	Joints in Concrete	03290 - 1 to 3
03300	Cast-In-Place Concrete	03300 - 1 to 19
03313	Tightness Testing of Concrete Structures	00313 - 1 to 2
03350	Concrete Finishes	03350 - 1 to 4
03370	Concrete Curing	03370 - 1 to 4
03400	Precast Concrete	03400 - 1 to 5
03415	Precast Prestressed Concrete Hollow Core Planks	03415 - 1 to 3
03600	Grout	03600 - 1 to 4
03930	Repair Existing Concrete Structures	03930 - 1 to 5
	DIVISION 4 – MASONRY	
04200	Unit Masonry	04200 - 1 to 21
	DIVISION 5 – METALS	
05010	Metal Materials	05010 - 1 to 4
05120	Structural Steel	05120 - 1 to 4
05140	Structural Aluminum	05140 - 1 to 3
05500	Metal Fabrications	05500 - 1 to 7
05521	Pipe & Tube Railing	05521 - 1 to 7
	DIVISION 6 – WOOD AND PLASTICS	
06101	Rough Carpentry	06101 - 1 to 5
06610	FRP Fabrications	06610 - 1 to 3
	DIVISION 7 - THERMAL AND MOISTURE PROTECTION	
07140	Fluid-Applied Waterproofing	07140 - 1 to 6
07175	Water Repellents	07175 - 1 to 2
07210	Building Insulation	07210 - 1 to 2
07272	Fluid-Applied Membrane Air Barriers	07272 - 1 to 5
07530	EPDM Roofing	07530 - 1 to 6
07600	Flashing and Sheet Metal	07600 - 1 to 5
07710	Roof Specialties	07710 - 1 to 9
07900	Joint Sealers	07900 - 1 to 8

Section Number	Title	Pages
	DIVISION 8 – DOORS AND WINDOWS	
08220	FRP Doors and Frames	08220 - 1 to 4
08312	Floor Doors	08312 - 1 to 4
08331	Overhead Coiling Doors	08331 - 1 to 6
08520	Aluminum Windows	08520 - 1 to 8
08710	Door Hardware	08710 - 1 to 11
08800	Glass and Glazing	08800 - 1 to 6
	VOLUME 2	
	DIVISION 9 - FINISHES	
09912	Exterior Painting	09912 - 1 to 4
09925	Moisture Mitigation Primer	09925 - 1 to 5
09961	High Performance Coatings	09961 - 1 to 16
	DIVISION 10 – SPECIALTIES	
10200	Aluminum Louvers and Vents	10200 - 1 to 7
10522	Fire Extinguishers and Accessories	10522 - 1 to 4
	DIVISION 11 - EQUIPMENT	
11226	Weirs and Baffles	11226 - 1 to 4
11285	Hydraulic Gates	11285 - 1 to 10
11322	Degritting Equipment	11322 - 1 to 18
11330	Screening Equipment	11330 - 1 to 7
11335	Rectangular Sludge Collector	11335 - 1 to 7
	DIVISION 13 - SPECIAL CONSTRUCTION	
13410	Basic Instrumentation Requirements	13410 - 1 to 5
13413	Optical Fiber Cabling Systems	13413 - 1 to 4
13421	Flow Measurement	13421 - 1 to 3
13423	Level Measurement	13423 - 1 to 2
13424	Pressure Measurement	13424 - 1 to 2
13430	Control Panels	13430 - 1 to 7
	DIVISION 14 – CONVEYING SYSTEMS	
14551	Screenings Washer-Compactor Conveyors	14551 - 1 to 6
	DIVISION 15 – MECHANICAL	
15013	Common Motor Requirements for HVAC Equipment	15013 - 1 to 3
15017	Sleeves and Sleeve Seals for Plumbing Piping	15017 - 1 to 4

Section Number	Title	Pages
15018	Escutcheons for Plumbing Piping	15018 - 1 to 2
15019	Meters and Gages for Plumbing and HVAC Piping	15019 - 1 to 3
15023	Ball Valves for Plumbing Piping	15023 - 1 to 3
15029	Hangers and Supports for Plumbing and HVAC Piping and Equipment	15029 - 1 to 7
15048	Vibration Controls for HVAC	15048 - 1 to 3
15050	Basic Mechanical Requirements	15050 - 1 to 5
15053	Identification for Plumbing and HVAC Piping and Equipment	15053 - 1 to 5
15060	Supports and Anchors	15060 - 1 to 6
15071	Plumbing Piping Insulation	15071 - 1 to 10
15072	HVAC Piping Insulation	15072 - 1 to 9
15080	Mechanical Insulation	15080 - 1 to 7
15093	Testing, Adjusting, and Balancing for HVAC	15093 - 1 to 11
15100	Pressure Process Piping	15100 - 1 to 16
15105	Basic Piping Materials and Methods	15105 - 1 to 16
15110	Process Valves	15110 - 1 to 11
15116	Domestic Water Piping	15116 - 1 to 7
15117	Gray-Water Piping	15117 - 1 to 5
15119	Domestic Water Piping Specialties	15119 - 1 to 3
15123	Facility Natural-Gas Piping	15123 - 1 to 11
15300	Refrigerant Piping	15300 - 1 to 5
15311	Nonmetal Ducts	15311 - 1 to 5
15316	Sanitary Waste and Vent Piping	15316 - 1 to 7
15319.13	Sanitary Drains	15319.13 - 1 to 3
15330	Air Duct Accessories	15330 - 1 to 5
15343	HVAC Power Ventilators	15343 - 1 to 5
15723.16	Packaged, Indirect-Fired, Outdoor Heating Only Makeup Air Unit	15723.16 - 1 to 11
15823.13	Computer Room Air Conditioners, Ceiling Mounted Units	15823.13 - 1 to 7
	DIVISION 16 - ELECTRICAL	
16050	Basic Electrical Requirements	16050 - 1 to 8
16052	Coordination Study and Arc Flash Analysis	16052 - 1 to 6
16060	Grounding	16060 - 1 to 3
16070	Supporting Devices	16070 - 1 to 2
16075	Electrical Identification	16075 - 1 to 3
16090	Demolition and Earthwork	16090 - 1 to 4
16120	Wires and Cables	16120 - 1 to 5
16130	Raceways	16130 - 1 to 4
16135	Cabinets, Boxes, and Fittings	16135 - 1 to 4

Section Number	Title	Pages
16139	Vaults	16139 - 1 to 5
16140	Wiring Devices	16140 - 1 to 2
16220	Motors	16220 - 1 to 5
16270	Transformers	16270 - 1 to 2
16330	Medium-Voltage Transformers	16330 - 1 to 7
16334	Medium-Voltage Switchgear	16334 - 1 to 5
16410	Circuit and Motor Disconnects	16410 - 1 to 2
16420	Motor Controllers	16420 - 1 to 3
16421	Motor Control Centers	16420 - 1 to 4
16422	Variable Frequency Drives	16422 - 1 to 4
16440	Panelboards	16440 - 1 to 2
16450	Busways	16450 - 1 to 3
16497	Fuses	16497 - 1 to 2
16529	Hazardous Material Disposal	16529 - 1 to 2
	DIVISION 32 – EXTERIOR IMPROVEMENTS	
323223	Concrete Block Retaining Wall	323223 - 1 to 7

SECTION 09912 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Primers.
2. Finish coatings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of topcoat product.

1.3 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. Behr Paint Company
2. Benjamin Moore & Co.
3. PPG Paints
4. The Sherwin-Williams Company
5. The Valspar Corporation

2.2 PAINT PRODUCTS, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by topcoat manufacturer for use in paint system and on substrate indicated.

B. Colors: As selected by Architect from manufacturer's full range.

2.3 PRIMERS

A. Exterior, Alkali-Resistant, Water-Based Primer: Pigmented, water-based primer formulated for use on alkaline surfaces, such as, vertical concrete, and masonry.

1. Subject to compliance with specified requirements, manufacturers offerings products which may be incorporated into the Work include:

a. Behr Paint Company
b. Benjamin Moore & Co.
c. PPG Paints
d. The Sherwin-Williams Company
e. The Valspar Corporation

2.4 FINISH COATINGS

A. Exterior Latex Paint, Flat: Water-based, pigmented coating; formulated for alkali, mold, microbial, and water resistance and for use on exterior surfaces, such as, masonry.

1. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated into the Work include:

a. Behr Paint Company
b. Benjamin Moore & Co.
c. PPG Paints
d. The Sherwin-Williams Company
e. The Valspar Corporation

2. Gloss and Sheen: Manufacturer's standard flat finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify suitability of substrates, including surface conditions and compatibility, with finishes and primers.

B. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems specified in this Section.

3.3 INSTALLATION

A. Apply paints in accordance with manufacturer's written instructions.

B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 CLEANING AND PROTECTION

A. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

B. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 EXTERIOR PAINTING SCHEDULE

A. Concrete Masonry Unit Substrates:

1. Latex System over Alkali-Resistant Primer System:

a. Prime Coat: Exterior, alkali-resistant, water-based primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Exterior latex paint - flat.

END OF SECTION

SECTION 09925 – MOISTURE MITIGATION PRIMER

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Concrete Slab Moisture Mitigation

B. Related Sections:
   1. Section 07920 "Joint Sealants" for sealants installed at joints in resinous flooring systems.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.

B. System Application Guide: Manufacturer’s detailed installation instructions for system being installed

C. Samples for Initial Selection: NA

D. Samples for Verification: NA.

E. Product Schedule: For resinous flooring.

1.03 INFORMATIONAL SUBMITTALS

A. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.

B. Material Certificates: For each resinous flooring component, from manufacturer.

C. Material Test Reports: For each resinous flooring system.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of flooring systems required for this Project.
   1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

C. Mockups: NA

D. Retain paragraph below if Work of this Section is extensive or complex enough to justify a preinstallation conference.

E. Pre-installation Conference: Conduct conference at project CONTRACTOR office trailer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide HP Spartacote product named or comparable product:

2.02 Moisture Mitigation

A. Resinous Flooring: Abrasion-, impact- and chemical-resistant, high-performance, resin-based, monolithic floor surfacing designed to produce a seamless floor and integral cove base.
   1. Basis-of-Design Product: Tnemec Company (Epoxoprime MV). All other manufacturers shall provide equivalent product subject to Engineer Approval.
   2. Hydro-Shield SL™

B. System Characteristics: NA

1. Color and Pattern: As selected by Architect from manufacturer's full range.
2. Wearing Surface: Manufacturer's standard wearing surface.
3. Overall System Thickness: varies depending on slab moisture content
4. Federal Agency Approvals: USDA approved for food-processing environments.

C. Single Coat:
1. Name:
    a. Tnemec Compnay: Epoxoprime MV
    b. Hydro-Shield SL™ Moisture Primer from HP Spartacote®
2. Resin: Polyaspartic Aliphatic Polyurea
3. Formulation Description: 100 Solids Chemmically Enhanced Epoxy
4. Application Method: Notched Squeegee and backroll
    a. Thickness of Coats: 16-20 mils
    b. Number of Coats: Two

D. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
1. Adhesion: 400+ concrete fracture per ASTM D 4541.
2. Viscocity: 600 +/- 80 cps

2.03 ACCESSORIES

A. Patching and Fill Material: HP Spartacote Fast Fix™ or resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

B. Joint Filler Material: HP Spartacote Joint-Flex® flexible polyuria joint filler or similar product.

PART 3 - EXECUTION

3.01 PREPARATION

A. General: Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry substrate for resinous flooring application.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
1. Roughen concrete substrates as follows:
    a. Mechanically profile surfaces with an apparatus that abrades the concrete surface to a profile as specified by system application guide.
    b. Comply with ASTM C 811 requirements unless manufacturer's written instructions are more stringent.
2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.
3. Verify that concrete substrates are dry and moisture-vapor emissions are properly tested to determine adequate coverage ratios and ending DFT

a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) of slab area in 24 hours.

b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

4. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

C. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

D. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

E. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.

3.02 APPLICATION

A. General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
   1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum inter-coat adhesion.
   2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
   3. At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.

B. Apply waterproofing membrane, where indicated, in manufacturer's recommended thickness.
   1. Apply waterproofing membrane to integral cove base substrates.

C. Integral Cove Base: Where indicated, apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, and top coating of cove base. Round internal and external corners.
   1. Integral Cove Base: 4 inches (100 mm) high.

D. Apply primer and body coats in thickness indicated for flooring system.

E. Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer.

3.03 FIELD QUALITY CONTROL

A. Core Sampling: At the direction of Owner and at locations designated by Owner, take one core sample per 1000 sq. ft. (92.9 sq. m) of resinous flooring, or portion of, to verify

thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring and correct deficiencies.

B. Material Sampling: Owner may at any time and any number of times during resinous flooring application require material samples for testing for compliance with requirements.

3.04 PROTECTION

A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION

SECTION 09961 - HIGH PERFORMANCE COATINGS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Water Works Association (AWWA):
   a. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot-Applied.
   b. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
   c. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   d. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
2. Environmental Protection Agency (EPA).
3. International Concrete Repair Institute (ICRI) Guideline No. 310.2 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
4. NACE International (NACE): SP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
5. ANSI / NSF International (NSF): 61, Drinking Water System Components-Health Effects.
6. National Association of Pipe Fabricators (NAPF)
   a. 500-03-04, Abrasive Blast Cleaning for Ductile Iron Pipe.
7. Occupational Safety and Health Act (OSHA).
8 The Society for Protective Coatings (SSPC):
   a. SSPC-PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
   b. SSPC-PA 3, Guide to Safety in Paint Applications.
   c. SSPC-SP 1, Solvent Cleaning.
   d. SSPC-SP 2, Hand Tool Cleaning.
   e. SSPC-SP 3, Power Tool Cleaning.
   f. SSPC-SP 5/NACE 1, White Metal Blast Cleaning.
   g. SSPC-SP 6/NACE 3, Commercial Blast Cleaning.
   h. SSPC-SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
   i. SSPC-SP 10/NACE 2, Near-White Blast Cleaning.
   j. SSPC-SP 11, Power Tool Cleaning to Bare Metal.
   k. SSPC-SP 12, Surface Preparation and Cleaning of Metals Waterjetting Prior to Recoating.
   l. SSPC-SP 13/NACE 6, Surface Preparation of Concrete.
   m. SSPC-SP 16, Brush-off Blast cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
   n. Guide 15, Field Methods for Retrieval and Analysis of Soluble Sa1ts on Steel and Other Nonporous Substrates.
   o. SSPC-TU 11, Inspection of Fluorescent Coating Systems.
9. National Fire Protection Association (NFPA).
10. American Society for Testing and Materials (ASTM International).

1.02 SUMMARY

A. Section Includes: Field painting as shown and/or herein required. See specific items not requiring field painting under Work Not Included.

B. Provide all labor, materials, equipment and services for furnishing and installing the finishes as indicated on drawings and schedules, and as herein specified.

C. In general, exposed surfaces of factory and/or shop-primed work that are delivered to Site without a final finish shall be painted. The shop priming and intermediate shop coatings shall not be considered as included in the number of field coats specified under Part 2, Field Painting Systems Article, Finish Paints paragraph in this Section.

D. Ferrous metal surfaces, excluding stainless steel surfaces that will be exposed in the completed Work, shall be sandblasted either at the point of fabrication or under this Section prior to placement of primers. Field fabrication, including welds and cuts, shall be sandblasted, primed, and painted as herein specified.

E. Ferrous metal items that will be in contact with precast concrete slabs, masonry, etc., shall be finish painted.

F. Galvanized steel items that are not included under "Work Not Included," shall be prepared, primed, and finish painted as herein specified.

G. Bruises, mars, and/or scratches in the shop painting due to handling, shall be immediately touched up in the field by Contractor prior to any storage or installation.

H. Work includes field painting of exposed bare and covered pipes and ducts (including color coding), and of hangers, exposed steel and iron work, and primed metal surfaces of equipment installed under mechanical and electrical work, except as otherwise indicated.

I. "Paint" as used herein means all coating systems materials, including primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.

J. Surfaces to be Painted: Except where natural finish of material is specifically noted as a surface not to be painted, paint exposed surfaces whether or not colors are designated in "schedules". Where items or surfaces are not specifically mentioned, paint the same as similar adjacent materials or areas. If color or finish is not designated, Architect-Engineer will select these from standard colors or finishes available.

K. Painting of piping includes pipe hangers, valves, and piping accessories, and also includes surfaces that will be in contact with piping supports. ALL PIPING SHALL BE COMPLETELY PAINTED.

L. Existing surfaces shall be painted where shown and/or called for. Preparation for repainting and priming shall be as herein specified.

M. Altered existing Work or damaged surfaces that are a result of the revisions shall be painted under this item of Work. The finishes shall match the existing adjacent coatings.

N. Miscellaneous equipment shipped to Site with factory-applied coatings as follows, shall be painted under this Work as specified:
   1. No Factory Finish: Surface preparation, priming, and finish painting.
   2. Prime Coat: Surface preparation, touch-up, and finish painting.
   3. Intermediate Coat: Surface preparation, touch-up, and finish painting.
   4. Pre-finished Equipment: Touch-up as required. Equipment manufacturer shall furnish necessary touch-up paint.
   5. Factory finish coats, not matching the approved finish colors, that are provided in lieu of the shop prime specified shall be properly prepared and receive a final field coat to match the adjacent related Work.

O. Painting as called for on Drawings is for guidance only and does not limit the requirements for painting.

P. Work Not Included: Unless specifically called for on Drawings or specified in this Section, the following are not included:
   1. Exterior exposed concrete surfaces and exterior exposed concrete surfaces below the ground floor plan.
   2. Nonferrous metals and stainless steel, except copper and brass.
   3. Exterior aluminum siding.
   4. Nonexposed surfaces of treated lumber.
   5. Concealed Surfaces: Unless otherwise indicated, painting is not required on surfaces such as walls or ceilings in concealed areas and generally inaccessible areas, furred areas, pipe spaces, and duct shafts.
   6. Conduits below the main floor, except in rooms that are painted.
   7. Exterior gratings with a hot-dipped galvanized finish.
   8. Manufacturer's name and identification plates, such as Underwriters' Laboratories and Factory Mutual, or any equipment identification, performance rating, name or nomenclature plates.
   9. Overhead sectional doors - shall have a factory finish on both interior and exterior exposed surfaces.
   10. All interior and exterior sealant and caulking unless adjacent to latex-coated surfaces and approved by Engineer.
   11. Interior concrete surfaces of tanks and basins, immersed and exposed not to be painted.
   12. Operating Parts: Unless otherwise indicated, moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sensing devices, motors, and fan shafts will not require finish painting.

1.03 DEFINITIONS

A. Terms used in this section:
   1. ASTM D 16, unless otherwise specified.
   2. Coverage: total-minimum dry film thickness in mils or square feet per gallon.
   3. DFT: Dry Film Thickness – Thickness of a coat of cured paint measured in mils (1/1000 inch).
   4. FRP: Fiberglass Reinforced Plastic.
   5. HCl: Hydrochloric Acid.

6. MDFT: Minimum Dry Film Thickness, mils.
7. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
8. Mil: Thousandth of an inch.
9. PDS: Product Data Sheet.
10. PSDS: Paint System Data Sheet.
11. PVC: Polyvinyl Chloride.
12. SFPG: Square Feet per Gallon.
13. SFPGPC: Square Feet per Gallon per Coat.
14. SP: Surface Preparation.

1.04 SUBMITTALS

A. Action Submittals:
1. Shop Drawings: Submit in accordance with Division 1 Submittal Procedures.
a. Data Sheets:
1) For each product, furnish a Product Data Sheet (PDS), the manufacturer's technical data sheets, and paint colors available (where applicable). The PDS form is appended to the end of this section.
2) For each paint system, furnish a Paint System Data Sheet (PSDS).
3) Technical and performance information that demonstrates compliance with Specification.
4) Furnish copies of paint system submittals to the coating applicator.
5) Indiscriminate submittal of only manufacturer's literature is not acceptable.
b. Detailed chemical and gradation analysis for each proposed abrasive material.
2. Samples:
a. Proposed Abrasive Materials: Minimum 5-pound sample for each type.
b. Reference Panel:
1) Surface Preparation:
a) Prior to start of surface preparation, furnish a 4-inch by 4-inch steel panel for each grade of sandblast specified herein, prepared to specified requirements.
b) Provide panel representative of the steel used; prevent deterioration of surface quality.
c) Panel to be reference source for inspection upon approval by Engineer.
2) Paint:
a) Unless otherwise specified, before painting work is started, prepare minimum 8-inch by 10-inch sample with type of paint and application specified on similar substrate to which paint is to be applied.
b) Furnish additional samples as required until colors, finishes, and textures are approved.
c) Approved samples to be the quality standard for final finishes.

B. Informational Submittals:
1. Typewritten schedule of Painting Operations. This schedule shall include for each surface to be painted, the brand name, generic type, solids by volume, application method, the coverage and number of coats in order to achieve the specified dry film thickness, and color charts.
2. Coating manufacturer's Certificate of Compliance, in accordance with Division 1, Manufacturers' Field Services.
3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
4. Manufacturer's written verification that submitted material is suitable for the intended use.
5. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
6. Manufacturer's written instructions and special details for applying each type of paint.

C. Warranty:
1. Submit manufacturer's standard warranty in accordance with requirements of Division 1, warranties covering the items included under this Section.

1.05 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum 5 years' experience in application of specified products.

B. Regulatory Requirements:
1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
2. Perform surface preparation and painting in accordance with recommendations of the following:
a. Paint manufacturer's instructions.
b. SSPC PA 3, Guide to Safety in Paint Applications.
c. Federal, state, and local agencies having jurisdiction.

C. Mockup:
1. Before proceeding with Work under this section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of work, and special details.
2. After Engineer approval, sample spaces or items shall serve as a standard for similar work throughout the Project.

D. Pre-application Meeting:
1. Convene a pre-application meeting two [2] weeks before start of application of coating systems. Require attendance of parties directly affecting work of this section, including Contractor, Engineer, applicator, and manufacturer's representative. Review 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.

E. Single Source Responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer, and use only within recommended limits.

F. Coordination of Work: Review other sections of these Specifications in which prime paints are to be provided to ensure compatibility of total coatings systems for various substrates. Upon request from other trades, furnish information or characteristics of finish materials provided for use, to ensure compatible prime coats are used.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Shipping:
1. Where precoated items are to be shipped to the Site, protect coating from damage. Batten coated items to prevent abrasion.
2. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.

B. Deliver materials to job site in original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
1. Name or title of material.
2. Fed. Spec. number, if applicable.
3. Manufacturer's stock number, batch number, and date of manufacturer.
4. Manufacturer's name.
5. Contents by volume, for major pigment and vehicle constituents.
6. Thinning instructions.
7. Application instructions.
8. Color name and number.

C. Storage:
1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
2. Primed surfaces shall not be exposed to weather for more than 2 months before being topcoated, or less time if recommended by coating manufacturer.
3. Handling: Protect materials during handling and application to prevent damage or contamination.
4. Keep storage area neat and orderly. Remove oily rags and waste daily. Take all precautions to ensure that workmen and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of paints.

1.07 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.
   2. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dew point of ambient air.
   3. Apply water-base paints only when temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F (10 degrees C) and 90 degrees F (32 degrees C), unless otherwise permitted or restricted by paint manufacturer's printed instructions.
   4. Apply solvent-thinned paints only when temperature of surfaces to be painted and surrounding air temperatures are between 45 degrees F (7 degrees C) and 95 degrees F (35 degrees C), unless otherwise permitted or restricted by paint manufacturer's printed instructions.
   5. Do not apply paint in snow, rain, fog or mist, or when relative humidity exceeds 85%, or to damp or wet surfaces, unless otherwise permitted or restricted by paint manufacturer's printed instructions. Painting may be continued during inclement weather if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer during application and drying periods.
   6. Paint only when the surface temperature is at least 5 degrees F above the dew point, unless otherwise permitted by paint manufacturer’s printed instructions.

B. Status of Existing Coatings:
   1. Perform tests as required to verify condition of existing coatings and substrate conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.

B. Minimum of 5 years' verifiable experience in manufacture of specified product.

C. Each of the following manufacturers is capable of supplying most of the products specified herein:
   1. TNEMEC Company, Inc.
   2. The Sherwin-Williams Company (Basis of Design).
   3. PPG Industries.
   4. Carboline.

2.02 ABRASIVE MATERIALS

A. Abrasives for blasting shall be sharp, washed, salt free, angular, and free from feldspar or other constituents that tend to breakdown and remain on the surface.

B. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.03 PAINT MATERIALS

A. General:

1. Manufacturer's highest quality products suitable for intended service. Materials not displaying manufacturer's identification as a standard, best-grade product will not be acceptable.
2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.
3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.
4. Color Pigments: Pure, non fading, applicable types to suit substrates and service indicated.
    a. Lead content in pigment, if any, is limited to contain not more than 0.06% lead, as lead metal based on the total non volatile (dry film) of paint by weight.

B. Products:

Product	Definition
Acrylic Latex	Single-component, 100% acrylic finish as required
Block Filler	Primer-sealer designed for rough masonry surfaces, acrylic emulsion, cementitious acrylic, or epoxy
Coal-Tar Epoxy	Amine, polyamide, or phenolic epoxy type, suitable for immersion service
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and surface, nonshrinking, suitable for application to concrete and masonry
Epoxy Nonskid (Aggregated)	100% solids two-component catalyzed epoxy aggregated; aggregate may be packaged separately
Epoxy Primer- Ferrous Metal	High-build, two-component catalyzed epoxy primer.
Epoxy Primer- Other	Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service
Fusion Bonded, TFE Lube or Grease Lube	Tetrafluoroethylene, liquid coating, or open gear grease as supplied by McMaster-Carr Supply Corporation, Elmhurst, IL; RL 736 manufactured by Amrep, Inc., Marietta, GA
High Build Epoxy	High-build, two-component catalyzed epoxy, capability of 3 to 5 MDFT per coat
Epoxy Novolac	100% solids two-component, highly chemical resistant epoxy
Latex Primer Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum board and plaster. Capable of providing uniform seal and suitable for use with specified finish coats.

Product	Definition
Gloss Polyurethane -	Two-component, aliphatic acrylic based polyurethane; high gloss finish
Multipolymeric Matrix Coating	Heat resistant single component inert multipolymeric matrix coating for high heat applications under insulation.
Water Base Epoxy	Two-component, polyamide epoxy emulsion, finish as required.

2.04 MIXING

A. Multiple-Component Coatings:
   1. Prepare using each component as packaged by paint manufacturer.
   2. No partial batches will be permitted.
   3. Do not use multiple-component coatings that have been mixed beyond their pot life.
   4. Furnish small quantity kits for touchup painting and for painting other small areas.
   5. Mix only components specified and furnished by paint manufacturer.
   6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.

C. Stir materials before application to produce a mixture of uniform density, and stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
   1. Colors: Formulate paints with colorants for reasons of color or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

PART 3 - EXECUTION

3.01 GENERAL

A. Provide Engineer minimum 7 days' advance notice to start of field surface preparation work and coating application work.

B. Perform the Work only in presence of Engineer or their representative, unless Engineer grants prior approval to perform the Work in Engineer's absence.

C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Engineer.

D. Protection: Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damage by cleaning, repairing or replacing, and repainting, as acceptable to Architect-Architect-Engineer. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of painting

operations. At completion of work of other trades, touch up and restore all damaged or defaced painted surfaces.

3.02 EXAMINATION

A. Factory Finished Items:
   1. Scheduling Inspection with Engineer before repairing damaged factory finished items delivered to Site.
   2. Repair abraded or otherwise damaged areas on factory-finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.

B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.

C. Starting of painting work will be construed as acceptance of surfaces and conditions within any particular area.

D. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable paint film.

3.03 PROTECTION OF ITEMS NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering.

E. Protect surfaces adjacent to or downwind of Work area from overspray.

3.04 SURFACE PREPARATION

A. General: Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as herein specified, for each particular substrate condition, or as required by this specification, the more stringent requirements shall apply.
   1. Provide barrier coats over incompatible primers or remove and re-prime as required. Notify Architect-Architect-Engineer in writing of any anticipated problems in using the specified coating systems with substrates primed by others.
   2. Remove hardware, hardware accessories, machined surfaces, plates, lighting

fixtures, and similar items in place and not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items.

3. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning per SSPC SP-1. Program cleaning and painting so that contaminants from cleaning process will not fall onto wet, newly-painted surfaces.
4. Abrasives for blasting shall be sharp, washed, salt free, angular, and free from feldspar or other constituents that tend to breakdown and remain on the surface.
5. Concrete floors shall be dry as indicated by testing in accordance with ASTM D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

B. Field Abrasive Blasting:
1. Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed or coated.
2. Refer to coating systems for degree of abrasive blasting required.
3. Where the specified degree of surface preparation differs from manufacturer's recommendations, the more stringent shall apply.

3.05 SURFACE CLEANING

A. Brush-off Blast Cleaning:
1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.
3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
5. Engineer will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
6. Repair or replace surface damaged by blast cleaning.

B. Solvent Cleaning:
1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.
2. Meet requirements of SSPC SP 1.

3.06 APPLICATION

A. General:
1. The intention of these Specifications is for existing and new interior masonry, interior and exterior wood, and metal and submerged metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.

2. Extent of Coating (Immersion): Coatings shall be applied to internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.
3. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating until completion of curing cycle.
4. Apply coatings in accordance with these Specifications and paint manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
5. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
6. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
7. Keep paint materials sealed when not in use.
8. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.
9. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.
10. Provide finish coats which are compatible with prime paints used.
11. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Give special attention to insure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
12. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness or other surface imperfections will not be acceptable. Holiday test coated steel in immersion areas in accordance with NACE International RP 0188-90.
13. Transparent (Clear) Finishes: Use multiple coats to produce glass smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections. Provide satin finish for final coats, unless otherwise indicated.
14. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

B. Porous Surfaces, Such as Concrete and Masonry:
1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.
2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
   a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
3. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.

C. Film Thickness and Coverage:

1. Number of Coats:
   a. Minimum required without regard to coating thickness.
   b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
2. Application Thickness:
   a. Do not exceed coating manufacturer's recommendations.
   b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
   a. Perform with properly calibrated instruments.
   b. Recoat and repair as necessary for compliance with Specification.
   c. Coats are subject to inspection by Engineer and coating manufacturer's representative.
4. Visually inspect concrete, masonry, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.
6. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

3.07 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.

B. The Finish Schedule on Architectural Drawings addresses walls, floors and ceilings for various buildings Additional requirements are included in the following schedule which addresses structural steel, prefabricated steel trusses, process equipment, pumps, piping and other items.

C. NSF International approval required for coatings used in contact with the water treatment plant process water.

D. **System No. 1** Chemical Resistant Concrete Floor / Secondary Containment (hazardous chemical exposure)

Surface Prep	Paint Material	Min. Coats, Cover
SSPC-SP 13/NACE 6 to achieve ICRI CSP as required by manufacturer	Urethane Cement Vapor Barrier / Surfacer	Manufacturer Recommended Primer – 4.0 to 6.0 mils DFT 2 coats – 15.0 – 20.0 mils DFT

Verify resistance to stored commodities and anticipated traffic load PRIOR to installation.

3.08 FIELD QUALITY CONTROL

A. Testing Equipment:
   1. Provide magnetic type dry film thickness gauge to test coating thickness specified in mils, as manufactured by Nordson Corp., Anaheim, CA, Mikrotest.
   2. Provide low-voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high-build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.
   3. Provide high-voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer.

B. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.

C. Unsatisfactory Application:
   1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
   2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
   3. Repair defects in accordance with written recommendations of coating manufacturer.

D. Damaged Coatings, Pinholes, and Holidays:
   1. Feather edges and repair in accordance with recommendations of paint manufacturer.
   2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
   3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

E. The right is reserved by Owner to invoke the following material testing procedure at any time, and any number of times during period of field painting:
   1. Engage services of an independent testing laboratory to sample paint being used. Samples of materials delivered to project site will be taken, identified and sealed, and certified in presence of Contractor.
   2. Testing laboratory will perform appropriate tests for any or all of following characteristics: Abrasion resistance, apparent reflectivity, flexibility, washability, absorption, accelerated weathering, dry opacity, accelerated yellowness, recoating, skinning, color retention, alkali resistance and quantitative materials analysis.

F. If test results show that material being used does not comply with specified requirements, Contractor may be directed to stop painting work, and remove non-complying paint; pay for testing; repaint surfaces coated with rejected paint; remove

rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are non-compatible.

3.09 MANUFACTURER'S SERVICES

A. In accordance with Division 1, Manufacturers' Field Services, coating manufacturer's representative shall be present at Site as follows:
   1. On first day of application of any coating system.
   2. A minimum of two additional Site inspection visits, each for a minimum of 4 hours, in order to provide Manufacturer's Certificate of Proper Installation.
   3. As required to resolve field problems attributable to or associated with manufacturer's product.
   4. To verify full cure of coating prior to coated surfaces being places into immersion service.
      a. Inspection Reports: Submit written reports to Engineer and Contractor describing inspections made and actions taken to correct nonconforming work. Report nonconforming work not corrected.
      b. Manufacturer’s Field Services: Manufacturer’s representative shall provide technical assistance and guidance for surface preparation and application of coating systems.

3.10 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.

B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.

C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

D. As soon as painting Work is accepted by Contactor, it shall become its responsibility for protection, final cleaning, and tough-up. Recoat entire surface where touch-up result is visibly different, either in sheen, texture, or color. Repair coating defects in accordance with manufacturer’s written instructions.

E. Upon completion of painting work, clean window glass and other paint spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

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.

END OF SECTION

SECTION 10200 - ALUMINUM LOUVERS AND VENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fixed metal wall louvers.

2. Blank-off panels for wall louvers.

3. Wall vents.

B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.02 DEFINITIONS

A. Louver Terminology: Refer to AMCA Publication 501-85 for definitions of terms for metal louvers not otherwise defined in this Section, or referenced standards.

1.03 PERFORMANCE REQUIREMENTS

A. Structural Performance: Design, engineer, fabricate, and install exterior metal wall louvers to withstand the effects of loads and stresses from wind and normal thermal movement without evidencing permanent deformation of louver components including blades, frames, and supports; noise or metal fatigue caused by louver blade rattle or flutter, and permanent damage to fasteners and anchors:

1. Wind Load: Uniform pressure (velocity pressure) of 20 pounds per square foot acting inwards or outwards.

2. Normal thermal movement is defined as that resulting from the following maximum change (range) in ambient temperature. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.
   a. Temperature Change (Range): 100 degrees F (55.5 degrees C).

B. Air Performance, Water Penetration, and Air Leakage Ratings: Provide louvers complying with performance requirements indicated as demonstrated by testing manufacturers' stock units, of height and width indicated, according to Air Movement and Control Association (AMCA) Standard 500.

1.04 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Drawings of louver units and accessories. Include plans, elevations, sections, and details showing profiles, angles, spacing of louver blades, unit dimensions related to wall openings and construction, free areas for each size indicated, and profiles of frames at jambs, heads, and sills.

2. Product data for each product indicated.

3. Samples for initial selection purposes in form of manufacturer's color charts showing full range of colors available for those units with factory-applied color finishes.

4. Samples for verification purposes of each type of metal finish required, prepared on 6-inch square metal samples of same thickness and alloy indicated for final unit of Work. Where finishes involve normal color and texture variations, include sample sets showing full range of variations expected.

1.05 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain louvers and vents from a single source where alike in one or more respects with regard to type, design, and factory-applied color finish.

B. Codes and Standards:

1. Qualify welding processes and welding operators in accordance with D1.2, "Structural Welding Code - Aluminum," and D1.3, "Structural Welding Code - Sheet Steel."
   a. Certify that each welder employed in unit of Work of this Section has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
   b. Testing for recertification is CONTRACTOR's responsibility.
   c. Comply with SMACNA "Architectural Sheet Metal Manual" recommendations for fabrication, construction details, and installation procedures.

1.06 PROJECT CONDITIONS

A. Field Measurements: Check actual louver openings by accurate field measurements before fabrication; show recorded measurements on final Shop Drawings. Coordinate Fabrication schedule with construction progress to avoid delay of Work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. Louvers:
   a. Airolite Co.
   b. American Warming and Ventilating, Inc.
   c. Construction Specialties, Inc.
   d. Industrial Louvers, Inc.
   e. Greenheck Fan Corporation.

f. Ruskin Manufacturing Division, Phillips Industries, Inc.

2. Metal Wall Vents (Brick Vents):
   a. Airolite Co.
   b. Construction Specialties, Inc.
   c. Industrial Louvers, Inc.
   d. Ruskin Manufacturing Division, Phillips Industries, Inc.
   e. Sunvent Industries, Sylro Sales Corp.

2.02 MATERIALS

A. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005, with temper as required for forming or as otherwise recommended by metal producer to produce required finish.

B. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.

C. Fasteners: Of same basic metal and alloy as fastened metal, unless otherwise indicated. Do not use metals which are corrosive or incompatible with materials joined.

1. Use types, gauges, and lengths to suit unit installation conditions.

2. Use Phillips flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Anchors and Inserts: Of type, size, and material required for type of loading and installation indicated. Use nonferrous metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or expansion bolt devices for drilled-in-place anchors.

E. Bituminous Paint: SSPC-Paint 12 (cold-applied asphalt mastic).

2.03 FABRICATION, GENERAL

A. Fabricate louvers and vents to comply with requirements indicated for design, dimensions, materials, joinery, and performance.

B. Preassemble louvers in shop to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

D. Fabricate frames, including integral sills, to fit in openings of size indicated with allowances made for fabrication and installation tolerances of louvers, adjoining construction, and perimeter sealant joints.

E. Include supports, anchorages, and accessories required for complete assembly.

F. Provide vertical mullions of type and at spacings indicated, but not further apart than recommended by manufacturer, or 72 inches on center, whichever is less. At horizontal joints between louver units, provide horizontal mullions except where continuous vertical assemblies are indicated.

G. Provide sill extensions and loose sills made of same material as louvers, where indicated, or required for drainage to exterior and to prevent water penetrating to interior.

H. Join frame members to one another and to fixed louver blades as follows, unless otherwise indicated, or size of louver assembly makes bolted connections between frame members necessary:

1. With fillet welds concealed from view, and concealed from view mechanical fasteners only where required for continuous assemblies.

2.04 FIXED EXTRUDED ALUMINUM WALL LOUVERS

A. Horizontal, Non-drainable Fixed Blade Louvers: Extruded aluminum frames and louver blades, complying with the following requirements:

1. Louver Depth: 1 foot 4 inches, unless otherwise indicated.

2. Frame Type: Channel flange, unless otherwise indicated.

3. Frame Thickness: 0.081 inch, unless otherwise indicated.

4. Louver Blade Thickness: 0.081 inch, unless otherwise indicated.

5. Louver Blade Profile: Plain blade with no center baffle.

6. Louver Blade Angle: 45 degrees, unless otherwise indicated.

7. Performance Requirements: As follows, determined by testing units 48 inches wide by 48 inches high per AMCA Standard 500:
   a. Louver Free Area: Not less than 6.67 square feet.
   b. Static Pressure Loss: Not more than 0.15 inch water gauge at an airflow of 810 fpm free area intake velocity.
   c. Water Penetration: Not more than 0.02 ounce per square foot of free area at an airflow of 855 fpm free area velocity when tested for 15 minutes.

8. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

9. Louver Security Bars: ½" diameter (or ½" x ½") at 6" on center (horizontal and vertical) aluminum security bars factory installed on all fixed louver frames. Finish to match louver.

2.05 LOUVER SCREENS

A. Provide each exterior louver with louver screens complying with the following requirements:

1. Screen Location for Fixed Louvers: Interior face unless otherwise indicated.

2. Screening Type: Bird screening on all exhaust louvers unless otherwise indicated.

3. Screening Type: Insect screening on all intake louvers unless otherwise indicated.

4. Screening Type: Bird screening on all intake louvers unless otherwise indicated.

B. Secure screens to louver frames with stainless steel machine screws, spaced at each corner and at 12-inch on center between.

C. Louver Screen Frames: Fabricate screen frames with mitered corners to louver sizes indicated and to comply with the following requirements:

1. Metal: Same kind and form of metal as indicated for louver frames to which screens are attached.
   a. Reinforce extruded aluminum screen frames at corners with clips.

2. Finish: Same finish as louver frames to which louver screens are attached.

3. Type: Rewireable frames with a driven spline or insert for securing screen mesh.

D. Louver Screening for Aluminum Louvers: Fit aluminum louver screen frames with screening covering louver openings and complying with the following requirements:

1. Bird Screening: 1/4-inch square mesh formed with 0.080-inch-diameter aluminum wire.

E. Insect Screening: 18 by 16-mesh formed with 0.012-inch-diameter aluminum wire. Security Bars: Where indicated on the Mechanical Schedule Sheet, provide security bar on louvers. Install security bar on the interior side of louver with steel frame attached to wall. Bars shall be ½" steel bars on 6" on center and orientated vertically.

2.06 WALL VENTS

A. Extruded Aluminum Wall Vents: Extruded aluminum louvers and frames not less than 0.125-inch thick and assembled by welding, with 18 by 14-mesh aluminum wire insect screening on inside face. Incorporating weep holes, continuous drip at sill, and integral water stop on inside edge of sill, of load-bearing design and construction.

2.07 FINISHES

A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

B. Finish louvers after assembly.

2.08 ALUMINUM FINISHES

A. Finish designations prefixed by "AA" conform to the system established by the Aluminum Association for designating aluminum finishes.

B. Class I Clear Anodized Finish: AA-M12C22A41 (Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class I Architectural: Clear film thicker than 0.7 mil) complying with AAMA 607.1.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Site.

3.02 INSTALLATION

A. Locate and place louver units plumb, level, and in proper alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers as indicated.

E. Repair finishes damaged by cutting, welding, soldering, and grinding operations required for fitting and jointing. Restore finishes so there is no evidence of corrective Work. Return items which cannot be refinished in field to shop, make required alterations, and refinish entire unit, or provide new units.

F. Protect nonferrous metal surfaces from corrosion or galvanic action by application of a heavy coating of bituminous paint on surfaces which will be in contact with concrete, masonry, or dissimilar metals.

G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where required to make louver joints weathertight. Comply with Section 07900 for sealants applied during installation of louver.

3.03 ADJUSTING AND PROTECTION

A. Protect louvers and vents from damage of any kind during construction period, including use of temporary protective coverings where needed and approved by louver manufacturer. Remove protective covering at time of Substantial Completion.

B. Restore louvers and vents damaged during installation and construction period so that no evidence remains of correction Work. If results of restoration are unsuccessful, as judged by ENGINEER, remove damaged units and replace with new units.

C. Clean and touch-up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

3.04 CLEANING

A. Periodically clean exposed surfaces of louvers and vents which are not protected by temporary covering to remove fingerprints and soil during construction period; do not let soil accumulate until final cleaning.

B. Before final inspection, clean exposed surfaces with water and with a mild soap or detergent not harmful to finishes. Rinse thoroughly and dry surface.

END OF SECTION

SECTION 10522 - FIRE EXTINGUISHERS AND ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Extent of fire extinguishers and accessories as indicated on Drawings and Schedule.

B. Types of products required include:

1. Fire extinguishers.
2. Mounting brackets.

C. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.02 DEFINITIONS

A. Fire Extinguishers: Refers to units which can be hand carried, as opposed to those which are equipped with wheels or to fixed fire extinguishing systems.

1.03 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Submit product data for each type of product included under this Section.

2. Submit samples of each required finish for verification purposes. Prepare samples on metal of same gauge as used for actual production run. Where normal color variations are to be expected, include two or more units in each sample set showing limits of such variations.

a. For initial selection of colors and finishes, submit manufacturer's color cards showing full range of standard colors available.

1.04 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain products under this Section from one manufacturer.

B. Codes and Standards:

1. UL Listed Products: Provide new, portable fire extinguishers which are UL listed and bear UL "Listing Mark" for type, rating, and classification of extinguisher indicated.

2. FM Listed Products: Provide new, portable fire extinguishers which are approved by Factory Mutual Research Corporation for type, rating, and classification of extinguisher indicated and carry appropriate FM marking.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

1. Fire Extinguishers and Accessories:

a. Amerex Corporation.
b. Badger Fire Protection.
c. J.L. Industries.
d. Kidde Frynetics.
e. Larsen's Manufacturing Co.
f. Potter Roemer, Div. of Smith Industries, Inc.

2.02 FIRE EXTINGUISHERS

A. Portable fire extinguishers shall be purchased, certified, and installed by a local supplier who has a maintenance contract on OWNER's existing installation, or can provide such a contract if none exists. Provide fire extinguishers for each extinguisher cabinet and other locations indicated, in colors and finishes selected by ENGINEER from manufacturer's standard, which comply with requirements of governing authorities. The fire extinguishers shall have a minimum 1-year warranty and shall include inspection and recharging at end of 1 year.

1. All units shall comply with Underwriter's standards. Valves shall be aluminum or brass.

2. Extinguishers shall be red in color to conform to OSHA standards, sized as noted on Fire Extinguisher Schedule appended, and shall be made of all metal for tank, valve, and valve stem.

3. Extinguisher shall be mounted with wall-mount bracket unless cabinets are called for on Fire Extinguisher Schedule.

4. Fill and service extinguishers to comply with requirements of governing authorities and manufacturer's requirement.

5. Abbreviations indicated below to identify extinguisher types relate to UL classification and rating system and not necessarily to type and amount of extinguishing material contained in extinguisher.

B. Multi-Purpose Dry Chemical Type: UL-rated 4-A:60-B:C, 10-pound nominal capacity, in enameled steel container, for Class A, Class B, and Class C fires.

2.03 MOUNTING BRACKETS

A. Provide manufacturer's standard bracket designed to prevent accidental dislodgement of extinguisher, of sizes required for type and capacity of extinguisher indicated in manufacturer's standard plated finish.

1. Provide brackets for extinguishers not located in cabinets.

2. Provide brackets for extinguishers not located in cabinets and for those located in cabinets, where indicated or required.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install items included under this Section in locations and at mounting heights indicated, or if not indicated, at heights to comply with applicable regulations of governing authorities.

1. Securely fasten mounting brackets to structure, square and plumb, to comply with manufacturer's instructions.

2. Where exact location of surface-mounted bracket-mounted fire extinguishers is not indicated, locate as directed by ENGINEER.

3. Mount bracket-mounted fire extinguishers weighing 40 pounds or less at 4’-6” above finish floor to the top of the fire extinguisher; for those weighing more than 40 pounds, at 3’-6” above finish floor to the top of the fire extinguisher.

3.02 IDENTIFICATION

A. Identify bracket-mounted extinguishers with red letter decals spelling "FIRE EXTINGUISHERS" applied to wall surface. Letter size, style, and location as selected by ENGINEER.

FIRE EXTINGUISHER SCHEDULE

Room No.	Location	Bracket	Cabinet	Type and Quality				Remarks
				Clean Agent 2A-10BC	Dry Chemical 4A-60BC	CO_2 10BC-15	Water-Mist 2A-C	
	Refer to Life Safety Plans for quantity and location of fire extinguishers.	X			X			

END OF SECTION

SECTION 11226 - WEIRS AND BAFFLES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Labor, materials, and equipment necessary for furnishing the fabrication, production, installation, or erection of the items specified in this Section as shown on Drawings or listed on Schedule.

B. Related Sections: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.02 REFERENCE STANDARDS

A. Reference Standards:
   1. ASTM D 638 Ultimate Tensile Strength.
   2. ASTM D 790 Flexural Strength and Flexural Modulus of Elasticity.
   3. AWWA F102. Match Die Molded Fiberglass Reinforced Plastic Weir Plates, Scum Baffles and Mounting Brackets
   4. SSPC-SP-10 Sandblasting.
   5. USTT-S-230a Sealants.

1.03 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. General arrangement Drawings.
   2. Dimensional Drawings.
   3. Fiberglass-reinforced plastic product data.
   4. Materials of construction.
   5. Support, anchorage details.

B. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage:
   1. Care should be taken during storage and installation of the baffles to protect them from environmental extremes and from highly concentrated loads.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Weirs and Baffles:
      a. AK Steel / Armco.
      b. Enduro
      c. Fiberglass Fabricators, Inc.
      d. ITT / F.B. Leopold Company, Inc.
      e. NEFCO
      f. Ryerson.
      g. Warminster Fiberglass Company.
      h. MFG Water Treatment Products Company.
   2. Caulking:
      a. Williams Products – Dyna Seal.
      b. Sika - Sikaflex 1a.
      c. Tremco Sealants / Mameco - Vulkem 45 or 230.

2.02 MATERIALS

A. Weir Plate: Fiberglass-reinforced polyester.

B. Face Plates: Shall be provided as specified on drawings.

C. Fasteners: Non-magnetic stainless steel.

D. Anchor Bolts: Non-magnetic stainless steel.

E. Caulking Material: Single component polyurethane.
   a. Caulking material shall meet U.S. Specification with a 20-year minimum life expectancy and 10 years of proven performance.

F. Where weirs or baffles are of nonstandard length or nonstandard mounting hole configuration, such machined or cut edges shall be resin-sealed.

G. All edges shall be molded and sealed in the mold with no glass fibers exposed.

H. Minimum physical properties shall conform to AWWA Standards.

2.03 GRIT TANK WEIR

A. Weirs should be manufactured to the ANSI/AWWA F102 Standard for matched die-molded fiberglass-reinforced plastic weir plates and mounting brackets.

B. Weirs shall be 1/4-inch nominal thickness and have provisions for vertical and horizontal adjustment.

C. Fiberglass-reinforced plastic washers and butt or splice plates large enough to prevent short circuiting of the flow shall be provided. Provide O-ring rubber gaskets as necessary.

PART 3 - EXECUTION

3.01 ERECTION

A. Weirs and baffles shall be installed as detailed in the documents and as recommended by manufacturer.

B. Weirs shall be level within 0.0625 inch and shall be within 0.5 inch of the elevations noted on Drawings.

C. Baffles shall be adjusted to form a straight line or a true circle and shall project 3 inches above liquid surface.

D. Fasteners shall be loose enough to allow for expansion and contraction of weir and scum baffle in clarifier tank.

3.02 FIELD QUALITY CONTROL

A. Once weirs and baffles are installed, CONTRACTOR shall provide sufficient manpower to assist ENGINEER in verifying the tolerances specified. These verifications will be done with full tanks to simulate operating conditions. CONTRACTOR shall perform required adjustments as necessary.

WEIR SCHEDULE

Mark No.:	W.100.1 through W.100.2
Location:	Battery B Grit Tanks
Type:	FRP
Quantity:	2
Weir Plate Setting Elevation:	719.47
Straight Wall Installation:	Yes
Weir and Face Plate:	
A:	13’-0”
B:	0-6”

END OF SECTION

SECTION 11285 - HYDRAULIC GATES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Labor, materials, and equipment necessary for furnishing the fabrication, production, installation, or erection of the items specified in this Section as shown on Drawings or listed on Schedule.

B. Products Furnished But Not Installed Under This Section: Wiring to motor operators and limit switches shall be done under Division 16.

C. Items furnished under this Section shall be erected under Section 15100. Mechanical joint gaskets for gates shall be furnished and installed under Section 15100.

D. Anchor bolts shall be installed Division 3 in accordance with certified prints furnished by equipment manufacturer.

E. Related Sections: Drawings and general provisions of the Contract, including General and Supplemental Conditions and Division 1 Specification Sections, including Section 01600, apply to Work of this Section.

1.02 REFERENCES

A. ASTM References:
1. A 126 Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. A 276 Stainless Steel Bars and Shapes.
3. A 304 Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements.
4. A 582 Free-Machining Stainless Steel Bars.
5. B 21 Navel Brass Rod, Bar, and Shapes.
6. B 98 Copper-Silicon Alloy Rod, Bar, and Shapes.
7. B 209 Aluminum and Aluminum-Alloy Sheet and Plate.
8. B 308 Aluminum-Alloy 6061-T6 Standard Structural Shapes, Rolled or Extruded.
9. B 584 Copper Alloy Sand Castings for General Applications.

B. ANSI References:
1. B 16.1 Cast Iron Pipe Flanges and Flanged Fittings.

C. AWWA References:
1. AWWA/ANSI C501 Sluice Gates.

1.03 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Each gate, including accessories, shall be identified on Shop Drawings by its respective mark as noted on Gate Schedule.

B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.

C. Warranty: Submit in accordance with Section 01770, warranties covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the specified requirements, manufacturers offering products which may be included in Work include:
   1. Rectangular Butterfly Valve or Gate (RB)
      a. Henry Pratt
      b. Hydrogate
   2. Sluice Gates:
      a. Hydro Gate.
      b. Rodney Hunt.
      c. Waterman.
   3. Fabricated Stainless Steel Slide Gates:
      a. Hydro Gate.
      b. Rodney Hunt.
      c. WACO
      d. Waterman.
      e. Whipps Inc.
   4. Fabricated Stop Plates:
      a. Golden Harvest
      b. Hydro GateHydro Gate.
      c. Rodney HuntRodney Hunt.
      d. WACO
      e. Whipps Inc.
   5. Electric Motor Open-Shut Service Operators:
      a. Rotork.
   6. Electric Motor Operators for Throttling Service:
      a. Rotork.

2.02 COMPONENTS

A. Rectangular Butterfly Valves (RB):
   1. Rectangular butterfly valves shall be resilient seated and shall be bubble tight at rated pressures with flow in either direction.
   2. Valve design shall be rated for 10 psi working pressure and 15 psi test pressure. They shall be satisfactory for applications involving throttling service through the entire range of flow – open to closed. Valves shall withstand frequent operations and for applications involving valve operation after long periods of inactivity.
   3. Valve discs shall rotate 90 degrees from the full open position to the tight shut position.
   4. When subjected to the maximum design head, a stress safety factor of 3.0 on the yield point or 5.0 on ultimate strength, whichever is lower, shall not be exceeded.

5. Valve Bodies: The valve body shall be fabricated of ASTM A36 carbon steel. Upper trunnion shall be recessed bored for Chevron packing.
6. Valve Disc:
    a. The valve disc shall be fabricated of ASTM A36 carbon steel.
    b. Seating edge shall be Type 316 stainless steel and shall be ground, polished and contoured.
    c. Disc shall be streamlined in shape to prevent turbulence in the full open position and to minimize pressure drop across valve.
7. Valve Seat:
    a. The resilient valve seat shall be contained in the body of the valve. A seating face shall be furnished around the periphery of the disc.
    b. Resilient valve seats shall be resilient natural rubber or synthetic rubber Buna N. Seating face shall be type 316 stainless steel.
    c. Retaining screws shall be of Type 316 stainless steel.
    d. Seat adjustment possible and inherent in the design shall not be less than 1/8 inch and be fully field adjustable and replaceable without dismantling operator, disc or shaft. No special tools shall be required for this operation.
8. Valve Shafts:
    a. Valve shafts shall be the stub type with shafts extending into the disc for a minimum distance of at least 1.5 shaft diameters.
    b. Shafts shall be securely locked to the disc by Type 316 stainless steel taper pins.
    c. A shaft seal shall be provided where the valve shaft projects through the body for the actuator connection. The seal shall be of a type utilizing a stuffing box and packing gland, so that the packing can be adjusted or completely replaced without disturbing any part of the valve or actuator assembly. Packing shall be of the graphite impregnated, lattice braid square type, as approved by the Engineer.
9. Valve Bearings:
    a. Main shaft bearings shall be self-lubricated sleeve type fitted into each valve body trunnion bore. Unit bearing stress shall not exceed 4000 psi.
    b. Each valve assembly shall be furnished with a two-way thrust bearing assembly designed to hold the disc centered in the valve seat at all times.
    c. Thrust bearing shall be secured by locking device and easily accessible for field adjustment from operator end of the valve.
10. Valve Operators: Valve operators shall be motor actuated with manual over-ride as specified in this Section of the Work.

B. Sluice Gates (S):
1. Sluice gates shall meet the requirements of AWWA C501 and be furnished complete including gate, thimble, rubber gasket, mounting hardware, anchor bolts, and appurtenances as listed on Schedule or shown on Drawings.
2. Sluice gates shall be furnished with ASTM A 126, Class B, cast iron items, seating faces made of strips of ASTM B 21, Alloy A or B, extruded bronze, wedges, thrust nut, lift nut, or stem block, and stem couplings shall be ASTM B 584, Alloy 8A or B 584, Alloy B bronze. Assembly bolts, unless otherwise noted, shall be bronze per ASTM B 98 Alloy A, B, or D. Studs, nuts, anchor bolts, and stems shall be ASTM A 276,304, or ASTM A 582-303 stainless steel. Holes shall be made by drilling.
3. Sluice gate reinforcing ribs shall be designed to uniformly distribute wedge pressure and shall consist of a horizontal rib terminating at each wedge or heavy vertical ribs located along each side of the gate.
4. The seating face shall be mounted in full width dovetail slots and held in position without use of screws or other fasteners. After mounting, the seating faces shall be machined to a plane with a

32 micro-inch finish, or better. When the slide is in the fully closed position and wedged into position against the frame, the maximum clearance between seating faces shall not exceed 0.004 inch.

5. The side wedges shall be a tongue and groove type assembly, solid cast bronze, and keyed to the cast iron pads to maintain true alignment by preventing undesirable rotation or lateral movement. The wedge shall be attached to the slide by means of a bronze stud, hex nut, and washer. Top and bottom wedges shall be solid cast bronze, nonrotating, adjustable with a locking device, and attached to the frame with two stainless steel fasteners. Mating and contact faces on wedging devices shall be fully machined. Wedges shall be located at corners and at disc stiffeners as required. Top and bottom wedges are not required on gates below 8 feet unseating head.
6. Normally, Type "F" wall thimble shall be furnished for mounting sluice gates. Type "E" wall thimbles shall be furnished if recommended by the manufacturer for high unseating pressures. Special wall thimbles shall be furnished if noted on Schedule. A center ring water stop shall be around the periphery of the thimble. The front face of the thimble shall be machined, and holes drilled and tapped to attach the gate. Cored holes will be allowed only if specifically shown on Drawings.
7. Stem sizing must be designed to accept the maximum thrust of the operator based on 100 foot-pounds being applied to the operator. Stem size in conjunction with bronze bushed stem guides shall limit the L/r ratio to 200 maximum. Stems of more than one section shall be jointed by bronze or stainless steel, couplings threaded and keyed to the stems. The contact surface of the stem threads shall be machined to a plane with a minimum 32 micro-inch finish or better.
8. Operators shall be as specified herein and shown on Schedule.

C. Fabricated Stainless Steel Slide Gates (F):

1. Fabricated stainless steel slide gates shall be furnished complete including appurtenances as listed on Schedule or shown on Drawings.
2. Gate mounting shall be with guides embedded in the concrete or with frames mounted on the face of concrete as shown on Drawings.
3. Slide gates shall have assembly bolts, studs, nuts, stems, and anchor bolts of stainless steel.
4. The guides shall be of structural stainless steel. The guide shall be designed for maximum rigidity and shall be provided with keyways to lock into the concrete where it is to be embedded. Drilled holes shall be provided in the guide where it is to be bolted to the concrete wall. The guides shall be sufficiently strong so that where the guide extends above the operating floor to support the hoisting yoke, no further reinforcing shall be required.
5. The resilient seal may be mounted on the disc or the frame as per manufacturer's standard.
6. On self-contained stainless steel slide gates, the yoke shall be formed by 2 angles welded or bolted by not less than 2 bolts at the top of the guides. The arrangement of the yoke shall be such that the disc and stem can be removed without disconnecting the yoke.
7. The disc or sliding member shall be 316 stainless steel plate, with minimum thickness of 1/4 inch, reinforced with stainless steel structural members which shall be welded to the plate. The disc shall be designed so that it will not deflect more than 1/360 of the span of the gate under the designed head.
8. A specially molded resilient seal shall be mounted on the gate disc or gate frame as per manufacturer's standard for flush bottom closure. The vertical face of the seal shall be in contact with the seating surface of the guide to provide a proper seal at the lower corners.
9. Attaching bolts and anchor bolts are to be furnished by the slide gate manufacturer.
10. Where the fabricated stainless steel slide gates are to lower to open to be used as weirs, there shall be a stainless steel angle welded to the guide across the invert and up both sides for the full height of the opening. A hollow-built J-seal will be attached to this angle with stainless steel

strips and attaching screws. The seal shall be placed so that it is compressed a minimum of 1/16 inch by the disc. The gate guides shall be extended below the invert to contain the disc in the fully lowered position.

11. Stems shall meet the requirements as outlined under Sluice Gates.
12. Operators shall be as specified herein and as shown on Schedule.

D. Fabricated Stop Plates (SP):
   1. Stop plates shall be provided complete including appurtenances as listed on Schedule or shown on Drawings.
   2. Plate mounting shall be with guides embedded in the concrete or with frames mounted on the face of concrete as shown on Drawings.
   3. Stop plates shall be fabricated of aluminum orstainless steel, as noted on Schedule. They shall meet or exceed the quality of material, workmanship, design strength, and performance requirements of the Specifications set forth for Fabricated Slide Gates insofar as they are applicable to construction of stop plates.

2.03 ACCESSORIES

A. Operators:
   1. Operators shall be designed with a safety factor of 5 for torsional and shear stresses. The operating mechanism shall be so located and so designed that parts subject to maintenance shall be easily accessible.
   2. Manual operators shall be so sized that a maximum of 80 pounds of rim force per pull is required for operation.
   3. Positions of operators shall be approved by ENGINEER.
   4. Gate shall be made to open when turned to the left or counterclockwise.
   5. The direction of the operator to open position shall be indicated on the operator.
   6. Bevel Gear: Bevel gear activators shall provide vertical mounting of the handwheel. Handwheels shall be included.
   7. Crank/Handle: Cranks shall be cast iron with a rotating brass grip. They shall be a maximum of 15 inches in length and keyed to the operator nut.
   8. Chainwheel: Chainwheels shall be cast iron and furnished complete with chain and guides. Chain shall be galvanized and shall be looped to extend to within 4 feet of the floor below the valve.
   9. Handwheel: Handwheels shall be fabricated steel. They shall be a maximum of 30 inches in diameter and keyed to the operating nut.
   10. Wrench Head: Wrench heads shall be cast iron with set screw. They shall be furnished for wrench nuts except where extension stems or T-handle wrenches are required.
   11. Wrench Nut: Wrench nuts shall be provided with a 2-inch operating nut when a T-handle wrench or extension stem is required. Other wrench nuts shall be furnished with a wrench head.

B. Motor Operators:
   1. Electric Motor Open-Close Service:
      a. Electric motor operators for open-shut service shall meet the requirements of AWWA C501 Motor-Operated Lift Mechanisms except as hereinafter specified.
      b. Controls shall be either "integrally mounted" or separated in a "wall-mounted" enclosure. The type to be supplied will be designated on Schedule. Deviations from Schedule will not be accepted.
      c. Electrical equipment shall be mounted in a NEMA 4 enclosure, unless shown otherwise on Schedule.

d. Motorized gate operators shall include the motor, reversing starter with remote-local switch, associated gearing, limit switches, torque switches, auxiliary handwheel for manual operation, a mechanical dial position indicator, open-close-stop push-buttons, and accessories as listed on Schedule.
e. Motorized gate operators scheduled with "wall-mounted" controls shall include the motor, reversing starter and remote-local switch mounted in the valve body or the wall-mounted enclosure at the manufacturer's option, associated gearing, limit switches and torque switches mounted in the valve body, auxiliary handwheel for manual operation, a valve-mounted mechanical dial valve position indicator, the wall-mounted control enclosure, and accessories as listed on Schedule.
f. The wall-mounted control enclosure shall include gate "open" (amber) and "closed" (green) indicating lights, a remote-local switch even if there is a remote-local switch at the gate body, open-stop-close push-buttons and a terminal strip to accept incoming and outgoing wires.
g. Wires shall be tagged at each end of the wire with individual wire markers. Each terminal of the terminal strips shall be numbered and identified with a marker. Schematics shall be provided with Shop Drawings showing wire numbers, terminals, field wiring, etc. Connections for remote equipment shall be wired to terminal blocks. Equipment shall be factory wired and tested before shipment.
h. The motor starters shall be the reversing contactor type complete with gang-operated switch, two mechanically interlocking reversing contactors, 120 volt control power transformer when motor voltage is other than 120 volt, thermal overload protection for each phase, and associated wiring.
i. Limit switches shall be provided at the extreme open and close position of the operator travel. At least 2 independent switches at each end of motor travel shall be provided as standard for the local indicator lights and interlocking. An additional 4 switches shall be provided for remote use.
j. Torque switches shall be provided in both the open and closed circuits of the operators. The torque switches shall be field adjustable and designed to stop the operator motor when the torque exceeds safe limits for either the operator or the gate. An electrical or mechanical interlock shall be provided to prevent the open torque switch from tripping when unseating a torque-seated valve.
k. A local mechanical dial position indicator shall be provided on the gate operator to indicate the position of the gate.
l. Motors shall be standard duty rated, totally enclosed nonventilated, Class B insulated, 60 hertz with voltage and phase as noted on Schedules, especially designed for gate service. The design shall combine low inertia with a high starting and stalling torque. The motors shall be sized to operate the gate slide at a rate of 10-12 inches per minute under the full specified unbalance operating head stated on Specifications. The motor winding temperature rise shall be NEMA standard for Class "B" insulation at the rated service factor load.
m. Gear case shall be cast iron. Pedestals shall be fabricated steel or cast iron. Stem nut shall be high-tensile bronze.
n. Mechanical emergency operation in event of power failure shall be provided by a clutchable handwheel drive mechanism completely independent from the motor gearing. Hand operation shall be direct drive permitting fast manual gate operation. Failure of motor gearing shall not prevent emergency handwheel operation. Manual operation shall prevent (disconnect) electrical operation.

2. Electric Motor Throttling Service:
    a. Electric motor operator for throttling service on the gates shall meet the requirement of AWWA C501 Electric Operators except as herein specified. Enclosures shall be NEMA 4 unless shown otherwise on Schedule.
    b. The housing and covers shall be of cast aluminum or cast iron. Mechanical parts shall be designed for safety factor of at least 2. Construction of the operator shall be such that it may be mounted in any position required to facilitate manual operation. Manual operation of the gates shall be possible by a handwheel attached to the mechanism. Power to motor circuit shall be automatically disconnected to prevent accidental electric operation during manual operation. A mechanical dial position indicator shall be provided to continuously indicate valve position. Operator bearings shall be self-lubricating type or lubricated for life before operator is sealed at the factory.
    c. The operator motor shall be heavy-duty with continuous duty rating and totally enclosed and nonventilated. The motor shall be equipped with thermal overload protection.
    d. The power supplied shall be 115V single phase, 208V single phase, 230V single phase, 208/230V 3-phase, or 460V 3-phase, plus or minus 10 percent at 60 hertz as shown on Schedule. The motor supplied shall conform to the voltage specified.
    e. The winding temperature rise shall meet NEMA standard for the class of insulation used at the rated service factor load. The motor shall be for high-torque, variable-speed duty. The motor shall be reversible. A 4-20 mA throttling signal shall be provided by others. Control interface electronics, motor controller, and appurtenances to accept this signal and position the gate between 0 and 90 degrees, based on the value of the throttling signal, shall be provided with the gate operator. The controller shall be provided complete with NEMA 4 enclosure, auto-manual selector switch, and open-close push-buttons. Controller shall be completely solid state; contactors are not acceptable. Motor and controller shall be suitable for over 1,000 starts per hour. Controllers shall accept an isolated 4-20 mA signal for gate positioning from a remote source.
    f. The gear train shall be pre-selected to have open-close operating time from 1-3 minutes as shown on Gate Schedule.
    g. Limit switches shall be provided at the extreme open and close position of the operator travel. At least two independent switches at each end of motor travel shall be provided as standard for a local indicator and interlocking. An additional switch shall be provided at each end for remote use.
    h. Motor circuit limit switches shall be of the direct-break type. Limit switches shall be adjustable. Limit switch contacts shall be isolated. Auxiliary switches for secondary functions shall be of the cam-operated, spring-leaf type. The operator shall be equipped with a torque switch for protection in the closing direction. An electrical or mechanical interlock shall be provided to prevent the open torque switch from tripping when unseating a torque seated valve. In the event of power failure, the operator shall lock in the last control position until power is restored or switched over to standby power, or the manual operating handwheel is engaged.
    i. Torque switches, limit switches, and motor thermal switches are to be mounted as required inside the housing and connected to the master terminal strip. Provisions shall be made for 2 internal potentiometers for feedback on control operations. Wiring within operator shall be incorporated in a standard laced wiring harness using compression connectors and terminal strips. Internal wiring shall be UL approved for 105 degrees C operation. Insulation shall be suitable for 600 volts.
    j. Wires shall be tagged at each end of the wire with individual wire markers. Each terminal of the terminal strips shall be numbered and identified with a marker. Schematics shall be provided with Shop Drawings showing wire numbers, terminals, field wiring, etc.

Connections for remote equipment shall be wired to terminal blocks. Equipment shall be factory wired and tested before shipment.

C. Miscellaneous:
   1. One complete set of wrenches, spanners, and other tools necessary for the adjustment and dismantling of the equipment shall be furnished. Standard open end and pipe wrenches need not be included among these tools, but socket wrenches and offset wrenches, which can be used to better advantage than standard open wrenches, shall be included among the tools to be furnished with the equipment.
      a. Wrenches and spanners shall be case-hardened steel forgings and shall have a bright finish with working faces dressed to fit nuts.
      b. The gate shall be shipped as fully assembled as is practicable.
      c. The shipping crates shall be provided with skids and lifting devices for crane slings.
      d. Devices not attached to the gate during shipment shall be packed in boxes and properly labeled for assembly. Such equipment shall be shipped machined and fitted. No machining of parts in assembly shall be required.
   2. Bench Stand: Bench stands shall meet the requirements of floor stands as herein specified, except that baseplates shall replace pedestals.
   3. Extension Stem/Shaft (Length): Extension stems shall be 304 or 303 stainless steel with bronze couplings. Stems of more than one section shall be jointed by bronze couplings threaded and keyed to the stems. Extension stems shall have a 2-inch wrench nut end connection for T-handle wrench operation.
      a. Extension shafts shall be 304 or 303 stainless steel with universal joint couplings.
   4. Floor Stand:
      a. Floor stands shall meet the requirements of AWWA C501 for Manual Operating Mechanism except as herein specified.
      b. Floor stands shall be a high-strength cast iron pedestal type furnished with lubrication fittings and stainless steel, double-nutted anchor bolts.
      c. Geared floor stands shall have weatherproof housings.
      d. Floor stands shall be provided with a galvanized steel stem cover and position indicator, and the direction of rotation to open the gate shall be indicated.
      e. The operating stem will be 304 or 303 stainless steel. On aluminum gates the stem shall be connected to the disc by means of an aluminum angle connection, threaded and bolted for the stem and welded to the disc.
      f. A sleeve made from standard-weight galvanized steel pipe shall be provided for the opening in the floor beneath each operating stand.
      g. Connections of stems to stainless steel or fiberglass gates shall be as per the manufacturer's recommendations.
   5. Position Indicator: Position indicators shall be of bronze or cast iron construction.
   6. Stem Cover: Stem covers shall be clear PVC with position indicators and cap.
   7. Stem Guide: Stem guides shall be cast iron ASTM A 126, Class B construction with bronze bushings adjustable in two directions and furnished with mounting assembly and anchor bolts of stainless steel. The minimum thickness of any portion shall be 1/2 inch.
   8. Wall Bracket: Wall brackets shall be cast iron and furnished with stainless steel assembly and anchor bolts.

2.04 GATE SCHEDULE KEY

A. The Gate Schedule provided on Drawings gives the designation for each gate, its location, service size, quantity, and other pertinent data.

B. The distance given with extension stems or shafts is that from centerline of port to top of floor at floor stand or floor box, or from centerline of port to ground surface for valve box.

C. In general, no gates smaller than 4 inches are included on Schedule.

D. Unless otherwise noted on Schedule, stems shall be of the rising type for gates, service use shall be open-shut; motors shall be 230/460 volt, 60 cycle, 3-phase AC; and enclosures shall be NEMA 4.

E. Included in the remarks column will be exceptions to class, stem, service, motor, and motor enclosure requirements, etc.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operation condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer approved by ENGINEER.

B. Equipment furnished under this Section shall be installed under Section 15100, in accordance with procedures specified there.

3.02 FIELD QUALITY CONTROL

A. Installation: Special attention shall be given by CONTRACTOR to ensure that items furnished under this Section of the Work are installed in accordance with manufacturer's recommendations.

3.03 EQUIPMENT INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the manufacturer shall visit Site of Work a minimum of 1 trip, to inspect, check, adjust if necessary, set limit and torque switches, and approve the equipment’s installation. The equipment supplier’s representative shall revisit Site as soften as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to ENGINEER.

B. Manufacturer’s representative shall provide all necessary tools and testing equipment required including noise level and vibration sensing equipment.

C. Each equipment supplier’s representative shall check the equipment installation and furnish to OWNER, through ENGINEER, a written report certifying that the equipment:
   1. Has been properly installed and lubricated;
   2. Is in accurate alignment;
   3. Is free from any undue stress imposed by connecting conduit or anchor bolts;
   4. Limit and torque switches have been set;
   5. Verify wiring connections, remote control, and remote control indication feedback.
   6. Has been operated under full load condition and that it operated to the satisfaction of ENGINEER;

7. That OWNER's Representative has been instructed in the proper maintenance and operation of the equipment; and
8. Furnish OWNER through ENGINEER a copy of all test data recorded during the installation check.

3.04 OPERATION AND MAINTENANCE TRAINING

A. Provide services of manufacturer's service representative to instruct OWNER's personnel in operation and maintenance of equipment. Training shall include start-up and shutdown, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance.
   1. Manufacturer's representative shall provide 1 day, 8 hours, on-site training.
   2. Review operating and maintenance data contained in the operating and maintenance manuals.
   3. Schedule training with OWNER, provide at least 7-day prior written notice to ENGINEER after approved O&M manuals have been reviewed and accepted.

END OF SECTION

SECTION 11322 - DEGRITTING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Labor, materials, and equipment necessary for fabrication, production, installation, and erection of the items specified in this Section as shown on Drawings and listed on Schedule.
   1. The responsibility of furnishing a completely functioning Grit System is by the Grit System Supplier. The complete Grit System shall include grit hydraulic concentrator equipment, grit pumps, grit washer and classification unit, grit dewatering escalator, and all ancillary equipment as required and recommended by Grit System Supplier for a complete and functional system meeting the requirements of the Contract Documents.

B. Related Sections: Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections and the following sections apply to the Work of this Section.

1.	Section 05500	Metal Fabrications
2.	Section 05520	Handrails and Railings
3.	Section 05530	Grating

C. Products Furnished But Not Installed Under This Section: Anchor bolts shall be installed under Div 3, in accordance with certified prints furnished by equipment manufacturer.

D. This is a performance specification. System conditions and locations are identified in this Specification. The manufacturer is solely responsible for the design of the system including all materials of construction, to meet the required conditions. The design parameters indicated in this section are minimum requirements and shall not be construed as the ENGINEER assuming design responsibility or liability. If any of these specified parameters are incompatible with the manufacturer's design or specified operating conditions, it shall be the responsibility of the manufacturer to promptly inform the OWNER and ENGINEER in writing. In the event the manufacturer cannot achieve the performance requirement the OWNER will reject the equipment. The manufacturer is responsible for meeting or exceeding the design parameters indicated within this Contract.

1.02 REFERENCE STANDARDS

A. Reference Standards:
   1. AFBMA Standards
   2. AGMA Standards
   3. AISC Standards
   4. ANSI B-16.1
   5. ASTM A 36
   6. ASTM A 48
   7. ASTM A 53
   8. ASTM A 167
   9. ASTM A 240

10. ASTM A 276
11. ASTM A 312
12. ASTM A 479

1.03 SYSTEM DESCRIPTION

A. System shall consist of the following components:

1. Grit concentrator mounted in a concrete tank (Eutek HeadCell): The Grit Concentrator unit uses stacked trays mounted in a concrete tank. Flow enters the distribution box and enters each tray. This flow is introduced at the tangential to the stacked trays to create a vortex flow path in the tray/tank. The Grit Concentrator shall provide sufficient surface area to remove the specified grit particles from the specified peak flow and other flows listed on the schedule. These stacked trays shall concentrate the grit in a sump at the bottom of the unit. The de-gritted effluent from the Grit Concentrator shall be weir discharged as shown on the drawings.

   The Grit Concentrator shall be all-hydraulic, self-activating and shall not require internal moving parts.

   The Grit Concentrator technology shall be designed utilizing Computational Fluid Dynamics (CFD) and field data to verify its flow regime, headloss and grit removal characteristics.

2. Grit Pump: The Grit Pump shall convey the concentrated grit slurry from the underflow of the Grit Concentrator to the Grit Washing / Classification unit.

3. Grit Washing and Classification Unit (Eutek Slurry Cup): The Grit Washing / Classification unit shall receive the underflow from the Grit Concentrator. The unit shall be mounted above and discharge the concentrated and washed grit slurry to the Grit Dewatering Escalator. The de-gritted overflow shall be discharged upstream of the Grit Concentrator.

4. Grit Dewatering Escalator (Eutek Snail): The Grit Dewatering Escalator shall receive the underflow from the Grit Washing / Classification unit and allow the washed grit to settle in the integral clarifier. A slow moving belt shall carry the grit to the point of discharge allowing it to dewater during transport. The de-gritted overflow shall be discharged upstream of the primary grit removal equipment.

5. Control Valves and Accessories

6. Control Panels and Controls Logic Programming
   a. The manufacturer control panel shall be supplied with a Rockwell compact logix programmable logic controller and Hirshman ethernet switches for LAN and IO traffic. A panelview plus series 7 1500 touchscreen shall be supplied.
   b. The programmable logic controller, panelview and switch shall be programmed by the manufacturer for control of the manufacturer supplied equipment. Any signals needed for automatic operation shall be supplied over the fiber optic plant SCADA network. Coordinate with Tetra Tech for these signals to be delivered to the manufacturer's system for control and monitoring.

c. Turn over to OWNER and ENGINEER an electronic program copy for the panelview and PLC. Coordinate with OWNER and ENGINEER on software versions to use for the PLC programming software and the panelview plus software.
d. Coordinate IP addresses with OWNER and ENGINEER.
e. Integration of these manufacturer programmed systems to the existing plant-wide SCADA system shall be by Tetra Tech.
f. An on-line UPS shall be provided for powering the PLC, the panelview, and ethernet switch.
g. Refer to system configuration drawing I-100 for additional information and requirements. Provide copper and fiber patch cables as shown. Provide surface mounted fiber optic patch panel with ports and bulkheads as shown.
h. Variable frequency drives shall be supplied in separate enclosures and meet the requirements of specification section 16422. Variable frequency drives provided shall be Rockwell Powerflex 753 series or Schneider Electric Altivar Process 600 series. Provide with MTE Matrix AP input filter and output DV/DT filter for each drive. Control panel to be provided with transient voltage surge protection on the 480V 3 phase input.

7. Refer to the wiring diagrams on the electrical drawings and to the instrumentation system configuration for additional requirements to be provided.

1.04 DESIGN AND PERFORMANCE REQUIREMENTS

A. Grit system shall remove grit meeting all the required efficiencies listed on Schedule. Grit removal is defined as particles having specific gravity of 2.65 or greater and size for capture by mesh sizes indicated per schedule. Grit shall be discharged from the classifier in low moisture condition.

B. Grit system hydraulics recommended by the manufacturer shall be optimized for the current layout, the flow rates listed on the schedule, grit removal efficiencies listed on the schedule, and the position of the downward opening weir at the end of the grit tank channel.

C. Grit pump shall be provided by Grit System Supplier. Grit pump requirements shall be recommended by Grit System Supplier and shall meet all minimum requirements on the Schedule. Grit pump type shall meet all requirements listed in this Specification.

D. All equipment shall be provided by Grit System Supplier. Contractor to provide piping, electrical wiring, and conduit as recommended by Grit System Supplier. Contractor to install all equipment. All conduit, wire, and sensors may not be listed or shown in the Contract Documents. Contractor shall coordinate any additional conduit, wire, and sensors with Grit System Supplier.

E. Electrical and Instrumentation shall include all motor starters, transformers, relay control, control panel, instrumentation, and associated components shall be provided.

F. Grit System Supplier shall be responsible for coordinating the installation of all 480V, 115V, and control wiring to all pumps, equipment, components, controllers, and other accessories of the system for a complete operational system.

G. All equipment at the grit tanks and in the dumpster area for the grit classifiers shall be rated NEMA 7, Class 1, Division 2, Groups C & D. All equipment at the grit tanks that is within 5 feet above the tanks high water level shall be rated NEMA 7, Class 1, Division 1, Groups C&D.

H. All equipment in the grit pump room shall be rated NEMA 4X.

1.05 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01300, Shop Drawings covering the items included under this Section.
   1. Dimensional general arrangement drawings.
   2. Submit grit concentrator/tank and weir hydraulic calculations for all flow rates listed on Schedule. All calculations shall include guaranteed removal efficiencies listed on schedule for the flow rates in the Schedule.
   3. Submit grit pump hydraulic calculations. Calculations shall include grit pump selection, cut sheets, pump curves, efficiencies, and equipment and piping layout.
   4. Submit complete layout drawings of grit concentrator/tanks, grit pump, grit pump piping suction and discharge piping, grit washing and classification unit, and grit dewatering escalator, and grit classifier drainage piping including all elevations and dimensions for the complete system.
   5. Piping schematics.
   6. Description of equipment provided as the complete Grit System and description of the operation of the Grit System.
   7. Manufacturer's catalog data and descriptive literature including equipment weights and performance data.
   8. Written recommended procedures for job site storage, handling, and installation of the equipment.
   9. Electrical and P&ID diagrams.
   10. Control panel, electrical and instrument component data.
      a. Interconnects to all components outside the panel
      b. Door layout
      c. Interior Panel layout
      d. Wiring diagrams
      e. PLC Hardware
      f. PLC address points for remote monitoring and control
      g. Panelview
      h. Transformers
      i. Circuit breakers
      j. Motor starters
      k. Control switches
      l. Relays
      m. Timers

B. Test and Inspection Report: A written report shall be submitted to Engineer documenting testing and/or inspection results. The report shall be prepared as noted in this Section.

C. Record Information/Drawings:
   1. At Project closeout, submit record drawings of installed products, in accordance with requirements of Section 01770.

2. Programming hardcopy and a CD including initial set point and startup settings.

D. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.

E. Warranty: Submit in accordance with requirements of Section 01770, warranties covering items included under this Section.

1.06 MAINTENANCE

A. Extra Materials:
   1. Provide one set for each grit system:
      a. 1 grit snail set of bearings
      b. 1 grit snail set of gaskets
      c. 1 grit snail scraper blade
      d. 1 slurry cup baffle

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. The grit equipment package shall be assembled by the Grit System Supplier. The equipment package provided by Grit System Supplier shall include all items listed under System Description and as listed in this specification. The Grit System package shall be the provided by the following manufacturer:
      a. Hydro International.
   2. Grit Pumps:
      a. Hayward Gordon – Torus Model
      b. Weir / Wemco, Model C.

2.02 MATERIALS

A. Grit Concentrator:

1.	Trays	LDPE
2.	Support Frame	304 Stainless Steel
3.	Grit Collector	304 Stainless Steel

B. Grit Pump:

1.	Casing	Ni Hard, ASTM A532 Class 1, Type D, minimum 650 Brinell hardness
2.	Impeller	Ni Hard, ASTM A532 Class 1, Type D, minimum 650 Brinell hardness
3.	Wear Plate	Ni Hard, ASTM A532 Class 1, Type D, minimum 650 Brinell hardness

C. Grit Washing and Classification Unit:

1.	Dished Heads	304 Stainless Steel
2.	Side Walls	304 Stainless Steel

D. Grit Dewatering Escalator:

1.	Housing	304 Stainless Steel
2.	Liner	Polyurethane
3.	Conveyor Belt	Two Ply Polyester Reinforced
4.	Cleats	Neoprene
5.	Cleat Hinges	Neoprene
6.	Scraper	HDPE

E. Access Platforms:

1.	Platforms, walkways, landing	Aluminum
2.	Ladders, stairs	Aluminum

2.03 EQUIPMENT AND COMPONENTS

A. General Requirements: Provide manufacturer's standard pre-engineered degritting system which will comply with or fulfill the requirements of Schedule sheets at the end of this Section. Where components are not otherwise indicated, provide standard components, published by manufacturer, as included in standard pre-engineered degritting systems and as required for a complete system.

B. Grit Concentrator:
1. The Grit Concentrator shall have a maximum surface loading rate of 23.4 gpm/square foot to ensure adequate surface area for settling and specified particle removal efficiency.
2. The Grit Concentrator shall be characterized by a controlled boundary layer flow to enhance settleable solids concentration and removal.
3. The Grit Concentrator shall be all-hydraulic consisting of self cleaning corrosion resistant, non-metallic trays with no moving parts within the unit.
4. All flow passages shall be self-cleaning and free of sharp projections or fittings that may snag stringy or fibrous materials.
5. Water shall be continuously supplied to the solids underflow sump.
6. Grit Concentrator trays shall be constructed with a minimum ¼ inch thick LDPE on the pans and sidewalls.
7. The stack of trays shall securely fit into a stainless steel support frame. The support frame shall fit and secure to the bottom of the grit tank.
8. A fluidizing ring mounted in the sump of the concrete grit tank and incorporate the flanged underflow and threaded fluidizing pipe connections.
9. All pipe flanges shall conform to ANSI B16.1 bolt patterns.
10. Valves and Accessories
    a. One (1) 2” bronze globe valve to regulate the system water flow rate to the grit collector
    b. One (1) 2” NEMA 7 brass solenoid valve to automate the fluidizing water supply
    c. One (1) 2” bronze ball valve for shut off
    d. One (1) 2” 20-80 gpm acrylic flow meter with 4-20 MA output.

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C. Grit Pumps:
1. Recessed impeller, vortex-type grit pumps shall be provided where shown on Drawings and listed on Schedule.
    a. Pump casings shall be 2-piece, vertically split type, with inlet designed so that impeller can be withdrawn without removing discharge casing and/or disturbing discharge piping. Casing shall be of suitable thickness for abrasive service.

b. Case thickness shall be minimum of 1/2 inch for 3-inch pump, 3/4 inch for 4-inch and 6-inch pumps, and 7/8 inch for 8-inch pump with normal casting tolerances. Removable suction piece shall have a minimum thickness of 1 inch for 3-inch pump, 1-1/4 inches for 4-inch pump, and 1-1/2 inches for 6-inch pump, with normal casting tolerance at the area of maximum wear.

c. Pump shall be completely open from suction to discharge with no wearing rings or impeller faceplates required. Internal clearances shall be equal to the discharge diameter so that all material which will pass through the discharge will pass through pump.

d. Impeller shall be recessed. Impeller shall be mounted completely out of flow path between pump inlet and discharge connections so that the solids pumped are not required to flow through the impeller. Impeller shall be keyed to tapered shaft, secured by impeller bolt and locked against reverse rotation. Impeller shall be of radial vane design such that blade ends are surrounded by integral rim, which direct flow to center of volute, minimizing particle impact and reducing wear and degradation.

e. Removable wearplate shall be provided back of impeller and be designed to direct flow from behind impeller to center of volute for maximum protection to the casing.

f. Shaft shall be protected through packing area by a removable chrome-plated steel shaft sleeve.
   1) Stuffing box shall contain Two independently mounted mechanical face type seals.
   2) The oil chamber shall act as a barrier to trap moisture and provide sufficient time for a planned shutdown. The oil shall also provide lubrication to the internal seal
   3) Standard Bergman, U/L approved seals shall be provided. The inner seal shall be provided with carbon rotating face and ceramic stationary face. The outer seal shall be provided with a solid tungsten carbide rotating face and a silicon carbide or tungsten carbide stationary face
   4) The outer seal construction shall be designed for easy replacement.
   5) The outer seal assembly will be designed to allow solids and particles to be thrown away from the seal face.

g. Bearings shall be grease or oil bath lubricated with oil reservoir sealed at either end to prevent entrance of foreign matter. The thrust bearings mounted back to back preceded by a single row angular contact ball bearing for maximum protection from all thrust loads. The bearing housing shall be equipped with a pressure venting device or grease relief port and an oil lubricated bearing furnished with oil fill, level, and drain taps.
   1) Bearings shall be selected to provide minimum L10 rating life of 17,500 hours
   2) The motor shall be designed to limit the bearing temperature rise to a maximum of 60^{o} C under full load conditions

h. The common pump and motor base shall be suitably constructed to support the full weight of pump and motor and shall be provided with suitable anchor bolt holes.

i. The pump and motor shall be inline coupled.

j. Motors: Motors shall comply with the specifications set forth in Section 16220, and with details outlined on attached Schedule. Motors shall be watertight, but rated for non-hazardous area and shall be non overloading at all points on the performance curve of the impeller selected to meet the duty point including horsepower requirements of the drive. At no point shall the required brake horsepower exceed 85 percent of the motor nameplate horsepower multiplied by the motor service factor. The load conditions for these pumps shall be the maximum horsepower at any point

on the characteristic curve from shutoff head to static head (static head is assumed to be zero unless otherwise shown).

k. Testing: Pumps shall be fully tested with water at manufacturer's plant before shipment. The driving motor and pump shall be assembled and tested as unit. Tests shall consist of checking the unit at its rated speed, head, capacity, efficiency and brake horsepower, and any other conditions of head and capacity to properly establish the performance curve. Certified copies of test reports shall be submitted. Standards of the Hydraulic Institute shall govern the procedures and calculations for these tests.

1) In case pumps are tested separately from motors, Contractor shall furnish certified characteristic curves of motors to be furnished as guaranteed by motor manufacturer. These characteristic curves shall be obtained either from actual tests of motors to be furnished or from tests of motors of same size and type of construction.

D. Grit Washing Unit

1. The Grit Washing / Classification unit shall be designed to handle grit slurry underflow from the Grit Concentrator.
2. The Grit Washing / Classification unit shall be characterized by a dominant, strong free vortex which utilizes centrifugal and gravitational forces and secondary boundary layer velocities to effect the separation, collection and classification of grit from the unit's inflow.
3. Defining characteristics of the dominant free vortex / secondary boundary layer velocity type units are as follows:
   a. Dominating increasing tangential velocity profile toward the center of the unit.
   b. The ability to handle increasing flows with no loss of the specified grit removal efficiency and with increasing headloss requirements.
   c. The ability to classify (wash) the grit from lighter organic material to meet the specified organic solids content.
   d. No requirements for electrical or mechanical components, flow deflecting / guiding weirs or baffles, or compressed air lines within the unit to meet the specified performance.
   e. Continuous removal of washed, clean grit.
4. The Grit Washing / Classification unit shall be all-hydraulic with no moving parts within the unit
5. The grit underflow from the Grit Washing / Classification unit shall be transported by gravity to the Grit Dewatering Escalator unit.
6. Fluidizing Water shall be continuously supplied to the Grit Washing / Classification unit
7. The Grit Washing / Classification unit shall be fabricated from stainless steel. The dished and flanged heads shall be 1/4 inch thick. The vessel walls shall be 3/16 inch thick.
8. A coating of Belzona shall be applied to the inside bottom part of the Grit Washing / Classification body to add a secondary layer of abrasion resistance.
9. The Grit Separation / Classification unit shall be designed to withstand a maximum working pressure of 14.7 psig. The actual maximum pressure at the inlet shall be no more than 14.7 psig.
10. A minimum 18 inch diameter access shall be provided in the top of the Grit Washing / Classification unit. All internal elements shall be removable from inside the unit.
11. The Grit Washing / Classification unit shall be free standing on three legs and mounted above a Grit Dewatering Escalator unit. Clearance shall be provided between the bottom of the grit underflow pipe and the Dewatering Unit clarifier surface.

12. The Grit Washing / Classification unit shall include a Hydraulic Valve (HV) to deliver a continuous flow of "washed" grit slurry to the dewatering unit. The HV shall have no mechanical or moving parts.
13. The Grit Washing / Classification Unit shall have a single 1-1/2 inch NPT pipe stub for connection of the system water.
14. The unit shall have one (1) 1.5" grit underflow connection, one (1) 3" threaded drain connection and one (1) 1.5" NPT fluidizing water connection for the Hydraulic Valve supply and Hydraulic Valve backwash.
15. Valves and Accessories
    a. One (1) 1.5" bronze ball valve for utility water supply shut off.
    b. One (1) 1.5" bronze globe valve to regulate water flow to the HV.
    c. One (1) 1.5" NEMA 7 brass solenoid valve to automate system water to the HV.
    d. One (1) 1.5" NEMA 7 brass solenoid valve to automate system backwash water.
    e. One (1) 0-100 psig pressure gauge to monitor the utility water delivery pressure.
    f. One (1) 0-30 psig pressure gauge (Pd) to monitor the pressure in the grit slurry discharge (underflow) line.
    g. One (1) 0-30 psig pressure gauge (Pi) to measure the inlet pressure to the Grit Washing / Classification unit.
    h. Three (3) ¼" bronze ball valves to isolate the pressure gauges.
    i. One (1) 0-50 gpm SS flow meter.
    j. Slurry Cup shall be provided with an access platform complete with stairs and handrail adequately sized to maintain and observe operation. Platforms shall be configured to fit with the grit escalator and supports arranged to not interfere with equipment below.

E. Grit Dewatering Escalator
1. The Grit Dewatering Escalator unit shall be designed to capture and dewater concentrated, washed grit slurry from the Grit Washing / Classification unit.
2. The Grit Dewatering Escalator unit clarifier shall be designed based on a settling rate not to exceed 3.2 gpm/ft^2.
3. The tail roll mechanism shall be self-cleaning. As the belt rotates with the tailroll at the bottom of the unit the belt cleats shall lift from the belt to provide a gap of at least a 1-inch. The Grit Dewatering Escalator unit belt shall be provided with 2" openings to allow transfer of fine solids internal to the belt to the underside of each cleat. The tailroll shall be fitted with a scraper, which shall also function as an internal belt scraper.
4. The Grit Dewatering Escalator shall be provided with an integral square clarifier which shall provide at least 3 inches of freeboard.
5. The housing for the Grit Dewatering Escalator belt shall be fitted under the clarifier. The housing for the Grit Dewatering Escalator belt shall be stainless steel with urethane bonded to the internal surfaces. The belt housing shall be inclined at 30 degrees.
6. The belt housing shall be provided with clean out plates and one (1) flanged drain.
7. The Grit Dewatering Escalator unit shall be supplied with a belt made of 1/8 inch x 1/32 inch two-ply polyester reinforced continuous conductor belting. The belt cleats shall be 3-3/8" X 4-9/16" of molded 60 Durometer neoprene and shall be vulcanized on the belt. The cleats shall attach to the belt with minimum 5/32 inch thick neoprene hinges.
8. The Grit Dewatering Escalator unit shall be provided with a 9-3/4 inch diameter lagged headroll. The headroll shall be adjustable to allow take-up of slack in the Grit Dewatering Escalator belt. Adjustment of the headroll shall not affect the headroll retainer plate, scraper, or drive unit.
9. The Grit Dewatering Escalator unit shall be provided with a headroll scraper having 1/4 inch thick high density polyethylene (HDPE) contact surfaces with a 1/4 inch thick

HDPE retainer plate. Both retainer plate and scraper shall be loaded to keep belt cleats closed tightly around the headroll during operation.

10. The Grit Dewatering Escalator unit shall be provided with a tailroll designed to mount internally to the unit belt housing with external sealed bearings.
11. The Grit Dewatering Escalator unit support structure shall be as shown on the general arrangement drawing and anchored to a stable base.
12. The Grit Dewatering Escalator unit shall be supplied with a factory installed rinse bar system. The system shall include:
    a. Two spray bars located above the belt and below the clarifier liquid level to enhance grit washing
    b. One spray bar located at the bottom of the clarifier as a tailroll area rinse
13. Drive Unit
    a. The Grit Dewatering Escalator shall be provided with a drive unit consisting of the motor and the helical gear reducer, mounted as a single integrated unit. All Bearings shall be anti-friction, ball, or roller type bearings
    b. The helical gear reducer shall have hardened alloy steel gears accurately cut to shape
    c. A mechanical torque-limiting clutch shall be mounted on the headroll gear assembly to prevent an accidental overload of the drive unit and belt
    d. The drive speed shall be adjusted by a variable speed drive housed in the control enclosure. The belt speed shall be adjustable from 1-5 ft/min
14. Valves and Accessories
    a. One (1) 3" eccentric cast iron plug valve located on the unit drain
    b. One (1) 1" NEMA 7 brass solenoid valve to automate the water to the rinse bar system.
    c. Two (2) 1" bronze ball valves to manually shut off flow to the rinse bar system.
    d. One (1) 1" bronze globe valve to manually regulate flow to the tailroll spray bar.
    e. One (1) 3/4" bronze ball valve to manually shut off the top rinse bars.
    f. One (1) 1-10 gpm acrylic flow meter.
    g. One (1) motion sensor installed on the side of the Grit Dewatering Escalator unit to detect movement of the headroll scraper arm.

F. Finishes
    1. All stainless steel surfaces shall be acid washed.
    2. All non submerged surfaces shall be glass bead blasted to a uniform finish.

G. Controls
    1. Two control panels shall be provided: one for each set of grit equipment. The control system shall be provided by the manufacturer and shall have switches, indicator lights starters, and other components as necessary to operate the system. The main panels shall have painted NEMA 4 enclosures and suitable for mounting as shown.
    2. Panel enclosures shall be furnished with a flange mounted disconnect switch, main circuit breaker, control power transformer, surge arrester and be suitable for connection to a 480 volt, 3-phase, 60 Hertz feeder circuit.
    3. The main control panels shall be supplied with a Rockwell compact logix programmable logic controller and Hirshman ethernet switches for LAN and IO traffic. A panelview plus series 7 1500 touchscreen shall be supplied. Panel shall be equipped with all required indicating lights, push buttons, selector switches, and alarm lights. The VFDs shall be in a separate enclosure. Refer to Electrical Drawings for information.
    4. The main control panel PLC's shall meet the requirements of sheets I-100 and I-101.
    5. Panel construction shall be in conformance with Section 13430.

6. All PLC monitored data and HMI information shall be made available via Ethernet to Owner's SCADA system. Manufacturer shall coordinate with OWNER/Tetra Tech for addressing and tagging.
7. Controls logic will allow only one grit train to backwash at a time.
8. Control system will include operator input and adjustment for:
    a. Hand-Off– Auto selector switch
    b. Elapsed time meters
    c. Reset Buttons
    d. Escalator on off time adjustment
    e. Escalator belt speed
    f. Grit pump speed
    g. Grit pump stop
    h. Escalator on time adjustment
    i. Escalator off time adjustment
    j. Escalator speed adjustment
    k. Escalator off time delay adjustment
9. Control System will accept the following inputs:
    a. Grit system start enable
    b. Start grit system
    c. Stop grit system
    d. Pause escalator for truck changing
    e. Enable escalator start
    f. Grit pump assignments
    g. Grit pump start enable
    h. Wet weather mode
    i. Dry weather mode
    j. Discharge conveying system fault
10. Control system will provide output:
    a. Grit pump start request
    b. Grit pump assignment in Local or Remote
    c. Grit pump running
    d. Grit pump fault
    e. Truck loading pause timer alarm
    f. Escalator call to start
    g. Escalator running
    h. Escalator fault
    i. Slurry cup fault
    j. Classifier backwash in progress
    k. Classifier blowdown in progress
11. Local controls stations
    a. Grit Pump Local Station shall be NEMA 4X stainless steel.

1) E-Stop
2) Hand-Off –Remote
3) Start Stop

b. Classifier and Escalator Local Station shall be NEMA 7 copper free aluminum complying with NEMA 3R and NEMA 4 requirements.
1) Escalator E-stop
2) Hand-Off-Remote
3) Escalator Start and Stop Push Buttons
4) Slurry Cup Backwash
5) Fail Light
6) Fail Reset Button

PART 3 - EXECUTION

3.01 ERECTION

A. Equipment furnished and installed under this Section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of equipment manufacturer as approved by Engineer.

3.02 INSPECTION:

A. Prior to commencing degritting system installation, inspect basins and piping, as constructed, verify all critical dimensions, and examine supporting structure and all other conditions under which work is to be installed. Notify Contractor in writing of any dimensional discrepancies or other conditions detrimental to the proper installation or performance of degritting system Work. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.03 INSTALLATION OF DEGRITTING SYSTEM:

A. Comply with manufacturer's instructions and recommendations for Work required during installation.

B. Coordination: Coordinate degritting system Work with work of other trades, for proper time and sequence to avoid construction delays. Use benchmarks, lines and levels designated by Contractor, to ensure dimensional coordination of Work.

C. Lubricate operating parts of systems as recommended by manufacturers.

D. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment shall visit Site of Work a minimum of 2 times, once prior to installation to review installation procedures with Contractor and once after installation to inspect, check, adjust if necessary, and approve the equipment's installation. The equipment supplier's representative shall revisit Site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory to Engineer.

E. Manufacturer's representative shall provide all necessary tools and testing equipment required to check out system, including noise level and vibration sensing equipment.

F. Each equipment supplier's representative shall furnish to Owner, through Engineer, a written report certifying that the equipment:
   1. Has been properly installed and lubricated;
   2. Is in accurate alignment;
   3. Is free from any undue stress imposed by connecting piping or anchor bolts;
   4. Has been operated under full load condition and that it operated satisfactorily to Engineer;
   5. That Owner's Representative has been instructed in the proper maintenance and operation of the equipment; and
   6. Furnish Owner a copy of all test data recorded during the installation check including noise level and vibration readings.

3.04 FIELD QUALITY CONTROL

A. Protection: At time of Substantial Completion of degritting system Work (or portion thereof), provide suitable protective coverings, barriers, devices, signs or such other methods or procedures to protect equipment from damage or deterioration. Maintain protective measures throughout remainder of construction period.

3.05 OPERATION AND MAINTENANCE TRAINING

A. Provide services of manufacturer's service representative to instruct Owner's personnel in operation and maintenance of equipment. Training shall include start-up and shutdown, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance.

   1. Manufacturer’s representative shall provide two (2) days consisting of eight (8) hours each day for a total of sixteen (16) person hours of on-Site training.
   2. Review operating and maintenance data contained in the operating and maintenance manuals.
   3. Schedule training with Owner, provide at least 7-day prior written notice to Engineer.

GRIT EQUIPMENT SCHEDULE

GRIT CONCENTRATOR

Number of Tanks	2
Number of Units per Tank:	2
Location:	Grit Tanks Battery B Building
	Tanks No. 3 and 4
Unit Diameter (feet):	12
Tank Side Water Depth (feet):	13'-8 ½"
Number of Trays/Unit:	5
Surface Area/Unit (ft^2):	565
Loading Rate at Hydraulic	
Capacity Flow/Unit (gpm/ft^2):	23.4
Loading Rate at Peak	
Flow/Unit (gpm/ft^2)	12.3
Total Peak Flow (4 units):	40.0 mgd total (10 mgd per unit)
Removal Efficiency*:	95% particles 125 micron and larger
Headloss (inches):	4
Total Peak Flow (3 units):	40 mgd total (13.3 mgd per unit)
Removal Efficiency*:	95% particles 150 micron and larger
Headloss (inches):	6
Total Peak Flow (1 unit):	19 mgd
Removal Efficiency*:	95% particles 212 micron and larger
Headloss (inches):	12
Average Flow (4 units):	20 mgd total (5 mgd per unit)
Removal Efficiency*:	95% particles 75 micron and larger
Headloss (inches):	1
Average Flow (3 units):	20 mgd total (6.67 mgd per unit)
Removal Efficiency*:	95% particles 106 micron and larger
Headloss (inches):	2
Average Flow (2 units):	20 mgd total (10 mgd per unit)
Removal Efficiency*:	95% particles 125 micron and larger
Headloss (inches):	3

Under Flow Connection Diameter/Type:	4-inches/Flanged
Flushing Water Connection Diameter/Type:	2-inch/NPT
80 gpm at 50 psig minimum	

* Minimum Particle Removal Efficiency over the entire range of flows (Certification Required) with Specific Gravity 2.65. Minimum organic content of grit removal 10%.

GRIT PUMP

Service:	Grit Concentrator Underflow
Number of Units:	4
Installation:	Horizontal
Capacity (gpm):	200 gpm
Total Head (feet):	30 (verified by Grit System Supplier)*
Minimum Shutoff Head (feet):	45*
Maximum Pump Speed:	1,800
Speed Adjustment:	VFD
Motor:	10 HP (minimum), 460 Volt, 60 hz, 3 Phase, TEFC/TEWD*** Rated, Premium Efficiency, Inverter Duty Rated. (Non-hazardous area)
Minimum inlet pipe diameter (inches):	4
Minimum discharge pipe diameter (inches):	3

Remarks:

* Grit pump capacity shall be verified by Grit System Supplier to work with entire system including grit quantities and slurry cup sizing.

** Also Pump flow rate, head, and motor size shall be recommended by Grit System Supplier. Provide hydraulic calculations for grit pump operating points. Calculations shall include normal average conditions and verification pump can pump down to within 1 foot of the bottom of the grit sump for emptying a tank.

*** TEWD: Total Enclosed Wash Down

GRIT WASHING AND CLASSIFICATION UNIT

Number of Units:	4
Location:	Grit Tanks Battery B Building
Size:	24-inch diameter
Removal Efficiency in Flow Range*:	95%
Design Flow / Headloss:	200 gpm / 76-inches
Maximum Flow / Headloss:	260 gpm / 129-inches
Influent Solids Concentration:	Less than 1%
Influent Connection:	4-inch flange
Effluent Connection:	6-inch flange
Underflow Connection:	3-inch NPT
NPW Connection:	1.5-inch NPT

* Removal of all grit with specific gravity 2.65 with greater than 75 microns within flow range of 200-260 gpm.

GRIT DEWATERING ESCALATOR

Number of Units:	2
Location:	Battery B Building
Size:	2 cyd/hr with 60-inch square
Belt Width:	12-inches
Removal Efficiency for all Flows:	95%, greater than 75 microns (at 200-260 gpm). Grit in the dumpster shall contain less than 15% volatile solids and greater than 60% total solids.
Overflow Connection:	6-inch flange
Drain Connection:	3-inch flange
NPW Connection:	1-inch NPT
Speed Adjustment:	VFD
Motor:	
Volt:	480
Phase:	3
Enclosure:	XPFC
Minimum HP:	1

END OF SECTION

SECTION 11330 - SCREENING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Labor, materials, and equipment necessary for fabrication, production, installation and erection of the items specified in this Section as shown on Drawings or listed on Schedule.

B. This is a performance specification. Operating conditions are identified in this Section. The manufacturer is solely responsible for the design of this system, including all materials of construction, to meet these operating conditions. The design parameters indicated in this Section are minimum requirements and shall not be construed as the ENGINEER assuming design responsibility or liability. If any of these specified parameters are incompatible with the manufacturer's design or the specified operating conditions, it shall be the responsibility of the manufacturer to promptly inform the OWNER and ENGINEER in writing.

C. The system design is based on Duperon (Basis of Design). The screens are integral to the preliminary treatment system operation, performance and layout. Approval by ENGINEER is required for any proposed deviations from the basis of design.

1.02 SYSTEM DESCRIPTION

A. General
   1. Provide inclined mechanically cleaned bar screen equipment as indicated on Drawings and Schedule.
   2. The screening equipment system shall be a complete functional process with all necessary equipment components, and all associated instrumentation and controls.

B. Performance Requirements
   1. The equipment shall be designed for continuous screening operation for capture of debris and solids from municipal sanitary wastewater and combined sanitary and stormwater sewer system flow.
   2. The screen shall be automated to provide self-cleaning to maintain continuous flow through the unit at the flow range and maximum headloss tolerance indicated in the Schedule.
   3. The mechanical cleaning mechanism shall provide removal of collected material and shall automatically deposit collected screening material on to the conveyor system provided.
   4. The screening equipment shall be capable of handling the material removal rate indicated as the in the Schedule.
   5. Control Panels and Controls Logic Programming:
      a. The manufacturer control panel shall be supplied with a Rockwell compact logix programmable logic controller and Hirshman ethernet switches for LAN and IO traffic. A panelview plus series 7 1500 touchscreen shall be supplied.
      b. The programmable logic controller, panelview and switch shall be programmed by the manufacturer for control of the manufacturer supplied equipment. Any signals needed for automatic operation shall be supplied over the fiber optic plant SCADA network. Coordinate with Tetra Tech for these signals to be delivered to the manufacturer’s system for control and monitoring.

c. Turn over to OWNER and ENGINEER an electronic program copy for the panelview and PLC. Coordinate with OWNER and ENGINEER on software versions to use for the PLC programming software and the panelview plus software.
d. Coordinate IP addresses with OWNER and ENGINEER.
e. Integration of these manufacturer programmed systems to the existing plant-wide SCADA system shall be by Tetra Tech.
f. An on-line UPS shall be provided for powering the PLC, the panelview, and ethernet switch.
g. Refer to system configuration drawing I-100 for additional information and requirements. Provide copper and fiber patch cables as shown. Provide surface mounted fiber optic patch panel with ports and bulkheads as shown.
h. Any variable frequency drives provided shall be Rockwell Powerflex 753 series. Provide with MTE Matrix AP input filter and output DV/DT filter for each drive. Control panel to be provided with transient voltage surge protection on the 480V 3 phase input.

1.03 SUBMITTALS

A. Shop Drawings: Submit in accordance with requirements of Section 01330, Shop Drawings covering the items included under this Section.

B. Test and Inspection Report: A written report shall be submitted to ENGINEER documenting testing and/or inspection results. The report shall be prepared as noted under Section 01600.

C. Record Drawings: At Project closeout, submit record drawings of installed products, in accordance with requirements of Section 01770.

D. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.

E. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section. The equipment shall be warrantied for a period of 3 years (36 months) after component acceptance.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Subject to compliance with the specified requirements, manufacturers offering products which shall be included in Work include:
1. Link Chain Mechanically Cleaned Bar Screen:
a. Duperon Corporation.

2.02 MATERIALS OF CONSTRUCTION

A.	Bar Screen	Non-Magnetic304 Stainless Steel
B.	Scrapers	304 Stainless Steel, UHMW Polyethylene
C.	Stripper Assembly	UHMW, Non-Magnetic 304 Stainless Steel
D.	Enclosure	Non-Magnetic 304 Stainless Steel
E.	Drive Shaft	1018 Steel

F.	Fasteners	Non-Magnetic304 Stainless Steel
G.	Link System	Non-Magnetic 316 Stainless Steel Links, pins and snap rings
H.	Drive Head	ASTM A48 CL40 Iron, 1018 Steel, coated

2.03 MANUFACTURED UNITS

A. Each mechanical screen provided under this Section shall comprise a complete assembly consisting of, as a minimum, a bar rack with dead plate, an automatic raking system, enclosure, and controls as specified. Additional items shall be included as required by this Specification or the Contract Drawings, or as required for a complete working installation of the equipment specified.

B. Inclined mechanically cleaned bar screens shall be of the front-cleaned/front-return type. The system shall be designed to remove debris that comes into contact with the face of the bar screen and shall convey said debris up the bar screen onto the discharge system as shown on Drawings. Each bar screen shall operate independently and shall have its own drive components. The lifting capacity shall be 1000 pounds, evenly distributed or concentrated, per screen unit.

2.04 COMPONENTS

A. Link Chain Mechanically Cleaned Bar Screen

1. Bar Screen: The bar screen shall have no sprockets, bearings or moving parts under the water surface. The bar screen shall be constructed of 1/4-inch by 1inch bars with the 1/4-inch surface facing the flow of the water. The maximum clear opening between bars shall be 1/4-inch as indicated on the Schedule. The bar screen shall be inclined as noted on the Schedule and shall extend a minimum of 8 inches above the maximum water surface elevation in the channel as shown on Drawings. A dead plate of the same materials of construction as the bar screen shall be mounted immediately above the bar rack to prevent collected debris from being dropped back into the channel.

2. The Link System: Shall be constructed on 316 Stainless Steel investment castings, designed to bend in only one direction, becoming its own frame and lower sprocket. The pins and retaining rings shall be constructed of stainless steel.

3. Drive Head: Shall be primarily constructed on CL40 Iron and Steel materials. It shall be coated with the manufacturer’s standard coating system.

4. Bearings: Shall be a greasable, ball-bearing type, non-self-aligning, sealed and lubricated with a radial load rating of no less than 18,187 pounds at 10 rpm.

5. Scrapers: Scrapers shall be of 304 Stainless Steel and UHMW and shall not cause damage to the bar screen finish or structure. Scrapers shall be easily modified by Owner if necessary, to suit future changes in debris conditions. Scrapers shall penetrate the bar screen, cleaning the upstream and side surfaces of the bars. Scrapers shall be reinforced by FRP or Stainless Steel support angles for scrapers greater than 3 feet in width.

6. Stripper Assembly: Shall be constructed of Stainless steel, UHMW and other corrosion resistant materials and shall engage the scrapers to remove debris.

7. Enclosure: Each screen mechanism shall be provided with an enclosure. The enclosure shall extend above the operating floor on each side of the screen and upstream. The enclosure shall be designed to allow scraper contact when the link system expands for lifting large debris. The panels shall allow operator access to the screen mechanism when the unit is not in operation.

8. Drive Unit: The electric gear motor shall be shaft mounted and explosion proof. The motor shall be a minimum of 1/3 hp, 1750 rpm, 3 phase, 60 cycle, 230/460 volt, inverter duty rated. Drive shall operate at two speeds based on flow conditions. Each raking unit shall operate independently and will have its own drive unit and driven components. The drive unit shall be able to pivot from the bar screen if large debris is between the rake and screen.
    a. The link system shall be driven by an explosion-proof reversing gear motor as listed on Schedule. The gear motor shall be housed in a suitable cast iron housing and shall have a minimum service factor of 1.4 at full design loading.

9. Variable Frequency Drives: Variable frequency drives shall be supplied in separate enclosures and meet the requirements of specification section 16422. Drives shall be manufactured by Rockwell or Schneider Electric.

10. Control System: Each screen mechanism shall be provided with a locally mounted NEMA 7 push button control package for Local/Remote, Start, Forward, Jog Reverse, and Emergency Stop.
    a. A power monitor unit designed to provide instantaneous shut off for torque overload conditions shall be provided. Mechanisms which employ the use of shear pins for overload protection or designs which rely on the upward travel of the rake drive to pull the rake over obstructions shall not be acceptable.
    b. The Screen unit variable frequency drives will be fully controlled through SCADA system.

11. Spare Parts: Each screen mechanism shall be provided with the following spare parts:
    a. 10 Snap Rings.
    b. 4 Link Pins.
    c. 1 Drive Sprocket Pin.
    d. 4 sets of Stainless Steel Bolts and Nuts for Scrapers.
    e. 4 Scrapers.
    f. 4 Chain Links
    g. 4 3 oz. Supply of Never Seeze.
    h. 1 Snap Ring Tool.

12. Refer to the wiring diagrams on the electrical drawings and to the instrumentation system configuration for additional requirements to be provided.

B. Fabrication:
    1. Shop Assembly: Each screen shall be fully assembled in the shop to ensure proper fitting parts. It shall then be marked for erection and disassembly as required for shipment. Parts shall minimize erection costs but still be convenient for handling.
    2. Shop/Factory Finishing: Each screen shall be finished by the screening equipment manufacturer with the manufacturer's standard coating system.

C. Source Quality Control:
   1. Tests: Prior to shipping, the manufacturer shall perform operational testing to verify that the operation of the mechanism is in compliance with the specifications. Once assembled, the equipment shall be run for at least 10 complete cycles to verify a smooth, continuous running operation. All adjustments necessary shall be made prior to shipping.
   2. Inspection: Prior to shipping, the manufacturer shall inspect the screen mechanism for compliance with the specifications and Shop Drawings, and shall ensure that it is protected for shipment and on-site storage, if applicable.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: CONTRACTOR shall be responsible for field verification of Conditions. Verification shall include, but shall not be limited to, opening dimensions, height clearances and channel dimensions and ability to install as a unit without major modifications to the structure.

3.02 PREPARATION

A. Surface Preparation and Protection: The surface preparation and protection for any mechanism damaged during transit to Site shall be in accordance with Section 01600.

3.03 ERECTION

A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operation condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of equipment manufacturer approved by ENGINEER.

3.04 INSTALLATION

A. The equipment shall be erected in strict conformance with manufacturer's recommendations. Prior to start-up the manufacturer shall certify in writing that the completed installation is in accordance with manufacturer's recommendations.

3.05 FIELD QUALITY CONTROL

A. Inclined Mechanically Cleaned Bar Screen Testing: After completion of the installation, the screening unit shall be tested by CONTRACTOR in the presence of ENGINEER. CONTRACTOR shall test the equipment under "dry" conditions. The tests shall indicate that the equipment operates properly, has necessary clearances, operates without overheating or overstressing of any parts, provides positive overload protection, and in all other respects meets all requirements of the Specifications. The tests shall be conducted under the supervision of the manufacturer's representative.

B. Inspection: After completion of installation the manufacturer's factory representative shall inspect the installation of all equipment installed in this Section. Following field testing, manufacturer's factory representative shall inspect the equipment to verify that the mechanism operates properly and that there was no damage to the equipment during installation and testing.

C. Manufacturer's Field Service: Manufacturer shall provide the services of a factory-trained service engineer, specifically trained on the type of equipment specified to assist in the installation and start-up of the equipment and train personnel in the operation and maintenance of the equipment. The services shall be as noted under Section 01600.

3.06 CLEANING

A. CONTRACTOR shall be responsible for the cleaning of all equipment provided under this Section, prior to acceptance by OWNER.

3.07 DEMONSTRATION

A. The equipment shall arrive fully greased and sealed. CONTRACTOR must supply, at minimum, temporary power for testing the unit and additional services as needed for demonstration and start-up.

3.08 PROTECTION

A. The equipment provided in this Section shall be protected during shipment in accordance with manufacturer's recommendations. In cases where the equipment is to be stored on-site until installation, CONTRACTOR shall store equipment according to manufacturer's recommendations.

B. Once installed and prior to acceptance CONTRACTOR shall protect the equipment from any damage. If damage occurs, it shall be rectified promptly prior to acceptance by OWNER.

SCREENING EQUIPMENT SCHEDULE

No. of Units:	2
Location:	Grit Battery B Building
Service:	Raw Municipal Wastewater
Capacity:	
Average Flow per Unit (mgd):	10 MGD
Maximum Flow per Unit (mgd):	30 MGD
Channel Dimensions:	
Width:	6 feet 0 inches upstream of screen
	6 feet 0 inches downstream of screen
Depth:	8 feet 5 inches (Bottom El 714.08, Top of Channel El. 722.50)
Finish Floor	722.50
Angle of Inclination:	1 degrees from Vertical
Minimum Height to Discharge:	Coordinate with Compactor Manufacturer (5’-10”)
Maximum Height Above Finished Floor:	12 feet
Screen (Clear Opening):	1/4-inch
Motor:	Minimum 1/3 hp, 3/60/460V TEEP, inverter duty rated
Maximum Head Loss (30% blocked):	4 inches at 30 MGD per channel
Lifting Capacity per Unit:	1000 lbs.
Loading Capacity per Unit:	100 cu.ft./hr
Warranty Period:	3 year
Minimum On-Site Technical Assistance:	3 day

Remarks:

1. Motors shall be mounted on the Drive Unit as indicated on Drawings.

END OF SECTION

SECTION 11335 - RECTANGULAR SLUDGE COLLECTION MECHANISM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Labor, materials, and equipment necessary for furnishing the fabrication, production, installation, or erection of the items specified in this Section as shown on Drawings or listed on Schedule.

B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1, shall apply to Work of this Section.

C. Anchors: All anchors shall be stainless steel as specified herein and furnished under this Section. The anchors shall be installed under Section 03310 in accordance with certified prints furnished by equipment manufacturer.

D. Motors: Electric motors shall be furnished meeting the requirements of Section 16220.
   1. Electric motors shall be of the design and rated for the classifications noted on Schedule.
   2. All anchor bolts shall be of 316 stainless steel and of ample size and strength for the purpose intended. Anchor bolts shall be furnished by equipment manufacturer, and shall be set by others in accordance with their instructions.
   3. All parts of the mechanism shall be amply proportioned for all stresses that may occur during fabrication, erection, and intermittent or continuous operation. Workmanship shall be of high grade in all respects.

E. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 1 Specification Sections, including Section 01600, apply to the Work of this Section.

F. The system design is based on Evoqua (Basis of Design). The primary mechanisms are integral to the system operation, performance and layout. Approval by ENGINEER is required for any proposed deviations from the basis of design.

1.02 SYSTEM DESCRIPTION

A. Each sludge collector mechanism shall be a complete assembly of 2 parallel, endless chains with attached scraping flights, a drive with overload device, 4 pairs of sprockets, and all other accessories and anchorage parts.

B. For each longitudinal sludge-collecting mechanism, the chains will run over 4 sets of sprocket wheels at a nominal speed of 2 feet per minute with the flights cleaning the sludge from the tank bottom and discharging it into the collection trough at the end of the tank.

C. For each cross collector sludge-collecting mechanism the chains will run over 3 sets of sprocket wheels at a nominal speed of 4 feet per minute with the flights cleaning sludge from the collection trough bottom and discharging it into the sludge hopper where the sludge is removed with the primary sludge pumps.

D. All parts of the mechanism shall be amply proportional for all stresses that may occur during continuous operation, and for any additional stresses that may occur during fabrication, erection, and intermittent or continuous operation.

E. Mechanisms installed under this contract will be the primary tank's third generation. Bearings, shafts, scum pipes and other accessories that are attached to the tank structure shall have mounting plates that spread out the anchor bolt pattern to ensure anchor bolts are installed in solid concrete and avoid existing and previous locations. During shop drawing submittals coordination between Contractor and manufacturer, using actual field measurements of two representative tanks, will be required to determine the required anchor plate size.

1.03 SUBMITTALS

A. Prior to submitting shop drawings, the two representative tanks shall be field measured and inspected. In addition to measuring the overall tank layout Contractor will follow specific instruction and guidance from manufacturer to be sure critical areas are adequately documented. The condition of the existing floor 25-pound tee rails will need to be observed, measured and photos taken to determine the proposed floor wear strip mounting method.

B. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section.

C. Include a copy of the representative tank field measurements.

D. Certification documentation of collector chain endurance testing showing minimum load of 1,800 lbf with 15 degrees of twist.

E. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

1.04 QUALITY ASSURANCE

A. Tests: Testing shall be accomplished as herein specified under individual items.

1.05 DELIVERY, STORAGE, AND HANDLING

A. The equipment shall be assembled by manufacturer insofar as practical, and shipped in units which will minimize erection costs but still be convenient for handling. These subassemblies shall consist essentially of the collector chain sprockets, bearings, and set collars mounted in-place on the shafts.

B. The drive units shall be shipped with the drive sprockets and ball detent hubs mounted in place.

C. All flights shall be accurately drilled and notched at the factory and be carefully grouped and banded together for safe shipment and storage.

D. The collector chains shall be shipped in convenient coils of 10 feet in length for easy assembly in the field.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Evoqua Water Technologies LLC / Envirex.
   2. Or Approved Equal.

B. The sludge collector mechanism design is based on equipment from Evoqua. The original primary tank mechanisms from the 70's were Evoqua (Rex Chainbelt Inc.) and replacement mechanisms from the 90's were also Evoqua (Envirex). All mechanism components shall be provided by a single Manufacturer who is fully experienced, reputable, and qualified in the supply of the equipment specified. The Manufacturer shall have at least two dozen (24) installations of primary sludge collector mechanisms in North America. Submit evidence of conformance to experience. Lack of evidence, with details matching each specific requirement is cause for rejection of the Manufacturer.

C. The listing of any Manufacturer by name shall not imply tacit approval of same. The selected Manufacturer shall be required to meet the specifications. Equipment which is a "standard product" with the Manufacturer shall be modified, re-designed from the standard mode, if necessary, or furnished with special features, accessories, materials, or finishes as may be necessary to conform to the detailed requirements of these specifications and contract drawings.

D. Any modifications from that shown in the contract drawings shall be the Contractors responsibility, at no additional cost to the OWNER.

2.02 COMPONENTS

A. Collector Chain (Nonmetallic): The collector chains shall be NCS720 series nonmetallic, with 6-inch pitch links, average weight of 1.3 lbs/ft and connected with pins. The pins shall be of T-head construction not less than 15/16" diameter to prevent rotation, press fit into place, and shall be held in place without the use of pin locks, clips, or cotters and be designed to exclude abrasives. The chain shall have a rated working load of not less than 3,100 pounds and minimum ultimate tensile strength of 6,000 pounds. Rigid attachments shall be the full depth of the flight, molded integrally with the link sidebars and be provided with four 3/8-inch diameter type 316 stainless steel attachment bolts.

B. Flights (Nonmetallic): Flights shall be fiberglass scrapers 3-inch by 8-inch nominal size specially designed for sludge collector service. The scraper shall have minimum fiberglass content of 60% with continuous fiberglass filaments running the full length of the member and shall include a scraper lip on the leading edge to ensure cleaning of the tank floor. The scraper shall include filler blocks for bolting the member to the chain attachment links. Buoyant flight design will not be acceptable.
   1. Each flight shall be provided with 1/2-inch polyurethane, or other suitable composite material, wearing shoes to run on the floor wear strips and on return rails where required. Wearing shoes running on the floor wear strips shall be located central to the chain attachment. All wearing shoes shall be reversible, providing two useable wearing surfaces. Return shoes shall have a guide lug to improve tracking while traveling on the return track.
   2. Flight spacing shall be a noted on Schedule.

C. Squeegees: Each collector mechanism shall have two flights equipped with rubber squeegees to sweep sludge from the tank floor inside and outside of the wear strips. Attach squeegees to flight with stainless steel hardware.

D. Sprockets (Nonmetallic): Collector chain sprockets shall be modeled of polyurethane (ASTM D 2240) with an 80 Shore "D" hardness. Water adsorption shall not exceed 1.3 percent at saturation per ASTM D 570. Sprockets shall be split double life profile with tooth saver rims and be compatible with nonmetallic chain. Sprockets shall be held on the shaft with full-width type 316 stainless steel clamping bands on both sides. The bands shall exert full peripheral clamping force and restrict the lateral movement of the sprocket. Headshaft sprockets shall be keyed to the shaft using molded keyways that restrict lateral movement, maintaining chain alignment; 316 stainless steel wedge dogs will be required for sprocket assembly and alignment. Corner shafts shall revolve on bearing sleeves clamped to static shafts. Sprockets shall have the number of teeth and pitch diameter as listed on the Schedule.

E. Bearings for Rotating Shafts: Bearing shall be wall mounted of the split 316 stainless steel type, self-aligning, ball and socket with polyethylene liners able to operate with water lubrication when submerged and with provisions for grease lubrication. The bearing shall be designed so that the upper portion of the bearing can be removed without removing the shaft or the lower portion of the bearing from the wall bracket. Bearings shall also be designed so that the housing bracket does not have to be removed from the wall for removal or replacement of the bearing. Grease tubing, fittings and mounting hardware shall be provided to allow for easy greasing from the walkway level.

F. Bearings for Static Shafts: Bearing sleeves shall be molded 100% virgin UHMW-polyethylene, of split construction with a shoulder to restrict lateral movement of the sprocket. The sleeves shall be held in place on the shaft with 316 stainless steel clamps that exert full peripheral force. The clamps shall be held in place with shoulders integral with the sleeve.
   1. Headshaft and cornershaft sprockets shall be double-life type. Traction wheels, idler wheels, or other substitutes for sprockets will not be acceptable.

G. Shafts: All shafting shall be solid, cold-finished steel, straight and true, and shall be held in alignment with set-screwed set collar. The head shaft shall contain keyways with fitted keys where necessary and shall be of sufficient size to transmit the power required. All shafting shall extend across the full width of the tank and the headshaft shall turn in the bearings mounted on the tank. Static shafts shall be supported by brackets mounted on the tank walls.

H. Static Shaft Brackets: Brackets shall be 3/8-inch type 316 stainless steel minimum for support of corner shafts. Brackets shall be mounted with minimum 3/4-inch anchor bolts.

I. Floor Wear Strips: Made of 316 stainless steel and measuring 3/8” thick by 3” wide. Strips shall be plug welded to the existing 25-pound steel tee rails cast in the floor. Each section of wear strip shall utilize a minimum of five ¾” diameter plug weld holes for every 12 feet of strip length. Wear strip ends shall be beveled to allow smooth transition between sections.
   1. If existing Tee Rails are found to be in poor condition and not suitable for welding during the representative tank inspections, the wear strips shall be expansion anchored to the concrete floor. Location on tank floor and dimensions of wear strips will be determined by the manufacture so as not to conflict with existing tee rails which will remain in the tanks. Wear strips shall be made of 316 stainless steel minimum 3/8” thick by 3” wide with five chamfered holes for every 12 feet of strip length. Anchors shall be sized by the manufacturer with ¼” minimum diameter and have mating convex washers. A full ¼” wearing surface shall be

provided and strip ends shall be beveled as noted above. All mounting hardware shall be 316 stainless steel.

J. Return Rails: Return rails shall be 12-gauge 316 stainless steel material form rolled (not bent) into the shape of an upside down "J" with mechanical properties to adequately support the loads imposed during operation and maintenance with a wet or dry tank. Rails shall be designed to provide long life and polished smooth so as not to require wear strips.
   1. Rails shall be supported from the tank walls with brackets make of 316 stainless steel, plastic or composite materials and allow for easy adjustment during installation. All mounting hardware shall made be 316 stainless steel material.

K. Deflector Tracks: Deflector tracks shall be provided to prevent flight from contacting other components in the tanks. Deflector tracks made of 316 stainless steel angles and mounted with non-metallic brackets, 316 stainless steel anchors and fitted with UHWM-polyethylene wear strips shall be provide where shown.

L. Drive: Each collector mechanism shall be driven as shown on Drawings. The two longitudinal mechanisms shall have one drive and the cross collector will have one drive. The drive motor shall be directly connected to the speed reducer through a flexible coupling. Motors shall meet the requirements of Section 16220.
   1. Each drive unit speed reducer shall be of the helical gear type, 95 percent efficient, fully housed, running in oil, and of approved make, with antifriction bearings throughout. Minimum 1.25 service factor for drive gear reducer.
   2. The drive unit shall be mounted directly on the concrete and be supported on a 316 stainless steel base. A NEMA 7 rated limit switch and bracket shall also be furnished by equipment manufacturer to alarm when a shear pin or ball detent is tripped.
   3. The driving chain shall be H78 series, 2.609" pitch, reinforced plastic, with 300 series stainless steel connecting pins of minimum 7/16-inch diameter and constructed to prevent rotation. The chain shall have an average working load strength of 2,850 pounds.
   4. A chain tightener made of 316 stainless steel shall be provided to take up any unnecessary slack in each drive chain.
   5. The chain drive above the operating platform shall be covered with a removable FRP or stainless steel guard of No. 14 gauge thickness.
   6. Drive sprockets shall be equipped with a ball detent system to provide full protection of equipment in case of excessive loading.

2.03 ACCESSORIES

A. Rotary Scum Pipes:
   1. Stainless steel pipe shall be used. A nominal 60-degree slot shall be cut symmetrically about the vertical axis of the pipe with the edges of the slot serving as a weir over which the scum flows into the pipe when the pipe is rotated. The edges of the slot shall be parallel to the longitudinal axis of the pipe. At regular intervals of not more than 2'-6", 2-inch wide bands of the full pipe periphery shall be left in the pipe to act as stiffeners. Each revolving pipe shall be supported at each end in such a manner that a slight vertical or horizontal misalignment shall not interfere with the smooth operation of the pipe. Each end of the pipe shall be supported by and revolved in a rolled steel collar which shall be welded to an adjustable steel plate. The open-end supports shall have segments welded to the internal periphery of the collar to provide ample bearing surface for the pipe without crushing the seal. Marine grade plywood fillers shall be furnished

with the open-end supports to provide a watertight connection to the tank walls without grouting.

2. A suitable watertight seal shall be provided for the open end of each pipe. This seal shall be so constructed that it shall remain effective even with a slight misalignment of the pipe and collar. The seal shall not be affected by grease, oil, mild acids, or alkalies. The seal shall be readily removable without removing the pipe from the supporting brackets and shall not bind or impede the smooth action of the revolving pipe. All anchor bolts shall be stainless steel, furnished by the manufacturer. All anchor bolts shall be set by Contractor in accordance with the manufacturer's instructions.
3. Oversize wall mounts are required to ensure the proposed anchor bolts can be located in solid concrete.

B. Operator: As indicated on Schedule, one of the following operators shall be furnished:
   1. Lever Operator: The revolving scum pipe shall be operated by means of a 1-1/2-inch diameter standard stainless steel pipe lever.

PART 3 - EXECUTION

3.01 ERECTION

A. Erection shall include: furnishing necessary oil and grease for initial operation; and making final adjustments to place the equipment in operable condition.

B. Stainless steel return track shall be field butt welded. The top surface shall be grinded and polished smooth.

C. Grind smooth plug welds on floor wear strips.

D. All stainless steel hardware shall be fastened using non-galling compound.

3.02 FIELD QUALITY CONTROL CHECK

A. Installation Check: In addition to the requirements of installation check as described in Section 01600, under this Work manufacturer shall furnish a qualified representative, for a period of not less than 3 man days, to instruct OWNER's operator in the maintenance and operation of the equipment.

B. Non-Metallic collector chain shall have a minimum of five 6-pitch strands shall be randomly selected from the actual chain to be supplied to the Site for testing at the factory laboratory or a nearby independent laboratory. Each strand shall be proof loaded to 5,000 pounds to ensure proper molding and link design. The chain shall be unaffected by the proof load. Failure of any test strand shall be cause for rejection of the entire lot of chain.

RECTANGULAR SLUDGE COLLECTION MECHANISM SCHEDULE

Location:	Primary Settling Tanks 1 thru 10
No. of Units:	10 Tanks with 2 Longitudinal Each = 20 10 Tanks with 1 Cross Collector Each = 10
Service:	Primary Sewage
Anticipated Solids Concentration:	4%
Sludge Load Longitudinal Collectors:	5 lb/ft of Flight Length (based on 8" tall flight)
Sludge Load Cross Collectors:	10 lb/ft of Flight Length (based on 8" tall flight)
Head Shaft Sprockets Min Pitch Dia.:	22.2 inches
Idler Shaft Sprockets Min. Pitch Dia.:	16.1 inches
Longitudinal Collector Tank Dimensions:	Overall Length 142'-0", Scraped Length 131'-6", Width 20'-0" Approximate Water Depth 8'-0"
Cross Collector Tank Dimensions:	Overall Length 41'-6", Scraped Length 37'-2", Width 5'-0" Approximate Water Depth 14'-0"
Nominal Flight Spacing:	10 Feet Longitudinal 5 Feet Cross
Drive Power Supply:	480 V/ 3 Ph/60 Hz
Motor Enclosure:	TEEP Class I, Div. I, Group C & D
Rotary Scum Pipes	
No. of Units:	10
Diameter:	16 Inch
Nominal Length:	20 Feet
Operator:	Manual Lever

Remarks: All drives to have right angle gears so drive is positioned vertically as shown on Drawings.

END OF SECTION

SECTION 13410 - BASIC INSTRUMENTATION REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: General administrative and procedural requirements for instrumentation installations. Administrative and procedural requirements are included in this Section to expand on requirements specified in Division 1.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Sections 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product data for each product specified.
   2. Wiring diagrams, both elementary and schematic, differentiating between manufacturer installed and field-installed wiring.
   3. Digital Systems: Provide the following:
      a. Digital equipment layouts of input and output racks showing complete module model number and addressing assignment. Layouts of port pin assignment, connection schematic indicating cable types and port addresses.

B. Record Drawings: At Project closeout, submit record drawings of installed products, in accordance with requirements of Section 01770.
   1. Where Drawings are drafted by computer equipment, CONTRACTOR shall furnish files on a disk. These Drawings shall include changes made by Field Orders, Change Orders, Addenda, and errors discovered during start-up and acceptance.
   2. Drawings shall include terminal numbers at each wiring termination and piping termination. A complete system diagram shall be included.

C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.
   1. Instructions shall be short, easy-to-understand directions specifically written for this Project describing various possible methods of operating equipment. Instructions shall include procedures for tests required, adjustments to be made, and safety precautions to be taken with equipment. These documents are to be submitted to ENGINEER's office.
   2. Provide 1 complete set of manufacturer's documentation covering programmable equipment supplied. Include hardware manuals and prints as manufacturer normally ships with programmable equipment.

D. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

1.03 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
   1. National Electric Code.
   2. Applicable State and local requirements.
   3. UL listing and labeling shall be adhered to.

C. Equipment that does not have a UL, FM, CSA, or other listed testing laboratory label shall be furnished with a notarized letter signed by the supplier stating that equipment furnished has been manufactured in accordance with National Electric Code and OSHA requirements.

D. CONTRACTOR shall provide permits and licenses, observe and abide by applicable laws, regulations, ordinances, and rules of State, territory or political subdivision thereof, wherein the Work is done. CONTRACTOR shall pay fees for permits, inspections, licenses, and certifications when such fees are required.

E. Responsibility and Coordination: Drawings and Specifications are intended to include details of a complete equipment installation for purposes specified. CONTRACTOR shall be responsible for details which may be necessary to properly install, adjust, and place in operation complete installation. Any error on Drawings or in Specifications which prevents proper operation of supplied system shall be shown correct at time of Shop Drawing submittal for approval or brought to attention of ENGINEER with or prior to submittal.

F. CONTRACTOR shall be responsible for costs incurred to correct aforementioned errors brought to ENGINEER's attention. CONTRACTOR shall assume full responsibility for additional costs which may result from unauthorized deviations from Specifications.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Manufactured material shall be adequately packed to prevent damage during shipping, handling, storage, and erection. Material shipped to Site shall be packed in a container properly marked for identification. Blocks and padding shall be used to prevent movement.

B. CONTRACTOR shall inspect the material prior to removing it from carrier. If damage is observed, CONTRACTOR shall immediately notify carrier so that a claim can be made. If no such notice is given, material shall be assumed to be in undamaged condition; any subsequent damage that occurs to the equipment shall be the responsibility of CONTRACTOR. Repair and replacement of damaged parts will be done at no expense to OWNER.

C. CONTRACTOR shall be responsible for any damage charges resulting from handling of materials.

PART 2 - PRODUCTS

2.01 EQUIPMENT SUPPLIERS

A. Subject to compliance with specified requirements, equipment suppliers shall be the following (no "or equals"):
   1. West Michigan Instrumentation Systems Inc.
   2. Commerce Controls Inc.
   3. Revere Systms Inc.

B. References made in these Specifications to specific manufacturer's products are intended to serve as a guide to type, construction, and materials. Listing of a manufacturer does not imply acceptance by ENGINEER of a manufacturer's particular product, product line, or latest product revision if it does not meet Specifications.

C. Equipment Supplier: Equipment specified under Sections 13413 through 13899 and shown on Drawings shall be designed as a system, fabricated or purchased, shipped to Site, and started up by one of the qualified and approved equipment suppliers listed under this Section. Intent is for unit responsibility.
   1. Equipment supplier shall not assign any of its rights or delegate any of its obligations under these Sections without prior written acceptance by ENGINEER.
   2. Direct purchase of any items in these Sections by CONTRACTOR is not in compliance with this Specification and will not be permitted.
      a. Project Engineer/Project Manager's name shall be forwarded to CONTRACTOR and ENGINEER within 30 days after receipt of a purchase order by equipment supplier.
      b. Project Engineer/Project Manager shall be focal point for design, fabrication, Contract communications, and shall be responsible for start-up and acceptance. Project Engineer/Project Manager shall be at factory test at Site for start-up and at the Site during entire acceptance procedure. Only qualified and approved equipment suppliers shall be accepted as meeting this Specification.

2.02 EQUIPMENT

A. Transmitted electronic signals to equipment of other vendors and between control panels shall be a separate isolated-floating output for each item of equipment and shall conform to ISA Standard S50.1.

B. Enclosures shall be NEMA 1, 4, 4X, or 7 as indicated on Drawings. Intrinsically safe systems, as approved by Factory Mutual, shall be furnished when called for.

C. No external power connections shall be allowed unless specifically called for in Specification. Where an external power source is called for, unit shall accept 120 VAC, plus or minus 10 percent power.

D. Current-to-current converters shall be used as power boosters to provide sufficient signal power as required. It is equipment supplier's responsibility to determine under what circumstances and locations power boosters are required, provide them, and integrate them into the instrumentation system to make system function properly.

E. Separate power supplies shall be totally enclosed with solderless terminals for connections. They shall be short circuit current limiting type that will automatically resume regulation after removal of short circuit. They shall operate from 120 volt AC, plus or minus 10 percent power. Regulated voltage shall be fixed. Units with internal trim potentiometers will be accepted.
   1. Pneumatic instruments shall have an input and output range of 3-15 psig. Units shall require a 20 psi supply. Provide an air set for each pneumatic unit or for each 20 psi manifold. Bubbler air sets, regulators, valves, etc., must be factory assembled on a subplate as specified and detailed.
   2. Instruments shall be panel-mounted or enclosed for wall mounting as shown on Drawings.

F. Instruments shall be equipped with permanently attached identification tag. Tag shall be included on field- and panel-mounted devices. Tags shall include ENGINEER's tag identification and manufacturer's tag identification if different from ENGINEER's.
   1. Tags shall be either stamped metal or laminated phenolic with white letters engraved on a black background. Field-mounted devices shall have tags fastened with screws. Devices mounted in panels will be tagged inside panel on subplates or on device itself where it can be easily read.

G. Finish on instruments and accessories shall provide protection against corrosion by elements in environment in which they are to be installed. Both the interior and exterior of enclosures shall be finished. Extra paint of each color used on material shall be provided by manufacturer for touch-up purposes.

H. Provide equipment identification nameplates complying with Section 16075. Nameplates shall contain ENGINEER's item designation and, for indicators and transmitters, design range and units of device shown.

2.03 SOURCE QUALITY CONTROL

A. Procesor panels, IO panels, and associated fiber control panels shall be tested at the factory prior to shipment to the Site. ENGINEER is to be given 5 weeks notice before the factory test date; ENGINEER will witness the tests. The purpose of factory testing is to verify correct functioning of equipment and conformity to Project requirements before shipment. The equipment supplier shall power up all of the panels, connect the panels with fiber optic cabling and Ethernet cabling and test all communication before Engineer begins factory test of the Engineeer developed PLC and SCADA application software.

B. Schedule factory test not before 8 weeks after Shop Drawing status of deliverable items under this Section is either N.E.T. or F.A.C.

C. Engineer will download the PLC and application software for testing the enginer developed PLC and SCADA system programming.

D. At completion of the factory test, the panels shall remain connected for 2 weeks to allow Engineer to correct anhy software errors.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of equipment manufacturer as approved by ENGINEER.

B. Install equipment as indicated, in accordance with manufacturer's written instruction, and in compliance with recognized industry practices to ensure that products fulfill requirements.

C. Elements that are supported by plumbing or piping, or that have only plumbing or piping connections shall be installed under those Sections.

D. Plumbing, piping, or pneumatic signal connections to elements requiring such connections shall be made under those Sections. Control panels shall be installed in accordance with Division 16 Sections, with piping connections to control panels installed under Division 15 Sections.

E. Drawings are not intended to show every detail of construction or location of piping, ductwork, or equipment. Where proper operation or construction makes it necessary or advisable to change location of piping, instrumentation equipment, air ducts, or other equipment, CONTRACTOR shall so inform ENGINEER for his approval and permission.

3.02 DEMONSTRATION

A. Upon completion of installation and calibration, demonstrate functioning of equipment in accordance with requirements. Where possible, correct malfunctioning units at Site, then retest to demonstrate compliance; otherwise, remove and replace with new or repaired units, and retest to demonstrate compliance.

END OF SECTION

SECTION 13413 - OPTICAL FIBER CABLING SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Product and installation requirements for the following:
   1. Fiber-optic (E-FO, C-FO, V-FO, FO) Cables.
   2. Fiber-optic Connectors, Couplers, and Patch Panels.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product data for each type of product specified.
   2. Product certificates, signed by the communication system manufacturers, certifying that the cables are suitable for the connected equipment as described in "Quality Assurance" Article below.

1.03 QUALITY ASSURANCE

A. Manufacturers Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Connected Equipment Manufacturer Certifications: Where cables specified in this Section are used to provide signal paths for systems specified in other sections of these Specifications, or for systems furnished under other contracts, obtain review of the cable characteristics and certification for use with the connected system equipment by the connected equipment manufacturers.

C. UL Compliance: For cables that may be run in plenum ceilings or other air-handling spaces, provide cables tested for compliance with applicable requirements of UL Standard 910, "Test Method for Fire and Smoke Characteristics of Electrical and Optical Fiber Cables Used in Air-Handling Spaces." In addition, provide FO cables that have passed the UL VW-1 flame test.

D. EIA/TIA Compliance: Comply with applicable requirements of EIA Standards, EIA-440, -455, -458, -475, -509, –568-b.3, and 598-a pertaining to optical fiber cable and system component construction and installation. EIA/TIA-455-61, FOTP-61, Measurement of Fiber or Cable Attenuation Using an OTDR.

E. Fiber Optics Experience: CONTRACTOR must be able to prove to the satisfaction of OWNER that it has significant experience in the installation of fiber-optics cable systems. Installation must include installation of fiber-optics cable, fiber termination, knowledge of interconnect equipment, and a thorough knowledge of testing procedures.

F. Labeling: Handwritten labels are not acceptable. All labels shall be machine printed on clear or opaque tape, stenciled onto adhesive labels, or type written onto adhesive labels. The font shall be at least 1/8 inch in height, block characters, and legible. The text shall be of a color contrasting with the label such that is may be easily read. If labeling tape is utilized, the font color shall contrast with the

background. Patch panels shall exhibit workstation numbers or some type of location identifier, in sequential order, for all workstations or devices attached. Each fiber-optics cable segment shall be labeled at each end with its respective identifier.

G. Fiber-Optics Interconnect Equipment (Patch Panels): Interconnect equipment shall be used in all fiber cable installations. Patch panels shall be mounted in the equipment racks or panel mounted. Interconnect equipment mounted in racks shall be affixed to the rack by at least 4 screws. All fiber-optics interconnect devices shall be assembled and installed in accordance with the manufacturer's instructions and recommendations.

H. Patch Cords: Patch cords shall be provided for each fiber-optic port on the patch panel. Patch cords shall meet or exceed technical specifications of all installed fiber-optic cable. Patch cord connectors shall be matched with patch panel connector type and network fiber module connector type as required.

1.04 COMMISSIONING

A. Subsequent to hook-ups of FO system to signal sources and destination equipment, operate systems to demonstrate proper functioning. Replace malfunctioning FO cabling system items with new materials, and then retest until satisfactory performance is achieved.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. FO Cables:
      a. Corning Infinicor SX+ Optical Fiber, or Equal, for multi-mode applications.
      b. Corning NexCor Optical Fiber, or Equal, for single-mode applications.
   2. FO Connectors and Couplers:
      a. AMP Netcon.
      b. AT&T Network Systems.
      c. Corning.
      d. Honeywell, Inc.
      e. ITT Corp.
      f. Thomas and Betts Corp.
   3. FO Patch Panels:
      a. Panduit.
      b. Volition.

2.02 OPTICAL FIBER CABLING SYSTEMS

A. Fabricate system using manufacturer's standard materials as indicated by published product information and in sizes, types, and performance characteristics as indicated.

B. FO Cables: Factory fabricated, single channel, all di-electric low loss glass type, fiber-optic multimode graded-index cables with the following operational and construction features:
   1. Multi-mode Fibers:

a. Cable Type shall be Corning FREEDM One Indoor/Outdoor Tight-Buffered Cable OM4.
b. Number of Fibers: 6 minimum or as listed on Drawings.
c. Core Diameter: 50 microns or as listed on Drawings.
d. Cladding Diameter: 125 microns or as listed on Drawings.
e. Subunit Size: 2.0 mm or as listed on Drawings.
f. Maximum Attenuation: Less than 2.5 dB/850 nm.
g. Minimum Bandwidth: Greater than 500 MHz-km.
h. Minimum Bend Radius (Unloaded): 10 cm (3.1 in).
i. Operating Temperature Range: -20 to +70 degrees C.

2. Single-mode Fibers:
a. Cable Type shall be Corning FREEDM One Indoor/Outdoor Tight-Buffered all di-electric Cable.
b. Number of Fibers: 6 minimum or as listed on Drawings.
c. Cladding Diameter: 125 microns or as listed on Drawings.
d. Subunit Size: 2.0 mm or as listed on Drawings.
e. Maximum Attenuation: Less than 0.5 dB/1,350 nm.
f. Minimum Bandwidth: Greater than 500 MHz-km.
g. Minimum Bend Radius (Unloaded): 10 cm (3.1 in).
h. Operating Temperature range: -20 to +70 degrees C.

C. FO Connectors: Stainless steel, fiber-optic cable connectors, capable of terminating FO glass cables with diameters from 8 through 1,000 microns. Fabricate connectors with optical fiber, self-centering, axial alignment mechanisms. Select ST or SC style connectors as required or shown on Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions with the Installer present for compliance with requirements, and other conditions affecting the performance of optical fiber cabling system. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION

A. Install fiber-optic cables and associated equipment and devices in accordance with industry standards and manufacturer's written instructions.

B. Install fiber-optic cable without damage to fibers, cladding, or jacket. Ensure that media manufacturer's recommended pulling tensions are not exceeded. Do not, at any time, bend cables to smaller radii than minimums recommended by manufacturer.

C. Install FO cables simultaneously where more than one cable is being installed in same raceway. Use pulling lubricant where necessary; compound used must not deteriorate cable materials. Do not use soap. Use a pulling means, including fish tape, rope, and basket-weave grips, that will not damage media or raceway.

D. No splices are allowed, except at indicated splice points.

3.03 GROUNDING

A. Provide grounding connections for FO cable and other system components as required by manufacturer's written instructions.

3.04 APPLICATIONS

A. Install optical fiber cabling for project applications as detailed on drawings.

3.05 FIELD QUALITY CONTROL

A. Testing: Testing shall be done by CONTRACTOR with at least 5 years of experience in testing fiber-optic cabling systems. CONTRACTOR shall test each fiber strand. **OWNER reserves the right to have representation present during all or a portion of the testing process. CONTRACTOR must notify OWNER 5 days prior to commencement of testing**. If OWNER elects to be present during testing, test results will only be acceptable when conducted in the presence of OWNER. Any fiber-optic cable left non-terminated at the discretion of OWNER, shall be tested using an adequate light source to determine that all installed strands are not damaged.

B. Fiber-Optics Cable: Each fiber strand shall undergo bi-directional testing for signal attenuation losses using power meter and light source. Testing shall also include Optical Time Domain Reflectometer (OTDR) at both 850 and 1,300 nanometers for all installed fiber strands.
   1. Recommended Test Equipment:
      a. Multimode: Siecor OM-100F and OS-100D or equivalent power meter and light source.
      b. Multimode: Siecor OTDRPlus with appropriate modules for testing.
   2. Tests:
      a. Multi-mode: Bi-directional signal attenuation at 850 and 1,300 nm.
      b. Single-mode: Bi-directional signal attenuation at 850 and 1,300 nm.
   3. Test Criteria: Signal loss of less than 10 dB through entire fiber path, including cable, couplers and jumpers.

C. Documentation (Fiber Optic): CONTRACTOR shall provide documentation to include test results and as-built Drawings. Fiber Test Results: The results of the fiber testing shall be entered into the form "Fiber Attenuation Tests Results." Handwritten results are acceptable provided the test is neat and legible. Copies of test results are not acceptable. Only original signed copies will be acceptable.
   1. Each cable installed shall undergo complete testing in accordance with TIA/EIA TSB-67 to guarantee performance to this standard.
   2. All required documentation shall be submitted within 30 days at conclusion of the project to OWNER.
   3. Test Criteria: Pass rate to conform to latest TIA/EIA Standards that incorporate link performance testing through entire path, including cable, couplers, and jumpers.

D. Acceptance: Acceptance of the Data Communications System, by OWNER, shall be based on the results of testing, functionality, and the receipt of documentation.

3.06 CLEANING

A. Clean optical fiber cabling and components of dirt and construction debris upon completion of installation.

END OF SECTION

SECTION 13421 - FLOW MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Magnetic Flowmeter

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include(no or equal):
   1. Magnetic Flow Meter:
      a. Rosemount.

2.02 MAGNETIC FLOW METER

A. Magnetic flow meters shall be either flanged or flangeless type as indicated. Meters 4 inches or smaller shall be wafer style. Meters 6-inch or larger shall be of flange design.

B. Meter body shall be Schedule 10, 304 stainless steel or Schedule 40 steel with 150-pound ANSI flange or AWWA Class D flange when ANSI is not an available option. Meters 4 inches or smaller shall be wafer or flangeless style and shall be designed for installation between 150 Class and 300 Class ANSI, DIN, or BS pipe flanges.
   1. Wafer or flangeless style meters 4 inches or smaller shall have a ceramic, Teflon, or Tefzel liner and Hastelloy "C" or platinum electrodes as indicated.
   2. Meters 6 to 12 inches shall have Teflon or polyurethane liner and Hastelloy "C" or platinum electrodes as indicated.
   3. Meters 14 inches and larger shall have an Elastomer or polyurethane liner and Hastelloy "C" or platinum electrodes as indicated.

C. Liner material shall be suitable for the process flow indicated on Drawings.
   1. Meters 4 inches or smaller shall be furnished with a Teflon or Tefzel liner. Exception: Ceramic liner shall be furnished for meters 4 inches or smaller used for lime slurry, sludge, and abrasive process flows.
   2. Teflon liner shall be furnished for meters 6 to 12 inches.
   3. Polyurethane liner shall be furnished for meters 14 inches and larger, or if not indicated otherwise on Drawings or in the Specifications.

D. Electrodes shall be suitable for the process flow indicated on the drawings and shall be bullet nosed style made of Hastelloy "C." Exception: Platinum electrodes shall be provided for sodium hydroxide or other caustic process applications.

E. Start-up and acceptance check for flow meters shall be performed by a qualified employee of flow meter manufacturer. Service personnel of sales representative or of equipment supplier of this Section will not be accepted.

F. Meter shall be capable of withstanding continuous submergence in up to 30 feet of water without damage. Field coil design shall be such that they shall not overheat or otherwise be damaged if flow tube is not totally filled with fluid. Magmeters shall be provided with 2 grounding rings. Meter cables shall be factory sealed in meter head by manufacturer. Coordinate exact cable length between meter and transmitter with installation Contractor.

G. Magnetic flow meter signal converter shall consist of solid-state, feedback-type microprocessor circuitry. Operational parameters shall be user configurable locally via an integral push-button arrangement or via a remote intelligent terminal. Appurtenances, including hand-held programmer and/or programming software, shall be provided for local configuration of operational parameters. Converter shall change a low-level flow signal from sensor electrodes into a proportional isolated 4-20 mA DC signal. The converter shall have an extremely high input impedance and not be affected by quadrature noise. The unit shall be capable of accommodating uni-directional or bi-directional flow. Sensing of meter failure shall activate a user-configurable zero or 130 percent output signal and a failure alarm contact closure.

H. Where indicated on Drawings, a high-frequency digital proportional output shall be provided for use with high-accuracy totalizers. To eliminate errors, the converter shall incorporate an integral zero return circuit to provide a constant zero output signal in response to an external dry contact closure. An automatic empty pipe detector and low-flow cutoff shall be provided as standard.

I. Magmeter shall be electronically isolated for grounding. Where insulated or nonconductive pipe is used, only orifice plate-type grounding rings will be acceptable. Grounding electrodes which penetrate the liner will not be acceptable. Ground ring tabs shall be of suitable length to extent above flanges of meter.

J. Unit shall be supplied with an integral or local conduit-mounted flow indicator calibrated in engineering units. Indicator shall be tagged showing design range in units being measured and shall be capable of simultaneously displaying flow rate and totalization with an alphanumeric display.

K. Zero stability shall be achieved by pulsing the sensing head magnetic field coils with a regulated direct current, first in one direction and then in opposite direction.

L. Continuous zero stability shall be obtained by signal sampling during the quiescent coil states. There shall be no zero offset or zero adjustments required. The converter shall not require calibration over its expected life under normal use.

M. Flow meter shall operate within Specifications on 120 volt AC plus 10 percent and 60 hertz plus 5 percent. Power consumption shall not exceed 25 VA for meters 24 inches and smaller, and 50 VA for meters 30 inches or greater.

N. Input span shall be adjustable between 0-1 and 0-30 feet per second and range adjustment shall be digital. Converter shall include adjustable damping circuitry. Unit shall not be affected by power line aberrations such as those produced by SCR-type motor controllers or other voltage transients.

O. System accuracy, including primary magnetic flow meter, shall be plus 0.5 percent of rate for maximum flow velocities from 1.33 to 33.33 feet per second, and plus 1 percent of rate for maximum flow velocities from 0.7 to 1.32 feet per second. Repeatability shall be plus 0.1 percent of span. Rangeability shall meet or exceed 30:1 turndown.

P. The signal converter portion of the magnetic flow meter shall include both a magnetic driver to power the magnetic coils and the signal converter electronics. The converter shall have the ability to be either integrally or remotely mounted as specified. If not specified, converter shall be remotely mounted. It shall be housed in a NEMA 4X case. When remotely mounted, the signal cable shall be provided with the proper length.

Q. Magmeter manufacturer shall comply with ISO9000 Standards and the meter shall be FM approved. Signal converters shall be interchangeable without effect of meter accuracy or the need for recalibration for all meter sizes. Provide spool-piece for meters sized 12 inches and smaller.

PART 3 - EXECUTION

3.01 GENERAL

A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 13423 - LEVEL MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:
   1. Cord type float switch.
   2. Radar Transmitter

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include(no or equal):
   1. Cord Type Float Switch:
      a. Anchor Scientific, Inc.
      b. Consolidated Electric Co.
      c. Pulsar, Inc.
   2. Radar Transmitter(exact model as shown on drawings):
      a. Vega- Rated class 1, division 1 group c and d with remote indicator rated class 1, division 1 ground c and d.

2.02 FLOAT SWITCH (CORD TYPE)

A. Direct acting float switch shall be furnished to automatically detect liquid level change. Liquid rise of 1 inch from rest position shall operate float switch and reset will occur when liquid level drops 1 inch. Mounting shall be to a 1-inch vertical pipe for multiple float applications or to a flange for a single float application as shown. Free cable hanging floats with weights shall not be acceptable.

B. Float switch shall consist of 316 type stainless steel housing, mounting clamp for 1-inch-diameter pipe, flexible 3-conductor cable with a synthetic rubber jacket, and mercury switch. Inside float housing will be a (normally open/closed) mercury switch potted in epoxy. Electrical load for switch contacts shall be rated 115 volt AC at 0.5 horsepower inductive load.

C. Three-conductor cable shall be 14 AWG with 105 strands per conductor made for heavy flexing service and underwater use. A green grounding wire shall connect internally to float housing.

D. Provide mercury free float switches with molded ABS housing and Form C contact switch. CONTRACTOR shall ensure ampere rating is suitable for load shown on Drawing.

PART 3 - EXECUTION

3.01 GENERAL

A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 13424 - PRESSURE MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:
   1. Pressure seals.
   2. Diaphragm seals.
   3. Pressure to current (P/I).

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include (no or equal):
   1. Pressure Seals:
      a. Ashcroft.
      b. OPW (Ronningen-Petter).
      c. Red Valve.
   2. Diaphragm Seals:
      a. Ashcroft.
      b. ITT Conoflow.
   3. Pressure to Current:
      a. Rosemount.

2.02 PRESSURE SEALS

A. Pressure seals shall be of the isolation ring type.

B. The seal construction shall consist of a body, 360-degree flexible elastomeric cylinder with positive O-ring type sealing arrangement, captive sensing liquid and 2 assembly flanges. The Iso-Ring ID shall match the pipeline ID. The Iso-Ring OD shall not exceed the ID of the piping flange bolt circle. Units shall be designed to fit 125-pound, 150-pound, and 300-pound ANSI piping flanges, as shown on Drawings.

C. When not shown, this information shall be obtained by CONTRACTOR from ENGINEER.

D. The process liquid pressure is transmitted through the flexible cylinder wall and the captive sensing liquid to the pressure seal.

E. The seal body shall be carbon steel unless otherwise required. Two assembly flanges are carbon steel or 316SS. Flexible elastomeric cylinder is Buna-N or natural rubber. Captive sensing liquid is 50 percent ethylene glycol and water mix or silicone (specify one).

F. Seal weight in pounds not to exceed four times the nominal pipe size in inches.

G. Installation: Centering gauges shall be provided to align the ID of the isolation ring with the ID of the process pipeline, holding the ring in place during installation.

2.03 DIAPHRAGM SEALS

A. Diaphragm seals shall isolate the process measuring instruments from the process fluid. The diaphragm seal shall be of the removable type. The diaphragm seal shall be filled with liquid, compatible for the process shown to be measured on Drawings. The diaphragm seal shall be supplied with gaskets, bolts, capillary tubing, and fill fluids.

2.04 PRESSURE TO CURRENT (P/I)

A. Pressure to current signal converter shall be 2-wire, solid-state electronic, temperature-compensated, strain gauge or capacitive type. Process pressure shall be applied to sealing diaphragm in measuring section. This pressure shall be transmitted to a measuring element connected to the electronics of the transmitter. Converter shall include a repairable circuit board mounted in a cast aluminum explosion-proof housing. Transmitter shall output an isolated 4-20 mA signal proportional to pressure measurement. Adjustable electronic damping shall be provided from 0 to 16 seconds in electronically adjustable increments of 0.1 second.

B. Positive overage protection shall be provided to 2,000 psig. Diaphragms and wetted parts shall be 316 stainless steel, except where other special alloys are required to prevent corrosion.

C. Accuracy shall be within plus or minus 0.1 percent of calibrated span for spans from 1:1 to 15:1 of URL. Stability shall be plus or minus 0.1 percent of URL for 6 months. Zero suppression and elevation shall be at least 500 percent of range.

D. In applications where pressure transients may occur (i.e., level for elevated and ground storage tanks, pumping pressure, etc.), CONTRACTOR shall include snubbers in pressure tap line and an electronic signal time constant which will reduce pressure transients to plus or minus 1 percent of calibrated span. Time constant is to be achieved by placing it in panel providing power to pressure transmitter.

E. Units shall be supplied with an integral digital indicator calibrated 0 to 100 percent. Provide hand-held configurator.

PART 3 - EXECUTION

3.01 GENERAL

A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 13430 - CONTROL PANELS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Control panels and consoles.
2. Switches, push-buttons, lights.
3. Relays.
4. Intrinsically safe isolator relays.
5. Timing devices.
6. Terminal blocks.
7. Control power transformers.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Sections 01330 and 13410, Shop Drawings covering the items included under this Section.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Codes, Ordinances, and Industrial Standards: Design, testing, assembly, and methods of installation for materials, electrical equipment, and accessories proposed under this Section shall conform to National Electric Code and to applicable State and local requirements.
2. UL listing and labeling of custom-built panels (UL 508) shall be adhered to under this Contract.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Switches, Push-Buttons, Lights:
a. Allen-Bradley (Type 800MR).
b. American Solenoid Company.
c. Arrow Hart (Type OB).
d. Electroswitch. (Type M5, KW or Series 24)
e. Microswitch (Honeywell) (Series PW).
2. Relays:
a. Potter-Brumfield (Type KUP).
b. Schrack North America, Inc. (Type CAD).
c. Schneider Electric (Square D). (Type KU).
d. Struthers-Dunn (Type A283).
3. Latching Relays:
a. Deltrol (Type 105 ML).
b. Potter-Brumfield (Type KBP).

c. Struthers-Dunn (Type 255 or 455).

4. Signal Switching Relay:
   a. Airpax.
   b. American Zettler, Inc.
   c. Aromat.
   d. Potter-Brumfield (Type RIOL).
   e. Sigma.
5. Intrinsically Safe Isolator Relay:
   a. B/W Controls, Inc.
   b. MTL, Inc.
   c. R. Stahl, Inc.
   d. Symcom, Inc.
   e. Warrick Controls.
6. Solid-State Timers:
   a. ATC (Series 306D).
   b. Eagle Signal (Type DG100).
7. Solid State Repeat Cycle Timers:
   a. ATC (Series 342).
   b. Eagle Signal (Type DA100).
8. Terminal Blocks
   a. Allen-Bradley (Type 1492-CE6).
   b. Altech (Type CTS4U-N).
   c. Schneider Electric (Square D) (Class 9080, Type KCA-1).
   d. Thomas & Betts (100 series or 200 series).
   e. Weidmueller (SAKD2.5N or SAK2.5).
9. Fusible Terminal Blocks:
   a. Allen-Bradley (Type 1492-CE6).
   b. Altech (Type CAFL4U).
   c. Schneider Electric (Square D). (Class 9080, Type KH-1).
   d. Weidmueller (SAKS1 or ASK1).
10. Control Power Transformers:
    a. Acme.
    b. Sola.
11. Textured Polyurethane Enamel:
    a. Sherwin-Williams, Polane T and/or Polane HST.
12. Wire Markers:
    a. Brady.
    b. T&B.
    c. Westline.

2.02 CONTROL PANELS

A. Sheet Metal Construction:
   1. Panels shall be fabricated from sheet steel welded and bolted into a rigid self-supporting structure a maximum of 90 inches high and a minimum of 20 inches deep. Overall length shall be coordinated with space requirements as indicated by Drawings. Changes in length from that shown on Drawings must be brought to attention of ENGINEER within 90 days of Contract Award. Cost to modify floor plan or wall opening shall be at CONTRACTOR's expense after this 90-day period. Panel face layouts shown on Drawings are intended to indicate relative

position of all components. Supplier shall fix exact locations and overall dimensions to meet requirements of its equipment.

2. Panel and console bodies shall be 12 gauge minimum steel for panels up to 42 inches in width, and 10 gauge minimum steel for panels exceeding 42 inches in width. Panel subplates shall be same gauge as enclosure. Stiffening members shall be provided for strength and stiffness as required.
3. A minimum of 3 inches shall be provided between edge of panel subplate and outside walls of panel body to ensure adequate wire-way space for external wires entering panel. Panel subplate shall be mounted on collar studs for easy removal. Print pockets shall be provided on each panel. Brackets welded to inside of panel, complete with lights, shall be provided on panels where indicated by Drawings.
4. Identification plates shall be laminated phenolic with white letters engraved on a black background and mounted with screws or double-back adhesive foam tape.
5. All components inside panel shall have identification plates. This includes instruments, relays, switches, circuit boards in plug-in racks, etc. Identification plates shall include engineering symbols (FBQ-1, SW-3, FIC-4, CR-1, etc.). Switches and circuit breakers inside panel shall have names (Horn, Audio Tone, Panel Power, etc.) on identification plates as well as engineering symbol.
6. Identification plates shall be located on or adjacent to device they are identifying and shall be readable without looking around, under, or on top of device to find identification plate.

B. Access:
   1. Wall- and/or floor-mounted control panels shall have continuous piano-hinged doors for ease of access. Door openings shall expose a minimum of 80 percent of panel interior. Door openings shall be sealed with a 0.125-inch thick minimum cellular neoprene gasket cemented with oil-resistant adhesive and held in place with a retaining strip. Print pockets shall be provided on each door. Two door enclosures shall have a removable center post. Panel doors less than 40 inches high shall be equipped with a 2-point latching mechanism. Panel doors 40 inches high or more shall be equipped with a 3-point latching mechanism.
   2. Components and terminals shall be accessible without removing another component except covers. Swing out sections shall be used if mounting space is required that is not normally accessible.
   3. Panels shall have open bottoms except where structural members are required.

C. Finish:
   1. Panel face openings for mounting equipment shall be smoothly finished cut with counterboring and trim strips provided as required to give a neat finished appearance. Bezels shall be used on all front panel-mounted devices to cover panel cutouts. A chrome-plated or stainless steel bezel shall be used at parting line of panels that have shipping splits or at parting line of panels placed end to end.
   2. Graphic plates, when used, shall be fastened to panel frame with fasteners not visible from front of graphic.
   3. After fabrication, panel surfaces shall be given a phosphatizing treatment inside and out, and then finished with 2 coats of textured polyurethane enamel. Panel interior shall be painted white, ANSI No. 51. Exterior color will be selected by ENGINEER.
   4. Panels shall have identical exterior finishes as selected by ENGINEER. Panel finishes on matching colored panels shall be identical. It is supplier's responsibility to achieve this result, especially for panels fabricated in different shops.

D. Pneumatics:
   1. Interior panel piping shall be grouped, supported, and terminated at bottom of panel at bulkhead fittings unless indicated otherwise. Terminations shall be clearly tagged.
   2. Tubing shall be color-coded per ISA RP7.2. Pneumatic systems shall be tested per ISA RP7.1.

E. Electrical:
   1. Internal panel wiring shall be 19 strand No. 16 AWG, 90^{O}C MTW, Class C stranded, or THHN/THWN approved as 90^{O}C MTW. All panel wiring not run in wire ducts shall be bundled and tied. Each wire shall be identified at both ends with same exclusive number. Number shall be same number shown on control schematic. Number shall not be used again for any other purpose. Wires marked differently on each end will not be accepted. Wire markers shall be provided on end of each wire at termination point.
   2. Control wiring associated with control circuits de-energized when main disconnect is opened shall be color-coded red. Control wiring associated with control circuits which remains "hot" when main disconnect is opened shall be color-coded yellow. DC control wiring shall be color-coded blue. Ground wires shall be color-coded green. Terminal blocks shall be numbered in numerical order. Yellow wiring leaving panel shall be brought to an isolated set of terminal blocks.
   3. Provide an instrument common bus 0.1 by 0.5 by 6-inch minimum in enclosure and isolated from enclosure. A separate instrument common wire shall be run from each common terminal on an instrument to instrument common bus. Instrument common wires looped from one terminal to another and then to instrument common bus will not be accepted.
   4. Instrument common bus shall be connected to power supply common with a wire or wire braid strap as short as practical and of sufficient capacity to prevent troublesome voltage drop. Common terminals and common bus for instrument common shall be tagged "Instrument Common." Instrument signal wires of 4-20 mA or 1-5V shall be shielded wire. Telephone wires and telemetry equipment interconnection wires shall be shielded wires.
   5. Provide a copper ground bus 0.1 by 0.5 by 6-inch minimum in enclosure to which all instrument grounds and panel enclosure are tied. Separate ground wire shall be run from instrument enclosure ground terminal directly to ground bus. Instrument ground wires looped from one instrument to another will not be accepted. Under no circumstances shall neutral side of power source or any other terminals used for grounding power circuits be used as an instrument common.
   6. Wires to internal components shall be connected to inside of terminal strip. Wires to external components shall be connected to outside of terminal strip. No more than 2 wires shall be connected to one terminal point.
   7. Panel wire duct shall be provided between each row of components and adjacent to each terminal strip. Wire ducts shall be a minimum of 1-inch wide and 3 inches deep with removable snap-on covers and perforated walls for easy wire entrance. Wire ducts shall be constructed of nonmetallic materials with a voltage insulation in excess of maximum voltage carried therein.
   8. Floor-standing panels and consoles shall be equipped with a flange mounted 600V rated main non-automatic trip circuit breaker or disconnect switch. Single phase, 60 hertz power at voltage shown on Drawings shall be supplied to main disconnect. Panel fabricator shall provide any additional voltages and power requirements at control panel to meet requirements of equipment contained therein.
   9. Disconnect and transformer shall have enclosed protected terminations to prevent accidental shock.
   10. Relays, timers, etc., installed on panel subplate shall be provided with a minimum spacing between component and wire duct of 1.5 inches above and 1 inch below. Minimum spacing between adjacent components shall be 0.25 inch. Relays, timers, etc., shown in schematics are

intended to show function. Additional relays may be required in conjunction with items shown to provide total number of contacts required. Where limit, pressure, float switches, etc., are used and more than SPDT contacts are indicated by schematics, provide additional contacts required by using auxiliary relays. However, if a DPDT switch is called for, using a SPDT with a relay will not be accepted. All control and pilot devices such as relays, timers, etc., shall be 120V, 3 amp rated except where noted with coil voltage as required. One N.O. spare contact shall be provided on each relay.

F. Panel/Subplate Layout:
   1. Panel face-mounted equipment shall consist of pilot lights, push-buttons, selector switches, meters, indicating timer, etc. Spacing between horizontal rows of components shall be 1.5 inches minimum; spacing between vertical columns of components shall be 1.875 inches minimum. Components shall be grouped and/or located as indicated on Drawings. Distance from bottom row of components to floor shall be not less than 36 inches. Top row of recording and indicating instruments shall be centered approximately 60 inches above floor. Maximum height for annunciator windows shall be 85 inches above floor. In general, indicating lights, push-buttons, etc., shall be mounted in accordance with sequence of operation from left to right and top to bottom.
   2. A minimum of 2 inches shall be provided between terminal strips and wire ducts or terminal strips and terminal strips. In general, terminal strips shall be mounted on vertical edges of subplate. Where terminal strips are mounted side-by-side, terminals shall be elevated 1.5 inches above subplate to allow wires to pass underneath.
   3. Subplates shall have a minimum of 15 percent spare mounting space, and terminal strips shall have a minimum of 20 percent spare terminal blocks.

2.03 SWITCH, PUSH BUTTONS, LIGHTS

A. Selector switches shall be 120 VAC rated, oil-tight construction with standard operator knob.

B. Start push buttons shall be 120 VAC rated, oil-tight construction with extended guard and black color insert.

C. Stop push-buttons shall have a half-guard with red color insert. Contacts shall be rated NEMA B-150 and P-150.

D. Pilot lights shall be push-to-test oil-tight construction with cap colors and voltages as required. Pilot light shall be supplied with Light Emitting Diode (LED) type light module.

E. Nameplates for each switch and light shall conform to manufacturer's series and type with engraving as called for on Drawings.

2.04 RELAYS

A. Control Relays: Switching and output relays shall be plug-in type with contacts rated 120 VAC, 3 amp with 120 VAC or 24 VDC coil, indicating light, manual operator, and plastic transparent cover. Relays shall have a retainer mechanism to prevent loosening from vibration. Relays shall not be used for switching 1-5 VDC or 4-20 mA signals associated with instruments.

B. Latching Relays: Latching relays shall be transparent enclosed plug-in type with mechanical or magnetic latching, mechanical holding device, contacts rated 120V at 3 amps, and continuous duty

coils. These relays shall not be used for switching 1-5 VDC or 4-20 mA signals associated with instruments.

C. Signal Switching Relays: Instrument relays shall be those relays switching a 1-5 VDC or 4-20 mA signal. Instrument relays shall be transparent enclosed plug-in type with indicating LED and mechanical holding mechanism. Relay contacts shall be dry circuit type rated 250 mA maximum. Contact material shall be a gold-platinum-silver alloy.

2.05 TIMING DEVICES

A. Solid-state timers shall be plug-in type.

B. Solid-state timers with ON or OFF delay cycles shall operate at 120 VAC, 60 hertz. Solid-state device may be analog or digital in operation. Time interval shall be as shown on Drawings or as required.

C. Solid-state repeat cycle timers with adjustable ON-OFF cycles shall operate at 120 VAC, 60 hertz. Solid-state device may be analog or digital in operation. Time interval shall be as shown on Drawings or as required.

2.06 TERMINAL BLOCKS

A. Terminal blocks shall be 300 or 600 volt rated, channel-mounted box lug with pressure plate type or binding head screw type with pressure plate, and shall have a white marking strip. Terminal blocks shall be color-coded according to the following coloring scheme:

Black	120V power circuits de-energized when main disconnect is opened.
White	120V neutral conductors.
Red	120V control circuits de-energized when main disconnect is opened.
Yellow	120V control circuits which remain hot when main disconnect is opened.
Blue	Terminal blocks for DC wiring.
Gray	Terminal blocks for shields in DC wiring.
Green	Ground terminal blocks.

B. For terminals associated with 120V nonisolated input cards, individually fused terminal blocks shall be used for 120V power to field devices.

C. Provide a minimum of 20 percent spare terminals for each type and color of terminal used. All terminals of a given color shall be grouped with other terminals of the same color.

2.07 CONTROL POWER TRANSFORMERS

A. Control power transformers shall be sized to handle in-rush currents and to accommodate continuous load of circuits plus 25 percent future load with 5 percent or less voltage drop. Transformer primary voltage shall be as indicated on Drawings.

PART 3 - EXECUTION

3.01 GENERAL

A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

SECTION 14551 - SCREENINGS WASHER-COMPACTOR CONVEYORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Labor, materials, and equipment necessary for fabrication, production, installation, and erection of the items specified in this Section as shown on Drawings or listed on Schedule.

B. This is a performance specification. Operating conditions are identified in this Section. The manufacturer is solely responsible for the design of this system, including all materials of construction, to meet these operating conditions. The design parameters indicated in this Section are minimum requirements and shall not be construed as the ENGINEER assuming design responsibility or liability. If any of these specified parameters are incompatible with the manufacturer's design or the specified operating conditions, it shall be the responsibility of the manufacturer to promptly inform the OWNER and ENGINEER in writing. Equipment shall meet the control and communication requirements detailed in Electrical and Instrumentation drawings.

C. The system design is based on Duperon (Basis of Design). The washer-compactor are integral to the preliminary treatment system operation, performance and layout. Approval by ENGINEER is required for any proposed deviations from the basis of design.

D. Performance Requirements
   1. The washer/compactor system shall be a complete functional process with all necessary equipment components, and all associated instrumentation and controls.
   2. The equipment shall be designed for continuous conveyance operation for capture of debris discharged from screen unit to disposal of material in rolloff dumpster shown on drawings.
   3. The washer/compactor shall be automated to provide self-cleaning to maintain continuous operation for the loadings indicated in the Schedule

E. Related Sections
   1. Section 11330- Screening Equipment

1.02 REFERENCES

A. Reference Standards:
   1. ANSI B105.1, Welded Steel Conveyor Drum Pulleys.
   2. ASTM A 36, Steel.
   3. ASTM A 242, Steel.
   4. ASTM A 588, Steel.
   5. SAE 4140, HiCarbon Flats.

1.03 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section.

B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.

C. Record Drawings. At Project closeout, submit record drawings of installed products, in accordance with requirements of Section 01770.

D. Test and Inspection Report: A written report shall be submitted to ENGINEER documenting testing and/or inspection results. The report shall be prepared as noted under Section 01600.

E. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section. The equipment shall be warrantied for a period of 3 years (36 months) after component acceptance.

1.04 MAINTENANCE

A. The following spare parts shall be furnished for use after expiration of the warranty period:
   1. Screw Type Washer-Compactors:
      a. Lubrication grease.
      b. 1 spare set of brushes or wipers
      c. 2 spare set of auger slides or supports
      d. 1 spare set of wash water solenoids

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Screw Type Screenings Washer-Compactors:
      a. Duperon

2.02 MATERIALS OF CONSTRUCTION

A. Inlet Hopper: 304 stainless steel.

B. Screw Flights: 304 stainless steel.

C. Screw Shaft: 304 stainless steel.

D. Screw Housing: 304 stainless steel.

E. Drainage Trough: 304 stainless sheet steel.

F. Discharge Tube: 304 stainless steel

G. Fasteners: 304 stainless steel.

H. Finishes: All stainless steel components shall be fully submerged in a pickling bath for at least eight hours to remove welding spots and to protect the stainless steel from corrosion.

2.03 MANUFACTURED UNITS

A. A screenings washer-compactor as shown on Drawings and indicated on Schedule shall be provided to wash, compress, dewater, and convey sewage screenings, including rags, miscellaneous woods, plastics and metals. Each compactor shall consist of an inlet hopper, washing system, dewatering/conveyance mechanism, drive unit, discharge duct, drain system, and control panel. The complete system shall be factory-assembled and tested prior to shipment.

B. Washer-compactors shall have a minimum capacity as indicated on Schedule. The units shall be designed to reduce the screenings water content to 30 percent as a minimum.

C. All necessary structural members for supporting the washer-compactors, discharge tube, service platforms, and safety guards shall be designed and furnished by the equipment manufacturer. Washer-compactors shall be screw-type as herein specified and listed on Schedule.

2.04 COMPONENTS

A. Inlet Hopper:
   1. An inlet shall be provided to help direct material from the discharge chute of the screening equipment into the dewatering/compaction mechanism. The inlet hopper requirements shall be coordinated with the screeningequipment discharge design.
   2. The inlet hopper shall be fabricated of not less than 14-gauge stainless steel plate. Sidewalls shall be inclined at a minimum angle of 60 degrees from the horizontal axis to prevent solids accumulation in the hopper and on the three facing sides. The hopper shall extend approximately 6 inches above the discharge chute of the screening equipment to ensure complete collection of screened materials.
   3. The top of the inlet hopper shall not extend more than 3’-6” above the finished floor as shown on the Drawings.

B. Washing System:
   1. The spray system shall include nozzles as required for washing and removing organics from the screenings.
   2. A solenoid valve shall be included to control the flow so that the water supply is sequenced with the operation of the washer-compactor. Solenoid valves shall be suitable for use with Plant Effluent water.
   3. Piping shall be stainless steel and sized as required for washing and removing organics from the screenings.
   4. The housing shall be minimum 14 gauge stainless steel formed sheet metal with flanges and neoprene gasketing.
   5. Plant Effluent Water shall be connected to the Washing System by others and is supplied to the Grit Battery B Building at a pressure of approximately 60 psi through a 1-1/2 inch pipe.
   6. The washing system shall include a minimum of 3 feet of flexible water supply piping and a quick disconnect fitting at the compactor-washer.

C. Press Zone:
   1. The Press Zone shall be constructed of 12 gauge (min.) perforated Grade 304 Stainless Steel plate and/or 11 gauge (min.) Grade 304 Stainless Steel Plate. The perforations shall be a maximum 3/16” diameter.
   2. The Press Zone design shall tubular or rectangular in design with an integral collection pan located directly under the zone.

3. Periodically, water shall be introduced into the collection chamber under the Press Zone to flush organics and other fines. Flushing with water shall be five (5) seconds in duration and engage once every operating cycle. The Press Zone water supply shall be approximately 10 to 20 gpm at 30 psig. After each flushing cycle, the organics and other fines flow down to the base of the collection trough to the drain outlet and back into the wastewater flow. The Press Zone shall include a solenoid valve to control the flow into the collection trough.

D. Dewatering/Conveyance Mechanism:
   1. Screw Type Washer-Compactors. A variable or uniform pitch screw shall be provided to dewater the received screenings and convey the compacted material to the discharge point shown on Drawings. The screw shall be constructed of flights welded to a solid shaft. Flights shall have a minimum thickness of 14-gauge and shafts shall be a minimum diameter of 2-3/4 inches. The screw shall extend into the screw housing beyond the length of the inlet hopper.
   2. Screenings shall be compacted to a minimum of 60 percent by volume.
   3. The screenings shall be dewatered to a minimum of 30 percent solids.
   4. The flight assembly shall include a torque tube constructed from Schedule 80 Type 304 stainless steel pipe.
   5. The screw housing shall be fabricated of 14-gauge stainless steel. Wearing elements shall be arranged inside the housing to prevent all contact between the screw and housing. The lower section of the housing shall be provided with drainage slots which are designed to allow free drainage of water without excessive clogging.
   6. Brushes or wipers shall be attached to the screw to clear solids from the drain pan.
   7. Unit shall have min of 10-inch discharge flange connection.

E. Drive Units:
   1. Screw Type Washer-Compactors: A drive motor and speed reducer unit shall be provided to drive the dewatering/conveying screw. The motor shall be as listed on Schedule and shall conform to the requirements listed in Section 16220.
      a. The speed reducer shall conform to the requirements listed in Section 01600. The speed reducer unit shall include anti-friction bearings with high overhung load properties and a double-lip, high-temperature synthetic oil seal riding on a precision ground shaft.
      b. Gears shall be made of hardened and heat-forged steel. The main bearing for the screw shaft shall have machined mounting surfaces, precision-ground raceways and chrome alloy steel balls separated by spacers and shall be designed to recover the axial load developed by the compacting screw.
      c. The speed reducer shall be mounted inside a totally enclosed, oil or grease filled, cast iron gear casing. The gear case shall be isolated from the compactor body by seals which are specifically designed to prevent contamination of the gear case.
      d. Shall be rated for Class 1 Div 1 area.

F. Drain System:
   1. A drain system shall be provided to collect the water from the washing and dewatering process and return the flow to screening channel or other location as shown on Drawings. The drain system shall provide free drainage without plugging. A drainage trough shall be fabricated of 304 stainless sheet steel and shall be designed for easy removal to allow periodic cleaning. On washer-compactor designs where the collection trough is not easily removable, the trough shall be provided with inspection ports and a washing system designed to clean the trough and drainage openings. A minimum 3-inch-diameter drain shall be provided in the drainage trough. The drain system shall include a quick disconnect connection near the compactor-washer.

G. Discharge Chute:
   1. Discharge pipe shall be made of stainless steel and shall be connected to the unit by a flange connection. The diameter of the discharge pipe shall increase in size to ease in transport of material to disposal. All bend fittings shall have a radius of three times (3x) larger than the chute diameter. Manufacturer shall design chute sizing to convey material to location and distance indicated on the drawings.
   2. Manufacturer shall design and furnish stainless steel pipe stand supports to support the discharge chute (minimum of 2) to floor and overhead support beams. The connection of the support to the chute shall be able to be removed.
   3. The discharge chute shall have intermediate flange connection (minimum of 4) for disassembly and rotation of chute discharge.
   4. The discharge chutes shall have lifting eyes welded to the top of the chute for removal of pipe from above.

H. Local Control Panel: The screenings washer-compactor shall be provided with a locally mounted NEMA 7 push button control package for Local/Off/Remote, Forward, Jog Reverse, Selector Switches, and Emergency Stop.
   1. A power monitor unit designed to provide instantaneous shut off for torque overload conditions shall be provided. Mechanisms which employ the use of shear pins for overload protection shall not be acceptable.

I. Main Control Panel: The Washer/Compactor system shall be controlled through the Main Control Panel included with Screening Equipment, Section 11330.
   a. Panel shall include manufacture recommended selector switches, push buttons, control relays, terminal blocks, intrinsically safe relays, etc. for a fully function system. Each unit shall have controls, pushbuttons, monitoring, etc. for independent control of unit.
   b. At a minimum the following indicator lights shall be provided at each control panel:
      1) Compactor Fail
      2) Compactor Running
      3) System Power On
      4) Reset button
      5) E-stop button

J. Fasteners: All fasteners and anchor bolts shall be provided by the equipment manufacturer and shall be of 304 stainless steel.

2.05 ACCESSORIES

A. Positioning System: A caster type Positioning System shall be provided as indicated on the Drawings. A minimum of six casters shall be provided and the system shall be sized for supporting and manually moving loaded compacting equipment along the length of the beams. Each caster shall be capable of 360 degree rotation. A braking system shall be provided as part of the system to lock the compactor-washer in place.

B. Quick Disconnect Anchoring System: Provide quick disconnect anchoring system of clamping retractable pin type. The clamp shall extend, retract, and lock the pin into position. The pin shall penetrate the equipment supports and extend into a receiving end embedded into the floor. Furnish the receiving socket as part of the anchoring system. Coordinate the position of the sockets with CONTRACTOR. Provide a minimum of four anchoring locations. Pins shall be non-magnetic stainless steel and adequate size to prevent the compactor-washer from moving.

C. Rotation Sensor: Provide a Rotation Sensor mounted in the Discharge Module to detect the Spiral rotation.

D. Emergency Pull Cord: Provide an Emergency Pull Cord and Safety Switch. The cord shall run the full width of the inlet hopper. The Safety Switch shall immediately stop the system when the switch is actuated.

PART 3 - EXECUTION

3.01 ERECTION

A. Equipment furnished under this Section shall be fabricated, assembled, erected, and placed in proper operation condition in full conformity with detail drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer approved by ENGINEER.

SCREW WASHER-COMPACTOR CONVEYOR EQUIPMENT SCHEDULE

Location	Quantity	Approx. Compaction Zone Length	Service	Capacity (cu.ft./hour)	Motor Description	Accessories
Grit Battery B Building	2	40 Feet	Wastewater Screening	100	Minimum 1.5 Hp, TEEP, 460/3/60	Quick Disconnect Anchoring System Rotation Sensor, Emergency Pull Cord

Remarks:

1. Maximum inlet hopper height shall be 3'-6". Coordinate inlet hopper height with screening mechanism manufacturers.
2. Motor shall be right angle drive.
3. Manufacturer shall provide and factory test local and main control panels.

END OF SECTION

SECTION 15013 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Electronically commutated motors (ECM)

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type or ECM.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 15017 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.
4. Silicone sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized, with plain ends and integral welded waterstop collar.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.

4. Metraflex Company (The).

B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
4. Pressure Plates: Stainless steel, Type 316.
5. Connecting Bolts and Nuts: Stainless steel, Type 316 of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, and concrete walls as new walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   2. Using grout or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves.

2. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Interior Partitions:

a. Piping Smaller Than NPS 6: Steel pipe sleeves.

END OF SECTION

SECTION 15018 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.

1.3 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed and salvaged, or removed and reinstalled.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Cast-Brass Type: With polished, chrome-plated or rough brass finish and setscrew fastener.

C. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.

D. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.

E. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed or exposed-rivet hinge; and spring-clip fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
b. Chrome-Plated Piping: One-piece cast brass or split-casting brass with polished, chrome-plated finish.
c. Insulated Piping: One-piece cast brass with polished, chrome-plated finish.
d. Bare Piping in Equipment Rooms: One-piece cast brass with rough-brass finish.

3.2 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons.

END OF SECTION

SECTION 15019 - METERS AND GAGES FOR PLUMBING AND HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Dial-type pressure gages.
2. Gage attachments.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 DIAL-TYPE PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.

2. Case: Liquid-filled, Solid-front, pressure relief type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Stainless steel.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.2 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball, with NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

B. Install valve and snubber in piping for each pressure gage for fluids (except steam).

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each pressure-reducing valve shall be the following:

1. Sealed, direct-mounted, metal case.

PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Facility Natural Gas Piping: 0 to 100 in-wg.

END OF SECTION

SECTION 15023 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. PVC ball valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and soldered ends.
3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Actuator Types:
1. Handlever: For quarter-turn valves smaller than NPS 4.

G. Valves in Insulated Piping:

1. Include 2-inch stem extensions.
2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.2 PVC BALL VALVES

1. Description:

a. Standard: MSS SP-122.
b. Pressure Rating and Temperature: 150 psig Insert value at 73 deg F.
c. Body Material: PVC.
d. Body Design: Union type.
e. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded.
f. Ball: PVC; full port.
g. Seals: PTFE or EPDM-rubber O-rings.
h. Handle: Tee shaped.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

3.4 DOMESTIC COLD-WATER AND GRAY WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. PVC union ball valve.

END OF SECTION

SECTION 15029 - HANGERS AND SUPPORTS FOR PLUMBING, AND HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal hanger-shield inserts.
4. Fastener systems.
5. Equipment supports.

B. Related Requirements:

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. NFPA Compliance: Comply with NFPA 13.

D. UL Compliance: Comply with UL 203.

2.2 NONMETAL PIPE HANGERS AND SUPPORTS

A. Fiberglass Pipe Hangers and Supports:

1. Description: Factory-fabricated component constructed entirely out of non-metal components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of fiberglass.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with NFPA-approved, UL-listed, or FM-approved carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 FIBERGLASS FRAMING SYSTEMS

A. MFMA Manufacturer Fiberglass Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly, made of fiberglass channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
3. Channels: Continuous slotted fiberglass channel with inturned lips.
4. Channel Width: Selected for applicable load criteria.
5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of fiberglass.

2.5 THERMAL HANGER-SHIELD INSERTS

A. Insulation-Insert Material: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi minimum compressive strength.

B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Outdoor Applications: Stainless steel.

B. Chemical Epoxy Anchor:
1. Indoor applications: Hilti HIT-RE 500 V3.

2.7 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Low-Profile, Single Base, Single-Pipe Stand:

1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Vertical Members: Two, stainless-steel, continuous-thread 1/2-inch rods.
4. Horizontal Member: Adjustable horizontal, stainless-steel pipe support channels.
5. Pipe Supports: Strut clamps.
6. Hardware: Stainless steel.

7. Accessories: Protection pads.
8. Height: 12 inches above roof.

2.8 MATERIALS

A. Stainless Steel: ASTM A240/A240M.

B. Threaded Rods: Continuously threaded. Fiberglass for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

C. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Fiberglass Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass strut systems.

C. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install chemical anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.

E. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. MSS SP-58, Type 39 Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. MSS SP-58, Type 40 Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
b. NPS 4: 12 inches long and 0.06 inch thick.
c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 INSTALLATION OF EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Use fiberglass pipe hangers and supports and fiberglass framing systems and attachments for all indoor service applications.

C. Use stainless-steel pipe hangers and stainless-steel attachments for outdoor applications.

D. Use thermal hanger-shield inserts for insulated piping and tubing.

E. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Fiberglass Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.

F. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

G. Hanger-Rod Attachments: Comply with NFPA requirements for fire suppression piping. For all other piping:

1. Fiberglass Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

H. Plumbing and HVAC Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Chemical Anchors: For upper attachment to suspend pipe hangers from concrete ceiling.

I. Saddles and Shields:

1. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

J. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

END OF SECTION

SECTION 15048 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Spring hangers.

1.03 DEFINITIONS

A. IBC: International Building Code.

B. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device component.

PART 2 - PRODUCTS

2.01 ELASTOMERIC ISOLATION PADS (CU-1)

A. Elastomeric Isolation Pads:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Mountings & Controls, Inc.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.

3. Size: Factory or field cut to match requirements of supported equipment.
4. Minimum deflection as indicated on Drawings.
5. Pad Material: Oil- and water-resistant rubber.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient and elastomeric.

    a. Infused nonwoven cotton or synthetic fibers.

2.02 SPRING HANGERS (AC-1)

A. Combination Coil-Spring and Molded Fiberglass-Insert Hanger with Spring and Insert in Compression: .

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Kinetics Noise Control, Inc.
    b. Mason Industries, Inc.
    c. Vibration Mountings & Controls, Inc.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Minimum deflection as indicated on Drawings.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Molded Fiberglass Element: The fiberglass insert shall be individually coated with a flexible, moisture-impervious elastomeric membrane. The insert shall be molded from glass fibers with fiber diameters not exceeding 0.00027" and with a modulus of elasticity of 10.5 million PSI. Natural frequency of fiberglass vibration isolators shall be essentially constant for the operating load range of the supported equipment.
9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF VIBRATION CONTROL DEVICES

A. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

3.03 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.04 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

END OF SECTION

SECTION 15050 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: General administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:
   1. Submittals.
   2. Record documents.
   3. Maintenance manuals.
   4. Quality assurance.
   5. Delivery storage and handling.
   6. Guarantee.
   7. Rough-ins.
   8. Mechanical installations.
   9. Cutting and patching.

B. The Drawings are schematic and are not intended to show every detail of construction.
   1. In general, piping/ductwork transitions and offsets shown on Drawings indicate approximate locations in plan and elevation where the systems are intended to be run.
   2. CONTRACTOR shall fully coordinate mechanical work with other trades to avoid interferences.
   3. In the event of interferences, CONTRACTOR shall request clarification from ENGINEER in writing.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. A schedule indicating the system, line size, line material, joints, fittings, valves, insulation thickness, hanger type and spacing, test pressure and shop finish for each system shown on the Drawings and/or specified herein.
   2. Complete layout drawings of all pipe sleeves, ductwork, etc., showing all sizes and controlling elevations. These drawings shall be reproducible and submitted on tracing, mylar or sepia paper.
   3. No work shall be undertaken until such drawings, specifications and schedules have been approved by ENGINEER. Approval of this data by ENGINEER shall not relieve CONTRACTOR of responsibility for the completeness, coordination, and dependable operation of the system as installed.

B. Product Data: Submit in accordance with requirements of Section 01330, product data covering the items included under this Division of the Work.

C. Record Drawings: At Project closeout, submit record drawings of installed products, in accordance with requirements of Section 01770.

D. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.

1.03 QUALITY ASSURANCE

A. Permits, Inspections and Licenses: CONTRACTOR shall procure all necessary permits and licenses, observe and abide by all applicable laws, codes, regulations, ordinances, and rules of the State, territory or political subdivision thereof, wherein the Work is done, or any other duly constituted public authority.
   1. Upon completion of the Work, CONTRACTOR shall secure certificates of inspection from the inspector having jurisdiction and shall submit three copies of the certificates to OWNER. CONTRACTOR shall pay the fees for the permits, inspections, licenses and certifications when such fees are required.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.05 PROJECT CONDITIONS

A. Explosion-proof Requirements: All work and equipment located in areas designated "Explosion-proof" shall conform to all requirements of Article 500 of the National Electric Code for Class 1, Division 1, Group. D installations, except when otherwise noted. All mechanical equipment located in these areas shall be built from nonsparking material per AMCA Std. 401-66 Type B.

B. Corrosive Area Requirements: All heating, ventilating and air conditioning equipment, controls, ductwork, piping, supports and hangers shall be made of materials resistant to the chemicals or gases to which they are exposed, or be coated with the appropriate resistant coatings.
   1. The following is a partial list of areas which require equipment, piping, ductwork, supports, anchors etc. to be corrosion treated:
      a. grit and screen rooms,
      b. enclosed primary sanitary treatment structures,
      c. chemical storage and handling areas,
      d. filter areas,
      e. high-humidity areas,
      f. wet wells, and
      g. other areas as indicated on Drawings.
   2. Acceptable Manufacturers: Products shall meet the requirements of this Section and be the product of:
      a. Liberty Plastics.
      b. Plasite (Wisconsin Protective Coating Corp.).
   3. Hanger, supports, anchors in corrosive areas shall be 316 stainless steel or FRP unless otherwise noted on the drawings or herein.

C. Painting and Identification: Painting of piping and drainage lines installed as a part of this Work will be done under Section 09900, Painting.
   1. CONTRACTOR under this Section shall identify and label lines clearly so painting contractor can apply correct color(s) to each pipe.
   2. CONTRACTOR under this Section shall apply pipe labels to the pipe after painting has been completed. The piping labels shall include the pipe material and flow direction.

D. Motors: Motors shall comply with the specifications as set forth in Section 16220. Submit motor manufacturer's name with Shop Drawings for approval.
   1. All motors in Division 15 shall be TEFC Premium Efficiency unless noted otherwise in the specific Division 15 Sections or on mechanical drawing Schedules.

E. Stainless Steel: All stainless steel referenced in the specifications is 304 Stainless Steel unless otherwise noted herein or on the drawings.

PART 2 – PRODUCTS

2.01 PIPE LABELS

A. Provide Vinyl pipe label that attach to the pipe with tie-wraps or formed label that snaps on the pipe. Labels shall be rated for indoor and outdoor use.
   1. Label Manufactures: Seton Name Plate Corporation, W.H. Brady, James H. Matthews, or approved equal.

B. Labels that use adhesive shall not be used.

   Where product labels are not available for the media in the pipe, the contractor may paint the background the stencil the pipe product and flow arrow on the pipe.

PART 3 - EXECUTION

3.01 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 2 through 16 for rough-in requirements.

3.02 MECHANICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements.
   1. Coordinate mechanical systems, equipment, and materials installation with other building components.
   2. Verify all dimensions by field measurements.
   3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
   4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed. Furnish, set, and grout or secure in place all required sleeves.
   5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

B. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
   1. Unless noted otherwise on Drawings, mount unit heaters 8'-0" above finished floor.

C. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

D. Install systems, materials, and equipment to conform with approved submittal data. Conform to arrangements indicated by the Contract Documents, recognizing that portions of Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to ENGINEER.

E. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

F. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

G. Install access panel or doors where units are concealed behind finished surfaces.

H. Install systems, materials, and equipment giving right-of- way priority to systems required to be installed at a specified slope.

3.03 PIPE AND EQUIPMENT IDENTIFICATION:

A. Label all piping showing contents and direction of flow.

B. Place label adjacent to each valve and branch takeoff, at each side of a wall or partition through which pipe passes; and at 20 feet 0 inch spacing on straight runs.

C. Label Manufacturers: Seton Name Plate Corporation, W.H. Brady, Topflight Tape Company, James H. Matthews, or approved equal.

D. Paint or stencil 1-1/2 inch-high black enamel block type letters or numerals on all equipment items

3.04 VALVE IDENTIFICATION:

A. Brass Tags: 1-inch diameter, secured to each valve with brass S-hook and stamped with system designation and assigned number.

B. Obtain existing valve schedule from Owner and review existing valve naming sequence. Submit proposed schedule showing proposed continuation of sequence to Architect / Engineer for approval. Provide a printed schedule, in duplicate, describing each valve by number, giving location and service for which used.

3.05 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with the following requirements:
   1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
   1. Uncover Work to provide for installation of ill-timed Work.
   2. Remove and replace defective Work.
   3. Remove and replace Work not conforming to requirements of the Contract Documents.
   4. Remove samples of installed Work as specified for testing.
   5. Install equipment and materials in existing structures.

C. Upon written instructions from ENGINEER, uncover and restore Work to provide for ENGINEER observation of concealed Work.

D. Cut, remove, and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.

E. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

F. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

G. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers.

H. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers.

END OF SECTION

SECTION 15053 - IDENTIFICATION FOR PLUMBING AND HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Valve tags.
6. Warning tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

D. Stencils for Ducts:
1. Lettering Size: Minimum letter height of 1-1/4 inches for viewing distances up to 15 feet and proportionately larger lettering for greater viewing distances.
2. Stencil Material: Aluminum.
3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, alkyd enamel. Paint may be in pressurized spray-can form.

2.4 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass beaded chain or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Safety-yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and attics or plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 30 feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

C. Pipe Label Color Schedule:

1. Refrigerant Piping: White letters on a safety-purple background.
2. Domestic Water Piping: White letters on a safety-blue background.
3. Non-potable/Service Water: White letters on a safety gray background.
4. Sanitary Waste and Vent Piping: Black letters on a safety-orange background.
5. Natural Gas: Black letters on a safety-yellow background.
6. Compressed Air: White letters on a black background.

3.5 DUCT LABEL INSTALLATION

A. Stenciled Duct Label: Stenciled labels showing service and flow direction.

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape: 1-1/2 inches, round.

2. Valve-Tag Colors:

a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
b. Flammable Fluids: Black letters on a safety-yellow background.
c. Potable and Other Water: White letters on a safety-green background.
d. Compressed Air: White letters on a safety-blue background.
e. Defined by User: White letters on a safety-purple background, black letters on a safety-white background, white letters on a safety-gray background, and white letters on a safety-black background

3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 15060 - SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Extent of supports and anchors required by this Section is indicated on Drawings and/or specified in other Division 15 Sections.

B. Types of supports and anchors include the following:
   1. Horizontal piping hangers and supports.
   2. Vertical piping clamps.
   3. Hanger rod attachments.
   4. Building attachments.
   5. Saddles and shields.
   6. Miscellaneous materials.
   7. Anchors.
   8. Equipment supports.

C. Supports and anchors furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 15 Sections.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Manufacturer's assembly type Shop Drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.
   2. Submit manufacturer's technical product data, including installation instructions, for each type of support and anchor.

B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section. Include maintenance data and parts list for each type of support and anchor.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
   1. Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.

C. Manufacturers Standardization Society of the Valves and Fittings Industry, Inc. (MSS) Standard Compliance:
   1. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
   2. Select and apply pipe hangers and supports complying with MSS SP-69.
   3. Fabricate and install pipe hangers and supports complying with MSS SP-89.
   4. Terminology used in this Section is defined in MSS SP-90.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Hangers and Supports:
      a. B-Line Systems, Inc.
      b. Carpenter and Patterson, Inc.
      c. Corner & Lada Co., Inc.
      d. Elcen Metal Products Co.
      e. Fee & Mason Mfg. Co., Div. Figgie International.
      f. Anvil International.
   2. Saddles and Shields:
      a. Elcen Metal Products Co.
      b. Pipe Shields, Inc.

2.02 MATERIALS

A. Hangers, supports, and anchors shall be 304 stainless steel.

B. Hangers, supports, and anchors shall be 316 stainless steel or FRP construction in corrosive environments unless otherwise noted herein or on the drawings.

2.03 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. Except as otherwise indicated, provide factory-fabricated horizontal piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper-plated hangers and supports for copper piping systems.
   1. Adjustable Steel Clevis Hangers: MSS Type 1.
   2. Pipe Hangers: MSS Type 5.
   3. Adjustable Band Hangers: MSS Type 9.
   4. Pipe Rolls and Plates: MSS Type 45.

2.04 VERTICAL PIPING CLAMPS

A. Except as otherwise indicated, provide factory fabricated vertical piping clamps complying with MSS SP-58, of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper piping systems.
   1. Two-Bolt Riser Clamps: MSS Type 8.

2.05 HANGER-ROD ATTACHMENTS

A. Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper piping systems.
   1. Steel Turnbuckles: MSS Type 13.
   2. Malleable Iron Sockets: MSS Type 16.
   3. Steel Weldless Eye Nuts: MSS Type 17.

2.06 BUILDING ATTACHMENTS

A. Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper piping systems.
   1. Concrete Inserts: MSS Type 18. Inserts for concrete shall be 304 stainless steel for all applications in wastewater treatment and water treatment process areas unless otherwise noted on drawings.
   2. Top Beam Clamps: MSS Type 25.
   3. Steel Brackets:
      a. Side Beam Brackets: MSS Type 34.

2.07 SADDLES AND SHIELDS

A. Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

B. Protection Shields: MSS Type 40, of length recommended by manufacturer to prevent crushing of insulation.

2.08 MISCELLANEOUS MATERIALS

A. Metal Framing: Provide products complying with NEMA Standard ML 1.

B. Steel Plates, Shapes, and Bars: Provide products complying with ANSI/ASTM A 36.

C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1 part cement to 3 parts sand, by volume, with minimum amount of water required for placement and hydration.

D. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

E. Pipe Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted 2-section outer cylinder and base with 2-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any) and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 PREPARATION

A. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the Work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors, and other building structural attachments.

B. Prior to installation of hangers, supports, anchors, and associated Work, Installer shall meet at Site with CONTRACTOR, Installer of each component of associated Work, inspection and testing agency representatives (if any), Installers of other work requiring coordination with Work of this Section, and ENGINEER for purpose of reviewing material selections and procedures to be followed in performing the Work in compliance with requirements specified.

3.03 INSTALLATION OF BUILDING ATTACHMENTS

A. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

3.04 INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers, supports, clamps, and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

C. Support fire-water piping independently of other piping.

D. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper-plated or by other recognized industry methods.

E. Provisions for Movement:
   1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
   2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
   3. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31.1 Pressure Piping Codes are not exceeded.

F. Insulated Piping: Comply with the following installation requirements.
   1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.1.
   2. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install coated protective shields. For pipe 8-inch and over, install wood insulation saddles.
   3. Saddles: Where insulation without vapor barrier is indicated, install protection saddles.

3.05 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31.1, and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI B31.1 and with AWS standards.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

D. Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for pre-set of anchors as required to accommodate both expansion and contraction of piping.

3.06 EQUIPMENT SUPPORTS

A. Furnish to CONTRACTOR, scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction.

B. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

3.07 ADJUSTING AND CLEANING

A. Adjust hangers so as to distribute loads equally on attachments.

B. Provide grout under supports so as to bring piping and equipment to proper level and elevations.

C. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 15071 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic and gray cold-water piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, valves, and specialties for each type of insulation.
3. Detail removable insulation at piping specialties, equipment connections, and access panels.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less and smoke-developed index of 150 or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.

1. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ-SSL.
2. 850 deg F.
3. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

C. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

D. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
4. Color: White.

2.5 SEALANTS

A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. Permanently flexible, elastomeric sealant.
2. Service Temperature Range: Minus 100 to plus 300 deg F.
3. Color: White or gray.

C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Fire- and water-resistant, flexible, elastomeric sealant.
2. Service Temperature Range: Minus 40 to plus 250 deg F.
3. Color: White.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

2.9 SECUREMENTS

A. Bands:

1. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 2 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-

box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

C. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.9 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold and Gray Water:

1. NPS 1 and Smaller: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

2. NPS 1-1/4 and Larger: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Piping, Concealed:

1. None.

B. Piping, Exposed:

1. PVC: 30 mils thick.

END OF SECTION

SECTION 15072 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.
2. Refrigerant suction and hot-gas piping, indoors and outdoors.

B. Related Sections:

1. Section 230713 "Duct Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
3. Detail removable insulation at piping specialties.
4. Detail application of field-applied jackets.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

A. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

C. PVC Jacket Adhesive: Compatible with PVC jacket.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
   1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F.
   3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F.
   3. Solids Content: 60 percent by volume and 66 percent by weight.
   4. Color: White.

2.4 FIELD-APPLIED JACKETS

A. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

B. Metal Jacket:
1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    a. Finish and thickness are indicated in field-applied jacket schedules.
    b. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
    c. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.5 TAPES

A. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.6 SECUREMENTS

A. Bands:
1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.

2. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
5. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
6. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.8 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.9 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inches thick.

B. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inches thick.

3.10 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 2 inches thick.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:
1. PVC: 20 mils thick.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:
1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.020 inch thick.

END OF SECTION

SECTION 15080 - MECHANICAL INSULATION

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Labor, materials, tools, equipment, accessories, and services necessary for providing and installing mechanical insulation of all items as shown on Drawings and/or specified herein. All sizing required for preparation of painting shall be performed under this Section.

1.02 QUALITY ASSURANCE

A. Flame/Smoke Ratings: 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.
   1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.
   2. Exception: Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.

1.03 SUBMITTALS

A. Shop Drawings: Submit in accordance with requirements of Section 01330, Shop Drawings covering the items included under this Section.

B. CONTRACTOR shall furnish ENGINEER for approval a list of insulating materials and thickness for items listed on Schedule. The list shall be complete including all types and thicknesses of insulation used for the various services as well as the limits of Work.

C. Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

1.04 DELIVERY, STORAGE, AND HANDLING

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 Site.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than three years.

B. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Type I Insulation:
      a. CSG.
      b. Manville - Micro-lok 650.
      c. Owens/Corning Fiberglass.
      d. UpJohn Company.
   2. Type II Insulation:
      a. Armacell AP Armaflex.
      b. Manville – Aerotube.
      c. Rubatex.
   3. Paint for Exposed Pipe Insulation:
      a. Arabol.
      b. Fosters.
      c. Lagfas.

2.02 MATERIALS

A. Insulation for each of the applications listed on Schedule shall be one of the following types:
   1. Type I Insulation shall be a precision molded pipe covering composed of bonded fiberglass wool resin, minimum density 7.25 pcf, or polyurethane or phenolic foam minimum density 1.8 pcf formed in two half cylinders.
      a. Indoor insulation cover shall be the all service jacket ASJ type with integral vapor barrier unless otherwise noted on Schedule, and outdoor insulation cover shall be 0.016-inch aluminum jacket.
      b. All ASJ jacket laps and butt joint strips shall be of the adhesive contact type. Aluminum jackets shall have mastic laps and butt joints and banded using soft aluminum bands on 12-inch centers.
      c. Fittings and valve insulation shall be fabricated from mitered segments of pipe insulation or molded fitting covers. Fitting and valve insulation shall be coated with insulating cement, dried, coated with a vapor barrier mastic and, on indoor applications, wrapped with fiberglass reinforcing cloth and a second coat of mastic applied or, on outdoor applications, coated with a method recommended by the manufacturer and approved by ENGINEER.
   2. Type II Insulation shall be flexible tubing elastomeric thermal type with a minimum density of 5.5 pcf. Adhesives shall be as recommended by the insulating manufacturer.
      a. Indoor and outdoor piping shall be finished by applying two coats of a protective insulation coating as recommended by insulation manufacturer.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. Installer's Qualifications: Firm with at least three years successful installation experience on projects with mechanical insulations similar to that required for this Project.

3.02 INSPECTION

A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.03 INSTALLATION

A. The Mechanical Insulation Schedule gives the application, type, temperature, and thickness of insulation required. This Schedule should be used with the following interpretations.
   1. Insulation thickness selection not shown on Schedule shall be based on the ASHRAE Standard for the conditions of 80 degrees F ambient air temperature with 80 percent relative humidity indoor, and –20 degrees F ambient air temperature with 90 percent relative humidity outdoor, with operating temperatures as listed on Schedule.
   2. Type I insulation thickness shown on Schedule is based on fiberglass with a k-factor (thermal conductivity Btu/hour/square foot/degree F inch) of 0.255 at 40 degrees F. Insulation thickness may be increased or decreased in direct proportion to the k-factor of the insulation material furnished.
   3. Ground-buried pipe shall be considered as all pipe with at least 5 feet of earth cover. Pipe with less than 5 feet of cover shall be considered as exposed exterior piping when determining insulation thickness.
   4. Roof Drains: Insulation of roof drains shall include the drain, or to the underside, or roof opening enclosures, risers, all laterals or horizontal runs and internal vertical drops above main floor slabs.
   5. Insulation within 7’-0” of walking surfaces (horizontal or vertical distance) shall be installed with protective jacketing.

3.04 PLUMBING PIPING SYSTEM INSULATION

A. Omit insulation on chrome-plated exposed piping (except for handicapped fixtures), air chambers, unions, strainers, check valves, balance cocks, flow regulators, drain lines from water coolers, drainage piping located in crawl spaces or tunnels, buried piping, fire protection piping, and pre-insulated equipment.

B. Cold Piping:
   1. Application Requirements: Insulate the following cold plumbing piping systems:
      a. Potable and Non-Potable cold water piping.
      b. Potable chilled water piping.
      c. Plant effluent water piping.
      d. Interior aboveground stormwater piping.
      e. Plumbing vents within six lineal feet of roof outlet.
   2. Omit insulation of drain piping of the scrubber unit.

C. Hot Piping:
   1. Application Requirements: Insulate the following hot plumbing piping systems:
      a. Potable hot water piping.
      b. Potable hot water recirculating piping.
      c. Hot drain piping (where indicated).

3.05 AIR PIPING SYSTEM INSULATION

A. Hot Low-Pressure Piping (to 250 degrees F (121 degrees C):
   1. Application Requirements: Insulate the following hot low-pressure piping
      a. Low-pressure process air piping.

3.06 EQUIPMENT INSULATION

A. Cold Equipment (Below Ambient Temperature):
   1. Application Requirements: Insulate the following cold equipment:
      a. Pneumatic water tanks.

B. Hot Equipment (Above Ambient Temperature):
   1. Application Requirements: Insulate the following hot equipment:
      a. Condensate receivers.

3.07 INSTALLATION OF PIPING INSULATION

A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

C. 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.

D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.

F. Exposed covering shall be cleaned and sized for painting.

G. Premolded sectional covers shall be applied to flanges, fittings, and valves where possible. All other flanges, fittings, and valves shall be field-insulated and jacket applied manually. Insulation shall be the same thickness as that of the pipe.

H. In general, pipe hangers will be sized to fit the pipe with insulation placed over the pipe hanger assembly (except hot water or steam piping where hangers are sized to fit the insulation with a saddle). Insulation shall be grooved for hangers. The hanger area shall be completely filled with insulating material and sealed in vapor barrier areas.

I. Insulation, where terminated at equipment connections, ends of pipe, etc., shall be tapered at a 45-degree angle and sealed.

J. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.

K. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3-inch-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-inch-wide vapor barrier tape or band.

3.08 INSTALLATION OF EQUIPMENT INSULATION

A. Install equipment thermal insulation products in accordance with manufacturer's written instructions and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

C. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

D. Do not apply insulation to equipment, breechings, or stacks while hot.

E. Apply insulation using staggered joint method for both single- and double-layer construction where feasible. Apply each layer of insulation separately.

F. Coat insulated surfaces with layer of insulating cement, troweled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges, and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.

G. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least two inches. Apply over vapor barrier where applicable.

H. Do not insulate boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.

I. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance, including metal vessel covers, fasteners, flanges, frames, and accessories.

J. Protect outdoor insulation from weather by installation of weather-barrier mastic protective finish, or jacketing, as recommended by manufacturer.

3.09 EXISTING INSULATION REPAIR

A. Repair damaged sections of existing mechanical insulation, both previously damaged or damaged during this construction period. Replacement insulation shall be of same thickness as existing insulation. Jacket of replacement insulation shall overlap and seal to the existing insulation.

3.10 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Insulation installer shall advise CONTRACTOR of required protection for insulation work during remainder of construction period to avoid damage and deterioration.

MECHANICAL INSULATION SCHEDULE

Application	Type	Temp.(°F)	Duct/Pipe Size Minimum Insulation Thickness Interior < 2"	Interior 2"-4"	Interior > 4"	Exterior < 2"	Exterior 2"-4"	Exterior > 4"	Remarks
HVAC									
Steam and Condensate Piping	I	240	2	3	4	3	4	5	
Cooling Air Ducts	III	50	-	-	1	-	-	1	
Cooling and/or Hot Air Ducts	III	50-120	-	-	1-1/2	-	-	1-1/2	
Outside Air Ducts	III	-20	-	-	2	-	-	-	Install Aluminum Jacket on all duct in the incinerator room.
Return Air Ducts (cont.)	III	70	-	-	1	-	-	1-1/2	
PLUMBING									
Cold Water	I	40	1	1	1-1/2	1	1	1-1/2	All except ground-buried.
Hot Water/Tempered Hot Water	I	180	1	1-1/2	2	-	-	-	
Roof Drains	I	0	1-1/2	2	2	-	-	-	
PROCESS PIPING									
Plant Effluent Water	I or II	40	3/4	3/4	NR	3/4	3/4	NR	All except ground-buried.

END OF SECTION

SECTION 15093 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

    a. Constant-volume air systems.

2. Testing, Adjusting, and Balancing Equipment:

    a. Motors.
    b. Fans and ventilators.
    c. Furnaces.
    d. Condensing units.
    e. Heat-transfer coils.

3. Control system verification.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TABB: Testing, Adjusting, and Balancing Bureau.

F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

G. TDH: Total dynamic head.

1.4 ACTION SUBMITTALS

A. Sustainable Design Submittals:

1. TAB Report: Documentation indicating that Work complies with ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

C. System Readiness Checklists: Within 90 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

D. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

E. Certified TAB reports.

F. Sample report forms.

G. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.6 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.7 FIELD CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

K. Examine operating safety interlocks and controls on HVAC equipment.

L. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Duct systems are complete with terminals installed.
b. Volume dampers are open and functional.
c. Clean filters are installed.
d. Fans are operating, free of vibration, and rotating in correct direction.
e. Automatic temperature-control systems are operational.
f. Windows and doors are installed.
g. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

C. Mark equipment and balancing devices, including damper-control positions, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 15311 "Nonmetal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    b. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    c. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.

d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.

5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.7 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fan(s).

B. Measure and record entering- and leaving-air temperatures.

C. Measure and record entering and leaving refrigerant pressures.

D. Measure and record operating data of compressor(s), fan(s), and motors.

3.8 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Entering and leaving refrigerant pressure and temperatures.

3.9 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.10 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 5 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.11 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.12 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.

10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Terminal units.
4. Position of balancing devices.

E. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Fuel type in input data.
    g. Output capacity in Btu/h.
    h. Ignition type.
    i. Burner-control types.
    j. Motor horsepower and rpm.
    k. Motor volts, phase, and hertz.
    l. Motor full-load amperage and service factor.
    m. Sheave make, size in inches, and bore.

n. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

F. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.

e. Suction static pressure in inches wg.

G. Round, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

H. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.13 ADDITIONAL TESTS

A. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 15100 - PRESSURE PROCESS PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:
   1. Provide all labor, materials, and equipment necessary for fabrication and production of the items specified in this Section and as shown on Drawings or listed on Schedule.
   2. Unless otherwise noted on Drawings, or in this Section, pressure process piping 4 inches in diameter and larger shall be part of this Work.
   3. Dismantling of existing piping and supports, where required or shown or noted on Drawings; piping connections to existing piping, structures, valves, gates, measuring devices, pumps and other equipment, including equipment erected under other Contracts, are included in Work of this Section. Piping shall contain necessary unions or companion flanges to allow ease of equipment removal.
   4. Complete all the demolition work and repair thereof to existing walls and slabs as required for the installation of this Work including grouting of all sleeves and castings. Provide all necessary joint and coupling materials, including bolts, nuts and gaskets, wall castings or sleeves, and standard or special fittings. Furnish hangers, supports, anchors, blocking, harnesses, and other necessary closure pipe sections and special fittings. Provide and secure in proper alignment, all sleeve and casting openings in existing walls and slabs, including repair thereof.
   5. Provide all shop-applied interior and exterior pipe linings and coatings. Provide plugs in open ends of pipe, temporary bulkheads, protection of surface and subsurface improvements, cleaning, painting, testing, and disinfection, as required to accomplish Work as specified and shown on Drawings.

B. Products Installed But Not Furnished Under This Section: Install process valves, hydraulic gates, flow meters, and other appurtenances which are furnished under other Sections and incorporated in the piping systems as shown on Drawings and specified in this Section.
   1. All pipe insulation shall be accomplished under Section 15080. Under this Section of Work, all shop-applied surface coating shall be furnished as herein specified and pipe testing accomplished prior to insulating.
   2. Sewers are specified under Division 2.
   3. All exposed pipe, field-applied finish painting preparation and repair of existing painted surfaces shall be done under Division 9.
   4. Floor and roof drain systems are specified under Section 15150.

C. Products Supplied But Not Installed Under This Section:
   1. All piping, fittings, appurtenances, and shop-applied coatings shall be supplied as specified under this Section.
   2. The installation and testing of Water Distribution and Pumping Mains shall be performed as specified in this Section.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

1. Shop Drawings shall be fully dimensioned Drawings showing the piping in full detail with exact locations, dimensions, and schedules of all pipe, fittings, hangers, supports, and appurtenances. They shall be made in accordance with the general information shown on Drawing and special information furnished by the several manufacturers of equipment. Where special fittings are required, they shall be shown in large detail with all necessary dimensions.
2. Each pipe section, special fitting, casting, sleeve, and appurtenance shall be identified on Drawings by its respective erection mark.
3. Design details of joints and joint restraint shall be submitted to ENGINEER for ENGINEER's consideration and approval before ordering any pipe.
4. Product Data: Submit product data covering the items included under this Section.

B. Record Drawings: At Project closeout, submit record Drawings of installed products, in accordance with requirements of Section 01770.

1.03 QUALITY ASSURANCE

A. All Work under this Section shall be done in accordance with standard practices as recommended by manufacturer and AWWA.

B. Codes, Ordinances, and Standards: Manufacture, storage, and erection of equipment under this Contract shall be in accordance with current ASA (ANSI), AWWA, and ASTM Standards. Standards and Specifications referenced herein shall be the current published edition. The manufacturer of the pipe and fittings shall furnish ENGINEER a certified statement that all pipe and fittings furnished by manufacturer meet the material requirements and have been inspected and tested in accordance with the applicable Specification and Standard.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Disinfection compounds shall be stored in well-ventilated areas protected from moisture and fire.

B. Liquid Chlorine shall not be stored on Site except when more than one working day is required for disinfection. Prior approval from ENGINEER and the local authorities is required for gas chlorine storage.

C. Storage:
1. All pipe and related items installed under this Section shall be stored as recommended by manufacturer.
2. CONTRACTOR shall take all actions necessary to protect all items installed under this Contract including furnishing all special storage areas required by equipment manufacturers.
3. Pipe shall be stored on suitable timber skids free from contact with the ground. Gaskets shall be stored in as cool, clean, and shaded a place as practical.

D. Handling:
1. All items installed under this Contract shall at all times be handled as recommended by manufacturer and in such a manner as to avoid any damage.
2. All special handling equipment and temporary supports shall be provided by CONTRACTOR.
3. Items will be subject to inspection and approval upon delivery to the Site and after storage. No cracked, broken, or damaged pipe shall be used.
4. In the event coatings are damaged, the damaged area shall be recoated with an approved coating similar to that specified for that item.

5. Steel pipe shall be handled by means of rubber or fabric slings. No hooks shall be permitted to come in contact with joint rings or be inserted in the ends of the pipe and fittings for any reason.
6. During handling, hauling, and storage of pipe, each piece shall be kept from contact with adjacent pieces by means of wooden blocks or timbers.

1.05 PROJECT CONDITIONS

A. Existing Conditions: The Drawings are not intended to show every detail of construction or location of piping or equipment. Where existing conditions make it necessary or advisable to change location of piping or equipment, CONTRACTOR shall so inform ENGINEER for ENGINEER's approval.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Adapter Flange Coupling (AFC):
      a. EBAA Iron Sales, Inc. (Series 2100 Megaflange).
      b. Smith-Blair, Inc.
      c. Uni-Flange Corp.
      d. Victaulic Co.
   2. Bolted Flexible Coupling (BFC):
      a. Dresser Industries, Inc.
      b. Smith-Blair, Inc.
   3. Grooved Couplings (GC):
      a. Victaulic.
      b. Grinnell.
      c. Anvil.
   4. Plastic Pipe (PVC):
      a. Spears.
      b. Harvel.
      c. JM Eagle.
   5. High-Density Polyethylene Pipe (HDPE):
      a. Performance Pipe.
      b. KWH.
   6. Equipment Connections:
      a. Garlock.
      b. Metra Flex.
      c. Mercer Rubber Co.
      d. Redflex.
      e. Atlantic Metal Hose Co. (Vibra-flexor).
      f. Allied Metal Hose Company.
      g. Universal Oil Products Flexonics Division.
   7. Hangers and Supports:
      a. Grinnell.
      b. Elcen.
   8. Utility Markers:
      a. ScotchMark mid-range markers, Model 1258, as manufactured by 3M Company.

b. 3M Marker Locator Model 1265.

9. Mechanical Joint-Retaining Glands, no substitution or "or equals" will be accepted:
   a. "Megalug Series," as manufactured by EBAA Iron.
   b. "Blockbuster 1400 Series," as manufactured by Uni-Flange (Ford Meter Box Co.).
10. Mechanical Sleeve Seals:
    a. Thunderline Corp.
    b. Calpico, Inc.

2.02 MATERIALS

A. Disinfection Products:
   1. Liquid Chlorine shall not be allowed for this Project.
   2. Sodium Hypochlorite shall meet the requirements of AWWA B300. Containers shall have an expiration date marked at time of shipment to ensure that excessive deterioration has not occurred.
   3. Calcium Hypochlorite shall meet the requirements of AWWA B300.

2.03 PIPE JOINTS

A. All joint material and lubricants shall be furnished with the pipe, including all joint material required for connection to equipment furnished under other Sections. All joint materials shall be assembled in accordance with standard practice and manufacturer's recommendations. All equipment connections shall be flanged, union, or grooved coupling so that equipment can be removed without disassembly of the connecting piping.

B. Bolted Flexible Couplings (BFC): Bolted flexible couplings shall consist of a steel sleeve, with centering bead removed, rubber gaskets, follower rings, and a full complement of nuts and bolts. Couplings shall allow a deflection of approximately 4 degrees per joint.
   1. Couplings shall have a minimum middle ring thickness and minimum length as follows:

Pipe Size (inches)	Middle Ring Thickness	Middle Ring Length
4	0.203-inch	5-inch
6 to 12	1/4-inch	5-inch
14 to 20	5/16-inch	7-inch
24	3/8-inch	7-inch
30 to 48	3/8-inch	10-inch
54 to 72	1/2-inch	10-inch

   2. Couplings shall have a maximum gap between pipe ends as follows:

Sleeve Length	Max. Gap Allowed
5-inch	1-inch
7-inch	2-inch
10-inch	3-inch

   3. Couplings and accessories shall be galvanized and shall be shop coated with a sealer suitable for subsequent field painting or coating.
   4. Restraint rods shall be installed across coupling

C. Flanged Joints (FJ): Pipe flanges shall conform to American Standards: dimensions, ANSI B16.1 and threads, ANSI B2.1. Flange faces except stainless steel shall be coated with a rust inhibitor immediately after drilling.
   1. Flanges for cast or ductile iron pipe and fittings shall be ductile iron and meet the requirements of AWWA C115 (ANSI 21.15).
   2. Flanges for steel plate pipe and fittings shall meet the requirements of AWWA C207 Standard Steel Ring Flanges, Class B, except high service discharge piping as noted on Drawings or on Schedule, shall be Class D.
   3. Flanges for stainless steel pipe shall be fabricated from stainless steel flat plate of the same composition as the pipe.
   4. Flanges for stainless steel tubing shall be constructed using standard steel angle face rings (Van Stone Connection) and galvanized carbon steel backup flanges.
   5. Flanged joints shall be made up with full-face 1/8-inch rubber gaskets. Gaskets for gas lines shall be neoprene and asbestos.
   6. Flanges shall be firmly bolted with machine, stud or tap bolts of the proper size and number meeting the requirements of ASTM A 307, Grade B. Joints made with bolts or bolt studs shall have a nut on each side. Bolt projection through nuts shall be equal, and where studs are used, bolt projection on each side of the flange shall be equal.
   7. All nuts and bolts shall be cadmium plated or hot-dip galvanized except on stainless steel flanges shall be 316L stainless steel.
   8. Flange connections to all flexible connectors and expansion joints shall have a lock washer under all nut and bolt heads, 2 control rods across each joint and steel retainer rings at each flange. All steel materials shall be galvanized.
   9. Flange joints shall not be used on ground-buried pipe.

D. Grooved Couplings (GC): Provide rigid grooved couplings where shown or noted on Drawings or noted on Pipe Schedule. Flexible type shall only be used in applications approved by ENGINEER.
   1. Grooved couplings and fittings may be used in lieu of flanged joints.
   2. Couplings shall conform to AWWA Standard C606.
   3. Gaskets shall be molded or extruded of an elastomer that is recommended by coupling manufacturer and that will satisfy the end use. End use includes consideration for pipe material and material being transmitted by the pipe.
   4. Generally, ductile iron pipe gaskets shall be halogenated Butyl compound, and steel pipe shall be an ethylene, propylene, diene-monomer (EPDM) compound.
   5. Shop Drawings submitted shall identify the gasket material, pipe material, and material being transmitted in the pipe.
   6. Cast iron or ductile iron fittings shall conform to the requirements of ANSI Specifications A21.10 or AWWA C110 with end preparation of a radius cut groove configuration.
   7. Standard weight steel pipe or better may be cut grooved in accordance with manufacturer's standard groove dimensions. Where pipe is less than or standard weight, a ring shall be welded to steel pipe to form the necessary shoulder for the joint, or the pipe may be roll-grooved in accordance with manufacturer's recommendation for roll-grooving pipe as approved by ENGINEER.
   8. Ductile iron pipe in sizes 4-inch to 24-inch shall be radius cut grooved in accordance with manufacturer's specifications.

E. Mechanical Joints (MJ): Mechanical joint shall conform to ANSI A21.10 and AWWA C110, or ANSI A21.11.
   1. Each joint shall be complete with rubber gasket, cast iron gland and a full complement of high-strength, low-alloy steel bolts and nuts.
   2. All mechanical joints are to be restrained in accordance with the paragraph on joint restraints.

F. Screwed Joints (SJ): Screwed joints in steel plate, galvanized steel, or black steel pipe shall conform to American Standards: dimensions, ANSI B16.3; threads, ANSI B2.1. The ends of pipe shall be reamed and all burrs and cuttings shall be removed. Joints shall be sealed with Teflon thread tape or an approved compound.

G. Welded Joint (WJ): Butt-welded joints shall be used whenever shown or noted on Drawings. Welding shall comply with the current AWWA Standard C206. Lap-welded joints may be used if approved by ENGINEER.

H. Adapter Flange Coupling (AFC): Adapter flange couplings for steel or ductile iron pipe shall be provided where shown on Drawings.
   1. The coupling shall be designed to meet the test requirements of ANSI B16.1, 125-pound flanges.
   2. The coupling shall be designed to handle a 525 psi hydrostatic test and 175 psi working pressure at temperatures of -20 to 150 degrees Fahrenheit without leaking or requiring additional restraint.
   3. The coupling shall consist of a standard flange drilling (ANSI B16.1); a standard mechanical joint material (ANSI A21.11 or AWWA C111); and standard retainer gland construction (AISI 4140 steel setscrews, galvanized with ductile iron body ASTM A 536).

2.04 PIPING

A. Black Steel Pipe (BSP): Black steel pipe shall meet the requirements of ASTM A 53, Schedule 80.
   1. Fittings: Fittings shall be wrought carbon steel manufactured in accordance with ANSI/ASTM A 234, and welded conforming to ANSI B16.9, B16.11, B16.28, MSS SP-79, ASTM A 234, WPA-Grade, equal in thickness to the pipe.
   2. Joints: Black steel pipe joints shall be welded with flange connections where required for connection to equipment in accordance with the paragraph on "Pipe Joints," as shown or noted on Drawings, listed on Schedule, and approved by ENGINEER.
   3. Coating and Lining: Ground-buried black steel pipe and fittings shall be coated on the outside with a cold-applied wax coating.

B. Ductile Iron Pipe (DIP): Buried ductile iron pipe shall be either the Pressure Class indicated on Bid Form or on Schedule. If no classification is indicated, pipe shall be the highest Standard Pressure Class available. Ductile iron pipe shall be manufactured in accordance with AWWA C151 (ANSI A21.51). Pipe placed in buildings to be joined by flanges or grooved couplings for the pipe size shown shall have a minimum thickness of Special Thickness Class 53. Each pipe run shall be of the same class. Pipe sizes indicated are inside diameter (I.D.).
   1. Fittings for flanged ductile iron pipe shall be ductile iron or cast iron and shall meet the requirements of AWWA C110 (ANSI A21.10) and for 54-inch and larger sized shall meet the requirements of AWWA C153 (ANSI A21.53). Fittings for mechanical joint ductile iron pipe shall meet the requirements AWWA C110 (ANSI A21.53) Ductile iron fittings shall be rated for 350 psi, pipe sizes 24-inch diameter and less and 250 psi for pipe sizes over 24-inch

diameter, except that ductile iron flanged fittings shall be rated for 250 psi for all pipe diameters.

2. Cast iron fittings shall be rated for 250 psi, pipe sizes 12-inch diameter and less and 150 psi for pipe sizes over 12-inch diameter.
3. Ductile iron joints shall be mechanical, bolted flexible coupling, and push-on, as specified under Pipe Joints, as shown or noted on Drawings, listed on Schedule, and approved by ENGINEER. Joints shall meet the requirements of AWWA C111 (ANSI A21.11). All joint materials shall be furnished with the pipe.
4. Coatings and Linings: Ductile iron pipe and fittings to be ground buried shall be coated by manufacturer on the outside with an asphaltic coating 1 mil thick, in accordance with AWWA C151 and C110 (ANSI A21.51) and cement lined, standard thickness, in accordance with AWWA C104/ANSI 21.4. The pipe shall be supplied with and wrapped in polyethylene encasement in accordance with AWWA C105 (ANSI 21.5) and shall be installed following Method "A."
5. Exposed pipe and fittings shall be coated by manufacturer on the outside with a universal rust-inhibitive primer 2 mils minimum dry thickness, and cement lined, standard thickness, in accordance with AWWA C104/ANSI 21.4.

C. Galvanized Steel Pipe (GSP): Steel pipe shall meet the requirements of ASTM A 53 standard weight class.
   1. Screwed fittings shall be 150-pound malleable iron galvanized for field installation and welded fittings ANSI B16.9, ASTM A 234, WPA Grade, equal in thickness to the pipe for factory fabrication.
   2. Galvanized steel pipe joints shall be flanged, shop welded, grooved coupling, bolted flexible coupling or screwed in accordance with the paragraphs under "Pipe Joints," as shown or noted on Drawings, listed on Schedule, and approved by ENGINEER.
   3. Coating and lining shall be galvanized after fabrication in accordance with ASTM A 153. No field galvanizing will be allowed.

D. Plastic Pipe (PVC): Plastic pipe shall be designed, fabricated, and installed in accordance with these Specifications and as shown or noted on Drawings and listed on Schedule.
   1. Plastic pipe shall meet the requirements of ASTM D 1785 (PVC) Schedule 80, socket end ASTM D 2467.
   2. Pipe sizes indicated are I.D.
   3. Plastic pipe fittings shall meet the same requirements as the pipe and connections shall be socket type ASTM D 2467.
   4. All plastic pipe joints shall be socket type in accordance with the paragraph on "Socket Type Joints."
   5. Installation shall be in accordance with the paragraph on "Pipe Installation." In addition, the recommendations of ASTM Committee D 20 on Plastics relating to the installation of flexible thermoplastic sewer pipe shall be followed. Hanger spacing shall be as shown or noted on Drawings and meet manufacturer's recommendations as approved by ENGINEER.

E. Stainless Steel Pipe (SSP): Stainless steel pipe shall be designed and fabricated in accordance with the ASTM Standards A 312 and A 409, and as shown on Drawings.
   1. The pipe and fittings and all appurtenant supports specified shall be made from 304 L stainless steel with a minimum No. 1 mil finish and a maximum carbon content of 0.035 percent.
   2. Pipe schedule shall be as shown on Drawings or on Pipe Schedule.
   3. Fittings shall be made to ASTM A 403 standards, to MSS SP-43 dimensional tolerances, and shall be equal in wall thickness to, and meet the conditions of, the pipe.

4. Special fittings shall meet the requirements of the pipe and shall be as shown on Drawings.
5. All welding shall be performed in shop and be accomplished using inert gas shielded-arc method. Where consumable electrode or filler wire is used, they shall be the same material as the parent metal. Butt welds shall have full penetration to the interior surface and gas shielding provided to the interior and exterior of the joint.
6. All interior weld finishes shall equal the smoothness of a minimum No. 1 mil sheet finish. The weld bead shall be smooth evenly distributed with an interior projection not exceeding 1/16 inch beyond the I.D. of the pipe or fitting. All unevenness shall be finely ground to meet the above requirements. Coarse grinding shall not be permitted.
7. All exterior weld finishes shall be wire brushed with stainless steel brushes used only on stainless steel. The joints shall then be cleaned of all discoloration, and deposits left during welding shall be removed by pickling.

F. Stainless Steel Tubing (SST): Stainless steel tubing shall be designed and fabricated in accordance with ASTM Standard A 778 and as shown on Drawings.
1. The pipe and fittings and all appurtenant supports specified shall be made from 304 L stainless steel with a maximum carbon content of 0.03 percent.
2. Finish shall be No. 2 mil finish or better.
3. Tubing Thicknesses: Nominal pipe size indicated for pipe less than 14-inch shall be iron pipe size (IPS), and pipe 14-inch and larger shall be outside diameter (O.D.). Pipe shall be fabricated in the thickness as given in the following Schedule:

Tube O.D.	Wall Thickness
8-inch and less	14 gauge
10-inch to 18-inch	12 gauge
20-inch and greater	10 gauge

4. Fittings shall be made to ASTM Standard A 774, MSS SP-43 dimensional tolerances and shall be equal in wall thickness to, and meet the conditions of, the pipe.
5. Special fittings shall meet the requirements of the pipe and shall be as shown on Drawings.
6. All welding shall be performed in shop and accomplished using inert gas shielded-arc method. Filler material shall be extra low carbon and appropriate for use with the base metal. Butt welds shall have full penetration to the interior surface and gas shielding provided to the interior and exterior of the joint.
7. All interior weld finishes shall equal the smoothness of a minimum No. 2 mil sheet finish. The weld bead shall be smooth and evenly distributed with an interior projection not exceeding 1/16-inch beyond the I.D. of the pipe or fitting.
8. All exterior weld finishes shall be wire brushed with stainless steel brushes.
9. Finished pipe and fittings shall be immersion pickled in 6 to 10 percent nitric acid and 3 to 5 percent hydrofluoric acid prior to shipment.
10. SST joints shall be flanged, shop welded, bolted flexible coupling or screwed, in accordance with the paragraphs under "Pipe Joints," as shown or noted on Drawings, listed on Schedule, and approved by ENGINEER. Field welded joints shall not be allowed.

G. Steel Plate Pipe (SPP): Steel plate pipe shall be designed, fabricated, and installed in accordance with these Specifications, AWWA Manual on Steel Pipe Design and Installation M11, and as shown or noted on Drawings.

1. Steel pipe shall meet the requirements of ASTM A 134 with steel plates meeting the requirements of ASTM A 283, Grade B, or ASTM A 139, Grade B, or ASTM A 36, spirally welded, straight seam or seamless equal to Armco or U.S. Steel welded steel pipe.
2. SPP shall conform to the requirements of AWWA C200.
3. In general, standard lengths of 40 feet shall be furnished except where shorter lengths are necessary for installation as shown or noted on Drawings and approved by ENGINEER.
4. Fittings shall meet the requirements of AWWA C208. All buried fittings shall be Table II. Welded fittings shall be equal in thickness to the pipe.
5. Specials shall be fabricated of steel plate and designed for the same conditions as the pipe. Collars, stiffeners, and other reinforcement shall be used as required to obtain the necessary strength in all parts of the special. A plate collar shall be welded around all outlet connections.
6. All steel plate pipe, fittings and specials shall receive a shop application of the coating and lining as herein specified or as shown or noted on Drawings.
7. Coating and lining for all steel air piping shall be galvanized in accordance with ASTM A 153.
8. Interior linings for the other steel pipe shall meet the requirements of AWWA C203 for hot coal-tar enamel, or AWWA C210 for coal-tar epoxy (3 coats, 24 mil total thickness minimum), except for high-pressure discharge piping and as noted on Drawings.
9. High service discharge piping as noted on Drawings shall be shop lined on the inside with centrifugally spun cement mortar lining 5/16-inch thick for 16- to 23-inch pipe, 3/8-inch thick for 24- to 36-inch pipe, and 1/2-inch thick for over 36-inch pipe. Mortar lining shall be in accordance with AWWA Standards C205, latest revision.
10. Exterior coatings for all steel pipe shall meet the following requirements: Ground-buried pipe after sandblasting (commercial blast) or grit blasting, dried, and primed shall receive one of the following coatings meeting the requirements of AWWA C203:
    a. Hot Coal-tar Enamel: Coal-tar enamel coating, in accordance with manufacturer's recommendations.
    b. Hot-applied Tape: A hot-applied coating tape consisting of a high tensile strength fabric completely saturated with a coal-tar pitch, which provides a compatible base for the bonding of a pliable coal-tar coating to both sides of the carrier, and with a tough polyester film overwrap. Installation, including the primer application, shall be in accordance with manufacturer's recommendations.
    c. For bolted flexible couplings buried in the ground, the outside coating shall be left off the pipe for a distance of 8 inches from each end. These areas shall be shop primed. After complete installation of the pipe and coupling, the uncoated portions of the outside of the pipe and outside of the coupling shall be thoroughly cleaned, primed, and given a field coating of the same material as specified for the pipe.
11. SPP joints shall be bell and spigot steel, bolted flexible coupling, grooved coupling, screwed or welded, in accordance with the paragraph on "Pipe Joints, " as shown or noted on Drawings, listed on Schedule, and approved by ENGINEER.
12. Pipe taps in steel pipelines shall include a steel 3,000-pound coupling fitting welded into the wall of the pipe and threaded to receive small piping, special fittings, or corporation stops of a size and location as noted or shown on Drawings.
13. Pipe Thickness: Nominal pipe size indicated for pipe less than 14 inches shall be I.D. and pipe 14 inches and larger shall be O.D. Pipe shall be fabricated meeting special design conditions as shown or noted on Drawings or listed on Piping Schedule with the minimum thickness as given in the following table:

Pipe Size (Inches)	Buried in Earth	Exposed
15 and less	0.188	0.135
15 to 28	0.250	0.188
30 to 40	0.312	0.250
42 to 51	0.375	0.313
54 to 66	0.438	0.375

H. Polyvinyl Chloride Pressure Pipe (PVCP):

1. PVCP pipe shall be manufactured of PVC resin compounds Class 12454 A or B conforming to ASTM D 1784 in accordance with ASTM D 2241. Unless otherwise indicated on Schedule or Bid Form, all PVCP pipe shall have a pressure rating of 200 psi (SDR 21).
2. If used for potable water service, PVCP shall meet the requirements of AWWA C900 & 905, ANSI/NSF 14 and ANSI/NSF 61.
3. Fittings shall be cast or ductile iron of comparable class, provided with special gaskets for SDR size pipe.
4. Joints shall be bell and spigot type with a flexible elastomeric gasket conforming to ASTM D 3139. Joints shall be made using lubricant as supplied and as directed by manufacturer. If it is necessary to field cut a standard length of pipe, the new spigot end shall be prepared as recommended by pipe manufacturer.
5. After delivery, PVCP pipe shall be stored on a flat surface so that the barrel is evenly supported. Pipe shall not be stored in piles higher than 4 feet. If the pipe is to be stored for an extended period of time, it shall be covered with an opaque material so it is protected from the sun's rays and the bells shall be inverted in alternate rows so they are not supporting the direct load of the pipe. Deflection of any particular amount of PVCP pipe shall not exceed 5 percent.

2.05 WALL AND SLAB SLEEVES AND CASTING

A. At all points where pipes must pass through the walls, floors, or slabs of structures, CONTRACTOR shall furnish and install suitable sleeves or wall castings. Unless otherwise shown or permitted, the space between the pipe and the sleeve shall be sealed at the inside and outside wall faces on walls exposed to earth or water/sewage, at one face of other walls, and at the top surface of floors and slabs with a rubber link seal.

B. In general, the wall sleeve or castings shall be of the same material as the pipe. Iron pipe wall castings, wall pipe, transition sleeves, and solid sleeves shall meet the requirements of AWWA Specifications C100 and shall be of the lightest class conforming to the pressure rating of the pipelines which they connect, but in no case shall be lighter than Class B.

C. Steel sleeves and wall pipe shall not be painted in areas to be embedded in the concrete. Under this Section, all loose rust, scale, grease, or oil shall be removed prior to pouring of the concrete.

D. Where watertightness is essential and at other locations where indicated on Drawings, wall castings, and sleeves shall be provided with an intermediate flange located approximately at the center of the wall.

E. Sleeves and castings at the point of manufacture shall be coated on the inside with a universal rust-inhibitive primer 1.5 to 2.0 mils minimum dry thickness.

F. Rubber link seal shall be identical rubber links interconnected with bolts and elongated nuts and washers. The sealing element shall be made of synthetic rubber material especially compounded to

resist aging, ozone, sunlight, and chemical action. Bolts and metal parts shall be made of galvanized or cadmium-plated steel to resist corrosion. Rubber link seal joints shall be submitted to ENGINEER for approval.

2.06 EQUIPMENT CONNECTIONS

A. The connecting piping to pumps and other equipment shall be supported independently of the pump or equipment so as to avoid any strain on the pump or equipment.

B. All equipment connections shall be flanged or have unions to facilitate removal of the equipment.

C. Piping to vibrating equipment shall contain control-rodded, retainer ringed flanges, flexible spool-type expansion joint of duct and chlorobutyl or Buna-N material as shown or noted on Drawings.

D. All carbon steel shall be galvanized.

2.07 JOINT RESTRAINT

A. Where water or air pressure exerts a disjoining force, at all pipe deflections over 20 degrees, and all tees and dead ends, joints shall be restrained, tied, or harnessed in a manner approved by ENGINEER.

B. The restraint shall be applied to joints in each direction from the deflection an adequate distance to resist the axial thrust of the test pressure as shown on Pipe Restraint Schedule on Drawings. Fire hydrants shall be restrained from the main line to the hydrant. Details of all proposed joint restraint, showing the type and locations, shall be submitted to ENGINEER for approval. Concrete thrust blocks will not be permitted except where noted. All pipe and fitting restrained joints shall be rated for a minimum of 250 psi.

C. For unit price items, joint restraint shall be considered as included in the prices Bid for the type and size of pipe listed on Bid Form.

D. Acceptable methods of joint restraint are as follows:
   1. Ductile Iron Pipe: Mechanical joint pipe with EBAA Iron "Megalug Series," or Uni-Flange Block Buster 1400 retainers, shall be used when shown on Drawings. Megalugs or Uni-Flange Block Buster 1400 retainers may also be used to restrain joints for unanticipated deflection points, or where connections require a mechanical joint. Restrained joint glands and hardware shall have surfaces factory prepared and protected with a corrosion resistant coating system. Glands shall have a polyester or epoxy fusion bonded coating. Wedges, nuts and bolts shall have two coats of a heat cured blue fluoropolymer coating or alternatively made of stainless steel. No other manufacturers or types of mechanical joint-retaining glands will be accepted. Push-on joint pipe shall be restrained with American Lok-Ring, Flex-ring or Fast-Grip Gaskets, U.S. Pipe TR Flex, or equal.
   2. Steel Pipe: Studs and lugs AWWA Manual MII (studs galvanized).

2.08 JOINT HARNESSING

A. Pipe and fittings that require harnessing shall be provided with standard lugs ASTM A 283, Grade B, or A 285, Grade C, or equal, meeting the requirements of AWWA Specification C111 or AWWA Manual M11, unless otherwise noted.

B. Harness tie rods and nuts shall be mild steel meeting the requirements of ASTM A 193, Grade B7, or A 307, Grade B, or equal with American Standard threads. The nuts shall seat on steel plate washers. The rod, washers, and nuts shall be hot-dip galvanized ASTM A 153.

2.09 HANGERS AND SUPPORTS

A. Hangers and supports shall include all hanging and supporting devices of metallic construction shown, specified, or required for piping, apparatus, and equipment installed under this Section. All supports and parts shall conform to the latest requirements of ANSI B31.1, except as supplemented or modified by the requirements of this Specification or as detailed on Drawings. Materials shall be stainless steel.

B. Hangers and supports shall be adequate to maintain the pipelines, apparatus, and equipment in proper position and alignment under all operating conditions with due allowance for expansion and contraction, and shall have springs where necessary. Hangers and supports shall be of standard design where possible and be best suited for the service required, as approved by ENGINEER. Supporting devices shall be designed in accordance with the best practice and shall not be unnecessarily heavy. Sufficient hangers and supports shall be installed to provide a working safety factor of not less than 5 for each hanger. Hangers shall have a minimum spacing in accordance with ANSI B31.1. Point loading hangers are not acceptable. Hangers shall be sling or saddle type.

C. Wherever possible, pipe attachments for horizontal piping shall be pipe clamp, and structural attachments shall be beam clamps. All rigid hangers shall provide a means of vertical adjustment after erection. Generally, hangers shall be sized for supporting the pipe, excluding insulation. Proper pipe protection saddles shall be installed on pipes that are covered with insulation where hangers and supports are outside the insulation. Overhead hangers shall be supported by threaded rods properly fastened in place by suitable screws, clamps, inserts or bolts, or by welding. Saddle stands shall be of the adjustable type. Each stand shall consist of a length of steel pipe fitted at the base with a standard threaded flange and at the top with an adjustable saddle or roll. The base flange shall be bolted to the floor, foundation, or concrete base.

D. Anchors shall be furnished and installed where specified, shown, or required for holding the pipelines and equipment in position or alignment. Anchors shall be designed for rigid fastening to the structures, either directly or through brackets. The design of all anchors shall be subject to approval by ENGINEER. Materials shall be stainless steel. Inserts for concrete shall be stainless steel and shall be installed in the concrete structures where required for fastening supporting devices. They shall be designed to permit the rods to be adjusted horizontally in one place and to lock the rod nut or head automatically. Inserts shall be recessed near the upper flange to receive reinforcing rods. Inserts shall be so designed that they may be held in position during concrete pouring operations. Inserts shall be designed to carry safely the maximum load that can be imposed by the rod that they engage.

E. Concrete supports shall be placed wherever shown or required under Division 3. Equipment shall be supported in accordance with manufacturer's recommendations.

2.10 CLEANOUTS

A. Cleanouts shall be provided where shown or specified. Cleanout openings for pipe 8 inches or larger in diameter shall be not less than 6 inches in diameter (unless otherwise noted on Drawings).

B. Cleanout openings for pipe 6 inches and smaller shall be of the same diameter as the pipe.

C. Cleanout covers shall be standard 125-pound blind flanges, where conformation is required with the inside curvature of the pipeline, in which case the covers shall be flanged of proper shape with standard flange drilling.

D. Covers shall be fastened by means of galvanized steel studs and nuts and shall be drilled and tapped for a 1-1/2-inch pipe connection. A 1-1/2-inch galvanized steel plug shall be furnished. The flange or conformed plugs shall be provided with a dowel or other suitable means to ensure proper setting.

2.11 TAPS AND PLUGS

A. Where indicated or required, pipe or fittings shall be tapped to receive small or special fittings under this or other headings of the Work. Required taps shall be provided as part of this Work.

B. All taps shall be temporarily plugged at point of fabrication.

2.12 SOURCE QUALITY CONTROL

A. Tests, Inspections:
   1. All pipe and fittings delivered to the Project shall be accompanied by certification papers showing that the pipe and fittings have been tested in accordance with the applicable Specifications and that pipe and fittings meet the Specifications for this Project. All pipe and fittings will be inspected upon delivery to the Site by ENGINEER or OWNER's Representative. No cracked, broken, or damaged pipe or fittings will be allowed in this Work.
   2. Ductile Iron Pipe:
      a. Each pipe shall be hydrostatically tested to 500 psi at the point of manufacture.
      b. The class of nominal thickness, net weight without lining, and casting period shall be clearly marked on each length of pipe. Additionally, the manufacturer's mark, county where cast, year in which the pipe was produced, and the letters "DI" or "ductile" shall be cast or stamped on the pipe.
      c. Where required, other designation marks shall be painted on the pipe or fittings to indicate correct location in the pipeline in conformity to a detailed layout plan.

PART 3 - EXECUTION

3.01 ERECTION

A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operation condition in full conformity with detail Drawings, specifications, engineering data, instructions, and recommendations of equipment manufacturer approved by ENGINEER.

3.02 INSTALLATION

A. Laying and Erecting Pipe: Pipe shall be installed as recommended by manufacturers or by the applicable AWWA installation manual or specification.
   1. Pipe shall be carefully laid to line and grade as shown on Drawings. Care shall be taken to keep the interior of the pipe clean and free from dirt and other foreign materials.

2. Bulkheads or other means shall be used at the open ends of the pipe for this purpose. At the end of each day's work, ground-buried pipe shall have its working end bulkheaded.
3. Ground-buried ductile iron pipe shall be wrapped with polyethylene encasement in accordance with AWWA C105 (ANSI 21.5) following Method "A."

B. Field Cutting Piping: The spigot ends of all pipe lengths, which have been cut in the field, shall be ground to a smooth surface and painted with 2 coats of asphaltum metal protective paint.

C. Bolted Flexible Couplings (BFC): All bolted flexible couplings shall be harnessed with tie bolts or studs across the joint, design based on test pressures.
1. On cast iron or ductile iron pipe, tie bolts shall be installed between flanges across the coupling unless otherwise noted on Drawings or approved by ENGINEER.
2. Piping of other materials shall be furnished with lugs. The number and size of the bolts and studs and other details of the harnessed joint shall be submitted to ENGINEER for review.
3. Tie bolts or studs shall be galvanized.

D. Concrete Cradle: Pipework shall be placed on Class "C" concrete cradle in locations and according to details shown on Drawings.

E. Bedding: Where the subgrade is disturbed during excavation, the space shall be refilled with bedding material solidly tamped to form a firm foundation for the pipe.
1. At least the bottom quarter of the pipe shall be laid on a sand or pea gravel bedding, except that the bedding shall be exclusively pea gravel for pipe 48 inches and larger in diameter. Bedding shall be provided as specified under Division 2.

F. Joints: All joints shall be assembled in accordance with that described in the "Pipe Joints" Article.

G. Connections to Existing Facilities:
1. CONTRACTOR shall furnish all labor and materials required for the connection of piping under this Contract to existing structures as called for on Drawings.
2. Where breaking holes for connections to existing structures, care shall be taken to prevent debris from entering.
3. After installation of the pipe, the structure shall be pointed up around the pipe, both on the inside and outside so that it is restored to a watertight condition.

H. Connections to Existing Mains: Where shown on Drawings, connections of existing main to the new mains shall be done only after the new mains are shown to be disinfected by the results of the bacteriological analysis. Care should be taken to prevent debris from entering water main.

3.03 PIPE LOCATING SYSTEMS

A. Utility Markers: All plastic pipe pumping mains shall have an electronic marker system furnished and installed complete with marker locator.
1. Markers shall be installed in a horizontal position 3 to 4 feet below the ground surface.
2. A marker shall be placed over every buried tee, bend, or saddle fitting, at intervals no greater than 100 feet along pumping mains and where directed by ENGINEER.
3. Holes shall be excavated over bored or directionally drilled pumping main for placement of markers.

3.04 REPAIR

A. Repair of all damaged interior pipe coatings, ground-buried exterior pipe coatings and galvanized coatings shall be under this Section. Repair of exposed painted pipe shall be as specified under Section 09900.

B. For field-welded joints, both inside and outside, coatings shall be left off for a distance of 6 inches from each end. These areas shall be shop primed. After completing the welded joint and under this Section, the interior of all joints and exterior of ground-buried pipe shall be thoroughly cleaned, primed, and given field coating of the same material as specified for the pipe. Coating shall meet the requirements of AWWA C203 or AWWA C210, as approved by ENGINEER. Exposed field-welded joints shall be cleaned under this Section to remove slag and scale, and then shall be finish cleaned, primed and painted under Division 9.

C. Damaged linings, coatings, and wrapping shall be repaired under this Section and, if possible, before pipe is laid.
   1. Surfaces shall be thoroughly cleaned, dried, and free of old materials.
   2. They shall then be given a field coating of the same material as specified for the pipe.
   3. Coating shall meet the requirements of AWWA C203, AWWA C210, or AWWA C602 as approved by ENGINEER.
   4. All other pipe coatings and linings shall be as stated in "Piping" Article.

3.05 FIELD QUALITY CONTROL

A. Defective Pipe: No pipe or special casting known to be defective shall be laid in Work.
   1. Any piece found to be defective after it has been laid shall be removed by CONTRACTOR and replaced by a sound and perfect piece.
   2. If the major part of a defective pipe is sound, the good end may be cut off and used.
   3. The cutting of pipes for this and any other purpose shall be done by skilled workers, and in such manner as will not injure the pipe. Every such cut shall be square and smooth. Cut surfaces shall be recoated as specified for the pipe.

B. Tests:
   1. After completion, each run of pipe shall be tested by CONTRACTOR in the presence of ENGINEER. All appurtenances such as service connections, corporation stops, and curb stops shall be tested with the run of pipe.
      a. Any leaks shall be made tight.
      b. Under this Work, CONTRACTOR shall furnish all water or air, piping, bulkheads, pumps or compressors, gauge, and other equipment required for the test.
      c. The section of pipe to be tested shall be cleaned and isolated by valves or plugs, and shall not exceed 2,000 feet for any individual test. Such valves or plugs shall be designed to hold against the test pressure. Sections of pipe shall have an opening through which air or water can be introduced. The supply line shall be fitted with suitable control valves and a pressure gauge for continually measuring the pressure. The pressure gauge shall have a minimum diameter of 3-1/2 inches and a range compatible with the test pressure. Pipelines that cannot be closed for a direct pressure test shall be tested by filling the tanks to which they are connected to the highest operating level or installing temporary test bulkheads. After completion of tests, all pipes shall be drained. Buried pipelines shall be pressure tested with all pipe joints exposed for visual inspection unless otherwise directed by ENGINEER.

d. If requested by ENGINEER, CONTRACTOR shall furnish proposed test procedures for approval including pipe identification, test pressure and a description of the method of testing.
e. In the event that the leakage exceeds the specified amount, the joints in the line shall be carefully inspected for leaks and repaired where necessary. Any pipes or special castings found to be cracked shall be removed and replaced with new pieces by CONTRACTOR. After this Work has been done, the test shall be repeated. Final acceptance of the lines will not be made until satisfactory tests have been passed.

2. Test Pressures: In general, pipelines shall be tested at 1-1/2 times their working pressure or at the test pressure indicated on Piping Schedule. Adjustments for hydrotest water temperature and water column elevation differences at point of test must be made.
3. Hydrostatic Testing (except HDPE): The section of pipe to be tested shall be filled with water, the entrained air within the line shall be removed, and water shall be pressurized up to test pressure at the pipe low point within 5 to 10 minutes.
   a. The test period shall start immediately after initial pressurization. The line shall be maintained under the test pressure for a continuous 2-hour period.
   b. The section of pipe to be tested shall hold the test pressure with no more than a 5 percent loss in pressure over the test period or the leakage per hour under the conditions of test shall not exceed values determined by the following equation:

$$L = \frac{SD\sqrt{P}}{148{,}000}$$

where L = allowable leakage per hour (gallons)
S = length of pipe in test (feet)
D = nominal diameter of pipe (inches)
P = average test pressure (psi, gauge)

   c. Piping with flanged, grooved coupling, screwed, socket type, and welded joints shall be completely tight at the designated test pressure.
   d. The test pressure shall not vary by more than 5 psi throughout the entire test period.
4. Pneumatic Testing: The section of pipe to be tested shall be filled with air and pumped up to test pressure.
   a. Sufficient time shall be allowed for the air pressures to stabilize at the test pressure. After the stabilization period, the air control valve shall be closed and the test period started. The section of pipe shall be maintained under the test pressure for a continuous 4-hour period with no more than a 10 percent loss in pressure over the entire test period.
   b. Pneumatic testing of HDPE pipe shall not be allowed.
5. Each valve assembly shall be tested by CONTRACTOR; the test shall consist of opening and closing the valve.
6. Each hydrant assembly shall be tested by CONTRACTOR; the test shall consist of flushing the hydrant for a minimum of ten minutes. During the test period the 6-inch gate valve shall be closed and opened. CONTRACTOR shall furnish necessary hoses for the disposal of OWNER-furnished water.

END OF SECTION

SECTION 15105 - BASIC PLUMBING PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Piping materials and installation methods common to more than one Section of Division 15 and includes pipe, fitting and joining materials, piping specialties, and basic piping installation instructions.

B. All fastening hardware shall be 304 stainless steel.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Sections 01330 and 15050, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Submit product data on the following items:
      a. Escutcheons.
      b. Dielectric Unions and Fittings.
      c. Mechanical Sleeve Seals.

B. Quality Control Submittals: Submit welders' certificates specified in Quality Assurance below.

1.03 QUALITY ASSURANCE

A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
   1. Welding procedures and testing shall comply with ANSI Standard B31.1.0, Standard Code for Pressure Piping, Power Piping, and The American Welding Society, Welding Handbook.

B. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Mechanical Refrigeration.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-applied plastic end-caps on each length of pipe and tube except for concrete, corrugated metal, hub-and-spigot, and clay pipe. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

C. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

D. Store pipe in a manner to prevent sagging and bending.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Pipe Escutcheons:
      a. Chicago Specialty Mfg. Co.
      b. Grinnell.
      c. Sanitary-Dash Mfg. Co.
   2. Dielectric Waterway Fittings:
      a. Epco Sales, Inc.
      b. Victaulic Company of America.
   3. Dielectric Unions:
      a. Eclipse, Inc.
      b. Perfection Corp.
      c. Watts Regulator Co.
   4. Mechanical Sleeve Seals:
      a. Thunderline Corp.
   5. Malleable Iron Unions:
      a. Crane, No. 1259.
      b. ITT-Grinnell, Figure 470.
   6. High-Impact Thermoplastic Wall Sleeve:
      a. Thunderline.
   7. Silicone Rubber Adhesive:
      a. General Electric.
   8. High Density Polyethylene Pipe (64.2):
      a. Driscopipe 8000.
      b. Nipak.
      c. Dupont.

2.02 PIPE MATERIALS

A. Refer to the individual piping system specification Sections in Division 15 for specifications on piping materials required from those listed from the following.

Steel Pipe (61.1)

Normal Service: Pressure to 150 psig
Temperature to 366 degrees F

	Size	Specifications
PIPE	1/4-inch through 4-inch	Carbon steel pipe, Schedule 40, ASTM A 53 seamless or electric welded.
	6-inch and larger	Carbon steel pipe, standard weight, ASTM A 53 seamless or electric welded. Note: Standard weight and Schedule 40 are the same in all sizes through 10 inches; in larger sizes, the wall thickness differs.
TYPE of JOINTS	1/4-inch through 2-inch	Screwed.
	2-1/2-inch and larger	Welded.
FITTINGS	1/4-inch through 2-inch	Black malleable iron, 150-pound class, screwed. ANSI standard B16.3.
	2-1/2-inch and larger	Carbon steel, standard weight, butt welding, ANSI Standard B16.9.
NIPPLES	1/4-inch through 2-inch	Carbon steel, extra strong, ASTM A 120 or A 53.
UNIONS	1/4-inch through 2-inch	Malleable iron, 250-pound class (500 WOG), rail-road type with brass seats.
FLANGES	2-1/2-inch and larger	Carbon steel, 150-pound class, weld neck, standard raised face. ANSI standard B16.5. Exception: Face shall be flat when matching C.I. such as for mission check valves.
FLANGE GASKETS	2-1/2-inch and larger	1/16-inch Garlock Blue - Gard, Style 3200 (Style 3800 for natural gas), ring type. Exception: For flat-face flanges use face gaskets of same material as above.
THREAD SEALANT		Pipe dope. John Crane Insoluble Plastic Lead Seal No. 2, or approved equal. Exception: For temperatures in excess of 250 degrees F, use Teflon ribbon, 1/2-inch wide.

Steel Pipe (61.3)

Normal Service: Pressure to 150 psig
Temperature to 366 degrees F

Note: For condensate in sizes 1-1/2-inch and smaller use Schedule 80 pipe and fittings.

	Size	Specifications
PIPE	1/4-inch through 4-inch	Carbon steel pipe, Schedule 40, ASTM A 120 seamless or electric welded.
	Above 4-inches	Carbon steel pipe, standard weight, ASTM A 53 seamless or electric welded. Note: Standard weight and Schedule 40 are the same in all sizes through 10 inches; in larger sizes, the wall thickness differs.
TYPE OF JOINTS	1/4-inch through 1-1/2-inch	Screwed.
	2-inch and larger	Butt-welded.
FITTINGS	1/4-inch through 1-1/2-inch	Black malleable iron, 150-pound class, screwed. ANSI standard B16.3.
	2-inch and larger	Carbon steel, standard weight, butt welding, ANSI Standard B16.9.
NIPPLES	1/4-inch through 1-1/2-inch	Carbon steel, extra strong, ASTM A 120 or A 53.
UNIONS	1/4-inch through 1-1/2-inch	Malleable iron, 250 psig saturated steam rating, railroad type, with brass seats.
FLANGES	All sizes	Carbon steel, 150-pound class, weld neck, standard raised face. ANSI standard B16.5. Exception: Face shall be flat when matching C.I.
GASKETS	All sizes	1/16-inch Garlock Blue - Gard, Style 3200, ring type. Exceptions: For flat-face flanges, use face gaskets of same material as above. Use Teflon for CO_2 and N_2. Use Gylon or Flexitallic Style CG stainless steel with Teflon fill for high temperature compressed air.
THREAD SEALANT		Teflon ribbon, 1/2-inch wide.

Steel Pipe (61.10)
(Galvanized)

Normal Service: Pressure to 150 psig
Temperature to 180 degrees F

	Size	Specifications
PIPE	1/4-inch through 4-inch	Galvanized steel pipe, Schedule 40, ASTM A 120 butt or electric welded.
	6-inch and larger	Galvanized steel pipe, standard weight, ASTM A 53 seamless or electric welded. Note: Standard weight and Schedule 40 are the same in all sizes through 10 inches; in larger sizes, the wall thickness differs.
TYPE OF JOINTS	1/4-inch through 4-inch	Screwed.
	5-inch and larger	Flanged.
FITTINGS	1/4-inch through 4-inch	Galvanized malleable iron, 150-pound class, screwed. ANSI Standard B16.3.
	5-inch and larger	Galvanized cast-iron, 125-pound class, flanged. ANSI Standard B16.1.
NIPPLES	1/4-inch through 4-inch	Galvanized steel, standard weight, ASTM A 120 or A 53.
UNIONS	1/4-inch through 2-inch	Galvanized malleable iron, 250-pound class, rail-road type, with brass seats.
FLANGES	2-1/2-inch and larger	Companion flanges, black cast iron, 125-pound class, screwed, flat-face. ANSI Standard B16.1.
GASKETS	2-1/2-inch and larger	1/16-inch Teflon, full-face type, or Durco "Taskline" Teflon.
THREAD SEALANT		Teflon tape.

Steel Pipe (61.11)
(Galvanized)

Maximum Pressure: 150 psig
Maximum Temperature: 200 degrees F

	Size	Specifications
PIPE	1/4-inch through 4-inch	Galvanized steel, Schedule 40, ASTM A 120 seamless or electric welded. Mill galvanized.
	6-inch and larger	Galvanized steel, standard weight, ASTM A 53 seamless or electric welded. Mill galvanized. Note: Standard weight and Schedule 40 are the same in all sizes through 10 inches; in larger sizes, the wall thickness differs.
TYPE OF JOINTS	1/4-inch through 2-inch	Screwed.
	2-1/2-inch and larger	Mechanical couplings.
FITTINGS	1/4-inch through 2-inch	Galvanized malleable iron, 150-pound class, screwed. ANSI Standard B16.3.
	2-1/2-inch and larger	Galvanized steel, grooved end for mechanical coupling. Gustin-Bacon, Victaulic.
NIPPLES	1/4-inch through 2-inch	Galvanized steel, standard weight, ASTM A 120 or A 53.
UNIONS	1/4-inch through 2-inch	Galvanized malleable iron, 250-pound class, rail-road type, with brass seats.
COUPLINGS	2-1/2-inch and larger	Malleable iron mechanical coupling with Grade M chlorinated butyl rubber gasket. Gustin-Bacon Series 100, Victaulic Style 77.
FLANGES	2-1/2-inch through 12-inch	Galvanized flanged adapter nipples, 125-pound flat-face. Gustin-Bacon No. 54, Victaulic Style 77.
	14-inch and larger	Companion flanges, black cast-iron, 125-pound class, screwed, flat-face. ANSI Standard B16.1
FLANGE GASKETS	2-1/2-inch and larger	1/16-inch Teflon, full-face type, or Durco "Taskline" Teflon.
THREAD SEALANT		Teflon tape.

Steel Pipe (61.12)
(Galvanized)

Normal Service: Pressure to 150 psig
Temperature to 180 degrees F

	Size	Specifications
PIPE	1/4-inch through 4-inch	Galvanized steel, Schedule 40, ASTM A 120 seamless or electric welded.
	6-inch and larger	Galvanized steel, standard weight, ASTM A 53 seamless or electric welded. Notes: 1. Standard weight and Schedule 40 are the same in all sizes through 10 inches; in larger sizes, the wall thickness differs. 2. To be mill galvanized having smooth appearance.
TYPE OF JOINTS	1/4-inch through 2 1/2-inch	Screwed.
	3-inch and larger	Mechanical couplings.
FITTINGS	1/4-inch through 2 1/2-inch	Galvanized malleable iron, 150-pound class, screwed. ANSI Standard B16.3.
	3-inch and larger	Galvanized steel, grooved end for mechanical coupling. Gustin-Bacon, Victaulic.
NIPPLES	1/4-inch through 3/4-inch	Galvanized steel, standard weight, ASTM A 120 or A 53.
UNIONS	1/4-inch through 3/4-inch	Galvanized malleable iron, 250-pound class, rail-road type, with brass seats.
COUPLINGS	1-inch and larger	Malleable iron mechanical coupling with flush-seal type chlorinated butyl rubber gasket. Gustin-Bacon Series 100 with Type II gasket, Victaulic Style 77 with Grade E gasket. Exception: Butyl rubber gasket is suitable for system supplied with oil-free air only. If air com-pressors are oil-lubricated type, use Buna-N flush-seal type gaskets.
FLANGES	1-inch through 12-inch	Galvanized flanged adapter nipples, 125-pound flat-face. Gustin-Bacon No. 54, Victaulic Style 77.
	14-inch and larger	Companion flanges, black cast-iron, 125-pound class, screwed, flat-face. ANSI Standard B16.1.
FLANGE GASKETS		1/16-inch Teflon, full-face type, or Durco "Taskline" Teflon.
THREAD SEALANT		Teflon tape.

Ductile Iron Pipe (62.5)

Normal Service: Pressure to approx. 250 psig
Temperature to 180 degrees F

	Size	Specifications
PIPE	3-inch and larger	Ductile Iron, ASTM 21.51 (AWWA C151) and ASTM A 536, Grade 60-45-10 Class 54 cement-lined interior, coal tar varnish coating - ground-buried universal rust-inhibitive primer exposed.
TYPE OF JOINTS	3-inch and larger	Push-on joint, compression with restrained mechanical joint fittings - ground-buried, flanged or grooved coupling - exposed.
FITTINGS	3-inch and larger	Ductile Iron, ASA 21.10, 250 psi rating.
GASKETS	3-inch and larger	1/16-inch rubber.
FLANGES (when required)	3-inch and larger	Ductile iron, ANSI 21.15 (AWWA C115) dimensions ANSI B16.1; threads ANSI B 2-1, bolts ASTM A 307, Grade B. All nuts and bolts to be cadmium-plated.

NOTE: Ground-buried pipe to be restrained for pressures up to 180 psi as noted in the pipe restraint schedule.

Copper Tubing (63.1)

Normal Service: Pressure to 150 psig
Temperature to 250 degrees F

NOTES: 1. Use solder fittings at all joints between terminal points.

2. Bends may be used for 1/4-inch and 3/8-inch tubing. Bends shall be made with a bending tool to the following minimum radii:

1/4-inch: 9/16-inch min. radius
3/8-inch: 15/16-inch min. radius

	Size	Specifications
PIPE	All sizes	Copper tubing, type L, hard-drawn above ground. Type K (soft) for below grade.
TYPE OF JOINTS	1/4-, 3/8-, 1/2-inch	Soldered or compression type as required. (see Note 1).
	5/8-inch and larger	Soldered. (Exposed.) Flared. (Buried.)
SOLDERED FITTINGS	All sizes	Wrought copper or cast bronze, solder-joint fittings. ANSI Standard B16.22.
COMPRESSION FITTINGS (EXPOSED)	1/4-, 3/8-, 1/2-inch	Brass compression type fittings. Gyrolok, Swagelok, Parker CPI.
UNIONS	1/4-inch through 2-inch	Wrought copper or cast bronze, solder joint union.
FLANGES	All sizes	Copper, solder-joint flange. 150-pound ASME drilling. Raised or flat face to match equipment.
GASKETS		1/16-inch Teflon; ring type for raised-face, or full-face for flat face flange.
SOLDER		Tin/Antimony (or lead-free to meet code requirements).
THREAD SEALANT (where necessary)		Teflon tape.

PVC Pipe (64.1)

Normal Service: Maximum Pressure: 150 psig
Maximum Temperature: 150 degrees F

	Size	Specifications
PIPE	1/2-inch through 6-inch	PVC Type I, Schedule 80, ASTM D 1785.
TYPE OF JOINTS	1/2-inch through 6-inch	Solvent welded.
FITTINGS	1/2-inch through 6-inch	PVC, Schedule 80, socket type, ASTM D 2467.
FLANGES (where necessary)	1/2-inch through 6-inch	PVC, 150-pound, flat-face, Schedule 80, socket type.
GASKETS	1/2-inch through 6-inch	1/16-inch solid neoprene, full-face type.

NOTE: Provide 20-gauge (0.032-inch) aluminum jacket on all piping in return air plenums.

Sodium hypochlorite and sodium hydroxide piping joints shall be made with Oatey, Lo-Voc heavy-duty gray, Industrial Grade PVC cement. PVC cement shall be NSF listed and meet ASTM D 2564 and D 1412. Cement shall be resistant to caustics and hypochlorites up to 15 percent solution.

CPVC Pipe (64.8)

Normal Service: Maximum Pressure: 100 psig
Maximum Temperature: 180 degrees F

	Size	Specifications
PIPE	1/2-inch through 2-inch	rigid chlorinated polyvinyl chloride (CPVC) compound, Type IV Grade I, with a Cell Classification of 23447 as defined in ASTM D1784
TYPE OF JOINTS	1/2-inch through 2-inch	Solvent welded.
FITTINGS	1/2-inch through 2-inch	CPVC, Schedule 80, socket type, ASTM F 439.
FITTINGS - THREADED (where necessary)	1/2-inch through 2-inch	CPVC, , Schedule 80 ,THREADED, ASTM F 437
LISTING		Only for transition to different piping system approved by NSF for use with potable water

Stainless Steel Pipe (66.1)

Normal Service: Pressure to approx. 150 psig
Temperature to 300 degrees F

	Size	Specifications
PIPE	1/2-inch through 6-inch	Types 304, 304L, 316 or 316L stainless steel pipe, Schedule 5S. ASTM A 312 seamless or electric welded.
TYPE OF JOINTS	1/2-inch through 6-inch	Butt-welded, Press Fittings or threaded as required.
FITTINGS	1/2-inch through 6-inch	Press Fittings by Viega or approved equal per ASME A312 or ASTM A554. Types 304, 304L, 316 or 316L stainless steel, schedule 5S, butt-welding. ASTM Standard A 403 and ANSI Standard B16.9, or tangential fittings as manufactured by Horace T. Potts Co. (Speedline) or by Picor, Inc.
FLANGED CONNECTIONS	1/2-inch through 6-inch	Types 304, 304L, 316 or 316L stub ends, schedule 5S, butt-welding. Type A or B as covered by MSS or ANSI. All stub ends must be true schedule 5 -- not taper-bored. Speedline or Camco 150-pound. C.S. lightweight backup flanges are permitted for stub ends.
GASKETS	1/2-inch through 6-inch	Press Fitting O-rings shall be EDPM or FKM depening on application 1/16-inch solid Teflon, ring type. (Gylon is an acceptable alternate where cold flow of Teflon could be a problem.)

2.03 JOINING MATERIALS

A. Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

B. Brazing Materials: Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.

C. Gaskets for Flanged Joints: Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.04 PIPING SPECIALTIES

A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

B. Unions: Malleable-iron, Class 150 for low-pressure service and Class 250 for high-pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

C. Dielectric Unions: Provide dielectric unions with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion. Insulated and gasketed, galvanized, malleable iron unions as manufactured by Crane No. 1259, ITT - Grinnell Figure 470, or equal.

D. Dielectric Waterway Fittings: electroplated steel or brass nipple, with an inert and non-corrosive, thermoplastic lining.

E. Sleeves: Unless otherwise shown on Drawings, at all points where pipes must pass through walls, floors or roofs of structures, CONTRACTOR shall furnish and install suitable sleeves or wall castings meeting the requirements of Section 01600.
   1. In general, the wall sleeve or casting shall be of the same material as the pipe, or standard weight steel pipe thimbles of at least one size larger than the pipe itself shall be installed. Iron pipe wall castings, wall pipe, transition sleeves and solid sleeves shall meet the requirements or AWWA Specifications C100 and shall be of the lightest class conforming to the pressure rating of the pipelines which they connect, but in no case shall be lighter than Class B. All sleeves shall be shop-coated with universal primer 2 mils minimum thickness.
   2. A high-impact thermoplastic wall sleeve as manufactured by Thunderline, may be used for low and standard temperature service.

F. Sleeve Seals: Unless otherwise shown or permitted, the space between the pipe and the sleeve shall be caulked at the inside and outside wall faces on walls exposed to earth or water/sewage, at one face of the other walls, and at the top surface of floors and slabs. The space shall be caulked with lead and oakum as specified under Bell and Spigot Lead with an RTV-silicone rubber adhesive as

manufactured by General Electric, or sealed with a rubber link seal. Rubber link seal shall be identical rubber links interconnected with bolts and elongated nuts and washers. The sealing element shall be made of synthetic rubber material especially compounded to resist aging, ozone, sunlight, and chemical action. Bolts and metal parts shall be made of galvanized or cadmium-plated steel to resist corrosion. Rubber link seal joints shall be submitted to ENGINEER for approval.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.02 INSTALLATION

A. Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

B. Piping shall be exposed, unless indicated otherwise.

C. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

D. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on Drawings.

E. Install piping far enough from slabs, beams, joists, columns, walls, and other permanent elements of the building to permit access for painting. Provide space to permit insulation applications, with 3-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

F. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

G. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple and cap.

H. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals.

I. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, or floors, the fire rated integrity shall be maintained. Refer to Division 7 for special sealers and materials.

J. Buired Plastic Pipe: Install a yellow insulated copper tracer wire or other approved conductor adjacent to underground nonmetallic piping. The tracer wire shall terminate above ground at each end of the nonmetallic piping. The tracer wire size shall not be less than 18 AWG and unsulation type shall be suitable for direct burial.

3.03 FITTINGS AND SPECIALTIES

A. Use fittings for all changes in direction and all branch connections.

B. Remake leaking joints using new materials.

C. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, and elsewhere as indicated.

D. Install unions adjacent to each valve, and at the final connection to each piece of equipment and plumbing fixture having 2-inch and smaller connections, and elsewhere as indicated.

E. Install flanges in piping 2-1/2-inch and larger, where indicated, adjacent to each valve, and at the final connection to each piece of equipment.

F. Install dielectric unions to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum).

G. Install dielectric fittings to connect piping materials of dissimilar metals in wet piping systems (water, steam).

H. HDPE to Metallic
   1. Provide an anodeless transition fitting between the underground HDPE gas piping and the above ground metallic piping.

3.04 JOINTS

A. Steel Pipe Joints:
   1. Pipe 2-inch and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.
   2. Pipe Larger than 2-inch:
      a. Weld pipe joints (except for exterior water service pipe) in accordance with ASME Code for Pressure Piping, B31.
      b. Weld pipe joints of exterior water service pipe in accordance with AWWA C206.
      c. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.1.0 Code for Pressure Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

B. Non-ferrous Pipe Joints:
   1. Brazed and Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.1.0 - Standard Code for Pressure Piping, Power Piping, and ANSI B9.1 - Standard Safety Code for Mechanical Refrigeration.
   2. Mechanical Joints: Flared compression fittings may be used for refrigerant lines 3/4-inch and smaller.

C. Joints for other piping materials are specified within the respective piping system sections.

3.05 FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system Specification Sections.

END OF SECTION

SECTION 15110 - PROCESS VALVES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Labor, materials, and equipment necessary for fabrication, production, installation, and erection of the items specified in this Section and as shown on Drawings or on Valve Schedule on Drawings.

B. Items furnished under this Section shall be erected under Division 15. Hanger rods, inserts and supports, flange bolts, and gaskets for valves shall be furnished and installed under Section 15100.

1.02 REFERENCES

A. ANSI:

1.	B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, 250, and 800.
2.	B16.3, B2.1	Threaded Valve Joint Standards.
3.	B16-104	Reinforced Teflon Steel Standard.

B. ANSI/AWWA:

1.	C110/A21.10	Ductile Iron and Gray Iron Fittings, 3-inch through 48-inch for Water and Other Liquids.
2.	C111/A21.11	Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
3.	C500	Metal Seated Gate Valves for Water Supply Service.
4.	C507	Ball Valves.
5.	C504	Rubber Seated Butterfly Valves, 3-Inch through 72-Inch.
6.	C508	Swing-Check Valves for Waterworks Service, 2-Inch Through 24-Inch
7.	C509	Resilient Seated Gate Valves for Water Supply Service.
8.	C512	Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
9.	C515	Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
10.	C517	Resilient-Seated Cast-Iron Eccentric Plug Valves
11.	C530	Pilot Operated Control Valves
12.	C541	Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates
13.	C542	Electric Motor Actuators for Valves and Slide Gates
14.	C550	Protective Interior Coating for Valves and Hydrants

C. ASTM:

1.	A 48	Specification for Gray Iron Castings.
2.	A 126	Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
3.	A 182/A 183M	Specification for Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings and Valves and Parts for High Temperature Service.
4.	A 183	Specification for Carbon Steel Track Bolts and Nuts.
5.	A 194/194M	Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service.
6.	A 276	Specification for Stainless and Heat Resisting Steel Bars and Shapes.
7.	A 436	Specification for Austenitic Gray Iron Castings.

8. A 536 Specification for Ductile Iron Castings.
9. B 148 Specification for Aluminum Bronze Castings.
10. B 584 Specification for Copper Alloy Sand Castings for General Applications.
11. B 61 Specification for Steam of Bronze Castings.

1.03 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Each valve, including accessories, shall be identified on Shop Drawings by its respective mark as noted on Valve Schedule.

B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.

C. Warranty: Submit in accordance with requirements of Section 01770, warranties covering the items included under this Section.

1.04 QUALITY ASSURANCE

A. All Work under this Section shall be performed in accordance with standard practices as recommended by manufacturer and AWWA.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Butterfly Valves (B):
      a. DeZurik.
      b. Henry Pratt Co.
      c. M&H Valve Co.
      d. Rodney Hunt Co.
      e. Val-matic Valve and Manufacturing Corp.
   2. Industrial Butterfly Valves (IB):
      a. Cooper Cameron Corp. (Demco Valve).
      b. DeZurik SPX.
      c. Henry Pratt Co.
      d. Hilliburton Co. (Dresser Valve Div.).
      e. Kennedy Valve.
      f. Keystone Valve.
      g. Mark Controls Corp. (Center Line Valve).
   3. Resilient Seated Gate Valves (RA):
      a. American Flow Control Valves.
      b. Clow Valve Co.
      c. M&H Valve Co.
      d. Mueller Co. (A-2360 Resilient Wedge).
      e. U.S. Pipe (Metroseal 250).

4. Standard Swing Check Valves (C):
    a. Clow Valve Co.
    b. G.A. Valves (Golden Anderson).
    c. Kennedy Valve.
    d. M&H Valve Co.
    e. Rensselaer Valve Mfg. Co.
5. Double Vane Check Valves (DC):
    a. Mission Manufacturing Co. - Duo-Chek.
    b. Techno Corporation - Technocheck.
6. Plug Valves (P):
    a. Clow Valve Co.
    b. DeZurik.
    c. Homestead Valve (Div. of Olson Technologies, Inc.).
    d. Milliken Valve Co.
    e. Henry Pratt Co.
    f. Val-Matic Valve and Manufacturing Co.
    g. Victaulic Co.
7. Tapping Sleeves and Valves (TPSV):
    a. A.P. Smith Co.
    b. Clow Valve Co.
    c. Kennedy Valve Co.
    d. M&H Valve Co.
8. Electric motor open-shut service operators:
    a. Rotork.
9. Electric motor operators for throttling service:
    a. Rotork.
10. Floor Box:
    a. Clow Valve Co.
    b. Ludlow.
11. Limit Switches, spring-centered:
    a. Allen-Bradley.
    b. Square D Co.
12. T-handle Wrench:
    a. Clow Valve Co.

2.02 VALVE AND GATE IDENTIFICATION

A. Each valve and gate shall be tagged with its distinguishing mark letter and number. Mark letter and number will be as listed on Valve Schedule. Identification tag shall be 1-1/2-inch in diameter, 18-gauge polished brass or aluminum with 1/2-inch-high, embossed, black-filled mark letter and number placed thereon. Tags shall be securely fastened to the valve or gate operator with No. 16 brass jack chain or plastic seals.

2.03 COMPONENTS

A. Butterfly Valves:
    1. Shall be Class 150B and meet the requirements of AWWA Specification C504. Butterfly valves shall be short body laying length and be provided with square wrench nut operators.
    2. Butterfly valves shall be installed in manholes or ground buried as shown on Drawings and/or as listed on Bid Form. Butterfly valves to be installed in manholes shall be provided with

flanges which are ductile iron and meet the requirements of AWWA C115 (ANSI 21.15). Ground-buried butterfly valves shall be provided with mechanical joint end connections, except with polyethylene water main valve shall have flanges which are ductile iron and meet the requirements of AWWA C115 (ANSI 21.15).

B. Resilient Seated Gate Valves (RA):
   1. Resilient seated gate valves shall be designed for 150 psi working pressure and shall meet the requirements of AWWA Specification C509 or C515 except as otherwise specified herein. Valves shall be cast or ductile iron body, bronze stem, O-ring stem seal, and non-rising stem. The interior and exterior surfaces of the valve body shall be coated with an epoxy coating meeting the requirements of AWWA C550. The bronze or iron or ductile iron wedge shall be fully encapsulated with molded rubber. No bare metal shall be left exposed. The valve shall seal on both sides of the wedge. Gate valves shall have a clear waterway equivalent in area, when fully open, to that of the connecting pipe. Valves shall be made to open when turned to the left, or counterclockwise. The gate valves shall have square wrench nuts mounted on non-rising stems. All fasteners shall be stainless steel. Ground-buried gate valves shall be furnished with valve boxes. Flanges shall meet the requirements of AWWA C115 (ANSI 21.15). Two complete sets of joint accessories shall be furnished with each valve.
   2. The force mains will be laid with a minimum 5 feet of cover or as noted on Drawings. One operating wrench of suitable length shall be provided under this Section.

C. Standard Swing Check Valves (C):
   1. Standard swing check valves shall meet the requirements of ANSI/AWWA C508.. Check valves shall be cast or ductile iron body with end flanges conforming to ASME B16.1 Class 125. Reslient to metal type seat shall be provided with stainless steel seating surface mechanically attached to machined body area with the buna-N seat material integral with or mechanically attached to the disc. Check valves shall be of the balanced single disc type with the disc hinged at the top, with outside lever and adjustable weight or spring. A clear waterway opening equal to the full area of the connecting pipe shall be provided when the valve is open.
   2. Disc shall be shall be cast or ductile iron.. Hinge pins shall be one piece stainless steel and protrude through both sides of the body. Bronze or stainless steel bushings with adjustable packing or O-ring seal shall be provided where pins pass through the valve body.
   3. Valves shall be interior coated with epoxy meeting requirements NSF/ANSI 61 approved epoxy in accordance with AWWA C550 and, as minimum, be painted with primer on the exterior.

D. Plug Valves (P):
   1. Plug valves shall meet the requirements of AWWA C517, be nonlubricated, eccentric type with nitrile butadiene (hycar) or Buna-N resilient faced plugs. End connections shall generally be flanged or grooved for inside valves and mechanical joint for exterior ground-buried valves. Port areas shall be equal to at least 80 percent of the nominal size pipe area. Valve shall be suitably marked to indicate whether it is open or closed.
   2. The seating surface of the valve body shall be welded in stainless steel or nickel. Bearings at the top and bottom supporting the rotating element shall be self-lubricating, corrosion-resistant type, suitable for sewage plant service. The valve shall be of the bolted bonnet design. Packing shall be visible for inspection without dismantling valve or removing operator. The packing shall be adjustable and replaceable without disassembling of the valve and actuator. The valve body shall be cast or ductile iron marked to show seat side of valve.
   3. Plug valves shall be of adequate design to operate with a pressure of 50 psi on both sides or on either side of the valve without leakage.

2.04 VALVE JOINTS

A. Bell and Spigot Lead: Bell lead joints shall meet the requirements of ANSI/AWWA C110/A21.10.

B. Flange Joint: Flanges shall meet the requirements of ANSI-B16.1 Standard Class 125, except that bolt holes at shaft hubs may be drilled and tapped on the flanges. Flange faces shall be coated with a rust inhibitor immediately after drilling.

C. Grooved Coupling: Grooved coupling joints shall be the rigid type and shall have housing fabricated in 2 or more parts of malleable iron in accordance with ASTM Specification A 47, Grade C32510. Ends shall be factory grooved in accordance with the coupling manufacturer's standard groove dimension. Bolts shall be oval neck track head type with hexagonal heavy nuts, per ASTM A 183 and A 194/A 194M. Gasket material shall be Grade H, E chlorinated butyl, or E.P.D.M. for water service and Grade T Buna-N for sewage.

D. Mechanical joints shall conform to ANSI/AWWA C110/A 21.10 and ANSI/AWWA C111/A 21.11.

E. Push-on joints shall conform to ANSI A21.11 and AWWA C111.

F. Screwed joints shall conform to American Standard dimensions ANSI B16.3 and threads ANSI B2.1.

G. Wafer joints shall be flat face or raised face for use between standard flanges.

2.05 ACCESSORIES

A. Manual Operators: Operators shall be designed with a safety factor of 5 for torsional and shear stresses. The operating mechanism shall be so located and so designed that parts subject to the maintenance shall be easily accessible.
   1. Manual operators shall be so sized that a maximum of 80 pounds of rim force/pull is required for operation.
   2. Positions of operators shall be approved by ENGINEER.
   3. Valve shall be made to open when turned to the left or counterclockwise.
   4. The direction of the operator to open position shall be indicated on the operator.
   5. Bevel gear activators shall provide vertical mounting of the handwheel. Handwheels shall be included.
   6. Crank/Handle: Cranks shall be cast iron with a rotating brass grip. They shall be a maximum of 15 inches in length and keyed to the operator nut.
   7. Chainwheels shall be cast iron and furnished complete with chain and guides. Chain shall be galvanized and shall be looped to extend to within 4 feet of the floor below the valve.
   8. Handwheels shall be fabricated steel. They shall be a maximum of 30 inches in diameter and keyed to the operating nut.
   9. Lever shall be fabricated steel, shall include a setscrew and be grease lubricated.
   10. Chain lever shall indicate chain and lever. Materials shall be galvanized.
   11. Infinite lever shall be of extra heavy steel and capable to be moved to any position and locked in place by a simple wing nut.
   12. Position lever shall be of extra heavy steel with a multiple position throttling plate.
   13. Wrench heads shall be cast iron with setscrew. They shall be furnished for wrench nuts except where extension stems or T-handle wrenches are required.

14. Wrench nuts shall be provided with a 2-inch operating nut when a T-handle wrench or extension stem is required. Other wrench nuts shall be furnished with a wrench head.

B. Motor:
   1. Electric Motor Open-Close Service: Electric motor actuators for open-shut service shall meet the requirements of ANSI/AWWA C542, except as herein specified.
      a. Controls shall be "integrally mounted" as part of the actuator body. If designated on Valve Schedule a "wall-mounted enclosure" or “remote control station” shall be provided for mounting important actuator controls separate from the actuator body in an easily accessable location. Deviations from the Valve Schedule will not be accepted.
      b. The valve manufacturer shall provide the required seating, unseating dynamic torque requirements and any other trust or static loading information necessary to properly size the electric motor actuator.
      c. Electrical equipment shall be mounted in a NEMA 4 or 7 enclosure whether on the valve body or in the wall-mounted enclosure. The enclosure shall be NEMA 4 unless shown otherwise on Valve Schedule.
      d. Actuator materials of construction shall be selected by the manufacturer to be compatable with the environmental conditions that will be present at the valves installed location. Actuators installed in water treatment plants or other potable water applications shall have materials that comply with the Safe Water Drinking Act requirements including food grade lubricants.
      e. Motorized valve actuators shall include the motor, reversing starter with remote-off-local switch, associated gearing, limit switches, torque switches, auxiliary handwheel for manual operation, a valve mounted mechanical dial valve position indicator, Open-Close-Stop position switch or push-buttons, and accessories as listed on Valve Schedule.
      f. The remote control station shall be provided by the actuator manufacturer, have a NEMA 4 rated enclosure unless noted otherwise on Schedule and be powered by the actuator. Signal and power wires shall be integrally linked to the actuator with wires landed on appropriately marked termainal stips in the actuator. Unit shall be capable of being mounted 300 feet away from the actuator and with enclosure suitable for wall, rack or pole mounting. Locable Local-Off-Remote selector and Open-Close valve postion switches, push buttons, and open-closed indicator lights or valve position indication shall be provided.
      g. Wires shall be tagged at each end of the wire with individual wire markers. Each terminal of the terminal strips shall be numbered and identified with a marker. Schematics shall be provided with Shop Drawings showing wire numbers, terminals, field wiring, etc. Connections for remote equipment shall be wired to terminal blocks. Equipment shall be factory wired and tested before shipment.
      h. The motor starters shall be the solid state reversing contactor type complete with gang-operated switch, 2 solid state reversing contactors, 120 volt control power transformer when motor voltage is other than 120 volt, thermal overload protection for each phase, and associated wiring. Operating voltage shall be 460 Volts unless indicated otherwise on Valve Schedule.
      i. Limit switches shall be provided at the extreme open and close position of the operator travel. At least 2 independent switches at each end of motor travel shall be provided as standard for the local indicator lights and interlocking. An additional 4 switches shall be provided for remote use.
      j. Torque switches shall be provided in both the open and closed circuits of the operators. The torque switches shall be field adjustable and designed to stop the operator motor when the torque exceeds safe limits for either the operator or the valve. An electrical or

mechanical interlock shall be provided to prevent the open torque switch from tripping when unseating a torque seated valve.

k. A local mechanical dial position indicator shall be provided on the valve operator to indicate the position of the valve.

l. Motors shall be standard-duty rated, totally enclosed nonventilated, Class B insulated, 60 hertz and specially designed for valve service. If voltage and phase are not noted on Valve Schedule configure motors for 460 Volt three phase service. The design shall combine low inertia with a high starting and stalling torque.

m. Lost motion drive for increased unseating torque shall be provided.

n. Unless indicated otherwise on Valve Schedule the actuator shall be sized to stroke valves from full open to full closed and vise versa in one to three minutes under the full specified unbalance operating head stated in the Specifications and at a frequency not to exceed 60 cycles per hour. The motor winding temperature rise shall be NEMA standard for Class B insulation at the rated service factor load.

o. Gear case shall be cast iron. Pedestals shall be fabricated steel or cast iron. Stem nut shall be high-tensile bronze.

p. A heater shall be provided if indicated in the Schedule to prevent condensation in the controls cavity and terminal chamber of the actuator body. Heaters shall be 120 V powered. Multiple heaters shall be provided if necessary depending on the actuator body configuration.

q. Mechanical manual operation shall be provided by a clutchable handwheel drive mechanism completely independent from the motor gearing. Hand operation shall be direct drive permitting fast manual valve operation. Failure of motor gearing due to power failure or gearing problem shall not prevent handwheel operation. Manual operation shall prevent (disconnect) electrical operation. Gear reducers shall be provided for manual handwheel if required. Maximum rim force required for handwheel operation shall not exceed 40 pounds for dynamic loads. Manual operator shall engage the actuators lost motion device.

2. Electric Motor Throttling Service:

a. Electric motor actuator for throttling service on the valves shall meet the requirements of ANSI/AWWA C542 except as herein specified. Enclosures shall be NEMA 4 unless shown otherwise on Valve Schedule.

b. The valve operator torque shall be as required for a 150 psi pressure drop across the valve, minimum, except those for low pressure air service. The valve operator torque for low pressure air service valves shall be as required for a 25 psi pressure drop across the valve, minimum.

c. The valve manufacturer shall provide the operating seating, unseating and dynamic torque requirements along with any other thrust or static loading information necessary to properly size the electric motor actuator.

d. Actuator materials of construction shall be selected by the manufacturer to be compatable with the environmental conditions that will be present at the valves installed location. Actuators installed in water treatment plants or other potable water applications shall have materials that comply with the Safe Water Drinking Act requirements including food grade lubricants.

e. Mechanical parts shall be designed for safety factor of at least 2. Construction of the operator shall be such that it may be mounted in any position required to facilitate manual operation. Manual operation of the valves shall be possible by a handwheel attached to the mechanism. Power to motor circuit shall be automatically disconnected to prevent accidental electric operation during manual operation. A mechanical dial position indicator shall be provided to continuously indicate valve position. Operator bearings shall be self-lubricating type or lubricated for life before operator is sealed at the factory.

f. The operator motor shall be heavy-duty with continuous duty rating and totally enclosed and nonventilated. The motor shall be equipped with thermal overload protection. Operating voltage shall be as listed on Valve Schedule.

g. The winding temperature rise shall meet NEMA standard for the class of insulation used at the rated service factor load. The motor shall be for high torque variable speed duty. The motor shall be reversible. A 4-20 mA throttling signal shall be provided by others. Control interface electronics, motor controller, and appurtenances to accept this signal and position the valve between 0 and 90 degrees based on the value of the throttling signal shall be provided with the valve operator. The controller shall be provided complete with NEMA 4 enclosure, Auto-Manual selector switch and Open, Close push-buttons. Controller shall be completely solid state; contactors are not acceptable. Motor and controller shall be suitable for 600 starts per hour. Controllers shall accept an isolated 4-20 mA signal for valve positioning from a remote source. Valve operators shall be equipped to be field adjustable to fail open, fail closed, or fail in place upon loss of control signal (4-20 mA). Actuators shall be set up to fail in place unless otherwise noted on Valve Schedule.

h. The actuator motor gear train in conjunction with any gearing provided as part of the valve shall be pre-selected to have a stroking time from opento close or vise versa between 1 and 3 minutes or as shown on Valve Schedule.

i. Limit switches shall be provided at the extreme open and close position of the operator travel. At least 2 independent switches at each end of motor travel shall be provided as standard for a local indicator and interlocking. An additional switch shall be provided at each end for remote use.

j. Motor circuit limit switches shall be of the direct break type. Limit switches shall be adjustable. Limit switch contacts shall be isolated. Auxiliary switches for secondary functions shall be of the cam-operated, spring leaf type. The operator shall be equipped with a torque switch for protection in the closing direction. An electrical or mechanical interlock shall be provided to prevent the open torque switch from tripping when unseating a torque-seated valve. In the event of power failure, the operator shall lock in the last control position until power is restored or switched over to standby power or the manual operating handwheel is engaged.

k. Torque switches, limit switches, and motor thermal switches are to be mounted as required inside the housing and connected to the master terminal strip. Provisions shall be made for 2 internal potentiometers for feedback control operations and for remote valve position indicator. Wiring within operator shall be incorporated in a standard laced wiring harness using compression connectors and terminal strips. Internal wiring shall be UL approved for 105 degrees C operation. Insulation shall be suitable for 600 volts.

l. Wires shall be tagged at each end of the wire with individual wire markers. Each terminal of the terminal strips shall be numbered and identified with a marker. Schematics shall be provided with Shop Drawings showing wire numbers, terminals, field wiring, etc. Connections for remote equipment shall be wired to terminal blocks. Equipment shall be factory wired and tested before shipment.

3. Electric Motor Actuator Retrofit.

a. Existing valves shall be retrofitted with new motor actuators when shown on the Valve Schedule.

b. Prior to submitting shop drawings the actuator manufactures representative shall perform a field inspection to verify mounting requirements and existing configurations that may effect valve mounting.

c. If the existing valve and operator need to be partially disassembled or operated through open-close cycles to acquire the necessary information for installation of new actuators the Engineer and Owner shall be notified in advance to allow time for scheduling.

d. Actuator representative is responsible to either contact the existing valve manufacturer to obtain torque requirements. If this information is not available loadings shall be as determined by the actuator manufacturer based on field observation and measurements of existing actuator and anciallary support utilities, historical data of similar valves or other means. Actuator manufacturer shall assume increased torque will be required for old valves and make allowances when sizing new actuators.
e. Adapter plates, bushings, couplings, mounting brackets, secondary gear assemblies and any other items necessary for proper actuator mounting shall be provided. If not indicated otherwise materials shall be compatible with the environment at the mounting location.
f. Actuator representative shall perform installation and start-up site visits to ensure the actuators are functioning properly and communicating with the control system.
    1) Actuator representative shall configure the valve including setting the open/close limits and seating/unseating torque settings. All settings shall be carefully adjusted to avoid overloading existing valve components.
    2) Installation Check: The manufacturer shall provide the services of a factory-trained representative to check the installation of all equipment installed in this Section. The services shall be as noted in Section 01600.

C. Bench Stand: Bench stands shall meet the requirements of floor stands as specified in this Section, except that baseplates shall replace pedestals.

D. Remote Control Station: The control package shall consist of indicating lights, Open-Close-Stop push-button stations, Local-Remote control selector, strip headers, and wiring factory assembled, mounted in a NEMA 4 enclosure unless otherwise noted on Valve Schedule.

E. Extension Bonnet (Length): Extension bonnets shall be cast iron and be provided complete with galvanized assembly bolts.

F. Extension Stem/Shaft (Length): Extension stems shall be 304 or 303 stainless steel with bronze couplings. Stems of more than one section shall be jointed by bronze couplings threaded and keyed to the stems. Extension stems shall have a 2-inch wrench nut end connection for T-handle wrench operation.
    1. Extension shafts shall be 304 or 303 stainless steel with universal joint couplings.

G. Floor Box (Length): Where openings through concrete slabs are provided for key operation of valves and extension stems connected therewith, the operating nut being in or below the slab, such openings shall be provided with a floor box, complete with cover. Each floor box shall be of the depth required for installation as shown on Valve Schedule and shall have cast on the cover an appropriate name designating the service for which the valve is used. In addition, where the operating nut is in the slab, the floor box shall be bronze bushed; where below, the opening in the bottom of the box shall be sufficient for passage of the operating key.
    1. Each floor box and cover therefor shall be coated by dipping in hot asphaltum varnish.

H. Floor Stand: Floor stands shall meet the requirements of AWWA C501 for Manual Operating Mechanism except as specified in this Section.
    1. Floor stands shall be a high-strength cast iron pedestal type furnished with lubrication fittings and stainless steel, double-nutted anchor bolts.
    2. Geared floor stands shall have weatherproof housings.
    3. Floor stands shall be provided with a galvanized steel stem cover and position indicator, and the direction of rotation to open the valve shall be indicated.

4. The operating stem will be 304 or 303 stainless steel.
5. A sleeve made from standard weight galvanized steel pipe shall be provided for the opening in the floor beneath each operating stand.

I. Position Indicator: Position indicators shall be of bronze or cast iron construction.
1. Limit Switch. Two limit switches shall be factory-mounted to the valve for indicating full open and full closed positions.

J. Manual Screw: Manual screw operators shall meet the requirements of AWWA C504 operators.

K. Remote Position Indicator: Remote position indicators shall be the isolated 1,000 ohm potentiometer design for use with a remote position indicator. Resolution of 1/2 percent shall be required and potentiometer shall be directly attached to or geared from the valve operating shaft.

L. Stem Cover: Stem covers shall be galvanized steel with position indicators and cap.

M. Stem Guide: Stem guides shall be cast iron ASTM A 126, Class B, construction with bronze bushings adjustable in two directions and provided with mounting assembly and anchor bolts of stainless steel. The minimum thickness of any portion shall be 1/2 inch.

N. Valve Box (Length): Valve boxes shall be either cast iron or ABS plastic. Cast iron lids shall be provided with valve boxes and shall be marked "WATER" in raised letters.
1. Cast iron boxes shall be of the 3-piece adjustable type. A Number 6 base shall be furnished with valves 8 inches or less, and a Number 160 base shall be provided for valves over 8 inches.
2. ABS plastic boxes shall be of high-grade ABS polymer, two sections, adjustable to varying, desired grade levels by means of a friction design (upper section slides inside lower section), with base to fit various sized valves with arch.
3. Plastic material shall meet requirements of ASTM D 1788.
4. Cast iron material shall meet requirements of ASTM A 126-B or ASTM A 48, Class 30B.
5. Bolt material shall meet requirements of ASTM B 316 and B 253.
6. A magnet shall be permanently molded into both the upper and lower sections for easy locating with a dip needle or magnetic locator.

O. Wall Bracket: Wall brackets shall be cast iron and provided with stainless steel assembly and anchor bolts.

PART 3 - EXECUTION

3.01 ERECTION

A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operation condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer approved by ENGINEER.

B. Equipment furnished under this Section shall be installed under Section 15100.

3.02 FIELD QUALITY CONTROL

A. Installation: Special attention shall be given by CONTRACTOR to ensure that items furnished under this Section are installed in accordance with manufacturer's recommendations.

END OF SECTION

SECTION 15116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. PP-R pipe and fittings.
2. Transition fittings.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Pipe and tube.
2. Transition fittings.

1.4 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 POLYPROPYLENE (PP-R) PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aquatherm.
2. IPEX USA LLC.
3. Nupi Americas.

B. Polypropylene Pipe: ASTM F2389, pipe pressure rating to comply with temperature and pressure ratings of code requirements for the applicable service.

1. Polypropylene Fittings: ASTM F2389, socket fusion, butt fusion, electrofusion, or fusion outlet fittings to be used for fusion-welded joints between pipe and fittings.
2. Mechanical fittings and transition fittings to be used where transitions are made to other piping materials or to valves and appurtenances.
3. Polypropylene pipe is to be unthreaded. Threaded transition fittings per ASTM F2389 to be used where a threaded connection is required.

C. Integration of PP-R Piping Systems with Other Systems:

1. When integrating PP-R piping systems with other systems or with components not made of PP-R (for example, valves, pumps, other piping, check valves, or strainers), ensure the operating parameters for PP-R will not damage other materials in the system or vice versa.
2. Verify that all parts of the system are compatible with the medium being carried before installation. PP-R pipe does not require treatment to protect it from corrosion. Metals (ferrous and non-ferrous) in the system may be susceptible to corrosion. Provide water treatment to protect system metals.
3. Do not mix PP-R pipe with other piping systems in conditions that will cause the other system or components to fail.

D. PP-R Socket Fittings: ASTM F2389.

2.3 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Unions may be used for aboveground piping joints unless otherwise indicated.

C. Aboveground domestic water piping, NPS 3 and smaller, shall be the following:

1. Polypropylene (PP-R), SDR 11 pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install valves according to the following:

1. Section 1523.12 "Ball Valves for Plumbing Piping."

C. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping to permit valve servicing.

F. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 15017 "Sleeves and Sleeve Seals for Plumbing and HVAC Piping."

J. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 15017 "Sleeves and Sleeve Seals for Plumbing and HVAC Piping."

K. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 15018 "Escutcheons for Plumbing and HVAC Piping."

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 INSTALLATION OF TRANSITION FITTINGS

A. Install transition couplings at joints of dissimilar piping.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for hangers, supports, and anchor devices in Section 15029 "Hangers and Supports for Plumbing and HVAC Piping and Equipment."

B. Install fiberglass hangers for PP piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping within 12 inches of each fitting.

D. Support vertical runs of PP-R piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Plumbing Fixtures: Cold- water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

3.7 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 15053 "Identification for Plumbing and HVAC Piping and Equipment."

3.8 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.

3. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
4. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

    a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

        1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
        2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

    c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
    d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

    a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
    b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Hydrostatic testing and documentation of test results for polypropylene piping to be in accordance with the manufacturer's instructions and submitted to the manufacturer upon successful completion per warranty requirements.
f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
g. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball for piping NPS 2and smaller.
2. Drain Duty: Hose-end drain valves.

END OF SECTION

SECTION 15117 - GRAY-WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Aboveground gray-water pipes, tubes, and fittings inside buildings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Pipes, tubes, fittings, and specialties for each type of piping.
2. Transition fittings.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Water Piping Minimum Working Pressure: 100 psig unless otherwise indicated.

2.2 PP PIPE AND FITTINGS

A. PP Water Pipe: ASTM F 2389, SDR 11 purple in color.

B. PP Water Socket Fittings: ASTM F 2389, purple in color.

2.3 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine walls, floors, and roofs for suitable conditions where gray-water piping will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of gray-water water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

C. Install piping to permit valve servicing.

D. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 15017 "Sleeves and Sleeve Seals for Plumbing and HVAC Piping."

H. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 15017 "Sleeves and Sleeve Seals for Plumbing and HVAC Piping."

I. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 15018 "Escutcheons for Plumbing and HVAC Piping."

J. Install gray-water water piping level with 0.25 percent slope downward toward drain and plumb.

K. Comply with requirements for pipe hangers and supports specified in Section 15029 "Hangers and Supports for Plumbing and HVAC Piping and Equipment."

3.3 WATER PIPE JOINT CONNECTIONS

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Aboveground Force Main Piping: Fitting-type transition couplings.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for pipe hanger, supports, and anchor devices in Section 15029 "Hangers and Supports for Plumbing and HVAC Piping and Equipment."

B. Install fiberglass hangers for PP piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping within 12 inches of each fitting and coupling.

D. Support vertical runs of PP piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 15053 "Identification for Plumbing and HVAC Piping and Equipment."

B. Label pressure piping with system operating pressure.

C. Label all non-potable water piping "NON-POTABLE, DO NOT DRINK."

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

    a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

        1) Roughing-In Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
        2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Water Piping Tests" Subparagraph and to ensure compliance with requirements.

    c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
    d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Water Piping Tests:

    a. Fill gray-water piping. Check components to determine that they are not air bound and that piping is full of water.
    b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
    c. Leave new, altered, extended, or replaced gray-water water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
    d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
    e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.

f. Prepare reports for tests and for corrective action required.

B. Gray-water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.

4. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
5. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.9 GRAY-WATER PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Unions may be used for aboveground piping joints unless otherwise indicated.

C. Aboveground gray-water piping, NPS 2 and smaller, shall be the following:
1. PP, SDR 11 socket fittings; and fusion-welded joints.

END OF SECTION

SECTION 15119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Hose bibbs.
2. Wall hydrants.
3. Drain valves.

1.3 DEFINITIONS

A. AMI: Advanced Metering Infrastructure.

B. AMR: Automatic Meter Reading.

C. FKM: A family of fluroelastomer materials defined by ASTM D1418.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

1. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National

Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 HOSE BIBBS

A. Hose Bibbs:
   1. Standard: ASME A112.18.1 for sediment faucets.
   2. Body Material: Bronze.
   3. Seat: Bronze, replaceable.
   4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
   5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
   6. Pressure Rating: 125 psig.
   7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
   8. Finish: Rough bronze
   9. Operation: Wheel handle.

2.4 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:
   1. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
   2. Pressure Rating: 125 psig.
   3. Operation: Loose key.
   4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
   5. Inlet: NPS 3/4 or NPS 1.
   6. Outlet, Concealed: With integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
   7. Box: Deep, flush mounted with cover.
   8. Box and Cover Finish: Polished nickel bronze.
   9. Outlet, Exposed: With integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
   10. Nozzle and Wall-Plate Finish: Polished nickel bronze.
   11. Operating Keys(s): Two with each wall hydrant.

2.5 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

   1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
   2. Pressure Rating: 400-psig minimum CWP.
   3. Size: NPS 3/4.

4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

PART 3 - EXECUTION

3.1 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.2 ADJUSTING

A. Adjust each pressure vacuum breaker in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections.

1. Test each pressure vacuum breaker according to authorities having jurisdiction and the device's reference standard.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 15123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Manual gas shutoff valves.
5. Pressure regulators.
6. Dielectric fittings.

1.3 DEFINITIONS

A. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.
2. Corrugated, stainless-steel tubing with associated components.
3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Dielectric fittings.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

C. Qualification Data: For qualified professional engineer.

D. Welding certificates.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.9 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 100 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

2.2 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

4. Protective Coating for Outside Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

2.3 PIPING SPECIALTIES

A. Appliance Flexible Connectors:
   1. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
   2. Corrugated stainless-steel tubing with polymer coating.
   3. Operating-Pressure Rating: 0.5 psig.
   4. End Fittings: Zinc-coated steel.
   5. Threaded Ends: Comply with ASME B1.20.1.
   6. Maximum Length: 72 inches

B. Y-Pattern Strainers:

   1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
   3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
   4. CWP Rating: 125 psig.

2.4 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 MANUAL GAS SHUTOFF VALVES

A. See "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

   1. CWP Rating: 125 psig.
   2. Threaded Ends: Comply with ASME B1.20.1.
   3. Tamperproof Feature: Locking feature for valves indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   4. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
   5. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

   1. Body: Bronze, complying with ASTM B584.
   2. Ball: Chrome-plated bronze.
   3. Stem: Bronze; blowout proof.

4. Seats: Reinforced TFE; blowout proof.
5. Packing: Threaded-body packnut design with adjustable-stem packing.
6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. CWP Rating: 600 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Dormont; a WATTS brand.
   b. Elster-American Meter; a Honeywell Company.
   c. Maxitrol Company.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 5 psig.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Dormont; a WATTS brand.
b. Eaton.
c. Maxitrol Company.

2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 2 psig.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

C. Install fittings for changes in direction and branch connections.

3.4 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Locate valves for easy access.

F. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Verify final equipment locations for roughing-in.

J. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

K. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

L. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

M. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

N. Connect branch piping from top or side of horizontal piping.

O. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

P. Do not use natural-gas piping as grounding electrode.

Q. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

R. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 15019 "Meters and Gages for Plumbing and HVAC Piping."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 15017 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 15017 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 15018 "Escutcheons for Plumbing Piping."

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.

2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Section 15029 "Hangers and Supports for Plumbing Piping and Equipment."

B. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping within 12 inches of each fitting.

D. Support vertical runs of steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 CONNECTIONS

A. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

B. Install piping adjacent to appliances to allow service and maintenance of appliances.

C. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Section 15053 "Identification for HVAC Piping and Equipment" for piping and valve identification.

3.10 PAINTING

A. Paint exposed, exterior metal piping, valves, service regulators, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.

c. Topcoat: Exterior alkyd enamel (gloss).
d. Color: Safety Yellow.

B. Paint exposed, interior metal piping, valves, service regulators and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI INT 5.1E.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Interior alkyd matching topcoat.
c. Topcoat: Interior alkyd (gloss).
d. Color: Safety Yellow.

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.12 OUTDOOR PIPING SCHEDULE

A. Aboveground natural-gas piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

A. Aboveground, branch piping NPS 1 and smaller shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with steel welding fittings and welded joints.

3.15 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.

B. Valves in branch piping for single appliance shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION

SECTION 15300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Refrigerant pipes and fittings.
2. Refrigerants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve, refrigerant piping, and piping specialty.

B. Shop Drawings:

1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
2. Show interface and spatial relationships between piping and equipment.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-407C:

1. Suction Lines for Air-Conditioning Applications: 230 psig.
2. Suction Lines for Heat-Pump Applications: 380 psig.
3. Hot-Gas and Liquid Lines: 380 psig.

B. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8/A5.8M.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Working Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.3 REFRIGERANTS

A. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.

****** OR ******

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A or R-407C

A. Suction Lines NPS 3-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

3.2 PIPING INSTALLATION

A. Install refrigerant piping according to ASHRAE 15.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping free of sags and bends.

E. Install fittings for changes in direction and branch connections.

F. Select system components with pressure rating equal to or greater than system operating pressure.

G. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

H. Install refrigerant piping in rigid conduit in locations where exposed to mechanical injury.

I. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Liquid lines may be installed level.

J. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

K. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

L. Identify refrigerant piping and valves according to Section 15053 "Identification for HVAC Piping and Equipment."

M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 15017 "Sleeves and Sleeve Seals for Plumbing Piping."

N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 15017 "Sleeves and Sleeve Seals for Plumbing Piping."

O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 15018 "Escutcheons for Plumbing Piping."

3.3 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

3.4 HANGERS AND SUPPORTS

A. Comply with requirements for pipe hangers and supports specified in Section 15029 "Hangers and Supports for Plumbing Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:

1. NPS 1/2: Maximum span, 60 inches; minimum rod, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod, 3/8 inch.
6. NPS 2: Maximum span, 96 inches; minimum rod, 3/8 inch.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.6 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

END OF SECTION

SECTION 15311 - NONMETAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Thermoset FRP ducts and fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
   1. Thermoset FRP duct materials.

B. Shop Drawings:

   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Duct layout indicating sizes and pressure classes.
   3. Elevation of top of ducts.
   4. Dimensions of main duct runs from building grid lines.
   5. Fittings.
   6. Reinforcement and spacing.
   7. Seam and joint construction.
   8. Penetrations through fire-rated, smoke-rated, and other partitions.
   9. Equipment installation based on equipment being used on Project.
   10. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Delegated-Design Submittal: For nonmetal ducts, signed and sealed by a qualified professional engineer.

   1. Duct materials and thicknesses.
   2. Joint and seam construction and sealing.
   3. Reinforcement details and spacing.
   4. Materials, fabrication, assembly, and spacing of hangers and supports.
   5. Design calculations for selecting hangers and supports. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Welding certificates.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Hanger and Support Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for steel hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum hangers and supports.

1.6 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of ductwork system that fail in material or workmanship within specified warranty period.

1. Warranty Period, HDPE Duct System: 10 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including duct closure, reinforcements, and hangers and supports, shall comply with the following and with the Works' performance requirements and design criteria:

1. SMACNA's "Thermoset FRP Duct Construction Manual."
2. Static-Pressure Classes:

a. Supply Ducts: 2-inch wg.
b. Exhaust Ducts (Negative Pressure): 1-inch wg.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1, Section 5.4 - "Airstream Surfaces."

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

E. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

2.2 THERMOSET FRP DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Monoxivent Co.
2. Perry Fiberglass Products, Inc.
3. Spunstrand
4. Viron International.

B. Duct and Fittings:

1. Thermoset FRP Resin: Comply with UL 181, Class 1, maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL according to ASTM E84.
2. Round Duct: ASTM D2996, Type I, Grade 2, Class E, filament-wound duct, minimum 0.125-inch wall thickness, with tapered bell-and-spigot ends for adhesive joints or with plain ends with couplings.
3. Round Fittings: Compression or spray-up/contact, molded of same material, pressure class, and joining method as duct.
4. Rectangular Fittings: Minimum 0.125-inch- thick, flat sheet with fiberglass roving and resin-reinforced joints and seams.

C. Joining Materials: Roving and polyester resin.

D. Fabrication:

1. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, and access doors and panels according to SMACNA's "Thermoset FRP Duct Construction Manual," Ch. 7, "Requirements."
2. Fabricate 90-degree rectangular mitered elbows to include turning vanes, and 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

2.3 HANGERS AND SUPPORTS

A. Hanger Rods for Corrosive Environments: Fiberglass, all-thread rods and fasteners by Unitstrut framing systems or similar..

B. Duct Attachments: No penetrations. Horizontal ducts shall rest on fiberglass framing systems by Unistrut or equivalent, and shall be strapped down using non-metal straps and fasteners. Vertical ducts shall be strap clamped to fiberglass framing systems that have been secured to wall using fiberglass fasteners that have been chemically or mechanically anchored to the wall.

C. Trapeze and Riser Supports: Polyester and vinyl ester channels complying with ASTM D 3917 and ASTM D 4385.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install duct sections in maximum practical lengths with fewest possible joints.

C. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

D. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

E. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

F. Install ducts with a minimum clearance of 1 inch.

G. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

H. Install duct-mounted accessories in air ducts where indicated on Drawings.

I. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

J. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes, and 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

K. Branch Connections: Use lateral or conical branch connections.

L. Install thermoset FRP ducts and fittings to comply with SMACNA's "Thermoset FRP Duct Construction Manual."

3.2 HANGER AND SUPPORT INSTALLATION

A. Install hangers and supports for thermoset FRP ducts and fittings to comply with SMACNA's "Thermoset FRP Duct Construction Manual," Ch. 7, "Requirements."

B. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 PAINTING

A. Paint exterior of thermoset FRP . Apply two coats of high-gloss, safety grey, urethane paint that is chemically compatible with duct material. Confirm compatibility information with paint manufacturer and apply a primer coat as necessary.

3.4 STARTUP SERVICE

A. Air Balance: Comply with requirements in Section 15093 "Testing, Adjusting, and Balancing for HVAC."

3.5 FIELD QUALITY CONTROL

3.6 DUCT SCHEDULE

A. Supply and Exhaust:

1. Thermoset FRP ducts and fittings.
2. Install exhaust ducts without dips and traps that may hold condensate or other liquid, and sloped a minimum of 2 percent to drain.

END OF SECTION

SECTION 15316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. PVC pipe and fittings.
2. Specialty pipe fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

1.5 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

2.2 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 PVC PIPE AND FITTINGS

A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.

E. Solvent Cement: ASTM D 2564.

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2. Shielded, Nonpressure Transition Couplings:

a. Standard: ASTM C 1460.
b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
c. End Connections: Same size as and compatible with pipes to be joined.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 02310 "Earthwork"

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
   1. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

C. Install piping at indicated slopes.

D. Install piping free of sags and bends.

E. Install fittings for changes in direction and branch connections.

F. Install piping to allow application of insulation.

G. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

   1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.

   2. Do not change direction of flow more than 90 degrees.
   3. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

      a. Reducing size of waste piping in direction of flow is prohibited.

H. Lay buried building waste piping beginning at low point of each system.

   1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
   2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
   3. Maintain swab in piping and pull past each joint as completed.

I. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

   1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
   3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

J. Install aboveground PVC piping according to ASTM D 2665.

K. Install underground PVC piping according to ASTM D 2321.

L. Plumbing Specialties:

M. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

N. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 15017 "Sleeves and Sleeve Seals for Plumbing Piping."

O. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 15017 "Sleeves and Sleeve Seals for Plumbing Piping."

P. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 15018 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Shielded, nonpressure transition couplings.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 15029 "Hangers and Supports for Plumbing and HVAC Piping and Equipment."

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 15053 "Identification for Plumbing and HVAC Piping and Equipment."

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
c. Air pressure must remain constant without introducing additional air throughout period of inspection.
d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:
1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

C. Aboveground, vent piping NPS 4 and smaller shall be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

D. Underground, soil, waste, and vent piping NPS 4 and smaller shall be the following:
1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION

SECTION 15319.13 - SANITARY DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Trench drains.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene styrene.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene.

D. PE: Polyethylene.

E. PP: Polypropylene.

F. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 TRENCH DRAINS

A. Trench Drains:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. MIFAB, Inc.
    d. Watts; a Watts Water Technologies company.
    e. Zurn

2. Channels are 80" long, 6-3/4"wide reveal and have a 4" throat. Modular channel sections are made of 0% water absorbent High Density Polyethylene (HDPE). Channels have a positive mechanical connection between channel sections that will not separate during the installation and mechanically lock into the concrete surround every 10". Channels weigh less than 2.31 lbs. per linear foot, have a smooth, 1-1/2" radiused self-cleaning bottom with a Manning's coefficient of .009 and .75% or neutral 0% built in slope. Channels have rebar clips standard to secure trench in its final location. Channels provided with standard DGC grates that lock down to frame. Provide with black acid resistant epoxy coated ductile iron grate with DIN 19580 Load Class E loading.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install trench drains at low points of surface areas to be drained.

1. Set grates of drains flush with finished surface, unless otherwise indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 15316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 15319 "Sanitary Waste Piping Specialties" miscellaneous sanitary drainage piping specialties.

C. Install piping adjacent to equipment to allow service and maintenance.

3.3 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 15330 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Manual volume dampers.
   2. Control dampers.
   3. Flexible connectors.
   4. Duct accessory hardware.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

   1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

      a. Special fittings.
      b. Manual volume damper installations.
      c. Control-damper installations.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MANUAL VOLUME DAMPERS

A. Fiberglass-Reinforced Plastic, Manual Volume Dampers:

1. General:

a. Damper frame shall have a resin rich corrosion barrier a minimum of 100 mils thick on the service side. The structural layers shall be applied after exotherm of the corrosion liner is complete and shall consist of alternating layers of chopped strand mat to conform to ASME/ANSI RTP1-1989, Mandatory Appendix M-1. The glass to resin ratio shall be minimum of 32-35% glass to a maximum of 65-67% resin, documented to ASTM-2584-68. Lamination of the frame web will include a minimum 5/8" thick build up at the axle location. The outer surface of the finished laminate shall comply with ASME/ANSI RTP1-1989, paragraph M1A-224. To minimize ultraviolet degradation of the laminate, certain U.V. absorbers, or screening agents, must be applied. Damper blade shall be constructed of the same material as the damper frame. A surfacing veil allowing a resin rich coating, minimum 100 mils thick, shall be applied to both service sides of blades. Laminate construction shall conform to PS-15-69 and ASME/ANSI RTP1-1989. A full length pultruded fiberglass axle shall be supplied. The axle shall be constructed of a vinyl ester based material, combined with continuous strand roving, and complete with surfacing veil. Axle construction shall conform to ASTM D4385-84a. Fiberglass dampers shall have been tested for pressure drop in accordance with AMCA Standard 500 in an AMCA registered laboratory. Blade deflection shall not exceed 1/180 of the span at 10" w.g

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. MK Plastics
b. Perry Fiberglass
c. Ruskin

3. Comply with AMCA 500-D testing for damper rating.
4. Suitable for horizontal or vertical applications.

5. Frames:

    a. Tubular.
    b. Fiberglass channel, Vinyl Ester Resin, 1/8” thick.

6. Blades:

    a. Single round blade.
    b. Fiberglass channel, Vinyl Ester Resin, 1/4” thick.

7. Blade Axles: Fiberglass channel, Vinyl Ester Resin.
    a. Extends 6” beyond frame.

8. Bearings:

    a. Molded PTFE.

9. Blade Seals: None.

10. Accessories:

    a. Include stainless steel locking device to hold single-blade dampers in a fixed position without vibration.

B. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.3 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. MK Plastics
2. Perry Fiberglass
3. Ruskin Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:

1. Dampers shall be constructed with premium vinyl ester resins suitable for specified contaminants. Vinyl ester construction shall be throughout, both corrosion liner and structural layers laminated using specified vinyl ester resin. Polyester, vinyl ester

combinations are not acceptable. Resins used shall carry a flame spread of 25 or less. Uses of flame retardant or fillers in the corrosion liners are not acceptable. Damper frame and flange face shall have an integral corrosion barrier not less than 100 mils thick, and utilize specified resin. Additional surfacing veils should be used if required to meet or exceed corrosion resistance requirements. Corrosion liner shall be free of any inclusions, translucent and meet or exceed ASTM C 582- 87. Chemical resistance shall be performed to ASTM 581-87.

2. Structural layers will be applied only after exotherm is complete from corrosion liner and shall consist of alternating layers of 1.5 oz\ft.sq. All entrapped air shall be removed in accordance with para. 6.3.4. of ASTM C 581-87. Glass to resin ratio shall be a minimum of 32-35 percent glass to a maximum of 65-67 percent resin. Structural layer of the webb and flange shall be integral, secondary or cold wrapped flanges are unacceptable. Lamination of the structural layer and flanges shall not produce excessive shrink and or exotherm causing pre-release, or warpage to the flange face, or damper I.D. Flange face to face tolerance shall be no more than 1\16 of an inch, flange flatness (when measured on a flat surface) shall have no deviation, insuring proper bolt up to mating flanges. Post applied pariffinated gel coat will be standard.

3. Flanges shall be routed to provide a concentric flange O.D not to deviate from out of round no more than l\8 of an inch. Damper frame shall meet 90% barcol of resin manufacturers requirements per ASTM D 2583. Flange lamination shall be continuous, pour type flanges are not acceptable

D. Blades:

1. Damper design shall be of single blade construction and center pivoted. Blades shall utilize coring material of either balsa or synthetic type centered in blade laminate. Add on or external stiffeners are not acceptable. Coring and lamination schedule shall be designed to hold blade deflection to a minimum of L/360 on dampers with seals.

2. Blade Seals Blade edge seals shall be of the "Single Tadpole" or Double design depending on pressures. Seal to be mechanically fastened to the blade perimeter using FRP retainer and Isoplast™ fasteners. Seal will be continuous and not break at axle. Blade seal will not be compressed against a blade stop. Blade seal will be of the wiper design. Seal and cored blade combination installed in damper frame shall meet or exceed 1.37 cfm leakage @10" w.g. static pressure. Damper assembly to be leak tested in both directions. Damper shall bear the AMCA label for Air Leakage in accordance to AMCA standard 511. Damper holding torque shall not exceed 181 inch pounds total to keep damper in the closed position during testing.

E. Blade Axles:

1. A full-length axle shall be permanently fastened to the blade centerline by using 316 grade stainless steel pins imbedded internally and not exposed to airstream contaminants. Two-part epoxies shall be utilized for additional bonding strength. Axles shall be located on damper blade center by means of an axle saddle integrally molded in the blade surface. Axle shall be supported on both the drive and non-powered side of the damper by means of a graphite filled PTFE machined bearing. Bearing to be flanged one end eliminating blade side to side motion during rotation. Vertical axle installation will

require additional ring retainer supports. Bearing support area will be no less than 5\8" thick as measured on the damper centerline. Support pads will be molded directly to the damper exterior. Manufacturer certification of bearing material and machining will be available upon request. Axle will be constructed of a premium grade vinyl ester and conform to ASTM D 435-84a.

2. Axle shaft seals will be of the spring-loaded single lip, double lip or "O" ring type seal housed in an FRP composite retainer. The use of PVC, UHMW and other Thermoplastics are not acceptable. Seal type selection shall be based on application and material availability. Seal shall be easily maintainable and not hinder damper axle rotation. Each shaft diameters will have dedicated axle seal. Use of flat stock elastomers for axle seals are not acceptable. Hand actuation devices will be designed to provide access for seal inspection or replacement.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Set dampers to fully open position before testing, adjusting, and balancing.

C. Install test holes at fan inlets and outlets and elsewhere as indicated.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.

END OF SECTION

SECTION 15343 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Centrifugal ventilators - roof upblast and sidewall.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Certified fan performance curves with system operating conditions indicated.
4. Certified fan sound-power ratings.
5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
6. Material thickness and finishes, including color charts.
7. Dampers, including housings, linkages, and operators.
8. Prefabricated roof curbs.
9. Fan speed controllers.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL VENTILATORS - ROOF UPBLAST OR SIDEWALL

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hartzell
2. MK Plastics
3. Loren Cook

B. Configuration: Centrifugal roof upblast ventilator.

C. Housing: Fiberglass reinforced plastic (FRP). Built in compliance with ASTM Standard D4167-97, for Fiber-Reinforced Plastic Fans and Blowers.

1. Fans are manufactured with high quality, corrosion resistant resins and are fiberglass reinforced, able to withstand temperatures up to 210 deg. F., subject to the exhaust chemicals and their concentrations. UV inhibitors are added to the resins and are flame retardant class 1 of 25 or less. The molded dome housings are smooth both exterior for aesthetic appearance and interior for unrestricted airflow, are virtually impossible to crack, dent or break and is resistant to weather, salt spray and most chemicals.

2. Upblast Units: Provide FRP discharge baffle to direct discharge air upward, with rain and snow drains.

D. Fan Wheels:

1. The RBK impeller is backward inclined, flat bladed design, single piece completely manufactured in solid fiberglass and coated with corrosion resistant vinyl ester resin. It is Class II and tested for its integrity at a minimum 50% higher speed than the maximum stated catalog performance. The impeller is electronically statically and dynamically balanced in accordance with ANSI/ AMCA 204-96 “Balance Quality and Vibration Levels for Fans” to Fan Application Category BV-3, Balance Quality Grade G6.3.

2. There is no exposed metal in the exhaust airstream. All hardware is 304 stainless steel and completely encapsulated in fiberglass where exposed to the exhaust. The motor is ventilated with air infiltrating through specially positioned openings and exhausting at the top of the motor cover.

3. The stainless-steel blower shaft is isolated from the corrosive airstream by the FRP impeller hub and internally by a FRP cap and O-ring. Shafts are turned, ground, polished and keyed at both ends. They are sized to operate well below critical speed.

E. Direct Drives:

1. Explosion proof.

F. Accessories:

1. Disconnect Switch: NEMA 4, Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired.
2. Motorized Dampers: Parallel-blade fiberglass-reinforced plastic factory dampers mounted in curb base with electric actuator; wired to close when fan stops.

G. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Built-in raised cant and mounting flange.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 15013 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.3 SOURCE QUALITY CONTROL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. AMCA Certification: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.

C. Fan Sound Ratings: Comply with AMCA 311, and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.

D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.

E. Operating Limits: Classify according to AMCA 99.

F. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 3 - EXECUTION

3.1 INSTALLATION OF HVAC POWER VENTILATORS

A. Install power ventilators level and plumb.

B. Secure roof-mounted fans to roof curbs with zinc-plated hardware. See Section 07530 "EDPM Roofing" and Section 07600 "Flashing and Sheet Metal" for installation of roof curbs.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 15053 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 16120 "Wires and Cables."

B. Ground equipment according to Section 16060 "Grounding."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 16050 "Basic Electrical Requirements."

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 16120 "Wires and Cables."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that there is adequate maintenance and access space.
4. Verify that cleaning and adjusting are complete.
5. Adjust damper linkages for proper damper operation.
6. Energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
7. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 15093 "Testing, Adjusting, and Balancing for Plumbing and HVAC" for testing, adjusting, and balancing procedures.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION

SECTION 15723.16 - PACKAGED, INDIRECT-FIRED, OUTDOOR, HEATING-ONLY MAKEUP-AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes outdoor, indirect, gas-fired, heating-only, makeup air units, including the following components:

1. Casings.
2. Outdoor-air intake hood.
3. Roof curbs.
4. Fans, drives, and motors.
5. Air filtration.
6. Dampers.
7. Indirect, gas-fired burners.
8. Unit control panel.
9. Controls.
10. Accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each outdoor, indirect, gas-fired, heating-only, makeup air unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Fans:

    a. Include certified fan-performance curves with system operating conditions indicated.
    b. Include certified fan-sound power ratings.
    c. Include fan construction and accessories.
    d. Include motor ratings, electrical characteristics, and motor accessories.

5. Include filters with performance characteristics.

6. Include direct, gas-fired burners with performance characteristics.
7. Include dampers, including housings, linkages, and operators.

B. Shop Drawings: For each outdoor, indirect, gas-fired heating and ventilating unit.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of gas-fired heating and ventilating units, as well as procedures and diagrams.
4. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Sample Warranty: For manufacturer's warranty.

C. Startup service reports.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For indirect, gas-fired, makeup air units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) for each unit.
2. Gaskets: One set(s) for each access door.

1.7 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of indirect, gas-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Entire Unit: Manufacturer's standard, but not less than one year(s) from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.2 CAPACITIES AND CHARACTERISTICS: Refer to Drawing Schedules.

2.3 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CaptiveAire Systems.
2. Greenheck Fan Corporation.
3. Modine Manufacturing Company.
4. REZNOR, a brand of Nortek Global HVAC.
5. Sterling HVAC Products; a Mestek company.
6. Weather-Rite, a brand of Specified Air Solutions.

2.4 UNIT CASINGS

A. General Fabrication Requirements for Casings:

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
2. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.
3. Makeup Air Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

B. Configuration: Horizontal unit with bottom discharge for roof-mounting installation.

C. Double-Wall Construction:

1. Outside Casing Wall: Galvanized steel, minimum 18 gauge thick, with high performance polyester coating rated for 5,000 salt spray test per ASTM B117, manufacturer's standard color.
2. Inside Casing Wall:

    a. Inside Casing, Burner Section: Galvanized steel, solid, minimum 14-gauge thick steel.
    b. Inside Casing, All Other Sections: Galvanized steel solid steel.

3. Floor Plate: Galvanized steel , minimum 18 gauge thick.
4. Casing Insulation:

    a. Materials: Glass-fiber blanket or board insulation, Type I or Type II ASTM C1071.
    b. Insulation Thickness: 1 inch.
    c. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

5. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

D. Panels and Doors:

1. Panels:

    a. Fabrication: Formed and reinforced, with same materials and insulation thickness as casing.
    b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow.
    c. Gasket: Neoprene, applied around entire perimeters of panel frames.
    d. Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.

2. Doors:

    a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
    b. Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
    c. Gasket: Neoprene, applied around entire perimeters of panel frames.
    d. Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.

3. Locations and Applications:

    a. Fan Section: Doors and inspection and access panels.
    b. Access Section: Doors.
    c. Gas-Fired Burner Section: Doors.

d. Damper Section: Doors.
e. Filter Section: Doors large enough to allow periodic removal and installation of filters.

2.5 OUTDOOR-AIR INTAKE HOOD

A. Type: Manufacturer's standard hood or louver.

B. Materials: Match cabinet.

C. Bird Screen: Comply with requirements in ASHRAE 62.1.

D. Filter: Aluminum, 2 inch cleanable.

E. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.6 ROOF CURBS

A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

a. Materials: ASTM C 1071, Type I or Type II.
b. Thickness: 2 inches.

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

a. Liner Adhesive: Comply with ASTM C 916, Type I.
b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
d. Liner Adhesive: Comply with ASTM C 916, Type I.

B. Curb Height: 24 inches.

2.7 FANS, DRIVES, AND MOTORS

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

B. Fans: Direct drive mixed flow plenum.

C. Motors:

1. Comply with NEMA Premium designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 15013 "Common Motor Requirements for HVAC Equipment."

2.8 AIR FILTRATION

A. Panel Filters:

1. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.
2. Filter Unit Class: UL 900.
3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.

B. Cleanable Filters:

1. Cleanable metal mesh.

C. Side-Access Filter Mounting Frames:

1. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. Galvanized steel track.

a. Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

2.9 DAMPERS

A. Outdoor-Air and Supply-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in parallel-blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg.

B. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 15013 "Common Motor Requirements for HVAC Equipment."
b. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
7. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
8. Temperature Rating: Minus 22 to plus 122 deg F.

2.10 INDIRECT-FIRED GAS BURNER

A. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47 and with NFPA 54.

B. CSA Approval: Designed and certified by and bearing label of CSA.

C. Burners: Stainless steel.

1. Rated Minimum Turndown Ratio: 24 to 1.
2. Fuel: Natural gas.
3. Ignition: Electronically controlled electric spark with flame sensor.
4. Gas Control Valve: Modulating.
5. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, electronic-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

D. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.

E. Heat Exchanger: Stainless steel.

F. Heat-Exchanger Drain Pan: Stainless steel.

G. Safety Controls:

1. Gas Manifold: Safety switches and controls complying with ANSI standards.
2. Vent Flow Verification: Differential pressure switch to verify open vent.
3. High Limit: Thermal switch or fuse to stop burner.
4. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.

5. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
6. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
7. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.
8. Control Transformer: 24 V ac.

2.11 UNIT CONTROL PANEL

A. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.

B. Control Panel: Surface-mounted remote panel, with engraved plastic cover and the following lights and switches:

1. On-off-auto fan switch.
2. Heat-vent-off switch.
3. Supply-fan operation indicating light.
4. Heating operation indicating light.
5. Thermostat.
6. Damper position potentiometer.
7. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
8. Safety-lockout indicating light.
9. Enclosure: NEMA 250, Type 1.

2.12 CONTROLS

A. Control Devices:
1. Discharge air temperature sensor.
2. Outdoor air/Intake air temperature sensor.

B. Fan Control, Interlocked: Fan to start automatically with exhaust fan(s) to which this heating and ventilating unit is associated for makeup air.

C. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall open when supply fan starts, and close when fan stops.

D. Temperature Control:

1. Operates gas valve to maintain discharge-air temperature with factory-mounted sensor in blower outlet.
2. Burner Control, Modulating: 20 to 100 percent modulation of the firing rate. 10 to 100 percent with dual burner units.

2.13 ACCESSORIES

A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

2.14 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "NRCA Roofing Manual: Membrane Roof Systems." Install units on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 07530 "EDPM Roofing" and Section 07600 "Flashing and Sheet Metal." Secure units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment.

B. Install gas-fired units in accordance with NFPA 54.

C. Install controls and equipment shipped by manufacturer for field installation with indirect, gas-fired heating and ventilating units.

3.3 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Gas Piping: Comply with requirements in Section 15123 "Facility Natural-Gas Piping." Connect gas piping with shutoff valve and union, and with sufficient clearance for burner removal and service. Make final connections of gas piping to unit with corrugated, stainless-steel tubing flexible connectors complying with ANSI LC 1/CSA 6.26 equipment connections.

B. Where installing piping adjacent to heating and ventilating units, allow space for service and maintenance.

3.4 DUCTWORK CONNECTIONS

A. Duct Connections: Connect supply ducts to indirect-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 15330 "Air Duct Accessories" for flexible duct connectors.

3.5 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 16120 "Wires and Cables."

B. Ground equipment according to Section 16060 "Grounding."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 16050 "Basic Electrical Requirements."

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect wiring according to Section 16120 "Wires and Cables."

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

3.8 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.9 CLEANING

A. After completing system installation and testing, adjusting, and balancing makeup air unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.10 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heating and ventilating units.

END OF SECTION

SECTION 15823.13 - COMPUTER-ROOM AIR-CONDITIONERS, CEILING-MOUNTED UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes ceiling-mounted, computer-room air conditioners.

1.3 DEFINITIONS

A. COP: Coefficient of performance.

B. EER: Energy efficiency ratio.

C. SCR: Silicon-controlled rectifier.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include material descriptions, dimensions of individual components and profiles, and finishes for computer-room air-conditioning units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For computer-room air conditioners.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from installers of the items involved.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set(s) of filters for each unit.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.

   1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
   2. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Compu-Aire, Inc.
   2. Data Aire Inc.
   3. Liebert; Vertiv Holdings Co.
   4. Stulz-ATS.

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

D. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

2.3 MANUFACTURED UNITS

A. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls.

1. Mounting Configuration: Exposed in the space.

B. Cabinet: Galvanized steel serviceable from one side, with baked-enamel finish, insulated with 1/2-inch- thick duct liner, and mounting bracket attached to the unit.

1. Integral factory-supplied supply and return grille to fit ceiling grid kit of 24 by 48 inches, with filter.
2. Unit with 24-by-48-inch air distribution plenum, with integral MERV 8 filter and three-way air distribution.
3. Unit with two-speed, centrifugal direct-drive fan.
4. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Supply-Air Fan:

1. Forward curved, double width, double inlet, centrifugal, with adjustable V-belt drive.

D. Refrigeration System:

1. Compressor: Scroll, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
2. Refrigeration Circuit Components:

a. Low-pressure switch.
b. Manually reset, high-pressure switch.
c. Thermal-expansion valve with external equalizer.
d. Sight glass with moisture indicator.
e. Service shutoff valves.
f. Charging valves.
g. Hot-gas bypass.

h. Refrigerant charge.

3. Refrigerant: R-407C or R-410A.
4. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
5. Refrigerant line-sweat-adapter kit to permit field brazing of refrigerant lines.

    a. Mount stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir under coil assembly.

6. Remote, Air-Cooled Refrigerant Condenser: Integral, copper-tube aluminum-fin coil with direct-drive, propeller fan.
7. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

E. Electric-Resistance Reheat Coil:

1. Finned-tube electric elements with contactor.
2. Dehumidification relay.
3. High-temperature-limit switches.
4. SCR to proportionally control the reheat elements providing precise temperature control.

F. Filter: 1-inch- thick, disposable, glass-fiber media.

1. Filter Minimum Efficiency Reporting Value:

    a. MERV Rating: MERV 8 according to ASHRAE 52.2.

G. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

H. Single point power kit permitting single electrical feed to the evaporator and condensing unit of a close-coupled system.

I. Epoxy-coated, step-down transformer suitable for mounting on the outdoor condensing unit to provide it with 277-V input power.

J. Control System:

1. Microprocessor remote-mounted panel.
2. Fan contactor.
3. Compressor contactor.
4. Compressor start capacitor.
5. Control transformer with circuit breaker.
6. Solid-state temperature- and humidity-control modules.
7. Humidity contactor.
8. Time-delay relay.
9. Heating contactor.

10. Smoke sensor.
11. Filter clog switch.
12. Alarm contacts.
13. High-temperature thermostat.
14. Solid-state, wall-mounted control panel with start-stop switch, adjustable humidity set point, remote temperature sensors, remote humidity sensors and adjustable temperature set point.
15. Remote panel to monitor and change temperature and humidity set points and sensitivities of the unit and unit alarms.

K. Fan Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 15013 "Common Motor Requirements for HVAC Equipment."

    a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.
    b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

2.4 CAPACITIES AND CHARACTERISTICS: Refer to Drawing Schedules.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Layout and install computer-room air conditioners and suspension system coordinated with other construction including light fixtures, electrical equipment, and piping.

B. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances. Install according to AHRI Guideline B.

C. Suspended Computer-Room Air Conditioners: Install using continuous-thread hanger rods and spring hangers of size required to support weight of computer-room air conditioner.

1. Comply with requirements for vibration isolation devices specified in Section 15048 "Vibration Controls for HVAC." Fabricate brackets or supports as required.
2. Comply with requirements for hangers and supports specified in Section 15029 "Hangers and Supports for Plumbing Piping and Equipment."

D. Air-Cooled Refrigerant Condenser Mounting: Install using elastomeric pads on concrete base. Comply with requirements for vibration isolation devices specified in Section 15048 "Vibration Controls for HVAC."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to computer-room air conditioners, allow space for service and maintenance.

C. Drainage Connections: Comply with applicable requirements in Section 15316 "Sanitary Waste and Vent Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.

D. Refrigerant Piping: Comply with applicable requirements in Section 15300 "Refrigerant Piping." Provide shutoff valves and piping.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

D. After startup service and performance test, change filters.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION

SECTION 16050 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: General administrative, procedural requirements, and installation methods for electrical installations specified in Division 16.

B. The Drawings are schematic and are not intended to show every detail of construction.
   1. In general, conduits/raceways, transitions and offsets shown on Drawings indicate approximate locations in plan and elevation where the systems are intended to be run.
   2. CONTRACTOR shall fully coordinate electrical Work with other trades to avoid interferences.
   3. In the event of interferences, CONTRACTOR shall request clarification from ENGINEER in writing.

B. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Sections, apply to Work of this Section.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with requirements of Section 01330, Shop Drawings covering the items included under this Section of Work. Shop Drawing submittals shall include:
   1. Submit product data covering the items included under this Section of Work.

B. Conforming to Construction Drawings: Submit a complete set of Drawings showing the locations of the piping, ductwork, etc., as actually installed. Such Drawings shall be submitted to ENGINEER on tracing cloth, Mylar, or sepia paper from which blueprints can be obtained.

C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section. Include following information for equipment items:
   1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
   2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
   3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
   4. Servicing instructions and lubrication charts and schedules.

1.03 RECORD DOCUMENTS

A. Prepare Record Documents in accordance with requirements in Section 01770. In addition, CONTRACTOR shall submit, prior to final payment, Drawings conforming to construction records of systems it has installed. Vendor drawings shall be sized as manufacturers' standard.

B. Provide typewritten data sheets on motor control circuits with following information on each branch feeder: Load name, horsepower or KVA (transformer), fuse size, starter size, service factor of motor, motor nameplate currents, power factor correction capacitor size (if used), and thermal overload part number.

1.04 QUALITY ASSURANCE

A. National Electrical Code: Comply with NFPA 70, National Electrical Code.

B. UL Compliance and Labeling: Use products and components labeled by UL.

1.05 PERMITS, INSPECTIONS, AND LICENSES

A. CONTRACTOR shall procure all necessary permits and licenses, observe and abide by all applicable laws, codes, regulations, ordinances, and rules of the State, territory, or political subdivision thereof, wherein Work is done, or any other duly constituted public authority, and further agrees to hold OWNER harmless from liability or penalty which might be imposed by reason of an asserted violation of such laws, codes, regulations, ordinances, or other rules.
   1. Upon completion of Work, CONTRACTOR shall secure certificates of inspection from the inspector having jurisdiction and shall submit 3 copies of the certificates to OWNER. CONTRACTOR shall pay the fees for the permits, inspections, licenses, and certifications when such fees are required.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to Project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification. Equipment shall be packaged to prevent damage during shipment, storage, and handling. Do not install damaged units; replace, and remove damaged units from Site.

PART 2 - PRODUCTS

2.01 AMMETER

A. Furnish for OWNER's use an Amprobe, Model ACD-4, digital clamp-on ammeter.

PART 3 - EXECUTION

3.01 GENERAL ELECTRICAL INSTALLATION

A. Provide electrical materials and equipment enclosures appropriate for areas in which they are installed. Each area will be designated on Drawings with a type of construction such as NEMA 4, 4X, 7 or 9 if it is other than NEMA 12. An area designated by a name and elevation includes space bounded by floor, ceiling, and enclosing walls.
   1. Exception: Provide manufacturer's standard construction for indoor or outdoor application where equipment is not manufactured to NEMA specifications (e.g., switchgear, transformers, high voltage capacitors, bus duct, and light fixtures; materials and equipment used in finished areas such as offices, laboratories, etc.).

B. Provide nonmetallic electrical materials and equipment enclosures in NEMA 4X areas; watertight NEMA 4 and equipment enclosures for outdoor applications and indoor applications below grade; explosion-proof NEC Class I, Division 1, Group C and Group D equipment for NEMA 7 areas; explosion-proof NEC Class II, Division 2, Group F equipment for NEMA 9 areas.

C. Coordinate with power company high voltage and/or low voltage metering requirements. Furnish, install, and connect metering equipment not furnished, installed or connected by power company.

D. Coordinate with telephone company the communication service requirements. Furnish, install, and connect cable and terminal equipment not furnished, installed, or connected by telephone company. Furnish and install a 4-foot by 8-foot by 3/4-inch plywood backboard painted white, raceway from backboard to property line, and cross-connect base and blocks which utilize punchdown wiring methodology.

E. Provide chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.

F. Supporting devices and sleeves shall be set in poured-in-place concrete and other structural components as they are constructed.

G. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide maximum headroom possible. Locate light fixtures at approximately 8 feet above floor and where fixtures may be readily serviced.

H. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

I. Install systems, materials, and equipment to conform with approved submittal data, including coordination Drawings, to greatest extent possible. Conform to arrangements indicated by Drawings recognizing that portions of Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to ENGINEER.

J. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components where installed exposed in finished spaces.

K. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.

L. Install access panel or doors where units are concealed behind finished surfaces.

M. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.02 RACEWAY INSTALLATION

A. Outdoors, use the following materials:
   1. Exposed Conduit: PVC externally coated rigid metal conduit and fittings.
   2. Underground Direct Buried Conduit: PVC externally coated rigid metal conduit.

3. Underground Concrete Encased Conduit: Fiberglass-reinforced conduit or rigid nonmetallic conduit if the conductors are used for power or 120 VAC; otherwise, use rigid metal conduit.
4. Conduit Used to Connect to Vibrating Equipment including transformers and hydraulic, pneumatic or electric solenoid or motor-driven equipment: Liquidtight flexible metal conduit.

B. Indoors, use the following wiring materials:
   1. Connection to Vibrating Equipment, including transformers and hydraulic, pneumatic or electric solenoid or motor-operated equipment: Liquidtight flexible metal conduit.
      a. Exception: NEMA 7 or 9 areas require explosion-proof flexible conduit.
   2. Exposed Conduit(Nema 12 and Nema 4 areas): PVC externally coated rigid metal conduit or aluminum conduit.
      a. Exceptions:
         1) Areas indicated as NEMA 4X, use rigid Schedule 80 PVC conduit.
         2) Areas indicated as NEMA 7 or NEMA 9 (such as grit and raw sewage rooms), use PVC externally coated rigid metal conduit.
   3. Concealed Conduit: Rigid metal conduit or aluminum conduit unless indicated otherwise.

C. Minimum size conduit shall be 1 inch unless shown otherwise.

D. Instrument Signal Conduit Requirements: Shielded signal wires for 4-20 mA type instruments or thermocouple wires assigned to the same control panel may be run in the same conduit. Shielded instrument signal wires, thermocouple wires, and shielded 2-wire intercom wires may be run in the same conduit. No other wires will be permitted in an instrument signal/2-wire intercom conduit. Conduit shall be RMC or PVC-coated RMC.

E. Conduit Thread Paint: Make threaded conduit joints watertight by coating threaded portions with a spray-on or brush-on zinc-bearing paint. Provide paint containing 90 percent minimum by weight of metallic zinc powder in the dried film. Clean field-cut threads of oil using the recommended solvent prior to coating threads.

F. Install expansion fittings in all exposed rigid nonmetallic conduit runs of 20 feet or more.

G. Install expansion/deflection fittings where conduit passes a building expansion joint or where conduits are attached to two structures joined by a concrete expansion joint.

H. Exposed or Concealed Construction: Install conduit exposed inside buildings except for areas with finished walls (e.g., offices, laboratories, lavatories, locker rooms, etc.) unless otherwise indicated.

I. Concealed Raceways: Raceways embedded in slabs shall be installed in the middle third of the slab thickness where practical and leave at least 1-inch concrete cover. Tie raceways to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in the concrete. Run 1-inch and smaller raceways with a minimum of bends in the shortest practical distance. Run larger conduit parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab. Where nonmetallic conduit or fiberglass-reinforced conduit is used, raceways must be converted to PVC externally coated rigid metal conduit before rising above floor.

J. Exposed Raceways: Install parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. Make bends and offsets so the inside diameter is not effectively reduced. Keep the legs of a bend in the same plane and the straight legs of offsets

parallel. Conduits shall slope away from loads to keep moisture from entering the load. Run parallel or banked raceways together. Make bends in parallel or banked runs from the same centerline so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run, such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

K. Space raceways, fittings, and boxes 0.25 inch from mounting surface in NEMA 4 and NEMA 7 areas. Spacers shall be one-piece construction of stainless steel, galvanized steel, PVC, ABS, or other noncorrosive material.

L. Sleeves: Install in concrete floor slabs except where conduit passes through a housekeeping pad. Install in exterior walls below grade.

M. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid metal conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this Contract, install screwdriver-operated threaded flush plugs with floor.

N. Flexible Connections: Use short length (maximum 6 feet for lighting fixtures; maximum 3 feet for all other equipment) of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement, and all motors. Use liquidtight flexible conduit in wet locations and rated flexible connections for hazardous locations. Install separate ground conductor across flexible connections.

O. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.

P. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate metal conduit, use threaded rigid metal conduit fittings. For PVC externally coated rigid metal conduit, use only factory-coated fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.

Q. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL listed sealing compound. For concealed raceways, install each fitting in a flush metal box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
   1. Where conduits enter or leave hazardous locations.
   2. Where conduits enter or leave NEMA 4X areas.
   3. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
   4. Where required by the NEC.
   5. Where noted on drawings.

R. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring. Provide knockout closures to cap unused knockout holes where blanks have been removed.

S. Install device boxes at the height above the floor as follows for:
   1. Light switches, 4 feet.
   2. Receptacles and telephone jacks, 18 inches except in NEMA 4 and 4X areas, 4 feet.
   3. Thermostats, 4'-0".
   4. Clock receptacles, 7'-0".

T. Avoid installing boxes back-to-back in walls. Provide not less than 6-inch (150 mm) separation.

U. Position recessed outlet boxes accurately to allow for surface finish thickness.

V. Fasten electrical boxes firmly and rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete masonry.

W. Provide fire-retardant barriers in all pull and junction boxes containing circuits that are otherwise continuously separated in conduit. Securely fasten these barriers within box. Size barriers so that space between barrier and box wall does not exceed 0.125 inch anywhere around the perimeter of barrier.

X. Support exposed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.

Y. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from building structure.

Z. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box and tighten the chase nipples so no threads are exposed.

AA. Complete installation of electrical raceways before starting installation of conductors within raceways and prevent foreign matter from entering raceways by using temporary closure protection. Cap spare conduit. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

BB. Install pull wires in empty raceways: Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-pound tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

3.03 WIRE AND CABLE INSTALLATION

A. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant where necessary.

B. Keep branch circuit conductor splices to minimum. Splice feeders only where indicated. Use a standard kit. No splices are allowed for instrument and telephone cables except at indicated splice points.

C. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced. Use splice and tap connectors which are compatible with conductor material and are UL listed as pressure type connectors.

D. Provide adequate length of conductors within electrical enclosures and train conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at terminal.

E. Terminate power conductors at equipment using pressure-type terminals specifically designed for type of terminations to be made. Terminate no more than 2 conductors No. 8 AWG and smaller within the same pressure-type terminal. These 2 conductors shall be no more than 4 wire gauge sizes apart. Terminate no more than 1 conductor larger than No. 8 AWG within any pressure-type terminal.
   1. Exception: Power factor correction capacitor conductors may be terminated at the motor disconnect switch load terminals.

F. Seal wire and cable ends until ready to splice or terminate.

3.04 CUTTING AND PATCHING

A. Perform cutting and patching in accordance with requirements in Section 01730. In addition, the following requirements apply.
   1. Perform cutting, fitting, and patching of electrical equipment and materials required to uncover Work to provide for installation of ill-timed Work, remove and replace Work that is either defective or does not conform to requirements of Drawings.
   2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated including, but not limited to, removal of electrical items indicated to be removed and items made obsolete by new Work. Protect structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed. Provide and maintain temporary partitions or dust barriers adequate to prevent spread of dust and dirt to adjacent areas.
   3. Patch existing finished surfaces and building components using new materials matching existing materials.

3.05 EQUIPMENT CHECKOUT AND TESTING

A. In addition to testing recommended by equipment or material supplier and called for in equipment or material specification, perform the following.

B. Motor Testing: Motor insulation shall be tested by using a 500 VDC (minimum) megger and applying test until a constant megohm reading of the following magnitude is obtained:

$R_{min.} = 4 (KV + 1)$ at 25 degrees C winding temp.
$R_{min.} = IV + 1$ at 40 degrees C winding temp.

   1. If motors do not meet requirements of megger test, blow hot air through motors to dry out and repeat until test is passed. If desirable, drying can be done by applying an electrical potential to

equipment. However, in no case, induced or direct, shall voltage or current exceed continuous rating of equipment being dried.

2. After passing megger test, motors shall be hi-pot tested at 200 percent rated voltage for a minimum of 1 minute.

C. Equipment Testing: The following tests which are applicable for a particular item of equipment shall be performed:
   1. Megger bus work phase-to-phase and phase-to-ground. Minimum acceptable steady-state value is 100 megohms.
   2. Megger power circuit breakers and circuits supplied phase-to-phase and phase-to-ground (100 megohms minimum).
   3. Test current transformer circuits by applying current to secondary wiring at current transformer terminals until contactor trips.
   4. Test, time, and set protective relays. Relays shall be timed at various multiples (minimum of 3 points) of the pick-up value to determine agreement with published curves and adjust as necessary to agree with coordination study required settings. Exact tests to be performed vary with type of relay. Manufacturer's instructions for relay shall be complied with.
   5. After Work has been completed, demonstrate to OWNER's Representative that entire electrical installation is in proper working order and will perform functions for which it was designed by functional testing.
   6. Make any specific tests required by the manufacturer's installation instructions.

D. Check-out Procedures. In general, check-out procedures (as listed below) which are applicable for a particular item of equipment shall be performed:
   1. Vacuum interior of cubicles and remove foreign material.
   2. Wipe clean with a lint-free cloth insulators, bushings, bus supports, etc.
   3. Check and adjust time delay, under-voltage devices, phase relay, over-current relays, etc., as required by coordination study or ENGINEER.
   4. Fill motor bearings requiring oil.
   5. Check and change, as required, thermal overload heater elements to correspond with motor full-load current and service factors of installed motor.
   6. Check direction of rotation of motors and reverse connections if necessary. Check rotation with motor mechanically uncoupled where reverse rotation could damage equipment.
   7. Equipment with two or more sources of power connected by tie breakers, transfer switches, or generator receptacles shall be checked for rotation from each possible combination of power sources. Power sources must have the same phase sequence for each source throughout entire facility.
   8. Check exposed bolted power connections for tightness.
   9. Check operation of breakers, contactors, etc., and control and safety interlocks.
   10. Check tightness of bolted structural connections.
   11. Check leveling and alignment of enclosures.
   12. Check operating parts and linkages for lubrication, freedom from binding, vibration, etc.
   13. Check tightness and correctness of control connections at terminal blocks, relays, meters, switches, etc.
   14. Clean auxiliary contacts and exposed relay contacts after vacuuming.

END OF SECTION

SECTION 16052 - COORDINATION STUDY AND ARC FLASH ANALYSIS

PART 1 - GENERAL

1.01 SUBMITTALS

A. Coordination Study detailing electrical system protection, protective equipment selectivity and arc flash hazard analysis studies shall be performed for this project.

B. Submit electronic copies of the SKM raw data software files(the files created by the SKM software). The reports shall include the following sections:
   a. One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations
   b. Descriptions, purpose, basis and scope of the study
   c. Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings
   d. Protective device time versus current coordination curves with associated one line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings
   e. Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout
   f. Incident energy and flash protection boundary calculations
   g. Comments and recommendations for system improvements, where needed
   h. Executive Summary including source of information and assumptions made

1.02 COORDINATION STUDY

A. Include as part of Contract a complete Coordination and Short Circuit Study from incoming power lines primary switches and transformers through the high voltage switchgear, unit substations, and the motor control centers branch circuits for the new work shown this contract. This includes new medium voltage equipment and circuit breakers installed within existing motor control centers. Obtain available short circuit current, inrush current, and upstream protective device time current curves from the power company. Include power company current data and protective device curve as part of study. Study shall include all coordinating curves with each fuse size, trip settings, and thermal overloads given for connected loads. Curves shall include feeder wire melting curves and transformer ANSI rating points. The study shall also include variable frequency drives harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear. Fuse sizes on motor control centers shall be those shown in Drawings throughout the short circuit and coordination study. Changes in loads from those shown on Drawings shall be incorporated in Study.

B. Analysis and labeling shall include the existing motor control centers as well as the new motor control centers and medium voltage equipment shown on the contract drawings.

C. Contractor shall furnish all field data as required for the power system studies and arc flash hazard analysis studies. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

D. Study/report shall be performed by Eaton. Study results shall be submitted to ENGINEER for approval. Report shall be stamped by a licensed professional electrical engineer in the state of Michigan. Final report shall include the SKM raw data files to be turned over to Owner.

E. After approval all electrical equipment settings, thermal overloads, and fuses shall be made to conform to approved results. CONTRACTOR shall test all trip settings, time delays, and indicating devices on all switchgear, unit substations, and motor control centers. Tests shall be witnessed by ENGINEER.

F. Data sheets for test are to be furnished by CONTRACTOR and shall be filled out showing the desired settings from Coordination Study and results obtained from witnessed test. Data sheets shall be signed by those performing test and witness. Test data sheets and motor list showing fuses, thermal overload sizes, etc. shall be submitted to ENGINEER as part of Contract.

G. As part of this contract, Eaton shall field verify the entire WWTP site electrical and update the study to include the current Grit B and Grit A upgrades shown on the contract drawings and shall also include the current projects being done by others at the treatment plant for the ultraviolet disinfection system and the grit A system upgrades. These projects shall be included in the arc flash, short circuit analysis and coordination study. Turn over SKM data files to Owner at project completion.

H. Report shall be stamped by a licensed professional engineer in the state of Michgain.

I. Eaton shall install new labels for the entire treatment plant.

PART 2 - PRODUCTS

2.01 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition. Transformer design impedances and standard X/R ratios shall be used when test values are not available.

B. Provide the following information in the study report:
1. Calculation methods and assumptions.
2. Base per unit quantities.
3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted.
4. Source impedance data, including electric utility system and motor fault contribution characteristics.
5. Typical calculations and tabulations of calculated quantities.
6. Results, conclusions, and recommendations.

C. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility's supply termination point.
2. Incoming switchgear.
3. Unit substation primary and secondary terminals.
4. Low voltage switchgear.
5. Motor control centers.
6. Standby generators and automatic transfer switches.
7. Branch circuit panelboards.
8. Other significant locations throughout the system.

D. On grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

E. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short circuit ratings.
2. Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses.
3. Adequacy of transformer windings to withstand short-circuit stresses.
4. Cable and busway sizes for ability to withstand short-circuit heating.
5. Notify Owner in writing, of existing circuit protective devices improperly rated for the calculated available fault current.

2.02 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.

B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the curve sheets, where applicable:
1. Electric utility's protective device
2. Medium voltage equipment relays
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points
9. Pertinent generator short-circuit decrement curve and generator damage point
10. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.03 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

D. The Arc-Flash Hazard Analysis shall include all medium voltage and 480v locations and significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.

E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm^2.

F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

2.04 REPORT SECTIONS

A. Input Data:
1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
2. Short-circuit reactance of rotating machines with associated X/R ratios
3. Cable type, construction, size, # per phase, length, impedance and conduit type
4. Bus duct type, size, length, and impedance
5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
6. Reactor inductance and continuous ampere rating
7. Aerial line type, construction, conductor spacing, size, # per phase, and length

B. Short-Circuit Data:
1. Source fault impedance and generator contributions
2. X to R ratios

3. Asymmetry factors
4. Motor contributions
5. Short circuit kVA
6. Symmetrical and asymmetrical fault currents

C. Recommended Protective Device Settings:
1. Phase and Ground Relays:
    a. Current transformer ratio.
    b. Current setting.
    c. Time setting.
    d. Instantaneous setting.
    e. Specialty non-overcurrent device settings.
    f. Recommendations on improved relaying systems, if applicable.
2. Circuit Breakers:
    a. Adjustable pickups and time delays (long time, short time, ground).
    b. Adjustable time-current characteristic.
    c. Adjustable instantaneous pickup.
    d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations.
1. Arcing fault magnitude
2. Device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 – EXECUTION

3.01 ARC FLASH WARNING LABELS

A. The CONTRACTOR shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The label shall have an orange header with the wording, “WARNING, ARC FLASH HAZARD”, and shall include the following information:
1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance
7. Engineering report number, revision number and issue date

C. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 600, 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided.
2. For each motor control center, two arc flash labels shall be provided, one at each end of the motor control center.
3. For each low voltage switchboard, one arc flash label shall be provided
4. For each switchgear or unit substations, two arc flash labels shall be provided, one at each end of the equipment or near each main breaker.
5. For each medium voltage switch, one arc flash label shall be provided.

D. Labels shall be field installed by the electrical supplier performing the studies, local power company, or engineering service division of the equipment manufacturer during the Startup and Acceptance Testing.

3.02 ARC FLASH TRAINING

A. Eaton shall train personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 16 hours, two trips to the Owners facility). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces, shall be provided in the equipment manuals. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET). Assume for twenty (20) individuals of the Owners staff to be trained.

END OF SECTION

SECTION 16060 - GROUNDING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Electrical grounding and bonding Work as follows:
   1. Solidly grounded.

B. Applications of electrical grounding and bonding Work in this Section:
   1. Underground metal piping.
   2. Underground metal water piping.
   3. Underground metal structures.
   4. Metal building frames.
   5. Electrical power systems.
   6. Grounding electrodes.
   7. Separately derived systems.
   8. Raceways.
   9. Service equipment.
   10. Enclosures.
   11. Equipment.
   12. Lighting standards.
   13. Landscape lighting.
   14. Signs.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.

1.03 QUALITY ASSURANCE

A. Codes and Standards:
   1. UL Compliance: Comply with applicable requirements of UL Standards No. 467, "Electrical Grounding and Bonding Equipment," and No. 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits, and equipment. In addition, comply with UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL listed and labeled for their intended usage.
   2. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141, and 142 pertaining to grounding and bonding of systems, circuits, and equipment.

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING

A. Materials and Components:
   1. Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type component product meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.
   2. Conductors: Electrical copper grounding conductors for grounding system connections that match power supply wiring materials and are sized according to NEC.
   3. Ground Bus: 0.25 inch by 1 inch minimum copper ground bus where indicated.
   4. Service Arrester: Electrical service arrester, 480 volts, 3-phase, 4-wire, for exterior mounting.
   5. Grounding Electrodes: Steel with copper welded exterior, 3/4-inch diameter by 20 feet.
   6. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

A. Connect grounding conductors to underground grounding electrodes using exothermic weld process or mechanical compression type connectors.

B. Ground electrical service system neutral at service entrance equipment to grounding electrodes.

C. Ground each separately derived system neutral to effectively grounded metallic water pipe, effectively grounded structural steel member, and separate grounding electrode.

D. Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

E. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug, bus, or bushing.

F. Connect grounding electrode conductors to 1-inch diameter or greater, metallic cold water pipe using a suitably sized ground clamp. Provide connections to flanged piping at street side of flange.

G. Connect building reinforcing steel, building steel beam, building steel roof and walls and duct bank and vault reinforcing steel to ground mat using No. 4/0 AWG bare copper grounding cable.

H. Bond bare No. 4/0 AWG grounding cable in duct banks to grounding cable in vaults and to power equipment ground bus at ends of each duct bank.

I. Bond strut and other metal inside of electrical manholes and vaults to bare No. 4/0 AWG grounding cable carried in duct bank.

J. Bond grounding cables to both ends of metal conduit or sleeves through which such cables pass.

K. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque-tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

L. Install braided type bonding jumpers with code-sized ground clamps on water meter piping to electrically bypass water meters.

M. Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible while following building lines to minimize transient voltage rises. Protect exposed cables and straps where subject to mechanical damage.

N. Apply corrosion-resistant finish to field connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed and are subjected to corrosive action.

3.02 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester using the 3-point fall of potential method. Testing shall be performed during normal dry weather conditions with at least 5 non-rain days elapsing prior to test. Where tests show resistance-to-ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms or less by driving additional ground rods; then retest to demonstrate compliance.

B. Test ground paths for continuity by applying a low DC voltage source of current, capable of furnishing up to 100 amps, between electrical equipment grounds and ground grid. Grounding path must conduct a 100-amp current at a resistance of 0.010 ohms or less as calculated from circuit voltage.

END OF SECTION

SECTION 16070 - SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product data for each type of product specified.

1.03 QUALITY ASSURANCE

A. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Slotted Metal Angle and U-Channel Systems:
      a. Allied Tube & Conduit.
      b. American Electric.
      c. B -Line Systems, Inc.
      d. Cinch Clamp Co., Inc.
      e. GS Metals Corp.
      f. Haydon Corp.
      g. Kin-Line, Inc.
      h. Unistrut Diversified Products.
   2. Conduit Sealing Bushings:
      a. Bridgeport Fittings, Inc.
      b. Cooper Industries, Inc.
      c. Elliott Electric Mfg. Corp.
      d. GS Metals Corp.
      e. Killark Electric Mfg. Co.
      f. Madison Equipment Co.
      g. L.E. Mason Co.
      h. O-Z/Gedney.
      i. Producto Electric Corp.
      j. Raco, Inc.
      k. Red Seal Electric Corp.
      l. Spring City Electrical Mfg. Co.
      m. Thomas & Betts Corp.

2.02 COATINGS

A. Coating: Supports, support hardware, and fasteners shall be stainless steel. Products for use outdoors, in NEMA 4 areas, or embedded in concrete or in Nema 12 areas indoors shall be stainless steel.

2.03 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and stainless steel spring clamps.
B. Fasteners. Types, materials, and construction features as follows:
   1. Expansion Anchors: 316 stainless steel wedge or sleeve type.
   2. Toggle Bolts: 316 stainless steel springhead type.
   3. Hanger Rods: 0.375-inch diameter minimum, 316 stainless steel.
C. Conduit Sealing Bushings: Factory fabricated, watertight conduit sealing bushing assemblies suitable for sealing around conduit or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
D. Cable Supports for Vertical Conduit: Factory fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of 304 stainless steel.
E. U-Channel Systems: 12 gauge or 0.105-inch-thick 316 stainless steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center in top surface. Provide fittings and accessories that mate and match with U-channel and are of same manufacturer.

2.04 FABRICATED SUPPORTING DEVICES

A. Shop- or field-fabricated supports or manufactured supports assembled from U-channel 316 stainless steel components.

B. 316 stainless steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

C. Pipe Sleeves: Provide a waterstop on pipe sleeves. Provide pipe sleeves of 2 standard sizes larger than conduit/pipe passing through it and of one of the following:
   1. Steel Pipe: Fabricate from Schedule 40 stainless steel pipe.
   2. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including, but not limited to, the following:
   1. Buried electrical line warnings.
   2. Identification labeling for cables and conductors.
   3. Operational instruction signs.
   4. Warning and caution signs.
   5. Equipment labels and signs.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product Data for each type of product specified.

PART 2 - PRODUCTS

2.01 ELECTRICAL IDENTIFICATION PRODUCTS

A. Colored Adhesive Marking Tape for Wires and Cables: Self-adhesive, vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.

B. Pre-tensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: Flexible acrylic bands sized to suit raceway diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.

C. Underground Line Marking Tape: Permanent, bright colored, continuous printed, plastic tape compounded for direct-burial service not less than 6 inches wide by 4 mils thick. Printed legend indicative of general type of underground line below.

D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with pre-printed numbers and letter.

E. Aluminum, Wraparound Cable Marker Bands: Bands cut from 0.014-inch-thick aluminum sheet, fitted with slots or ears for securing permanently around wire or cable jacket or around groups of conductors. Provide for legend application with stamped letters or numbers.

F. Engraved, Plastic Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16 inch minimum thick for signs up to 20 square inches or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in white letters on black face and punched for mechanical fasteners.

G. Baked Enamel Warning and Caution Signs for Interior Use: Pre-printed aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.

H. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, pre-printed cellulose acetate butyrate signs with 20-gauge galvanized steel backing, with colors, legend, and size appropriate to location. Provide 1/4-inch grommets in corners for mounting.

I. Fasteners for Plastic Laminated and Metal Signs: Self-tapping stainless steel screws or Number 10/32 stainless steel machine screws with nuts and flat and lock washers.

J. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18 inch minimum width, 50-pound minimum tensile strength, and suitable for a temperature range from minus 50 to 350 degrees F. Provide ties in specified colors when used for color coding.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification Work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by Code.

B. Underground Electrical Line Identification: During trench backfilling for exterior nonconcrete encased underground power, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench, do not exceed an overall width of 16 inches; install a single line marker.

C. Install line marker for underground wiring, both direct buried and in raceway.

D. Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the Project secondary electrical system following OWNER's method of phase identification or as follows:

Phase	480/277 Volts
A	Yellow
B	Brown
C	Orange
Neutral	White
Ground	Green

E. Wiring Standards:
1. 480/277 Volt, 3-Phase Power:
   a. Brown.
   b. Orange.
   c. Yellow.
   d. Grey Neutral.

2. 208 Volt, 3-Phase Power:
    a. Black.
    b. Red.
    c. Blue.
3. 240/120 Volt, 1-Phase Power:
    a. Black.
    b. Red.
    c. White Neutral.
4. Motor Leads, Control Cabinet/MCC:
    a. Black, numbered L1-T1, etc.
5. Control Wiring:
    a. Red Control circuit wiring that is de-energized when the main disconnect is opened.
    b. Yellow Control circuit wiring that remains energized when the main disconnect is opened.
    c. Blue DC.
    d. Green Ground.

F. Use conductors with color factory applied entire length of conductors except as follows:
    1. The following field applied color coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
        a. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last 2 laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
        b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply 3 ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

G. Power Circuit Identification: Securely fasten identifying metal tags of aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with 1/4-inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-pound test monofilament line or one-piece self-locking nylon cable ties.

H. Install wire/cable designation tape markers at termination points, splices, or junctions in each circuit. Circuit designations shall be as indicated on Drawings.

END OF SECTION

SECTION 16090 - DEMOLITION AND EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Limited scope general construction materials and methods for application with electrical installations as follows:
   1. Selective Demolition including:
      a. Nondestructive removal of materials and equipment for reuse or salvage as indicated.
      b. Dismantling electrical materials and equipment made obsolete by these installations.
   2. Excavation for underground utilities and services, including underground raceways, vaults, and equipment.

1.02 PROJECT CONDITIONS

A. Conditions Affecting Selective Demolition: The following Project conditions apply:
   1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
   2. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Conditions Affecting Excavations: The following Project conditions apply:
   1. Maintain and protect existing building services which transit the area affected by selective demolition.
   2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
   3. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. OWNER will not be responsible for interpretations or conclusions drawn from this information.
   4. Existing Utilities: Locate existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.
   5. Remove existing underground utilities indicated to be removed.
      a. Uncharted or Incorrectly Charted Utilities: Contact utility owner immediately for instructions.
      b. Provide temporary utility services to affected areas. Provide minimum of 48-hour notice to ENGINEER prior to utility interruption.
   6. Use of explosives is not permitted.

1.03 SEQUENCING AND SCHEDULING

A. Coordinate the shutoff and disconnection of electrical service with OWNER and utility company.

B. Notify ENGINEER at least 5 days prior to commencing demolition operations.

C. Perform demolition in phases as indicated.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 SELECTIVE DEMOLITION

A. Demolish, remove, demount, and disconnect abandoned electrical materials and equipment indicated to be removed and not indicated to be salvaged or saved.

B. Materials and Equipment to be Salvaged: Remove, demount, and disconnect existing electrical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to location designated for storage.

C. Disposal and Clean Up: Remove from Site and legally dispose of demolished materials and equipment not indicated to be salvaged.

D. Electrical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
   1. Inactive and obsolete raceway systems, controls, and fixtures.
   2. Raceways embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove materials above accessible ceilings.

E. Perform cutting and patching required for demolition in accordance with Section 01730.

3.02 EXCAVATION

A. Slope sides of excavations to comply with local codes and ordinances. Shore and brace as required for stability of excavation.

B. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

C. Remove and Bracing: Establish requirements for trench shoring and bracing to comply with local codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

D. Install sediment and erosion control measures in accordance with local codes and ordinances.

E. Dewatering: Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding Project Site and surrounding area.
   1. Do not allow water to accumulate in excavations. Remove to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.

2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

F. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
   1. Locate and retail soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
   2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

G. Excavation for Underground Vaults and Electrical Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
   1. Excavate, by hand, areas within drip line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
   2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

H. Trenching: Excavate trenches for electrical installations as follows:
   1. Excavate trenches to uniform width, sufficiently wide to provide ample working room and minimum of 6 to 9 inches clearance on both sides of raceways and equipment.
   2. Excavate trenches to depth indicated or required.
   3. Limit length of open trench to that in which installations can be made and trench backfilled within same day.
   4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide minimum of 6 inches of stone or gravel cushion between rock bearing surface and electrical installations.

I. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F (1 degree C).

J. Backfilling and Filling. Place soil materials in layers to required subgrade elevations for each area classification listed below:
   1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
   2. Under building slabs, use drainage fill materials.
   3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
   4. For raceway less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation of raceways, provide a 4-inch-thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
   5. Other areas, use excavated or borrowed materials.

K. Backfill excavations as promptly as work permits, but not until completion of following:
   1. Inspection, testing, approval, and locations of underground utilities have been recorded.
   2. Removal of concrete formwork.
   3. Removal of shoring and bracing, and backfilling of voids.
   4. Removal of trash and debris.

L. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

M. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

N. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.

O. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.
   1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
      a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact to 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
      b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
      c. Other Areas: Compact 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
   2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during or subsequent to compaction operations.

P. Subsidence. Where subsidence occurs at electrical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

END OF SECTION

SECTION 16120 - WIRES AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:
   1. Low-Voltage Wire and Cable.
   2. Medium-Voltage Cable.
   3. Instrument Cable.
   4. Local Area Network Wiring (LAN).

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Include Shop Drawings of wires, cables, connectors, splice kits, and termination assemblies.

B. Reports of field tests prepared as noted in Section 01600.

1.03 QUALITY ASSURANCE

A. UL Compliance: Provide components which are listed and labeled by UL. For cables intended for use in air handling space comply with applicable requirements of UL Standard 710, "Test Method for Fire and Smoke characteristics of cables used in Air Handling Spaces."

B. NEMA/ICEA Compliance: Provide components which comply with following standards:
   1. NEMA WC 70-1999/ICEA S-95-658-1999, Nonshielded Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.
   2. NEMA WC 71-1999/ICEA S-96-659-1999, Standard for Nonshielded Cables Rated 2,001-5,000 Volts for use in the Distribution of Electrical Energy.
   3. NEMA WC 74-2000/ICEA S-93-639, 5-46 kV Shielded Power Cable for use in the Transmission and Distribution of Electrical Energy.

C. IEEE Compliance: Provide components which comply with the following standard.
   1. Standard 82, Test procedures for Impulse Voltage Tests on Insulated Conductors.

D. Network Wiring Experience: CONTRACTOR must be able to prove to the satisfaction of OWNER that it has significant experience in the installation of Local Area Network cable systems. Installation must include installation of Network cable, cable termination, knowledge of interconnect equipment, and a thorough knowledge of testing procedures.

E. Labeling: Handwritten labels are not acceptable. All labels shall be machine printed on clear or opaque tape, stenciled onto adhesive labels, or typewritten onto adhesive labels. The font shall be at least 1/8 inch in height, block characters, and legible. The text shall be of a color contrasting with the label such that is may be easily read. If labeling tape is utilized, the font color shall contrast with the background. Patch panels shall exhibit workstation numbers or some type of location identifier, in sequential order, for all workstations or devices attached. Each Network cable segment shall be labeled at each end with its respective identifier.

F. Network Wiring Interconnect Equipment (Patch Panels): Interconnect equipment shall be used in all Local Area Network cable installations. Patch panels shall be mounted in the equipment racks or panel mounted. Interconnect equipment mounted in racks shall be affixed to the rack by at least 4 screws. All interconnect devices shall be assembled and installed in accordance with the manufacturer's instructions and recommendations.

G. Patch Cords: Patch cords shall be provided for each Local Area Network port on the patch panel. Patch cords shall meet or exceed technical specifications of all installed Local Area Network cable. Patch cord connectors shall be matched with patch panel connector type and network module connector type as required.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Low-Voltage Wire and Cable:
      a. American Insulated Wire Corp.
      b. General Cable.
      c. The Okonite Co.
      d. Southwire Co.
   2. Connectors for Low-Voltage Wires and Cable Conductors:
      a. AMP.
      b. O-Z/Gedney Co.
      c. Square D Company.
      d. 3M Company.
   3. Medium-Voltage Cable:
      a. American Insulated Wire Corp.
      b. General Cable.
      c. Kerite Co.
      d. The Okonite Co.
      e. Prysmian Cables & Systems.
      f. Southwire Co.
   4. Medium-Voltage Cable Splicing and Terminating Products and Accessories:
      a. Adelet-PLM.
      b. Amerace Corp.
      c. Electrical Products Division 3M.
      d. G&W Electric Co.
      e. M.P. Husky Corp.
      f. Raychem Corp.
      g. RTE Components.
   5. Instrument Cable:
      a. Belden (Trade Nos. 1120A and 1118A).
   6. Local Area Network Cable:
      a. Belden 7882A/7883A, or equal.

2.02 LOW-VOLTAGE WIRES AND CABLES

A. Conductors: Provide stranded conductors conforming to ASTM Standards for concentric stranding, Class B. Construction of wire and cable shall be single conductor (1/c) unless multiconductor cable is shown by notation in form (x/c) where x indicates the number of separate insulated conductors per cable.

B. Conductor Material: Copper. Minimum size power wire shall be No. 12 AWG.

C. Insulation: Provide RHW/USE insulation for power conductors used in single- and 3-phase circuits with more than 120 volts to ground. Provide RHW/USE, XHHW, or THWN/THHN insulation for power conductors used in single- and 3-phase circuits with 120 volts or less to ground
   1. Provide RHW, THHN/THWN, or XHHW insulation for grounding conductors installed in raceways.
   2. Provide THHN/THWN insulation for control conductors.

2.03 CONNECTORS FOR LOW-VOLTAGE WIRES AND CABLES

A. Provide UL listed factory fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types, and classes for applications and services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

2.04 MEDIUM-VOLTAGE CABLE

A. Cable shall be single-conductor type, size as indicated, and conforming to UL Standard 1072, "Medium Voltage Power Cables."

B. Cable shall be ethylene propylene rubber (EPR) insulated and shall conform to NEMA Standard WC 74-2000 (ICEA S-93-639) "5-46 kV Shielded Power Cable for use in the Transmission and Distribution of Electrical Energy."

C. Conductors: Class B stranded, annealed copper.

D. Conductor Shield: Extruded, semiconducting.

E. Insulation Shield: Extruded, semiconducting.

F. Concentric Neutral: Evenly spaced, annealed, coated, solid copper wires applied concentrically over semiconducting insulation shield. Individual wires shall be No. 14 AWG minimum. Concentric neutral ampacity shall be not less than 1/3 the ampacity of central conductor.

G. Metallic Shielding: Copper shielding tape, helically applied over semiconducting insulation shield or evenly spaced solid copper wires applied concentrically over semiconducting insulation shield.

H. Cable Jacket: Sunlight-resistant PVC, cross-linked polyolefin, or chlorosulfonated polyethylence (hypalon).

I. Cable Voltage Rating: 5 kV phase to phase.

J. Cable Voltage Rating: 8 kV phase to phase.

K. Cable Voltage Rating: 15 kV phase to phase.

L. Cable Voltage Rating: 25 kV phase to phase.

M. Cable Voltage Rating: 28 kV phase to phase.

N. Cable Voltage Rating: 35 kV phase to phase.

O. Cable Voltage Rating: 46 kV phase to phase.

2.05 MEDIUM-VOLTAGE SPLICING AND TERMINATING PRODUCTS

A. Types: Compatible with cable materials and shall be suitable for indoor or outdoor environments as required.

B. Connectors: Compression type as recommended by cable or splicing kit manufacturer for application.

C. Splicing and Terminating Kits: As recommended by manufacturer in writing for specific sizes, ratings, and configurations of cable conductor, splices, and terminations specified. Kits shall contain components required for a complete splice or termination including detailed instructions and shall be the product of a single manufacturer. Completed splices and terminations shall provide insulation equivalent to the insulation class of cable it connects and maintain current carrying capacity and mechanical strength of cable.

2.06 INSTRUMENT CABLE

A. Instrument Cable: 600 volt minimum insulated shielded cable with two or more twisted No. 16 or No. 18AWG stranded copper conductors; PVC, nylon, or polyethylene outer jacket; and 100 percent foil shielding.

2.07 LOCAL AREA NETWORK CABLE

A. Category 6 (Ethernet) Data and Patch Cable:
   1. Paired, 4-pair, 24 AWG, solid bare copper conductors with polyethylene insulation, overall aluminum foil-polyester tape shield with 24 AWG stranded tinned copper drain wire, 100 percent shield coverage, PVC jacket.
   2. UL verified to Category 6.
   3. Provide plenum rated cable where installed exposed.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. Prior to energizing, check installed 480 volt, 3-phase power circuits and higher wires and cables with a 1,000-volt megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Minimum acceptable megohm meter reading is 100 megohms held at a constant value for 15 seconds. A certified copy of megohm meter tests shall be submitted to ENGINEER. Test reports

shall include ambient temperature and humidity at time of testing. Notify ENGINEER 48 hours prior to test with schedule.

B. Medium-Voltage Cable Tests shall include high-potential test of cable and accessories and such tests and examinations required to achieve specified objectives. Where new cables are spliced to existing cables, high-potential test shall be performed on the new cable prior to splicing. After test results for new cables are approved and splice is made, an insulation resistance test and continuity test on the length of cable including the splice with existing cables being tested to the nearest disconnect point.

C. Local Area Network (LAN) Cable Tests: Testing of all cable segments shall be completed in compliance with EIA/TIA-568-B.1 Standards. Testing shall be done by CONTRACTOR with at least 5 years of experience in testing Network cabling systems.
   1. TESTING: CONTRACTOR shall test each network cable segment. **OWNER reserves the right to have representation present during all or a portion of the testing process. CONTRACTOR must notify OWNER 5 days prior to commencement of testing**. If OWNER elects to be present during testing, test results will only be acceptable when conducted in the presence of OWNER.
   2. DOCUMENTATION (Network Cable): CONTRACTOR shall provide documentation to include test results and as-built Drawings. Network Cable Results: Handwritten results are acceptable provided the test is neat and legible. Copies of test results are not acceptable. Only original signed copies will be acceptable.
      a. Each cable installed shall undergo complete testing in accordance with TIA/EIA-568-B.1 to guarantee performance to this Standard.
      b. All required documentation shall be submitted within 30 days at conclusion of the project to OWNER.
      c. Test Criteria: Pass rate to conform to latest TIA/EIA-568-B.1 Standards that incorporate link performance testing through entire path, including cable, couplers, and jumpers.
   3. ACCEPTANCE: Acceptance of the Data Communications System, by OWNER, shall be based on the results of testing, functionality, and receipt of documentation.

D. Reports (non-LAN cable): Testing organization shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Testing organization shall submit written reports to ENGINEER.

END OF SECTION

SECTION 16130 - RACEWAYS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Raceways for electrical wiring. Types of raceways in this Section include the following:
   1. Flexible metal conduit.
   2. Liquidtight flexible conduit.
   3. Underground plastic utilities duct.
   4. Rigid metal conduit.
   5. Rigid nonmetallic conduit.
   6. Surface raceways.
   7. PVC externally coated rigid metal conduit.
   8. Fiberglass reinforced conduit.
   9. Aluminum conduit.
   10. Wireway.
   11. Conduit bodies.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product data for the following products:
      a. Surface raceway and fittings.
      b. Wireway and fittings.
      c. Conduit.
      d. Conduit bodies.

1.03 QUALITY ASSURANCE

A. Codes and Standards:
   1. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
   2. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL, ETL, or CSA.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in Work include:
   1. Conduit:
      a. Allied Tube.
      b. Carlon.

c. Johns Manville.
d. Occidental Coatings.
e. Orangeburg.
f. Perma-Cote Industries.
g. Republic Steel.
h. Robroy Industries.
i. Steelduct Co.
j. Triangle Conduit.
k. Wheatland Tube.
l. Youngstown Sheet and Tube.

2. Liquidtight Conduit:
   a. Anamet, Inc.
   b. Carlon.
   c. Electric-Flex.
   d. Thomas and Betts.
3. Conduit Bodies:
   a. Adalet-PLM.
   b. American Electric.
   c. Appleton Electric Co.
   d. Carlon.
   e. Crouse-Hinds Division, Cooper Industries, Inc.
   f. Delta Industrial Products.
   g. Killark Electric Mfg. Co.
   h. Kraloy Products Co.
   i. O-Z/Gedney Co.
   j. Perma-Cote Industries.
   k. Robroy Industries.
   l. Spring City Electrical Mfg. Co.
4. Conduit Thread Paint:
   a. CRC Chemicals, USA.
   b. Sherwin Williams.
   c. ZRC Chemical Products Co.
5. Wireway:
   a. Alrey-Thompson Co.
   b. Anchor Electric Co.
   c. Hoffman Engineering Co.
   d. Keystone/Rees, Inc.
   e. Robroy Industries, Inc.
   f. Square D Company.
6. Surface Metal Raceway:
   a. Allied Tube & Conduit.
   b. B-Line Systems, Inc.
   c. Butler Mfg. Co.
   d. Hoffman Engineering Co.
   e. Isoduct Energy Systems.
   f. Isotrol Systems.
   g. Keystone/Rees, Inc.
   h. Square D Company.
   i. The Wiremold Co.

7. Surface Nonmetallic Raceway:
    a. Anixter Brothers, Inc.
    b. Hoffman Engineering Co.
    c. Hubbell, Inc.
    d. Panduit Corp.
    e. Premier Telecom Products, Inc.
    f. Thermotools Co.
    g. The Wiremold Co.

2.02 METAL CONDUIT AND TUBING

A. Rigid Metal Conduit: ANSI C 80.1, hot-dip galvanized.

B. PVC Externally Coated Rigid Metal Conduit and Fittings: ANSI C 80.1 and NEMA RN 1., Type 40, 40 mil nominal coating and thickness. The bond of the PVC to the substrate shall be stronger than the tensile strength of the PVC.

C. Flexible Metal Conduit: UL 1, zinc-coated metal.

D. Liquidtight Flexible Metal Conduit and Fittings: UL 360. Fittings shall be specifically approved for use with this raceway.

E. Rigid metal aluminum conduit: ANSI C 80.5, 6063 alloy in temper designation T-1.

2.03 NONMETALLIC CONDUIT AND DUCTS

A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.

B. PVC Conduit and Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.

C. Underground PVC and ABS Plastic Utilities Duct: NEMA TC 6, Type I for encased burial in concrete, Type II for direct burial.

D. PVC and ABS Plastic Utilities Duct Fittings: NEMA TC 9; match to duct type and material.

E. Liquidtight Flexible Nonmetallic Conduit and Fittings: UL 1660. Fittings shall be specifically approved for use with this raceway.

F. Fiberglass-Reinforced Conduit and Fittings: CSA B196.1 and B1089 A.

2.04 CONDUIT BODIES

A. Provide matching gasketed covers secured with corrosion-resistant screws. Use cast covers in NEMA 4 areas and stamped steel covers in NEMA 1 and 12 areas. Use nonmetallic covers in NEMA 4X areas and threaded, ground joint covers in NEMA 7 and NEMA 9 areas.

B. Metallic Conduit and Tubing: Use metallic conduit bodies as follows:
    1. Rigid Metal Conduit: Use cast or malleable iron conduit bodies with zinc electroplating, aluminum enamel or lacquer finish, and threaded hubs.

2. Intermediate Metal Conduit: Use cast or malleable iron conduit bodies with zinc electroplating, aluminum enamel or lacquer finish, and threaded hubs.
3. Electrical Metallic Tubing: Use cast or malleable iron conduit bodies with zinc electroplating, aluminum enamel or lacquer finish, and compression type or setscrew connectors.
4. PVC Externally Coated Rigid Metal Conduit: Use hot-dipped galvanized or cadmium-plated cast or malleable iron conduit bodies with threaded hubs factory PVC-coated. Field application of PVC coating to conduit bodies is not acceptable. Secure covers using PVC encapsulated or stainless steel screws.
5. Nonmetallic Conduit and Tubing: Use nonmetallic conduit bodies conforming to UL 514 B.
6. NEMA 7 and NEMA 9 Areas: Use materials conforming to UL standards for the area.

2.05 WIREWAYS

A. Fittings and accessories including but not limited to couplings, offsets, elbows, expansion joints, adapters, hold-down straps, and end caps shall match and mate with wireway as required for complete system. Where features are not indicated, select to fulfill wiring requirements and comply with applicable provisions of NEC.

B. Wireway covers shall be hinged type.

2.06 SURFACE RACEWAYS

A. Sizes and channels as indicated. Provide fittings that match and mate with raceway.

B. Surface Metal Raceway: Construct of galvanized steel with snap-on covers, with 1/8-inch mounting screw knockouts in base approximately 8 inches o.c. Finish with manufacturer's standard prime coating suitable for painting. Provide raceways of types suitable for each application required.

C. Surface Nonmetallic Raceway: Two-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color. Raceway and system components shall meet UL 94 requirements for nonflammable, self-extinguishing characteristics.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16135 - CABINETS, BOXES, AND FITTINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Cabinets, boxes, and fittings for electrical installations and certain types of electrical fittings not covered in other Sections. Types of products specified in this Section include:
   1. Outlet and device boxes.
   2. Pull and junction boxes.
   3. Terminal boxes.
   4. Bushings.
   5. Locknuts.
   6. Conduit hubs.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Shop Drawings for floor boxes and boxes, enclosures, and cabinets that are to be shop-fabricated, (nonstock items). For shop-fabricated junction and pull boxes, show accurately scaled views and spatial relationships to adjacent equipment. Show box types, dimensions, and finishes.
   2. Product data for boxes, fittings, cabinets, and enclosures.

1.03 QUALITY ASSURANCE

A. Codes and Standards:
   1. UL Listing and Labeling: Items provided under this section shall be listed and labeled by UL.
   2. NEMA Compliance: Comply with NEMA Standard 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Outlet Boxes, Concealed Conduit System:
      a. Adalet-PLM Div., Scott Fetzer Co.
      b. Appleton Electric, Emerson Electric Co.
      c. Bell Electric, Square D Company
      d. Eagle Electric Mfg. Co., Inc.
      e. Midland-Ross Corp.
      f. OZ/Gedney, General Signal Co.
      g. Pass and Seymour, Inc.

h. RACO Div., Harvey Hubbell, Inc.
i. Thomas & Betts Co.

2. Outlet Boxes, Exposed Conduit System:
   a. Appleton Electric, Type JB, GS, or SHE.
   b. Crouse-Hinds, Type GS or GRF.
3. Device Boxes, Concealed Conduit Systems:
   a. Adalet-PLM Div., Scott Fetzer Co.
   b. Appleton Electric; Emerson Electric Co.
   c. Bell Electric, Square D Company.
   d. Eagle Electric Mfg. Co., Inc.
   e. Midland-Ross Corp.
   f. OZ/Gedney, General Signal Co.
   g. Pass and Seymour, Inc.
   h. RACO Div., Harvey Hubbell, Inc.
   i. Thomas & Betts Co
4. Device Boxes, Exposed Conduit System:
   a. Appleton Electric, Type FS/FD.
   b. Crouse-Hinds, Type FS/FD.
5. Junction and Pull Boxes, Concealed System:
   a. Adalet-PLM Div., Scott Fetzer Co.
   b. Appleton Electric, Emerson Electric Co.
   c. Arrow-Hart Div., Crouse-Hinds Co.
   d. Bell Electric, Square D Company.
   e. GTE Corporation.
   f. Keystone Columbia, Inc.
   g. OZ/Gedney Co.; General Signal Co.
   h. Spring City Electrical Mfg. Co.
6. Junction and Pull Boxes, Exposed Conduit System:
   a. Appleton Electric, Type FS/FD.
   b. Crouse-Hinds, Type FS/FD.
7. Terminal Boxes:
   a. AMFCO.
   b. Boss.
   c. Hoffman.
   d. Keystone.
   e. Hope.
8. Bushings, Knockout Closures, Locknuts, and Connectors:
   a. Adalet-PLM Div., Scott Fetzer Co.
   b. AMP, Inc.
   c. Arrow-Hart Div., Crouse-Hinds Co.
   d. Appleton Electric Co., Emerson Electric Co.
   e. Bell Electric; Square D Co.
   f. Midland-Ross Corp.
   g. Midwest Electric, Cooper Industries, Inc.
   h. OZ/Gedney Co., General Signal Co.
   i. RACO Div., Harvey Hubbell, Inc.
   j. Thomas & Betts Co., Inc.

2.02 CABINETS, BOXES, AND FITTINGS - GENERAL

A. Outlet Boxes: Suitable for the conduit system installation as follows:
   1. Exposed Conduit: Provide cast outlet boxes finished with aluminum lacquer or enamel. Provide cast metal covers with neoprene gaskets for NEMA 12 and 4 areas and undesignated areas.
      a. Exception: Provide non-metallic outlet boxes for NEMA 4X areas. Provide the appropriate explosion-proof rating for outlet boxes installed in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated or 316 stainless steel boxes where PVC-coated conduit is specified.
   2. Concealed Conduit: Provide 316 stainless steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct outlet boxes with mounting holes and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding. Provide cast metal outlet boxes for exterior outlets.

B. Device Boxes: Suitable for the conduit system as follows:
   1. Exposed Conduit: Provide 316 stainless device boxes finished with aluminum lacquer or enamel. Provide exterior mounting lugs on device boxes.
      a. Exception: Provide non-metallic outlet boxes for NEMA 4X areas. Provide appropriate explosion-proof rating for device boxes installed in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated or 316 stainless steel device boxes where PVC-coated conduit is specified.
   2. Concealed Conduit: Provide 316 stainless steel non-gangable device boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, and with cable-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices. Provide cable clamps and corrosion-resistant screws for fastening cable clamps, and for equipment type grounding. Provide cast metal device boxes for exterior devices.

C. Junction and Pull Boxes: Suitable for the conduit system installation as follows:
   1. Exposed Conduit: For pull and junction boxes provide 316 stainless steel hinged boxes. Provide exterior mounting lugs. Grind exposed edges smooth or roll edges to prevent scuffing of wire during installation. Provide a continuous neoprene or rubber gasket cemented to the box cover where it contacts the box body.
      a. Exceptions: Provide nonmetallic pull and junction boxes in NEMA 4X areas. Provide appropriate explosion-proof construction for boxes located in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated or 316 stainless steel boxes for areas where PVC conduit is used.
   2. Concealed Conduit: Provide 316 stainless steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws, and washers.

D. Terminal Boxes: Provide compression lug type terminal strips in each terminal box with a minimum of 20 percent spare terminals. Provide appropriate NEMA enclosure rating for area in which terminal box is installed. Boxes to be 316 stainless steel.

E. Bushings, Knockout Closures, and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications. Provide watertight hubs on conduits terminated at 316 stainless steel enclosures in NEMA 12 and Nema 4 areas.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16139 - VAULTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Extent of underground concrete encased conduit (ductbank) vault, manhole, and handhole work as indicated by Drawings, and is hereby defined to include those units which are utilized exclusively for installation of instrumentation, communication, and control media and equipment; and electrical power cables, wires, and equipment.

B. Types of vaults, manholes, and handholes in this Section include, but are not limited to:
   1. Utility vaults.
   2. Electrical manholes.
   3. Electrical handholes.
   4. Concrete encased conduit (ductbank).

C. Related Work in Other Sections:
   1. Excavation and backfill required in connection with vaults, manholes, and handholes.
   2. Concrete Work required in connection with vaults, manholes, and handholes.
   3. Waterproofing and dampproofing of vaults, manholes, and handholes.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:

   1. Manufacturer's Data: Submit manufacturer's data on concrete encased conduit vault, manhole, and handhole components and associated specialty products.
   2. Submit Shop Drawings for vault system, showing raceway types and sizes, locations, and elevations for horizontal runs. Include details of underground structures, accessories, fittings, and connections.

1.03 QUALITY ASSURANCE

A. Prefabricators: Firms regularly engaged in manufacture of factory fabricated vaults, manholes, and handholes, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Codes and Standards:
   1. ANSI Compliance: Comply with requirements of ANSI C2, "National Electrical Safety Code," pertaining to construction and installation of concrete encased conduit vaults, manholes, and handholes.
   2. ASTM Compliance: Comply with applicable requirements of American Society for Testing and Materials (ASTM) standards pertaining to construction and materials for vaults, manholes, and handholes.
   3. UL Compliance: Comply with applicable requirements of Standard 486A, "Wire Connectors and Soldering Lugs for Use With Copper Conductors." Provide vault, manhole, and handhole accessories which are UL listed and labeled.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

B. Prefabricated Units:
   1. Advance Concrete.

C. Manhole Frames and Covers:
   1. James B. Clow & Sons.
   2. Neenah Foundry Co.

2.02 MATERIALS FOR FIELD FABRICATED UNITS

A. Concrete Materials: Comply with Division 3 requirements for applicable product requirements of concrete materials, except as otherwise indicated.

B. Concrete Masonry Units: ASTM C 139.

C. Masonry Mortar: ASTM C 270, Type M:
   1. For minor amounts of mortar comprising less than 2.0-cubic-foot packaged mortar materials complying with ASTM C 387, Type M, may be substituted at CONTRACTOR's option.

D. Manhole Frames and Covers: Grey cast iron, ASTM A 48, Class 30B:
   1. Dip coat frames and covers in black asphalt paint. Provide 30-inch-diameter openings for vaults and manholes carrying low-voltage circuits. Provide 36-inch-diameter openings for vaults and manholes carrying medium-voltage circuits.
   2. Furnish covers with cast-in legend "ELECTRIC" on roadway face.

E. Vault and Manhole Steps: Grey cast iron, ASTM A 48, Class 30B, integrally cast into vault and manhole sidewalls, unless otherwise indicated.

2.03 FACTORY FABRICATED VAULTS, MANHOLES, AND HANDHOLES

A. Concrete Vaults and Manholes: Provide watertight, precast concrete vaults and manholes in types and sizes indicated, with access knockout entrance holes for raceways and cable, cast-iron manhole access cover and frame with machined bearing surfaces, with pulling/lift irons, sump/drainage box and vertical embedded continuous slot inserts.

B. Manhole Frames and Covers: Grey cast iron, ASTM A 48, Class 30B:
   1. Dip coat frames and covers in black asphalt paint. Provide 30-inch-diameter openings for vaults and manholes carrying low-voltage circuits. Provide 36-inch diameter openings for vaults and manholes carrying medium-voltage circuits.
   2. Furnish covers with cast-in legend "ELECTRIC" on roadway face.

3. Provide reinforced concrete for vaults and manholes with slabs designed for H-20 highway loading and walls designed for a lateral earth pressure of 80 pounds per square foot per foot of depth.

C. Handholes and Boxes: Provide handholes and boxes for pulling, splicing, and terminating conductors, in types and sizes indicated, with watertight cover and penta-head bolts and knockout access holes; equip base with sump/drainage box.
   1. Provide concrete body with cast iron cover and ring.

D. Accessories: Provide vault, manhole, and handhole accessories, including pulling-in irons, embedded cable support accessories, cable rack arms, porcelain saddles, sump pump pits, ladders, mastics, and sealants as indicated or required.

PART 3 - EXECUTION

3.01 INSPECTION

A. Installer must examine areas and conditions under which concrete encased conduit vaults, manholes, and handholes are to be installed, and notify CONTRACTOR in writing of those conditions detrimental to proper completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 UNDERGROUND CONCRETE ENCASED CONDUIT

A. Support conduit to be encased on approved spacers at the dimensions shown on Drawings.

B. Reinforce concrete encasement as indicated.

C. Slope duct runs a minimum of 0.5 percent in the direction indicated.

D. Maintain a 12-inch minimum clearance between concrete encasement and yard piping.

E. Provide 24-inch minimum clearance from top of concrete encasement to finished grade unless otherwise noted.

F. Mandrel and clean all underground conduits prior to cable installation.

3.03 INSTALLATION OF VAULTS, MANHOLES, AND HANDHOLES

A. Install vaults, manholes, and handholes as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that vaults, manholes, and handholes comply with requirements.

B. Set manhole frames and covers flush with sidewalk, pavement, or ground surface. In gravel driveways set covers 4 inches below surface.

C. Coordinate with other Work, including electrical raceway and wiring Work, as necessary to interface installation of vaults, manholes, and handholes with other Work.

3.04 INSTALLATION OF FIELD FABRICATED UNITS

A. Fabricate vaults, manholes, and handholes, of types and sizes indicated, watertight, and equip with manhole metal access cover, steps, access holes for raceways and cables, sump/drainage box, and bolting inserts.

B. Masonry Construction Manholes:
   1. Use concrete masonry units to construct masonry manholes and vaults.
   2. Construct manholes and vaults in sizes and shapes indicated.
   3. Mix mortar with only enough water for workability. Retempering of mortar is not permitted. Keep mortar mixing and conveying equipment clean. Do not deposit mortar upon, or permit contact with, the ground.
   4. Lay masonry in mortar to form full-bed joints, with end and side joints formed in one operation, and with bed and vertical joints not more than 5/8-inch wide. Protect fresh masonry from freezing and also from too rapidly freezing and from too rapidly drying.
   5. Apply a 1/2-inch-thick mortar coating on both interior and exterior wall surfaces.
   6. Where manholes are installed in pavements, set tops of frames and covers flush with finish surface. Elsewhere, set tops 3 inches above finish surface unless otherwise indicated.
   7. Use an epoxy bonding compound where manhole steps are mortared into masonry walls.

C. Cast-In-Place Concrete Manholes:
   1. Use cast-in-place concrete to construct manholes and vaults.
   2. Construct manholes and vaults of sizes and shapes indicated.
   3. Dampproofing and Waterproofing:
      a. Coordinate dampproofing and waterproofing Work with installation of field fabricated units as necessary for proper interface.
      b. Install dampproofing and waterproofing materials as indicated.

3.05 INSTALLATION OF FACTORY FABRICATED UNITS

A. Install vaults, manholes, and handholes as indicated, in accordance with manufacturer's written instructions and recognized industry practices to ensure that vaults, manholes, and handholes comply with requirements and serve intended purposes.

B. Precast Concrete Units: Place precast concrete sections as indicated. Where units occur in pavements, set tops of frames and covers flush with finish surface, unless otherwise indicated. Use epoxy bonding compound where steps are mortared into unit walls.
   1. Install rubber joint gasket, complying with ASTM C 443, at joints between sections.
   2. Apply bituminous mastic coating at joints between sections.
   3. Coordinate dampproofing and waterproofing Work with installation of precast concrete units as necessary for proper interface.
   4. Install dampproofing and waterproofing materials as indicated.

3.06 BACKFILLING

A. Delay backfilling of excavations surrounding vaults, manholes, and handholes until after initial inspection has been completed.

3.07 GROUNDING AND BONDING

A. Provide equipment grounding and bonding connections for exposed metal parts in vaults, manholes, and handholes as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

END OF SECTION

SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:
   1. Receptacles.
   2. Ground fault circuit interrupter receptacles.
   3. Plugs.
   4. Plug connectors.
   5. Telephone and network outlets.
   6. Wall plates.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product data for each type of product specified.

1.03 QUALITY ASSURANCE

A. Codes and Standards:
   1. UL and NEMA Compliance: Provide wiring devices which are listed and labeled by UL and comply with applicable UL and NEMA standards.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Bryant Electric Co., Division of Hubbell Corporation.
   2. Cooper Wiring Devices.
   3. Hubbell, Inc.
   4. Leviton Manufacturing Co., Inc.
   5. Pass and Seymour, Inc.

2.02 WIRING DEVICES

A. Provide devices which are UL listed and which comply with NEMA WD 1 and other applicable UL and NEMA standards. Provide ivory color devices and wall plates except as otherwise indicated.

B. Receptacles: Provide specification grade or heavy-duty grounding receptacles with the NEMA rating shown on Wiring Device Schedule on Drawings. Comply with UL 498 and NEMA WD1.

C. Receptacles, Industrial Heavy-Duty: Provide pin and sleeve design receptacles conforming to UL 498. Comply with UL 1010 where installed in hazardous locations. Provide features indicated.

D. Ground Fault Interrupter (GFI) Receptacles: Provide specification grade or heavy-duty "feed-through" type ground fault circuit interrupter, with integral grounding type NEMA 5-20R duplex receptacles arranged to protect connected downstream receptacles on same circuit. Provide units rated Class A, Group 1, per UL Standard 94.3.

E. Plugs: 15 amperes, 125 volts, 3-wire, grounding, armored cap plugs, parallel blades with cord clamp, and 0.4-inch cord hole; match NEMA configuration with power source's.

F. Plug Connectors: 15 amperes, 125 volts, bakelite-body armored connectors, 3-wire, grounding, parallel blades, double wipe contact, with cord clamp, and 0.4-inch cord hole, match NEMA configuration to mating plug's. Arrange as indicated.

G. Telephone and Network Outlets: Telephone outlets shall consist of box, wall plate, and RJ-12 jack. Network outlets shall consist of box, wall plate, and RJ-45 jack. Network outlet shall comply with requirements of CAT-5E cabling systems. Wall plates shall match color and style of receptacle and switch wall plates used throughout the Project.

2.03 WIRING DEVICE ACCESSORIES

A. Wall plates: Single and combination, of types, sizes, and with ganging and cutouts as indicated. Provide plates which mate and match with wiring devices to which attached. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates. Provide wall plates with engraved legend where indicated. Exterior receptacle covers shall provide rainproof protection while in use. Conform to requirements of Section 16075. Provide plates possessing the following additional construction features:
   1. NEMA 12 and Unclassified Areas. Material and Finish: 0.04-inch-thick stainless steel, or 0.04-inch-thick brass, chrome plated.
   2. NEMA 4 Area Material and Finish: Cast screw cap and cover plate for receptacles. Cast cover plate with lever or plunger operator for switches.
   3. NEMA 4X Material and Finish: Non-metallic, watertight wall plates 0.05-inch-thick aluminum, anodized.
   4. NEMA 7 and NEMA 9 Material and Finish: cast metal cover plates meeting NEC requirements for area.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16220 - MOTORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section applies, in general, to all electric or DC motor-driven equipment provided under Divisions 2 through 16 Sections. This Section shall supplement the detailed Equipment Specifications, but in cases of conflict, the Specifications indicated in this Section shall govern.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Submittals for motors shall accompany the specific equipment the motor is to be supplied with.
   2. Submit product literature for each motor.

B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.

1.03 QUALITY ASSURANCE

A. Electrical Codes, Ordinances, and Industrial Standards: The design, testing, assembly, and methods of installation of the wiring materials, electrical equipment, and accessories proposed under this Contract shall conform to the National Electrical Code and to applicable State and local requirements. UL listing and labeling shall be adhered to under this Contract. Any equipment that does not have a UL, FM, CSA, or other listed testing laboratory label, shall be furnished with a notarized letter signed by the supplier stating that the equipment furnished has been manufactured in accordance with the National Electrical Code and OSHA requirements. Any additional cost resulting from any deviation from codes or local requirements shall be borne by CONTRACTOR.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, motors shall be standard design and construction. Manufacturers offering products which may be incorporated in Work include:
   1. Motors:
      a. Marathon Blue Chip Series.
      b. Siemens, Inc.
      c. General Electric Co.
      d. Reliance Electric Co.
      e. U.S. Electric Motors.

B. For motors that are integrally constructed as a piece of equipment, such as appliances, hand tools, etc., and where manufacturer would be required to redesign equipment to meet these general specifications, it is the intent to allow such standard motors to be used, provided they do not exceed 1-1/2 horsepower and are suitable for use on standard power systems.

2.02 MATERIALS

A. Shop primers shall be Tnemec "77 Chem-Prime," or equal.

B. Rust preventive compound shall be equal to Dearborn Chemical "No-Ox-ID2W," Houghton "Rust Veto 344," or Rust-Oleum "R-9".

2.03 MANUFACTURED UNITS

A. Electrical Motors: Motor design and application shall comply with current ANSI, IEEE, NEMA, and AFBMA standards and with the NEC where applicable. They shall be squirrel cage induction motors rated 60 hertz, continuous duty for use in 40 degrees C ambient temperature. Motors shall comply with NEMA MG1-1993, Rev. 1, Part 31, Definite Purpose Inverter-Fed Motors whether used with variable frequency drives or not.
   1. The motors shall be sized within their rated loads under the specified conditions without utilizing the top 15 percent of the 1.0 or 1.15 service factor. Motor sizing measured at the motor output shaft shall include all loadings on the motor. Motor loadings shall include the maximum or specified load condition of the driven equipment plus all drive losses of components, located between the motor and the driven equipment.
   2. The motor winding temperature rise shall be NEMA Standard for the class of insulation used at the rated service factor load.
   3. The motors shall be capable of handling unfiltered voltage peaks of up to 1600 volts, and rise times of 0.1 micro-seocnds.

B. Motors 50 horsepower and larger shall have embedded passive temperature switches in the windings for use in the motor control circuit that will limit the winding temperature as defined by NEMA Standard MG1-12.53 Type 1. The contact shall be normally closed and rated to operate a 120 volt AC control relay (40 VA).

C. All integral horsepower motors shall have oversize conduit boxes with clamp-type grounding terminals inside which are effectively connected to all noncurrent-carrying motor parts.

D. Multispeed motors are to be supplied with separate windings for each speed. The cost to change starters for motors supplied with reconnectable windings will be the responsibility of equipment (motor) supplier and must be coordinated with ENGINEER.

E. All explosion-proof motors shall meet NEC Class 1, Division I, Group D, requirements with T2A temperature rating.

F. Unless these general specifications are supplanted by the detailed equipment specifications, motors shall be rated and constructed as follows:
   1. Below 1/2 Horsepower: Motors shall be rated 115/230 volts, single phase, but shall be suitable for use on 208 volt power system. They shall have permanently lubricated sealed bearings (antifriction type where high radial or axial thrusts are produced by the driven equipment). Standard motors shall be totally enclosed fan cooled, totally enclosed air-over, or totally enclosed nonventilated capacitor start type as shown on Equipment Schedule(s) or specified in the equipment specifications. Totally enclosed explosion-proof motors shall be provided where required per equipment specifications section.

2. From 1/2 to 1-1/2 Horsepower: Motors shall be rated 115/230 volts single phase or shall be rated 230/460 volts 3-phase as indicated by Equipment Schedule(s). In either case they shall be suitable for use on 208 volt power systems under their given load conditions. They shall have bearings as in 2.03 F.1. The standard enclosures shall be totally enclosed fan cooled, totally enclosed nonventilated, totally enclosed explosion-proof, or open drip-proof as shown on Equipment Schedule(s) or specified in the equipment specifications.
3. From 2 to 200 Horsepower: Motors shall be rated 230/460 or 460 volt, 3-phase. They shall be grease lubricated, ball bearing, Class B insulated, minimum or as specified. Horizontal motors shall be open drip-proof, totally enclosed fan-cooled or totally enclosed explosion-proof (NEC, Class I, Group D) as shown on Equipment Schedule(s) or specified in the equipment specifications. Vertical motors shall meet NEMA standard open drip-proof specifications as a vertical motor when called for or totally enclosed fan cooled or totally enclosed explosion-proof as shown on Equipment Schedule(s).

G. Horizontal and vertical motors may also be weather protected, Type I, and shall have encapsulated or sealed windings.

H. Open drip-proof type motors shall have encapsulated or sealed windings when called for on Drawings or Equipment Schedules.

I. Special duty and severe environment application shall have motors which are designed specifically to meet the special conditions as specified.

J. Motors above 200 Horsepower: Motors shall be of special design as detailed in specific sections of the Specifications. All special purpose motors, such as wound-rotor, multi-speed, variable speed, etc., shall be as detailed in specific Sections of the Specifications. Motor shall be furnished with ten (10) 100-ohm (or as required to be accepted as inputs to the motor protective device) platinum RTD Type temperature sensors for the stator windings; 2 sensors per phase per winding; and 2 temperature sensors for motor bearings; 1 sensor per bearing and 1 for motor ambient temperaturre. RTD sensors shall be the 3-wire type and shall be wired to a terminal strip in a common frame mounted terminal box.

K. The following symbols will be employed on Equipment Schedule(s) to indicate the required motor enclosure and construction features:
1. TE Totally Enclosed, may be nonventilated, fan-cooled or air-over type.
2. TENV Totally Enclosed Nonventilated.
3. TEFC Totally Enclosed Fan-cooled.
4. TEEP Totally Enclosed Explosion-proof, Class I, Div. I, Group D.
5. ODP Open Drip-proof.
6. WPI Weather Protected Type I.
7. E/S Encapsulated or Sealed Windings.
    a. All motors with encapsulation or sealed windings shall have a water-tight conduit box.

L. See NEMA Standard MG1 for definition of above terms.

M. Motor Efficiency: Where Equipment Schedule(s) indicate that motors shall be designed for high efficiency, they shall meet or exceed the Motor Operating Characteristics shown on High Efficiency Motor Schedule No. 16220.2, appended to this Section. Guaranteed minimum efficiency at full load shall be based on IEEE Standard 112, Test Method B. Nominal motor efficiencies are average

expected values. Manufacturer's motor Shop Drawings shall indicate full compliance with the High Efficiency Motor Schedule No. 16220.2.

2.04 FABRICATION

A. Electric motors shall be shop-finished with 2 coats of enamel paint per manufacturer's recommendations.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with manufacturer's written installation and alignment instructions.

B. Lubricate oil-lubricated bearings.

C. Provide electrical wiring and connections as specified in Division 16 Sections.

3.02 FIELD QUALITY CONTROL

A. Inspect all terminations for proper connection.

B. Check motor for proper rotation.

3.03 INSTALLATION CHECK

A. Installation Check: Manufacturer shall provide the services of a factory-trained representative to check the installation of all equipment installed in this Section. The services shall be as noted in Section 01600. Equipment supplier's representative shall revisit Site as often as necessary until all trouble is corrected and equipment installation and operation is satisfactory to ENGINEER.

B. Manufacturer's representative shall provide all necessary tools and testing equipment required including noise level and vibration sensing equipment.

C. Inspection Report: A written report of the installation check shall be submitted to ENGINEER. The report shall be as noted under Section 01600 certifying that the equipment:
   1. Has been properly installed and lubricated;
   2. Is in accurate alignment;
   3. Is free from any undue stress imposed by any connection or anchor bolts;
   4. Has been operated under full load condition and that it operated satisfactorily to ENGINEER; and
   5. That OWNER's representative has been instructed in the proper maintenance and operation of the equipment.
   6. Furnish OWNER a copy of all test data recorded during the installation check including noise level and vibration readings.

HIGH EFFICIENCY MOTOR SCHEDULE NO. 16220.2
MOTOR OPERATING CHARACTERISTICS

		Efficiency (percent)						
		Guar.						
	RPM	Min.		Nominal		Power Factor (percent)		
HP	Syn.	Full	1/2	3/4	Full	1/2	3/4	Full
1	1800	81.5	78.1	81.0	81.5	54.2	67.3	75.8
	1200	75.5	69.5	75.6	78.5	38.4	49.4	58.3
	3600	78.5	78.4	80.2	81.5	75.3	84.4	88.8
1.5	1800	81.5	79.2	82.9	84.0	52.1	65.1	74.0
	1200	81.5	80.5	83.4	84.0	44.0	56.6	85.6
	3600	81.5	78.8	82.9	84.0	66.3	78.4	85.0
2	1800	81.5	78.8	82.6	84.0	48.9	61.7	70.0
	1200	84.0	83.0	83.6	86.5	46.6	59.6	68.0
	3600	84.0	75.4	84.3	86.5	69.7	80.0	85.6
3	1800	86.5	86.9	88.5	88.5	62.3	73.9	79.9
	1200	86.5	84.5	87.5	88.5	45.9	58.3	68.0
	3600	86.5	86.2	88.2	88.5	71.7	81.7	86.4
5	1800	88.5	84.0	88.2	88.5	68.5	79.2	84.6
	1200	86.5	85.8	88.2	88.5	50.8	63.8	71.9
	3600	86.5	82.9	86.7	88.5	75.9	84.3	88.1
7.5	1800	88.5	89.2	90.3	90.2	66.5	77.2	82.4
	1200	86.5	87.5	88.8	88.5	58.6	68.8	73.7
	3600	86.5	87.7	89.0	88.5	77.1	84.5	87.6
10	1800	88.5	89.3	90.4	90.2	67.6	77.4	81.9
	1200	88.5	89.0	90.3	90.2	60.1	70.2	74.9
	3600	88.5	82.3	87.4	90.2	81.1	87.2	90.4
15	1800	90.2	91.0	91.9	91.7	68.5	78.1	82.3
	1200	88.5	89.9	90.6	90.2	67.4	77.1	81.4
	3600	90.2	89.1	91.1	91.7	83.7	88.5	90.5
20	1800	90.2	90.9	91.9	91.7	68.9	78.1	81.8
	1200	90.2	91.0	91.0	91.7	69.8	78.5	81.9
	3600	90.2	91.6	92.0	91.7	81.9	88.6	90.6
25	1800	91.7	92.8	93.2	92.4	72.7	81.4	84.5
	1200	90.2	90.0	91.4	91.7	79.8	84.5	85.5
	3600	90.2	90.6	91.7	91.7	81.1	87.8	90.3
30	1800	91.7	92.8	93.3	93.0	71.5	80.6	84.2
	1200	90.2	91.7	92.0	91.7	78.9	85.4	86.8
	3600	90.2	89.1	91.2	91.7	83.8	88.6	89.9
40	1800	91.7	91.0	92.6	93.0	71.6	80.6	84.2
	1200	91.7	93.0	93.3	93.0	80.9	86.4	88.0
	3600	90.2	88.7	90.8	91.7	82.5	90.8	92.0
50	1800	93.0	92.4	93.7	94.1	76.4	83.7	86.3
	1200	91.7	93.0	93.3	93.0	80.9	87.3	88.9
	3600	91.7	89.9	92.0	93.0	84.9	89.9	91.6
60	1800	93.0	93.2	94.0	94.1	76.3	84.0	86.8
	1200	91.7	92.5	93.1	93.0	75.8	82.9	85.5
	3600	93.0	91.0	93.1	94.1	82.6	88.7	90.9
75	1800	93.0	92.6	93.8	94.1	76.4	83.8	86.6
	1200	93.0	93.5	94.2	94.1	75.1	82.4	84.7
	3600	93.0	91.3	93.3	94.1	86.1	89.7	91.0
100	1800	94.1	93.8	94.8	95.0	83.8	87.6	89.0
	1200	93.0	93.1	93.9	94.1	72.5	80.0	83.2
	3600	93.0	91.2	93.1	94.1	83.0	88.3	89.0
125	1800	93.7	93.5	94.6	95.0	79.2	84.6	86.0
	1200	93.0	93.5	94.2	94.1	75.2	82.3	85.2
	3600	93.0	91.8	93.4	94.1	85.3	89.3	89.1
150	1800	94.1	93.7	94.7	95.0	81.6	86.4	86.6
	1200	94.1	94.1	94.9	95.0	77.2	84.4	85.7
	3600	94.1	92.7	94.3	95.0	83.3	87.5	88.5
200	1800	94.5	94.2	94.9	95.0	80.0	85.6	86.7
	1200	94.3	94.2	94.9	95.0	78.0	84.5	86.0
	3600	94.3	94.8	95.5	95.3	83.0	87.5	88.5
250	1800	94.3	96.0	96.0	95.8	79.5	85.6	83.0

END OF SECTION

SECTION 16270 - TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Types of transformers specified, and include the following:
   1. Dry-type transformers (lighting transformers).

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product Data: Submit manufacturer's technical product data, including rated kVA, frequency, primary and secondary voltages, percent taps, polarity, impedance and average temperature rise above 40 degrees C ambient temperature, sound level in decibels, and standard published data.
   2. Submit manufacturer's Drawings indicating dimensions and weight loadings for transformer installations.
   3. Wiring Diagrams: Submit wiring diagrams for power distribution transformers.

1.03 QUALITY ASSURANCE

A. Codes and Standards:
   1. NEMA Compliance: Comply with NEMA Standard Pub/Nos. ST 20, "Dry-Type Transformers for General Applications," TR 1, and TR 27.
   2. UL Compliance: Comply with applicable portions of ANSI/UL 506, "Safety Standard for Specialty Transformers. Provide power/distribution transformers and components which are UL listed and labeled.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Acme Electric Corporation.
   2. Cutler-Hammer.
   3. General Electric Company.
   4. Hevi-Duty Electric Div., General Signal Corp.
   5. Square D Company.

2.02 POWER/DISTRIBUTION TRANSFORMERS

A. Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.

B. Dry-Type Distribution Transformers (45 kVA or less): Provide factory assembled, general purpose, air cooled, dry-type distribution transformers where shown; of sizes, characteristics, and rated capacities indicated, single phase, 60 hertz, 10 kV BIL, 4.0 percent impedance, with 480 volts primary and 240/120 volts secondary; or K-rated 13 three-phase, 60 hertz, 10 kV BIL, 4.0 percent impedance with 480-volts delta connection primary and 208/120 volts secondary wye connected. Provide primary winding with 4 taps; 2 to 2-1/2 percent increments above and below full-rated voltage for de-energized tap-changing operation. Insulate with Class 150 or 220 degree C insulation and rate for continuous operation at kVA, and limit transformer temperature rise to maximum of 115 or 150 degrees C, respectively. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections and electrical supply raceway terminal connector. Equip terminal leads with connectors installed. Limit terminal compartment temperature to 75 degrees C when transformer is operating continuously at rated load with ambient temperature of 40 degrees C. Provide wiring connectors suitable for copper or aluminum wiring. Cushion-mount transformers with external vibration isolation supports; sound-level ratings not to exceed 45 db as determined in accordance with ANSI/NEMA standards. Electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap. Provide transformers with fully enclosed sheet steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure. Provide transformers suitable for wall mounting.

C. Finishes: Coat interior and exterior surfaces of transformer, including bolted joints, with manufacturer's standard color baked-on enamel.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16330 - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Distribution and power transformers with medium-voltage primaries. Types of transformers specified in this Section include:
   1. Dry type secondary substation.
   2. Pad-mounted type.
   3. Liquid filled secondary substation type.
   4. Pole-mounted transformers.
   5. Cast coil dry type.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Shop Drawings for each transformer, including dimensional plans, sections, and elevations showing minimum clearances, installed devices, and materials lists.
   2. Product data for each product specified.
   3. Wiring diagrams from manufacturer differentiating between manufacturer-installed and field-installed wiring.

B. Product Test Reports: Certified copies of manufacturer's design and factory tests as follows.
   1. Turns ratio.
   2. Polarity.
   3. Resistance.
   4. Impedance.
   5. Load losses.
   6. No load losses.
   7. Exciting current.
   8. Regulation at 80percent power factor.
   9. Impulse test (transformers larger than 750 kVA only).
   10. Corona test (transformers larger than 1500 kVA only).

C. Power company approval for all transformers interfacing with power company connections. Submit one copy of product data signed by power company.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. ASEA Brown Boveri.
   2. Cooper Power Systems.
   3. Hevi-Duty Electric.

4. ABB National.
5. Niagara Transformer Corp.
6. Square D Co.

2.02 TRANSFORMERS, GENERAL

A. Medium-Voltage Transformers: Factory assembled and tested, general-purpose, air-cooled, dry type or liquid filled as indicated, and having characteristics and capacities as indicated.

B. Windings: 2-winding type, designed for operation with high-voltage windings connected to the system, indicated on Drawings. Provide 4- or 5-legged cores for all wye-wye connected transformers.

C. Finishes: Thoroughly clean interior and exterior prior to coating enclosure and equipment, including bolted joints, with rust inhibiting primer coat. Provide 2 finish coats of manufacturer's standard color finish.

D. Forced Air-Cooled Transformers shall comply with the following requirements:
   1. Forced air cooling equipment shall consist of cooling fans, temperature sensing devices, and controls complete with housing, mounting devices, conduit, and wiring. Operation of cooling fans shall be automatically and sequentially controlled by temperature sensing devices. A manually operable switch shall be connected in parallel with automatic control contacts. Controls shall be enclosed in a cabinet located on the side of transformer 60 inches or less above base.
   2. Cooling Fans: Propeller type, with aluminum blades and TEFC motors, direct drive. Motor circuits shall be individually fused or thermally protected. Fans shall have OSHA fan guards.
   3. Fan Control: Thermally operated winding temperature control devices.

E. Provisions for Future Forced Air Cooling: Include the following provisions where future forced air cooling is required:
   1. Top-Liquid Temperature Sensing on Liquid-Filled Transformers: Thermally operated control device with thermal element mounted in a well, and provisions for mounting control cabinet, conduit, and fans.
   2. Winding Temperature Sensing on Dry-Type Transformers: Insulated wells in all 3 coils for future installation of sensors directly in air ducts of each coil to monitor coil temperature, and provisions for future mounting of cooling fans, control cabinet, and conduit.

F. Windings: Copper or aluminum.

G. Provide fully insulated neutral terminal for wye-connected windings.

H. Equip each transformer with a permanent stainless steel nameplate which includes serial number, shop order number, transformer class, number of phases, frequency, kVA rating, primary and secondary voltage, tap voltages, connection and vector diagrams, manufacturer's name, percent impedance, temperature rise, weight of core, coils and fittings, weight and volume of fill liquid (if applicable), and BIL of high and low voltage windings.

2.03 DRY-TYPE TRANSFORMERS

A. Comply with NEMA Standard ST 20, "Dry-Type Transformers for General Applications" and ANSI/IEEE Standard C.57.12.01, "General Requirements for Dry-Type Distribution and Power Transformers." Transformers shall have the following features and ratings:
   1. Enclosure: Indoor, ventilated.
   2. Enclosure: Outdoor, ventilated.
   3. Enclosure: Totally enclosed, nonventilated.
   4. Insulation Class: 220 degrees C.
   5. Insulation Temperature Rise: 80 degrees C maximum rise above 40 degrees C.
   6. Insulation Temperature Rise: 115 degrees C maximum rise above 40 degrees C.
   7. Insulation Temperature Rise: 150 degrees C maximum rise above 40 degrees C.
   8. Basic Impulse Insulation Level: 60 kV for 5.0 kV class.
   9. Basic Impulse Insulation Level: 75 kV for 8.7 kV class.
   10. Basic Impulse Insulation Level: 95 kV for 15.0 kV class.

B. Full Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated high voltage.

C. Impedance: 5.75 percent unless otherwise indicated.

D. Surge Arresters: Low flash-over type, factory installed and connected to high-voltage terminals, complying with NEMA Standard LA 1. Provide metal-oxide type with ethylene propylene housing.

E. Surge Arresters: Low voltage type, factory installed and connected to low-voltage terminals, complying with NEMA Standard LA 1. Provide metal-oxide type with ethylene propylene housing.

2.04 CAST COIL DRY-TYPE TRANSFORMERS

A. Comply with NEMA Standard ST 20, "Dry-Type Transformers for General Applications," and ANSI/IEEE Standard C.57.12.01, "General Requirements for Dry-Type Distribution and Power Transformers." Transformers shall have the following features and ratings:
   1. Enclosure: Outdoor, ventilated, weather resistant.
   2. Insulation Class: 155 degrees C.
      a. Core shall be constructed of miter-cut, high-grade, grain-oriented, non-aging silicon steel. Core leg cross section shall be of cruciform shape to conform to the inside geometry of a round coil. Core laminations shall be free of burrs and stacked without gaps. The core framing structure shall be rigid construction and so designed to provide full clamping pressure upon the core and to provide points for applying blocking and jacking to support the coils.

B. Construction: Both HV and LV windings shall be of copper or aluminum conductors. Primary and secondary windings shall be of the same material. HV and LV windings shall each be separately cast as one rigid tubular coil, and arranged coaxially. Each cast coil shall be fully reinforced with glass cloth, and cast under vacuum to ensure complete void-free resin impregnation throughout entire insulation system. Coils shall be supported by cast epoxy bottom supports and space blocks and spring-loaded top blocks to absorb thermal expansion and contraction of the coils. There shall be no rigid mechanical connection between HV and LV coils.
   1. The windings must not absorb moisture, and shall be suitable for both storage and operation in adverse environments, including prolonged storage in 100 percent humidity at temperatures

from -40 to +40 degrees C and shall be capable of immediately being switched on after such storage without pre-drying.

2. Core and coil shall be supported on resilient mounting that shall effectively dampen vibration to the transformer enclosure.

C. Bus and Termination: Terminations shall be of the manufacturer's standard and shall incorporate a functional design which provides appropriate current density and bolting surface capability. Aluminum conductor-to-copper-bus transition shall be by bolt-less connections using DuPont Detaclad (or equal) explosively bonded aluminum-copper plates, to which the aluminum conductor shall be welded, and the copper silver soldered.

1. Outdoor, weather-resistant, ventilated enclosure shall be provided. The base shall be of welded structural steel (11 gauge, minimum) to permit jacking, rolling, and skidding in any direction, and shall have 2 ground pads. Removable panels shall be provided for access to the tap connections, disassembly for moving and installation in limited space, and for inspection and maintenance. Front and rear panels shall be provided with top and bottom weather-resistant ventilation grills to provide adequate cooling and to prevent rain and snow from entering the enclosure.

D. Insulation Temperature Rise: 80 degrees C maximum rise above 40 degrees C.

E. Basic Impulse Insulation Level: 75 kV for 5.0 kV class.

F. Full Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated high voltage.

G. Impedance: 5.75 percent unless otherwise indicated.

H. Surge Arresters: Low flash-over type, factory installed and connected to high-voltage terminals, complying with NEMA Standard LA 1. Provide metal-oxide type with ethylene propylene housing.

2.05 PAD MOUNTED TRANSFORMERS

A. Comply with ANSI/IEEE C57.12.22 and with the following features and ratings:

B. Comply with ANSI/IEEE C57.12.26 and with the following features and ratings:

1. Insulating Liquid: Mineral oil, conforming to ASTM D 3487, "Specifications for Mineral Insulating Oil Used in Electrical Apparatus," Type II, tested in accordance with ASTM D 117, "Guide to Test Methods and Specifications for Electrical Insulating Oils of Petroleum Origin."
   a. Insulation Temperature Rise: 65 degrees C.
   b. Basic Impulse Insulation Level: 60 kV for 5.0 kV class.
   c. Basic Impulse Insulation Level: 75 kV for 8.7 kV class.
   d. Basic Impulse Insulation Level: 95 kV for 15.0 kV class.
2. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated high voltage, with externally operable tap changer for de-energized use, with position indicator.
3. High-Voltage Terminals: Arranged for radial feed, with 3-phase, 2-position, gang-operated load-break switch, oil immersed in transformer tank, with hook-stick-operated handle in the primary compartment.
4. High-Voltage Terminals: Arranged for loop feed with 3-phase, 4-position, gang-operated load-break switch, oil immersed in transformer tank, with hook-stick-operated handle in the primary compartment.

5. Primary Fuses: Current limiting type in dry-fuse holder wells, mechanically interlocked with oil switch to prevent disconnect under load.
6. Surge Arresters: Comply with NEMA Standard LA 1, Distribution Class, supported from tank wall within high-voltage compartment, one for each primary phase.
    a. Provide Ohio Brass Co. metal-oxide type surge-arresters with ethylene propylene housing. Provide a barrier around the arresters which complies with Power Company's requirements.
7. Separable Insulated Connectors: Insulated bushing, parking stand, feed-through bushing, and dead-front elbow-type lightning arrester for each high-voltage terminal. Provide 3 portable insulated bushings for parking-energized load-break connectors on parking stands.
8. Secondary Feeder Breaker: Molded case type, mounted in secondary compartment; frame, trip, and interrupting ratings as indicated; complying with UL Standard 489, "Molded Case Circuit Breakers and Circuit Breaker Enclosures."
9. Impedance: 5.75 percent unless otherwise indicated.
10. Accessories: Provide the following accessories:
    a. One-inch drain valve with sampling device.
    b. Dial-type thermometer.
    c. Liquid level gauge.
    d. Pressure-vacuum gauge.
    e. Pressure relief device, self-sealing with indicator.
    f. Mounting provision for low-voltage current transformers and potential transformers.
    g. Busway opening in low-voltage compartment.
    h. Alarm contacts for above gauges.
    i. Key interlock on HV compartment door.

2.06 LIQUID-FILLED SUBSTATION TRANSFORMERS

A. Conform to ANSI/IEEE Standard C57.12.00, "General Requirements For Liquid-Immersed, Distribution, Power, and Regulating Transformers," and C57.12.13, "Conformance Requirements for Liquid Filled Transformers Used in Unit Installation Including Unit Substations," and the following requirements:
    1. Insulating Liquid: Mineral oil conforming to ASTM D 3487, "Specifications for Mineral Insulating Oil Used in Electrical Apparatus," Type II, tested in accordance with ASTM D 117, "Guide to Test Methods and Specifications for Electrical Insulating Oils of Petroleum Origin."
    2. Insulating Liquid: Silicone insulating liquid, UL listed as a "Less Flammable" transformer insulating liquid. Liquid shall have the ability to extinguish small arcing and shall have a minimum fire point of 330 degrees C, a maximum convective heat release of 350 Btu per cubic foot when tested in accordance with ASTM standards, and a minimum dielectric strength of 35 kV.

B. Insulation Temperature Rise: 65 degrees C.
    1. Basic Impulse Insulation Level: 60 kV for 2.5 kV class.
    2. Basic Impulse Insulation Level: 75 kV for 5.0 kV class.
    3. Basic Impulse Insulation Level: 95 kV for 8.7 kV class.
    4. Basic Impulse Insulation Level: 110 kV for 15.0 kV class.

C. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated high-voltage, with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

D. Cooling System: ANSI/IEEE Standard C57.12.00, Class OA.

E. Cooling System: ANSI/IEEE Standard C57.12.00, Class OA/FA.

F. Cooling System: Equipped for future forced-air cooling; Class OA/FFA.

G. Impedance: 5.75 percent unless otherwise indicated.

H. Accessories: The following accessory items are required:
   1. Drain Valve: 1-inch drain valve with sampling device.
   2. Dial-type thermometer.
   3. Magnetic liquid level gauge.
   4. Pressure-vacuum gauge.
   5. Pressure relief device: Self-sealing, with indicator.
   6. Upper filter pressure connection.
   7. Alarm contacts for above gauges.
   8. Grounding and bonding components complying with UL Standard 467, "Grounding and Bonding Equipment."
   9. Vacuum-Pressure Bleeder: Outdoor units only.

2.07 POLE-MOUNTED TRANSFORMERS

A. Comply with applicable NEMA, ANSI, and REA standards.

B. Insulating Liquid: Mineral oil, conforming to ASTM D 3487, "Specifications for Mineral Insulating Oil Used in Electrical Apparatus."

C. Insulating Temperature Rise: 65 degrees C.
   1. Basic Impulse Insulation Level: 60 kV for 2.5 kV class.
   2. Basic Impulse Insulation Level: 75 kV for 5.0 kV class.
   3. Basic Impulse Insulation Level: 95 kV for 8.7 kV class.

D. Full Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated high voltage with tap changer accessible from top through a handhole cover.

E. High-Voltage Terminals. Cover mounted high voltage porcelain bushings with tin-plated eyebolt terminal, keyed to prevent turning.

F. Low-Voltage Terminals: Porcelain bushings with tin-plated eyebolt terminal, keyed to prevent turning.

G. Impedance: As indicated.

H. Accessories: Provide the following accessories:
   1. ANSI support lugs (hanger brackets).
   2. Lifting lugs.
   3. Oil: Fill plug with cover ground strap.
   4. Tank ground pad.

PART 3 - EXECUTION

3.01 ADJUSTING

A. Adjust transformer taps to provide optimum voltage conditions at utilization equipment.

END OF SECTION

SECTION 16334 - MEDIUM VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Medium voltage switchgear and associated auxiliary equipment, and includes the following:

1. Metal-enclosed interrupter switchgear.
2. Fuses.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product data for each product specified.
   2. Shop Drawings for each switchgear lineup and accessory component. Include dimensional plans, sections, connection details, and elevations showing minimum clearances, installed devices, major features, and materials lists.
   3. Wiring Diagrams, both elementary and schematic, differentiating between manufacturer installed and field-installed wiring.
   4. Time-Current curves for power fuses.
   5. Protective relay settings for protective relays.

B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section.

C. Power company approval for switchgear interfacing with power company connections: Submit one copy of product data signed by power company.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Metal Enclosed Interrupter Switchgear:
      a. Eaton

2.02 MEDIUM VOLTAGE SWITCHGEAR, GENERAL REQUIREMENTS

A. Factory assembled, factory tested, with functions and circuit assignments for each bay, and types, characteristics, and ratings of busses and disconnecting, and protective devices as indicated. Switchgear shall conform to NEMA Standard SG5, "Power Switchgear Assemblies," and entire switchgear lineup shall be engineered, fabricated, and tested by nameplated manufacturer of major electrical components.

1. Circuit breaker type switchgear shall comply with ANSI/IEEE Standard C37.20.2, "Standard for Metal-Clad and Station-Type Cubicle Switchgear."
2. Metal enclosed interrupter-type switchgear shall comply with ANSI/IEEE Standard C37.20.3, "Standard for Metal-Enclosed Interrupter Switchgear."

B. System Type: Suitable for application on system indicated on Drawings.

C. Switchgear Ratings: As follows:
1. Nominal System Voltage: 4.16 kV; maximum design voltage: 4.76 kV.
2. Main Bus Continuous: As indicated on Drawings.
3. Nominal Interrupting Capacity Class: 350 MVA at 4.76 kV.
4. BIL Voltage: 60 kV at 4.16 kV class.
5. 60 Hertz Withstand Voltage: 19 kV (5 kV class switchgear).
6. Momentary Current Rating: 61,000 amperes, rms asymmetrical.
7. Short-Time Current Rating: 38,000 amperes, rms symmetrical.

D. Finishes: Thoroughly clean interior and exterior prior to coating the enclosure and equipment, including bolted joints, with rust inhibiting primer coat. Provide 2 finish coats of manufacturer's standard color finish.

E. Ground Bus: Copper; silver-plated at connection points extending the entire length of the switchgear.

F. Main Bus: Tin-plated aluminum.

G. Main Bus Supports: Porcelain or flame-retardant, track-resistant insulation.

H. Electric space heater in each compartment of outdoor equipment powered from a separate control power transformer supplied with switchgear.

I. Low Voltage Wiring: No. 14 AWG minimum, Type SIS, 600 volt, 90 degrees C labeled at each terminal point with designations keyed to wiring diagrams.

J. Utility Metering Unit: Constructed to suit Power Company requirements and to match and line up with basic switchgear assembly.

K. Bus transition and incoming line units: As indicated or required.

L. Load-Interrupter Switch Unit: With fuses equipped to house stationary device rated and arranged as indicated.

M. Access to Rear Interior of Switchgear: Through hinged doors secured by captive thumb screws.

N. Auxiliary Unit: Arranged to house meters, relays, controls, and auxiliary equipment as indicated.

O. Key Interlocks: Where indicated, arranged so interlocking keys are held captive at devices indicated. Where provision for future key interlocking is indicated, provide all necessary mountings and hardware as required for future installation of key interlocking devices.

P. Instrument Transformers: Conforming to NEMA Standard EI 21.1, "Instrument Transformers for Revenue Metering 110 kV BIL and Less," ANSI Standard C57.13, "Requirements for Instrument Transformers," and the following:
   1. Potential Transformer Secondary Voltage Rating: 120 volt with NEMA Accuracy Class of 0.3 with burdens of W, X, and Y. Provide primary and secondary fusing.
   2. Current Transformers Ratios: As indicated with accuracy class suitable for connected relays, meters, and instruments. Provide 0.3 accuracy class for B-0.1, B-0.2, and B-0.3 burdens.

Q. Microprocessor Based Bus Power Monitoring Device: Where indicated on Drawings, provide a device having the features and functions specified below. The device shall consist of a single microprocessor-based unit capable of monitoring and displaying the functions listed below with the accuracy indicated. The device shall provide the adjustable protection functions indicated, and the capability to communicate data via twisted pair network. The device shall be UL listed and also meet ANSI Standard C37.90.1 for surge withstand.
   1. Metered Values (Accuracy Percent Full Scale):
      a. AC Phase Amperes plus or minus (0.3 percent).
      b. AC Phase Voltage plus or minus (0.3 percent).
      c. Watts plus or minus (0.6 percent).
      d. VA plus or minus (0.6 percent).
      e. VARS plus or minus (0.6 percent).
      f. Power Factor (plus or minus 1 digit).
      g. Frequency plus or minus (0.1 hertz).
      h. Watt hours plus or minus (0.6 percent).
      i. VAR hours plus or minus (0.6 percent).
      j. VA-hours plus or minus (0.6 percent).
      k. Watt Demand with 10-, 15-, 20-, 25-, 30-, 45-, 60-minute interval).
      l. Percent THD (through 31st harmonic).
      m. Voltage -- minimum/maximum.
      n. Current -- minimum/maximum.
      o. Power -- minimum/maximum.
      p. Power Factor -- minimum/maximum.
      q. Frequency -- minimum/maximum.
      r. Peak percent THD.
      s. Peak Demand.
   2. Alarm Functions:
      a. Voltage Phase Loss.
      b. Current Phase Loss.
      c. Phase Voltage Unbalance (5 to 40 percent).
      d. Phase Voltage Reversal.
      e. Overvoltage (105 to 140 percent).
      f. Undervoltage (95 to 60 percent).
      g. Time Delay for Overvoltage (0 to 20 seconds).
      h. Time Delay for Undervoltage (0 to 20 seconds).
      i. Time Delay for Phase Unbalance (0 to 20 seconds).
   3. Outputs shall have separate Form C (NO/NC) trip and alarm contacts with ratings of 10 amperes at 115/240-volt AC.

4. Input ranges of the device shall accommodate external current transformers with ranges from 5/5 through 5,000/5 amperes. Provide external current transformers with rating as indicated on Drawings or sized for incoming service. Above 600 volts, provide fused external potential transformers.
5. Control power shall be capable of being supplied from the monitored incoming AC line without the need for a separate AC supply control circuit or separate remote power source (96 to 264 volt AC or 100 to 350 volt DC) where shown on Drawings.

R. Relays: Comply with ANSI/IEEE Standard C37.90, "Relays and Relay Systems Associated with Electric Power Apparatus." Types and settings with test blocks and plugs, as indicated.

S. Surge Arresters: Comply with NEMA Standard LA 1, "Surge Arresters." Arresters shall be distribution class with ratings as indicated, metal-oxide type, and ethylene propylene housing. Install in cable termination compartments and connect in each phase of circuit.

2.03 LOAD INTERRUPTER SWITCHES

A. Stationary mounted in switchgear and including the following features:
1. Arrangement and Rating: Gang operated, rated 600 amperes for continuous duty and for load break. Suitable for operation up to the maximum short circuit rating of integrated switchgear assembly.
2. Arrangement and Rating: Gang operated, rated 1,200 amperes for continuous duty and for load break. Suitable for operation up to maximum short-circuit rating of integrated switchgear assembly.
3. Switch Action: No external arc. Interrupting action shall not liberate significant quantities of ionized gas into enclosure.
4. Switch Construction: Switchblade material shall be copper. Switch and parts including electrical and mechanical connections shall be supported entirely from the interior framework of structure. Switch shall have external manual operating handle with lock-open padlocking provisions for multiple padlocks.
5. Operating Mechanism: Quick-make, quick-break, stored energy type.
6. Barriers: Phase barriers for the full length of the blades and fuses for each pole. If a protective barrier is used, it shall be designed for easy removal. The barrier material shall allow visual inspection of the switch with the barrier in place.
7. Protective shield to cover potentially live parts and terminals.
8. Fuses: De-energized when switch is open.
9. Mechanical interlock shall prevent opening door unless the switchblades are open and closing switch if door is open. Interlocks shall be provided to prevent closing of a breaker between operating and test positions, to trip breakers upon insertion or removal from housing, and to discharge stored energy mechanisms upon insertion or removal from the housing. The breaker shall be secured positively in the housing between and including the operating and test positions.
10. Window: For viewing switchblade positions.
11. Power Fuses: Current ratings as indicated. Each fuse shall have an indicator to show it has blown. Fuses shall meet applicable requirements of NEMA Standard SG 2, "High Voltage Fuses," and the following:
    a. Fuses shall be positively held in position with provision for easy removal and replacement from the front without the use of special tools.
    b. Spares: Each fusible bay shall include 3 fuses in use and 3 spare fuses in storage clips.

12. Current Limiting Fuses: Of full range, fast replaceable, current limiting type that will operate without explosive noise or expulsion of gas, vapor, or foreign matter from the tube.
13. Expulsion Fuses: Furnished in disconnect type mountings and renewable with replacement fuse units. Gases emitted on interruption shall be controlled and silenced by chambers designed for that purpose.
14. Interrupting rating of fuses at rated system voltage shall be compatible with switchgear being used and source short circuit current capability.
15. Refer to electrical one-line diagrams for additional requirements to be provided with each switch.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Anchoring: Anchor each switchgear assembly to two 4-inch minimum channel iron sills by tack welding or bolting.

B. Sills shall suit the switchgear and shall be leveled and grouted flush into floor.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchgear units and components.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Arrange and pay for services of a factory-authorized service representative to supervise field assembly and connection of components and testing and adjustment of switchgear components.

B. Testing: Upon completing installation of system, perform the following tests:
1. Make insulation resistance tests of switchgear buses, components, and connecting supply, feeder, and control circuits.
2. Make continuity test of circuits.
3. Perform test procedures required by the manufacturer's installation and testing instructions.
4. Perform mechanical and electrical operator tests. Check main and auxiliary contact alignment.
5. Check arc interrupter operation on load interrupter switches.
6. Verify key interlock operation.
7. Test insulation resistance on each phase to ground and from each phase to each other phase.
8. Test AC over-potential in accordance with applicable ANSI/IEEE standards.
9. Test contact resistance across each main contact set. Report contact resistance in excess of manufacturer's tolerances.
10. Test arc chutes for losses in accordance with manufacturer's instructions.

C. Retesting: Correct deficiencies identified by tests and completely retest switchgear. Verify by the system test that the total system meets the specified requirements.

D. A training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, and other major components.

END OF SECTION

SECTION 16410 - CIRCUIT AND MOTOR DISCONNECTS

PART 1 - GENERAL

1.01 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product data for each type of product specified.

B. Operation and Maintenance Manuals: Submit in accordance with requirements of Sections 01600 and 13410, operation and maintenance manuals for items included under this Section, including circuits and motor disconnects.

1.02 QUALITY ASSURANCE

A. Codes and Standards:
   1. Electrical Component Standards: Provide components which are listed and labeled by UL. Comply with UL Standard 98 and NEMA Standard KS 1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Allen-Bradley.
   2. Square D Company.
   3. Eaton

2.02 CIRCUIT AND MOTOR DISCONNECT SWITCHES

A. Provide NEMA 4, 4X, 7, 9, or 12 enclosure to match the rating of the area in which switch is installed. For motor and motor starter disconnects through 100 horsepower, provide units with horsepower ratings suitable to loads. For motor and motor starter disconnects above 100 horsepower, clearly label switch, "DO NOT OPEN UNDER LOAD."

B. Fusible Switches: (Heavy-duty) switches, with fuses of classes and current ratings indicated. See Section "Fuses" for specifications. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses.

C. Circuit Breaker Switches: Where individual circuit breakers are required, provide factory-assembled, molded-case circuit breakers with permanent instantaneous magnetic and thermal trips in each pole, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make, quick-break action and positive handle indication. Provide push-to-trip feature for testing and exercising circuit breaker trip mechanism. Construct breakers for mounting and operating in any physical position and in an ambient

temperature of 40 degrees C. Provide with AL/CU-rated mechanical screw type removable connector lugs.

D. Non-fusible Disconnects: (Heavy-duty) switches of classes and current ratings as indicated.

E. Double-Throw Switches: (Heavy-duty) switches of classes and current ratings as indicated.

F. Bolted Pressure Switches: Bolted pressure switches conforming to and listed under UL Standard 977, single- or double-throw arrangement as indicated. For fusible units, provide fuses as indicated.

G. Service Switches: (Heavy-duty) fusible/circuit breaker switches. UL listed for use as service equipment under UL Standard 98 or 869.

H. Switches for Classified (Hazardous) Locations: Heavy-duty switches with UL labels and listings for hazardous location classifications in which installed.

2.03 ACCESSORIES

A. Special Enclosure Material: Provide special enclosure material as follows for switches indicated:
   1. Stainless Steel for NEMA 12 and NEMA 4 switches.
   2. Molded fiberglass-reinforced plastic for NEMA 4X switches.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16420 - MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Types of motor controllers, including:

1. Combination controllers.
2. Solid-state reduced voltage controllers.
3. Fractional HP manual controllers.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Shop Drawings: Submit Shop Drawings of motor controllers showing dimensions and sizes.
   2. Product Data: Submit manufacturer's data and installation instructions on motor controllers.
   3. Wiring Diagrams: Submit power and control wiring diagrams for motor controllers

1.03 QUALITY ASSURANCE

A. Codes and Standards:
   1. UL Compliance: Comply with applicable requirements of UL 486A and B, and UL 508, pertaining to installation of motor controllers. Provide controllers and components which are UL listed and labeled.
   2. NEMA Compliance: Comply with applicable requirements of NEMA Standards ICS 2, "Industrial Control Devices, Controllers and Assemblies," and Pub No. 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," pertaining to motor controllers and enclosures.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include (no or equal):
   1. Allen-Bradley Co.
   2. Square D Company.
   3. Eaton

2.02 MOTOR CONTROLLERS

A. Except as otherwise indicated, provide motor controllers and ancillary components which comply with manufacturer's standard materials, design, and construction in accordance with published product information and as required for a complete installation.

B. Combination Controllers: Consist of controller and circuit breaker or fusible disconnect switch mounted in common enclosure of types, sizes, ratings, and NEMA sizes indicated. Equip starters with block-type manual reset overload relays. Provide control and pilot devices indicated. Provide 90 degree C SIS or MTW, No. 14 AWG control wiring, tagged at each termination. Provide operating handle for disconnect switch mechanism with indication and control of switch position, with enclosure door either opened or closed, and capable of being locked in OFF position with 3 padlocks. Construct and mount controllers and disconnect switches in single NEMA-type enclosure suitable for the location in which it is installed; coat with manufacturer's standard color finish.
   1. The 3-phase starter may be the following types:
      a. Full Voltage Non-reversing (FVNR): One 3-pole magnetic contactor with a set of 3 overload devices.
      b. Full Voltage Reversing (FVR): Two 3-pole magnetic contactors with a common set of 3 overload devices.
      c. Two-speed (for two winding motor): Two, 3-pole magnetic contactors, each with its own set of 3 overload devices.
      d. Two-speed (for single winding motor): Two magnetic contactors, a 5-pole for high speed, and a 3-pole for low speed, each with its own set of 3 overload devices.
      e. Reduced Voltage (for wye-connected part winding motors): Two 3-pole magnetic contactors, each with its own set of 3 overload devices and a timer for closing of the running contactor. Running contactor shall be sized for motor full load current, and starting (half-winding) contactor shall be sized for at least 75 percent of the full load current and shall be capable of interrupting at least 10 times full load current.
      f. Reduced Voltage (closed transition autotransformer type): Three magnetic contactors, two 2-pole and one 3-pole with a common set of 3 overloads, a timing relay and an autotransformer with taps at 50, 65, 80, and 100 percent, and an integral temperature switch or timing relay to protect transformer windings.

C. Solid-State Reduced Voltage Controllers: Provide 3-phase, solid-state, reduced voltage motor controllers of sizes and ratings indicated.
   1. The controller shall be microprocessor-based and shall provide as a minimum the following modes of operation.
      a. Soft start with selectable kick-start.
      b. Soft stop.
      c. Current limit.
      d. Full voltage.
   2. The controller shall be self-calibrating and shall automatically adjust itself for line voltage, frequency and current fluctuations. It shall have adjustable starting acceleration and stopping deceleration. Provide transient protection for all controllers furnished.

D. Control and Pilot Devices: Provide an individually fused control power transformer in each starter unit. Provide 2 fuses in the transformer primary circuit and 1 in transformer secondary circuit. Size transformers such that they can supply 100VA in excess of the unit requirements or provide 150VA rated transformer, whichever is greater. Provide 300 volt rated, oiltight type pilot lights, push buttons with extended guard and black color insert. Equip stop push buttons with half guard and red color insert. Provide 120/6 volt transformer type push-to-test pilot lights with lens color indicated. Provide machine tool type relays, each with 1 spare N.O. contact. Provide 6-digit elapsed time indicators with one-tenth hour increments. When timers are required, they shall be synchronous type.

E. Fractional HP Manual Controllers: Provide 3-phase and single-phase fractional horsepower manual motor controllers, of sizes and ratings indicated. Equip with manually operated quick-make, quick-break toggle mechanisms, and with one-piece melting alloy type thermal units. Controller shall become inoperative when thermal unit is removed. Provide controllers with double-break silver alloy contacts, visible from both sides of controller, and switch capable of being padlocked-OFF. Enclose controller unit in NEMA-type enclosure suitable for the location in which it is installed; coat with manufacturer's standard color finish.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16421 - MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product Data: Submit manufacturer's technical product data on NEMA Class 2, Type B motor control centers (MCCs).
   2. Submit layout Drawings of MCCs showing accurately scaled basic equipment sections including, but not limited to, motor starters, controllers, device panels, and circuit breakers. Show spatial relationships of MCC components to proximate electrical equipment. Clearly differentiate on wiring diagrams those conductors which are factory installed and those which are field installed.
   3. Fuse and Overload Sizes: Submit a compiled list of motors, fuse sizes, overload sizes, and types for motors actually installed.

B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section. Include data and parts list for each MCC and troubleshooting maintenance guide.

1.02 QUALITY ASSURANCE

A. Codes and Standards:
   1. NEMA Compliance: Comply with NEMA Standards Pub/No. ICS-2, pertaining to construction, testing, and installation of MCCs, and with applicable NEMA standards for circuit breakers and fuses.
   2. UL Compliance: Comply with applicable requirements of UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," and UL Standard 845, "Electric Motor Control Centers." Provide MCCs and ancillary equipment which are UL listed and labeled.
   3. IEEE Compliance: Comply with applicable requirements of IEEE Standard 241 pertaining to construction and installation of MCCs.
   4. ANSI Compliance: Comply with applicable requirements of ANSI as applicable to MCCs.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include (no or equal):
   1. Allen-Bradley Co.

2.02 MOTOR CONTROL CENTERS AND COMPONENTS

A. Provide MCCs and ancillary components of sizes, ratings, classes, types, and characteristics indicated, which comply with manufacturer's standard design, materials, components, and

construction in accordance with published product information and as required for complete installation and as specified herein.

B. MCCs: For operation on power source rating indicated, consisting of one or more vertical sections, each with groupings of control units containing motor starters, thermal overload units, disconnects, and including such other electrical equipment as controls, control transformers, metering panels, current transformers, and auxiliary devices as indicated. Provide MCC with NEMA Class 2, Type B wiring, wire units using 90°C SIS or MTW stranded copper wire; No. 14 AWG minimum. Tag all wires at each termination.

C. MCC Supporting Structures: Factory assembled, dead-front, MCC standard supporting structures with enclosed vertical sections, fastened together to form rigid freestanding assembly. Construct each section 90 inches high with 9-inch horizontal wireways at top and bottom, 20 inches wide, and with 20-inch section depth for front-of-board unit arrangement. Provide NEMA Type 1A enclosure. Provide gasketing on all enclosing sheet steel, wireways, and unit doors. Construct units with 4-5/8-inch wide, 8-inch deep, 90-inch high vertical wireway in each vertical structure on right side of unit, accessible through hinged doors, and with supports at proper intervals within for fastening wires/cables. Form supporting members of not less than 13 gauge hot-rolled steel. Construct structure doors with removable pin hinges and secure with quarter-turn indicating type fasteners. Provide front-accessible main lug compartment for connection of incoming cables in top or bottom as indicated. Provide removable lifting angle full length of MCC. Design lifting angle to support entire weight of MCC section. Design bottom channels to be removable; provide holes for bolting MCC units to floor.
   1. Provide shipping splits in MCC lineup to allow for shipment of maximum 60-inch-long units. Design MCCs so matching vertical sections of same current rating and manufacturer can be added later at either end of lineup without use of transition sections. Provide removable end and top plates to close off openings.

D. Bus System: Tin-plated aluminum or copper, braced to withstand faults of 65,000 rms symmetrical amperes minimum unless indicated otherwise. Provide main horizontal bus with rating shown, and vertical bus rating of 300 amperes minimum; and construct vertical bus bars with protective barriers to prevent accidental contact of personnel with bus. Vertical bus shall be full length.
   1. Provide 0.25-inch by 1-inch minimum copper ground bus running full width of MCC at bottom of lineup. Drill ground bus and furnish 1 lug per starter unit, minimum.

E. Starter Units: Draw-out type, magnetic motor starters with fusible switch or motor circuit protector type disconnects, auxiliary control devices, and NEMA size as indicated. Construct each starter unit with doors, unit support pans, saddles, and disconnect operators; enclose and isolate each unit from adjacent units. Design units so that faults will be contained within compartments. Equip with thermal and magnetic overload protection device for each motor circuit, unit-mounted pilot devices, timers, selector switches, indicating lights, and control relays. Provide 1 spare normally open auxiliary contact. Provide draw-out units with de-energized position where unit is still supported by structure, but no electrical connection is made. Provide method of locking unit in de-energized position. Design plug-in units of same NEMA size and branch feeder units of same trip rating, to be interchangeable with each other.
   1. Three-phase starter may be following types:
      a. Full Voltage Nonreversing (FVNR): One 3-pole magnetic contactor with a set of 3 overload devices.
      b. Full Voltage Reversing (FVR): Two 3-pole magnetic contactors with a common set of 3 overload devices.

F. Unit Plug-On: Provide plug-on connections for each electrical power phase. Design contact fingers to be floating and self-aligning; silver plate contacts for obtaining low-resistance connections.

G. Disconnect Operators: Provide external operator handles for switches and circuit breakers. Design handle with up-down motion and with down position indicating OFF. Construct handles which permit locking handle in OFF position with 3 padlocks.

H. Unit Doors: Securely mounted with rugged concealed-type hinges which allow doors to swing open minimum of 115 degrees for ease of unit maintenance and withdrawal. Fasten doors to structure so that they remain in place when unit is withdrawn.
   1. Closed door must cover unit space when unit has been temporarily removed. Provide interlock for each unit door with associated disconnect mechanism to prevent door from opening when unit is energized.

I. Control and Pilot Devices: Provide an individually fused control power transformer in each starter unit. Provide 2 fuses in transformer primary circuit and 1 in transformer secondary circuit. Size transformers such that they can supply 100VA in excess of unit requirements or provide 150VA rated transformer, whichever is greater.
   1. Provide synchronous type timers unless otherwise noted.
   2. Provide 300 volt-rated, oil-tight type pilot lights, push buttons, and selector switches. Equip Start push button with extended guard and black color insert. Equip Stop push buttons with half guard and red color insert.
   3. Provide 120/6 volt transformer type push button to test pilot lights with lens color indicated.
   4. Provide machine tool type relays, each with 1 spare N.O. contact.
   5. Provide 6-digit elapsed time indicators with 1/10 hour increments.

J. Fusible Switch: Quick-make quick-break, gang-operated switches with positive pressure fuse clips suitable for use with class of fuses required. Provide switches with continuous current rating indicated and with a 100,000 ampere interrupting capability at rated voltage.

K. Motor Circuit Protector: Adjustable trip magnetic-only instantaneous molded-case circuit breakers for use in starter units. Provide a continuous current rating of at least 125 percent of the motor full load current and an interrupting capacity of 65,000 amps symmetrical. Provide a field adjustable instantaneous trip unit capable of being adjusted from 7 to 13 times motor full load current.

L. Circuit Breakers: Factory assembled, molded-case circuit breakers with permanent instantaneous magnetic and thermal trips in each pole and with fault-current limiting protection; ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make quick-break action and positive handle indication. Provide push-to-trip feature for testing and exercising circuit breaker trip mechanism. Construct breakers for mounting and operating in any physical position and in an ambient temperature of 40 degrees. Provide with AL/CU rated mechanical screw type removable connector lugs.

M. Finishes: Thoroughly clean interior and exterior prior to coating of MCC, including bolted joints, with rust-inhibiting prime coat. Provide 2 finish coats of manufacturer's standard color baked-on enamel finish.

N. New motor control centers shall be supplied as smart motor control centers. These shall be supplied to match the existing motor control centers previously supplied by Allen-Bradley with Ethernet

versus Devicenet for the communication medium. Motor control centers shall be supplied pre-wired with Ethernet connectivity and shall be factory programmed by Rockwell. Supply each motor control center with a Control Logix processor, IO racks, cards, switches, power supplies, Panelview plus series 7 1500, cabling and programming as required. Include two ethernet bridge cards, one for IO network and one for connection to LAN network/existing plant SCADA system. Refer to one-line diagrams and notes on contract drawings for additional requirements and work to be provided as part of this specification section and contract drawings. Each motor control center to include a Rockwell PM-5000 power meter. Meter to include waveform capture and analytics. Turn over copies of PLC and Panelview applications to Owner/Tetra Tech for integration into plant wide SCADA system by Tetra Tech. Include fiber patch panel, patch and copper and fiber patch cables. Include multimode fiber SFP and Stratix switch for connection to plant SCADA network as shown on contract drawings.

O. For existing motor control center MCC 7D, obtain the services or Rockwell to furnish install and program on Devicenet a new molded case circuit breaker including new door and handle and nametag. Match existing ratings, construction features and programming. Furnish hardware as required to connect to the existing Devicenet network within existing motor control center MCC 7D.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16422 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Types of motor controllers, including:
   1. Variable Frequency Drives

1.02 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings (seven copies) covering the items included under this Section. Shop Drawing submittals shall include:
   1. Shop Drawings: Submit Shop Drawings of motor controllers showing wiring diagrams, dimensions and sizes.
   2. Product Data: Submit manufacturer's data and installation instructions on motor controllers.
   3. Wiring Diagrams: Submit power and control wiring diagrams for motor controllers
   4. Submit operation and maintenance manuals for the drives. Submit electronic copies on CD, as well as three hard cover copies.

1.03 QUALITY ASSURANCE

A. Codes and Standards:
   1. UL Compliance: Comply with applicable requirements of UL 486A and B, and UL 508, pertaining to installation of motor controllers. Provide controllers and components which are UL listed and labeled.
   2. NEMA Compliance: Comply with applicable requirements of NEMA Standards ICS 2, "Industrial Control Devices, Controllers and Assemblies," and Pub No. 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," pertaining to motor controllers and enclosures.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturer offering products shall be (no or equal):
   1. Allen-Bradley Co.(Power Flex 753 Series)
   2. Square D Altivar Process 630/660 Series

2.02 MOTOR CONTROLLERS

A. Variable Frequency Drives: This system shall comprise a motor and a variable frequency drive and
   1. Motor: as coordinated with the pump manufacturer.
   2. Variable Frequency Drive: The variable frequency drive unit shall convert 480 volt plus 10 percent, minus 5 percent; 3-phase; 60 hertz plus or minus 2 hertz, input power into an adjustable frequency output. Output power shall be of suitable capacity and wave form to provide stepless speed control of the specified AC motor throughout a continuous speed range of 10:1 under variable torque load not exceeding 1.25 times the motor's full load rating in an ambient of 0-40 degrees C with up to 95 percent humidity. The drive continuous run amperes

rating shall be 1.25 times the full load ampere of the load or as shown on the electrical one-line drawings whichever is greater. The drive shall be able to withstand external short circuits without fuse blowing or device failure. The drive shall comply with the latest requirements of IEEE519 2014.

3.

a. Drives of the pulse-width-modulation type shall have current limit protection for the drive and load of 110 percent of motor nameplate rating for variable torque loads for a minimum of 1 minute before automatically disconnecting the drive.
b. Provide instantaneous static overvoltage and overcurrent protection. Provide undervoltage trip upon input power loss or phase loss without component failure and automatic restart upon return of full power and command. The drive shall not be damaged by application of incorrect phase sequence.
c. Provide input circuit breaker interlocked with the door.
d. Provide input, output, and bypass contactors (Nema rated) where shown on contract drawings.
e. Provide three spare fuses of each type used.
f. Provide 3-phase thermal overloads at the output to the motor.
g. Provide line voltage transient suppression and immunity to local ambient electrical noise. The drive shall not create radiated or conducted RFI which disturbs the function of adjacent equipment. Units shall be furnished as six pulse drives with input and output filtering to comply with above requirements. Furnish 5% input line reactor or Matrix AP input filter as shown on drawings and DV/DT output filters on drive output for each drive.
h. Provide drive fault detection circuit with contacts for remote alarm used by others. The drive shall shut down on any type of failure. Cause of drive shutdown shall be displayed on operator interface.
i. Provide isolation of signal circuits from the power circuits. The drive shall have self-protection from regenerative power on rapid decrease of speed signals.
j. Provide a forced air ventilation system to remove heat from the drive enclosure. Power for the ventilation system shall be provided from the drive circuits. The fans shall be completely serviceable without having to dis-assemble the drive and shall be interlocked with the drive run status.
k. Where shown on the wiring diagrams, the drive shall accept a speed control signal from either an isolated or non-isolated 4-20 mA source while in the automatic speed control mode and from a door-mounted speed potentiometer when the manual mode is selected. In addition, provide a door-mounted operator interface panel that allows remote/local mode selection and manual speed control. Furnish selector switches and pilot lights for the control shown on the wiring diagrams. Devices to me mounted on face of drive door, controls section.
l. The drive shall output an isolated 4-20 mA speed signal for remote speed indication.
m. The drive shall accept a remote start/stop contact closure while in the Auto mode and from operator interface when the Local mode is selected. Refer to the wiring diagrams for additional control requirements.
n. The drive shall have an alphanumeric operator interface display capable of displaying amps, voltage, kW, rpm, frequency, and elapsed running time.
o. Provide a delay to restart the motor after the motor is running. The delay to restart shall be adjustable from 3 to 60 seconds. Minimum delays greater than 5 seconds will not be accepted.
p. The 4-20 mA input signal shall control the motor speed between 10 percent of full speed and full speed. The 20 mA signal being full speed and 4 mA being minimum speed. The 4-20 mA input signal shall control the motor speed between the adjustable minimum and

maximum speed settings. The minimum speed shall be field adjustable from 10-70 percent of rated speed. The maximum speed shall be field adjustable from 70-100 percent of rated speed. The minimum and maximum speed settings shall override the 4-20 mA signal at their respective settings. The speed signal shall follow a linear time ramp, adjustable from 4 to 20 seconds. Provide separate acceleration and deceleration control. The motor speed shall follow the input signal, in the steady state, with a plus or minus 2 percent linearity.

q. The drive shall be of modular construction for ease of maintenance.
r. The drive shall be capable of communicating monitoring and diagnostic functions.
s. Coordinate with the pump supplier for the installation and wiring associated with the seal leak/motor temperature sensor. Refer to the wiring diagrams for additional information.
    1) Provide, for remote use by others, two normally open contacts rated 3amps at 120-volt AC which close when the controller is running, or faults.
t. In pump applications and where shown on Drawings, the variable frequency drives shall contain the necessary circuitry to energize a 120-volt AC pump seal water solenoid valve when the pump is running. The rating of this circuit shall be sufficient to control a solenoid valve with an inrush of 360 VA and a holding VA of 120.
u. The drives shall be assembled, and built by the manufacturer. Drives assembled by the Contractor do not comply with this specification.
v. The entire drive electronics/circuit boards shall be conformal coated.
w. Drives shall be provided with input surge protection and fast acting electronic fuses.
x. Three spare fans shall be provided.
y. The drive shall be supplied within a free standing NEMA 12 enclosure or as shown on contract drawings. Drives shall be constructed such that they can be located back to back. Service of equipment including fans and ventilation filters shall be from the front, of the enclosure. No maintenance of parts shall be required from the drive rear. Cable entry for incoming power and pump wiring shall be from the bottom or top of the enclosure as coordinated with the Contractor.
z. The door mounted keypad shall also serve to maintain/store the drive configuration.
aa. Selector switches, contactors, relays, pilot lights, etc., shall be NEMA rated.
bb. The drive including the VFD, contactors, relays, switches, drive enclosure shall be supplied as a complete system by the VFD manufacturer Rockwell or Schneider Electric.
cc. Provide ethernet connectivity including switch, power supply, fiber media converter, patch panel, and associated copper and fiber patch cables where shown on contract drawings.
dd. Refer to electrical drawings for additional requirements for variable frequency drives.

4. All wires are to be identified, and the identifying mark shown on the schematics and wiring diagram. Documentation of schematics, wiring diagrams, terminal strips, and operating and maintenance manuals shall be supplied at Shop Drawing time and delivered with the equipment.
5. The drive manufacturer shall provide a field start-up and calibration service on-Site for five eight-hour days for the drives. The manufacturer shall configure the drive parameters based on the inputs shown and motor information as supplied by the Contractor/pump manufacturer. The manufacturer's personnel shall have a stable 4-20 mA source, and a plus or minus 0.5 percent accurate 3-1/2-digit, digital milliamp meter to be used in the calibration procedure.
6. The system calibration shall be checked at 100 percent, 75 percent, 50 percent, and minimum speed points. The minimum and maximum speeds shall be set. The deceleration and acceleration rates shall be set. The delay to restart shall be set. Settings by the drive manufacturer, to be performed on-site as coordinated with the Owner/Engineer.
7. Furnish a 36-month warranty on each drive from date drives are placed on-line at the Owner's facility.

8. Furnish one eight-hour day of follow-up training following installation and start-up of the drives at the Owners facility. Provide training materials and handouts for up to twenty (20) people of the Owners staff.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16440 - PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the following:
   1. Lighting panelboards.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Manufacturer's product data on panelboards and enclosures.

1.03 QUALITY ASSURANCE

A. Codes and Standards:
   1. UL Compliance: Comply with applicable requirements of UL 67, "Electric Panelboards," and UL's 50, 869, 486A, 486B, and 1053 pertaining to panelboards, accessories, and enclosures. Provide panelboard units which are UL listed and labeled.
   2. NEMA Compliance: Comply with NEMA Standards Pub/No. 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)," Pub/No. PB 1, "Panelboards," and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."
   3. Federal Specification Compliance: Comply with FS W-P-115, "Power Distribution Panel," pertaining to panelboards and accessories.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. General Electric
   2. Eaton.
   3. Square D Company.

2.02 PANELBOARDS

A. Except as otherwise indicated, provide panelboards, enclosures, and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; with design and construction in accordance with published product information. Equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.

B. Lighting Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, and types shown; with anti-

turn solderless pressure type lug connectors approved for use with copper conductors. Construct unit for connecting feeders at top of panel; equip with copper bus bars, full-sized neutral bar with bolt-in type heavy-duty, quick-make quick-break, single pole circuit breakers, and toggle handles that indicate when tripped. Provide suitable lugs on neutral bus for each outgoing feeder required and provide bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate and match properly with panelboards. Panelboards and circuit breakers shall be braced for 10,000 rms symmetrical amperes fault current unless otherwise indicated.

C. Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code gauge, minimum 16-gauge thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed piano door hinges and door swings as indicated. Equip with interior circuit directory frame and card with clear plastic covering. Provide baked gray enamel finish over a rust-inhibitor coating. Design enclosures for recessed or surface mounting as indicated. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate and match properly with panelboards to be enclosed.

D. Molded-Case Circuit Breakers: Provide factory assembled, molded-case circuit breakers of frame sizes, characteristics, and ratings, including rms symmetrical interrupting ratings indicated. Select breakers with permanent thermal and instantaneous magnetic trip, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position, and operating in an ambient temperature of 40 degrees C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated.

E. Ground Fault Protected Breakers: Provide UL Class A protected GFI breakers with 6 mA for personnel protection, and for general-purpose receptacles. For breakers dedicated to equipment (sump pumps, heat trace, etc.), provide breaker with 30 mA equipment protection.

F. Accessories: Provide panelboard accessories and devices including, but not necessarily limited to, ground-fault protection units or circuit breaker locking hardware as indicated.

G. Spares: In each panelboard provide 8 installed, single pole, 20A spare circuit breakers unless otherwise indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF PANELBOARDS

A. Type out panelboard's circuit directory card upon completion of installation Work.

END OF SECTION

SECTION 16450 - BUSWAYS

PART 1 - GENERAL

1.01 SUMMARY

A. Busways are defined as electrical distribution systems consisting of bus bars installed within protective enclosures. Busways are comprised of straight lengths, fittings, and devices.

B. Section includes the following:
   1. Branch circuit.
   2. Outdoor feeder.
   3. Indoor feeder.
   4. Indoor plug-in.
   5. Service entrance.
   6. Plug-in devices.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Dimensioned layout Drawings of busway systems including, but not limited to, offsets, cable tap boxes, and transformer connections. Show accurately scaled busway with locations of supports and fittings, including firestops and weather seals. Indicate spatial relationship of busways to other associated equipment.
   2. Wiring Diagrams: Submit wiring diagrams for busways, including electrical connections to feeders and distribution conductors. Differentiate between portions of wiring which are manufacturer installed and those portions to be field installed.
   3. Product Data: Submit manufacturer's data for busways, including sizes and types of enclosures, finishes, bus joints, bar configurations, temperature rise above ambient, and electrical ratings and characteristics. Include short circuit rating.

1.03 QUALITY ASSURANCE

A. Codes and Standards:
   1. NEMA Compliance: Comply with NEMA Standards Pub./No's. BU 1, "Busways," and BU 1.1, "Instructions for Safe Handling, Installation, Operation and Maintenance of Busway and Associated Fittings Rated 600 Volts or Less."
   2. UL Compliance: Comply with requirements of UL 857, "Electric Busways and Associated Fittings." Provide busways which are UL listed and labeled.
   3. IEEE Compliance: Comply with IEEE Standard 241, "Recommended Practice for Electric Power Systems in Commercial Buildings," pertaining to construction and installation of busways.
   4. ANSI Compliance: Comply with applicable requirements of ANSI C2, "National Electrical Safety Code," pertaining to metal enclosed bus.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
   1. Cutler-Hammer Group, Eaton Corporation.
   2. Distribution Apparatus Div., Crouse-Hinds Corp.
   3. Siemens-Allis, Inc.
   4. Square D Company.

2.02 MATERIALS AND COMPONENTS

A. Provide busway systems of sizes, types, and ratings indicated, complete with, but not limited to, conductor bus bars, electrical insulators, enclosures, flanges, elbows, offsets, tees, cable tap boxes, weatherheads, transformer connections, power take-off sections, reducers, expansion joints, end enclosures, and other components and accessories needed to form complete systems.

B. Outdoor Feeder Busway: Provide complete outdoor feeder busway distribution system; low impedance, factory fabricated weathertight galvanized steel housings with sealed seams, drain holes with removable plugs, of types, sizes and ratings indicated. Provide a 50 percent rated internal ground bus. Equip with bolted section joints, gasketed joint covers, and splice plates. Insulate bus bar conductors with Class B (130 degrees C) rated material except at section joints. Silver-plated bus bar conductors at electrical contact surfaces. Temperature rise in busways not to exceed 55 degrees C rise above 40 degrees C ambient temperature when operating at rated load current. Select busway where it is possible to remove a bus length in a run without disturbing the two adjacent lengths to which it connects. Design busways to withstand short-circuit currents in compliance with NEMA short circuit current ratings for feeder busways. Finish busways with 2 coats of manufacturer's standard color.
   1. Conductor Material: Copper with not less than 98 percent conductivity, or aluminum with not less than 55 percent conductivity.

C. Indoor Feeder Busway: Provide complete indoor feeder busway distribution system, low impedance, factory fabricated and assembled. Provide a 50 percent rated internal ground bus. Select busway with ventilated housings constructed of sheet steel with baked-on enamel finish, bottom cover welded to side "C" channels, and top cover bolted to side channels, of types, sizes, and ratings indicated. Equip with bolted section joints and splice plates; with bus bar conductors silver-plated at electrical contact surfaces, and insulated except at section joints. Temperature rise in busway not to exceed 55 degrees C rise above 40 degrees C ambient temperature when operating at rated load current. Select busway so it is possible to remove a bus length in a run without disturbing the two adjacent lengths to which it connects. Design busways to withstand short circuit currents in compliance with NEMA short-circuit current ratings for feeder busways. Finish busways with 2 coats of manufacturer's standard color.
   1. Conductor Material: Copper with not less than 98 percent conductivity, or aluminum with not less than 55 percent conductivity.

D. Indoor Plug-in Busway: Provide complete indoor plug-in busway distribution system; low impedance, factory fabricated and assembled. Provide a 50 percent rated internal ground bus. Select busway with nonventilated housing constructed of not less than 22-gauge sheet steel with baked-on enamel finish, bottom cover welded to side "C" channels, and top cover bolted to side channels, of

types, sizes, and ratings indicated. Provide plug-in outlets on 24-inch centers with maximum of 5 openings per side for 10-foot section; openings protected by hinged doors which fold back when plug-in devices are installed and swing back into place when plug-in devices are removed. Equip with bolted section joints and splice plates; with bus bar conductors silver plated at electrical contact surfaces, and electrically insulated except at section joints. Temperature rise in busway not to exceed 55 degrees C rise above 40 degrees ambient temperature when operating at rated load current. Select busway where it is possible to remove a bus length in a run without disturbing the two adjacent lengths to which it connects. Design busways to withstand short-circuit currents in compliance with NEMA short- circuit current ratings for plug-in busways. Finish busways with 2 coats of manufacturer's standard color.

1. Conductor Material: Copper with not less than 98 percent conductivity, or aluminum with not less than 55 percent conductivity.
2. Plug-in Devices: Provide plug-in devices, compatible with plug-in busways, in types, sizes, and ratings as indicated, and as recommended by busway manufacturer. Polarize plug-in units for maintaining correct phase orientation. Select enclosures of not less than 18-gauge steel, bonderized both inside and out, and finish with single coat of manufacturer's standard color. Provide means of fastening plug-in devices to busway housings with bolted clamping device. Equip units with safety grounding springs for electrically grounding units to busway housings.

E. Busway Components: Provide busway components including crosses, elbows, closures, and reducers, in types, sizes and ratings indicated, which are compatible with busway sections and as recommended by busway manufacturer.

F. Supports and Accessories: Provide busway supports and accessories, including hangers and anchors as indicated and as recommended by busway manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION OF BUSWAYS

A. Install busway expansion fittings at those locations where busway crosses building expansion joint.

B. Install integral fire stops where busway penetrates fire-rated walls and floors. Seal between busway and opening and around opening with fire-rated sealant not less than wall or floor fire ratings.

C. Install integral weatherseal where busway penetrates exterior wall or roof. Provide appropriate flange and seal around openings to maintain weathertight installation.

END OF SECTION

SECTION 16497 - FUSES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Types of fuses specified, including:
   1. Class L time-delay.
   2. Class RK1 time-delay.

1.02 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
   1. Product Data: Submit manufacturer's technical product data on fuses, including specifications, electrical characteristics, installation instructions, furnished specialties, and accessories. In addition, include voltages and current ratings, interrupting ratings, current limitation ratings, time-current trip characteristics curves, and mounting requirements.

1.03 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
   1. UL Compliance and Labeling: Comply with applicable provisions of UL 198D, "High-Interrupting Capacity Class K Fuses." Provide overcurrent protective devices which are UL listed and labeled.
   2. ANSI Compliance: Comply with applicable requirements of ANSI C97.1, "Low-Voltage Cartridge Fuses 600 Volts or Less."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with specified requirements, manufacturers offering fusable devices which may be incorporated in Work include:
   1. Bussmann Division, Cooper Industries.
   2. Commercial Enclosed Fuse Co.
   3. Littelfuse, Inc.
   4. Shawmut Division, Gould, Inc.
   5. Reliance Fuse Division, Federal Pacific Electric Co.

2.02 FUSES

A. Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics indicated, which comply with manufacturer's standard

design, materials, and constructed in accordance with published product information, and with industry standards and configurations.

B. Class L Time-Delay Fuses: UL Class L time-delay fuses rated 600 volts, 60 Hertz, 800 amperes, with 200,000 rms symmetrical interrupting current rating for protecting transformers, motors, circuit breakers.

C. Class RK1 Time-Delay Fuses: UL Class RK1 dual element time-delay fuses rated 600 volts, 60 Hertz, 400 amperes, with 200,000 rms symmetrical interrupting current rating for protecting motors and circuit breakers.

2.03 EXTRA MATERIAL

A. Spare Fuses: For the types and ratings required, furnish additional fuses, amounting to 1 unit for every 10 installed units, but not less than 1 set of 3 of each kind.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 16529 - HAZARDOUS MATERIAL DISPOSAL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Labor, materials, equipment, and services necessary to fully complete removal of hazardous materials specified herein including, but not limited to:
   1. Removal of scheduled equipment from OWNER's premises.
   2. Verified disposal of scheduled hazardous material.
   3. Verified disposal of contaminated equipment.

B. A complete description of hazardous material is given in Hazardous Material Schedule included in this Section.

1.02 HAZARDOUS MATERIAL DISPOSAL CONTRACTOR

A. Hazardous Material Disposal Contractor performing this Work (hereinafter referred to as CONTRACTOR) shall be experienced in the handling, disposal, clean up, and documentation of PCB capacitors, mercury filled pressure switches, Lead cables and Lead materials, and PCB light fixture ballasts. CONTRACTOR shall provide insurance certificates for performing this Work at levels of coverage as specified in Conditions of the Contract. Insurance policies shall not contain pollution exclusion clauses for performing Work required under this Contract. CONTRACTOR shall provide insurance certificates that cover environmental pollution Work for performance under this Contract and shall hold harmless from and indemnify OWNER and ENGINEER against claims, suits, actions, costs, counsel fees, expenses, damages, judgments, or decrees by reason of any person or persons or property being damaged or injured by performance of CONTRACTOR during the progress of this Work.

1.03 PERMITS, INSPECTIONS, AND LICENSES

A. Procure permits, licenses, approvals, and other documents which are required for processing removal, transporting, and disposal of hazardous material and equipment specified on Schedules. CONTRACTOR shall observe and abide by requirements of Federal, State, and local laws, rules, regulations, and/or ordinances applicable to the services to be performed. If changes occur with respect to such laws, rules, regulations, or ordinances which interfere with execution of this Contract, CONTRACTOR shall comply with these changes and shall obtain any additional permits, licenses, approvals, or other documents required by such changes to allow timely completion of this Contract. CONTRACTOR shall pay fees for these documents when such fees are required.

1.04 PAYMENT

A. An invoice shall be prepared by CONTRACTOR once disposal Work has been completed. Payments to CONTRACTOR will not be made until written verifications of disposal are submitted to ENGINEER.

1.05 SCHEDULE

A. Work shall be done between the hours of 8:00 a.m. and 4:00 p.m. local time, Monday through Friday, except holidays, as agreed upon with OWNER.

PART 2 – PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 PROCESSING, REMOVAL, AND DISPOSAL OF HAZARDOUS MATERIALS

A. Removal: CONTRACTOR shall remove and transport from OWNER's premises PCB capacitors, mercury filled pressure switches, Lead cables and lead materials, and PCB equipment as described above and as noted on drawings, equipment described on Schedules, and any contaminated debris generated by execution of this Contract, as soon as liquid, equipment, or debris is taken out of service. It is not acceptable to store any portion of removed Lead material on OWNER's premises while rest of Lead material is being taken out of service. CONTRACTOR shall load materials on a vehicle provided by CONTRACTOR and shall transport this material from OWNER's premises to disposal site(s). CONTRACTOR shall provide waste hauler manifest. It shall be CONTRACTOR's responsibility to thoroughly clean up and decontaminate hazardous material spilled during loading and transporting operations.

B. Disposal: Hazardous liquid and hazardous solids designated by CONTRACTOR shall be transported by CONTRACTOR to an EPA-approved facility and disposed.

C. Name of hazardous material facility site to be used shall be submitted to ENGINEER.

D. After destruction of hazardous liquids and/or solids, CONTRACTOR shall submit to ENGINEER a "disposal certificate" indicating that destruction of hazardous materials has been completed in compliance with Federal, State, and local regulatory requirements.

3.02 Contaminated equipment shall be transported by CONTRACTOR to an EPA-approved facility.

A. Name of hazardous contaminated equipment incineration site to be used shall be submitted to ENGINEER.

B. After delivery of contaminated equipment and materials to incinerator site, CONTRACTOR shall receive and submit to ENGINEER a "manifest of acceptance" of contaminated material and "disposal" certificate" indicating that destruction of contaminated equipment has been completed in compliance with Federal, State, and local regulatory requirements.

END OF SECTION

SECTION 323223 – Concrete Block Retaining Wall

PART 1 - GENERAL

1.01 SUMMARY

A. Work shall consist of designing, furnishing and construction of a concrete block unit retaining wall system in accordance with these specifications and in reasonably close conformity with the lines, grades, design and dimensions shown on the plans.

B. Work includes preparing foundation soil, furnishing and installing leveling pad, unit facing system, unit drainage fill and reinforced backfill to the lines and grades shown on the construction drawings.

C. Work incudes furnishing and installing geogrid soil reinforcement of the type, size, location and lengths designated on the construction drawings.

D. Related Sections:
   1. Section 02310 Earthwork

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO)
   1. AASHTO M 252 Corrugated Polyethylene Drainage Pipe
   2. AASHTO M 288 Geotextile Specification for Highway Applications

B. American Society for Testing and Materials (ASTM)

   1. ASTM C140 Sampling and Testing Concrete Masonry Units
   2. ASTM C1372 Specification for Dry-Cast Segmental Retaining Wall Units
   3. ASTM D442 Particle Size Analysis of Soils
   4. ASTM D698 Laboratory Compaction Characteristics of Soil – Standard Effort
   5. ASTM D1556 Standard Test Method for Density and Unit Weight of Soil In Place by the Sand Cone Method
   6. ASTM D1557 Laboratory Compaction Characteristics of Soil – Modified Effort
   7. ASTM D2487 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
   8. ASTM D2922 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
   9. ASTM D3034 Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer pipe and Fittings
   10. ASTM D4318 Liquid Limit, Plastic Limit and Plasticity Index of Soils
   11. ASTM D4475 Horizontal Shear Strength of Pultruded Reinforced Plastic Rods
   12. ASTM D4476 Flexural Properties of Fiber Reinforced Pultruded Plastic Rods
   13. ASTM D4595 Standard Test Method for Tensile Properties of Geotextiles by Wide-Width Strip Method
   14. ASTM D4873 Standard Guide for Identification, Storage and Handling of Geosynthetics
   15. ASTM D5262 Standard Test Method for Evaluating the Unconfined Tension Creep Behavior of Geosynthetics

16. ASTM D5321 Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
17. ASTM D5818 Standard Practice for Obtaining Samples of Geosynthetics from a Test Section for Assessment of Installation Damage
18. ASTM D6637 Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Method
19. ASTM D6638 Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units
20. ASTM D6706 Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil
21. ASTM D6916 Standard Test Method for Determining the Shear Strength Between Segmental Concrete Units

C. National Concrete Masonry Association (NCMA)
1. NCMA SRWU-1 Test Method for Determining Connection Strength of SRW
2. NCMA SRWU-2 Test Method for Determining Shear Strength of SRW

1.03 DEFINITIONS

A. Concrete Block Unit – a dry-stacked concrete retaining wall unit machine made from Portland cement, water, aggregates, manufactured by a licensed manufacturer.

B. Structural Geogrid – a polymeric material formed by a regular network of connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock or earth and function primarily as reinforcement.

C. Unit Drainage Fill – drainage aggregate that is placed within and immediately behind the concrete units.

D. Reinforced Backfill – compacted soil that is placed within the reinforced soil volume as outlined on the plans.

E. Retained Soil – the soil mass behind the reinforced backfill.

F. Foundation Soil – the soil mass below the leveling pad and reinforced backfill.

G. Leveling Pad – crushed stone, sand and gravel or unreinforced concrete material placed to provide a level surface for placement of the concrete units.

H. Geosynthetic Reinforcement – polymeric material designed specifically for soil reinforcement.

1.04 SUBMITTALS

A. Contractor shall submit a Manufacturer's certification, prior to the start of work, that the retaining wall system components meet the requirements of this specification and the structure design.

B. Contractor shall submit construction drawings and design calculations for the retaining wall system prepared and stamped by a Professional Engineer registered in the state of the project.

1.05 QUALITY ASSURANCE

A. Owner shall/may provide quality assurance inspection and testing during earthwork and wall construction operations. Contractor shall provide all quality control testing and inspection not provided by the owner. Owner's quality assurance program does not relieve the contractor of responsibility for quality control and wall performance

1.06 PROJECT CONDITIONS

A. Contractor shall check all materials upon delivery to assure that the proper type, grade, color, and certification have been received.
B. Contractor shall protect all materials from damage due to jobsite conditions and in accordance with manufacturer's recommendations. Damaged materials shall not be incorporated into the work.

PART 2 - PRODUCTS

2.01 CONCRETE RETAINING WALL UNITS

A. Retaining wall units shall be Keystone Compac III or approved equal.

B. Retaining wall units shall conform to the following architectural requirements
   1. Face color - concrete gray, unless otherwise specified. The Owner may specify standard manufacturers' color.
   2. Tri-plane or Straight Face finish - hard split in angular tri-plane or straight face configuration. Other face finishes will not be allowed without written approval of Owner.
   3. Bond configuration - running with bonds nominally located at midpoint in vertically adjacent units.
   4. Exposed surfaces of units shall be free of chips, cracks or other imperfections when viewed from a distance of 20 feet (6 m) under diffused lighting.

C. Concrete block units shall conform to the requirements of ASTM C1372 - Standard Specifications for Segmental Retaining Wall Units.

D. Concrete block units shall conform to the following structural and geometric requirements measured in accordance with ASTM C140 Sampling and Testing Concrete Masonry Units.

E. Concrete block units shall conform to the following constructability requirements:
   1. Vertical setback: 1/8 inch (3 mm) ± per course (near vertical) or 1 1/8 inch (28 mm) + per course, per the design.
   2. Alignment and grid attachment mechanism - fiberglass pins, two per unit.
   3. Maximum horizontal gap between erected units shall be ≤ 1/2 inch (13 mm).

2.02 SHEAR AND REINFORCEMENT PIN CONNECTORS

A. Shear and reinforcement pin connectors shall be 1/2-inch (12 mm) diameter thermoset isopthalic polyester resin pultruded fiberglass reinforcement rods to provide connection between vertically and horizontally adjacent units and geosynthetic reinforcement, with the following requirements:
   1. Flexural Strength in accordance with ASTM D4476: 128,000 psi (882 MPa) minimum.
   2. Short Beam Shear in accordance with ASTM D4475: 6,400 psi (44 MPa) minimum.

B. Shear and reinforcement pin connectors shall be capable of holding the geogrid in the proper design position during grid pre-tensioning and backfilling.

2.03 BASE LEVELING PAD MATERIAL

A. Material shall consist of a compacted crushed stone base, sand and gravel or unreinforced concrete, as shown on the construction drawings.

2.04 UNIT DRAINAGE FILL

A. Unit drainage fill shall consist of clean 1 inch (25 mm) minus crushed stone or crushed gravel meeting the following gradation tested in accordance with ASTM D-422:

Sieve Size	Percent Passing
1 inch (25 mm)	100
3/4-inch (19mm)	75 – 100
No. 4 (4.75 mm)	0 – 10
No. 50 (300 um)	0 – 5

B. Drainage fill shall be placed within the cores of, between, and behind the units as indicated on the design drawings. Not less than 1.3 cubic foot (0.036 m3), of drainage fill shall be used for each square foot (0.093 m2) of wall face unless otherwise specified

2.05 GEOGRID SOIL REINFORCEMENT

A. Geosynthetic reinforcement shall consist of geogrids manufactured for soil reinforcement applications and shall be manufactured from high tenacity polyester yarn or high density polyethylene. Polyester geogrid shall be made from high tenacity polyester filament yarn with a molecular weight exceeded 25,000 g/m and with a carboxyl end group value less than 30. Polyester geogrid shall be coated with an impregnated PVC coating that resists peeling, cracking and stripping.

B. Ta – Long Term Allowable Tensile Design Load. Ta of the geogrid material shall be determined as follows: Ta = Tult/(RFcr * RFd * RFid * FS). Ta shall be evaluated based on a 75 year design life.
   1. Tult – Short Term Ultimate Tensile Strength. Tult shall be determined in accordance with ASTM D4595 or ASTM D6637. Tult is based on the minimum average roll values (MARV).
   2. RFcr – Reduction Factor for Long Term Tension Creep. RFcr shall be determined from 10,000 hour creep testing performed in accordance with ASTM D5262. RFcr = 1.45 minimum.
   3. RFd – Reduction Factor for Durability. RFd shall be determined from polymer specific durability testing covering the range of expected soil environments. RFd = 1.10 minimum.
   4. RFid – Reduction Factor for Installation Damage. RFid shall be determined from product specific construction damage testing performed in accordance with ASTM D5818. Test results shall be provided for each product to be used with project specific or more severe soil types. RFid = 1.05 minimum.
   5. FS – Overall Design Factor of Safety. FS hall be 1.5 unless noted for the maximum allowable working stress calculation.

C. The maximum design tensile load of the geogrid shall not exceed the laboratory tested ultimate strength of the geogrid/facing unit connection divided by a factor of safety of 1.5. The connection

strength testing and computation procedures shall be in accordance with ASTM D6638 Connection Strength between Geosynthetic Reinforcement and Segmental Concrete Units or NCMA SRWU-1.

D. Ci – Coefficient of Soil Interaction. Ci values shall be determined per ASTM D6706 at a maximum 0.75 inch (19 mm) displacement.

E. The geogrid manufacturer shall have a Manufacturing Quality Control program that includes QC testing by an independent laboratory. The QC testing shall include Tensile Strength testing, Melt Flow Index testing for HDPE geogrids and Molecular Weight testing for polyester geogrids.

2.06 DRAINAGE PIPE

A. A. If required, drainage pipe shall be perforated or slotted PVC pipe manufactured in accordance with ASTM D3034 or corrugated HDPE pipe manufactured in accordance with AASHTO M252

2.07 GEOTEXTILE FILTER FABRIC

A. When required, geotextile filter fabric shall be a needle-punched nonwoven fabric that meets the requirements of AASHTO M288.

PART 3 - EXECUTION

3.01 EXCAVATION

A. Contractor shall excavate to the lines and grades shown on the construction drawings. The Owner or Contractors QA/QC representative shall inspect the excavation and test the foundation soils and approve prior to placement of the leveling pad material or fill soils. Any over-excavation required to remove unsuitable soils shall be oversized from the front of the leveling pad and back of the geogrid reinforcement.

B. Over-excavation and replacement of unsuitable soils and replacement with approved compacted fill will be compensated as agreed upon with the Owner.

3.02 BASE LEVELING PAD

A. Leveling pad material shall be placed to the lines and grades shown on the construction drawings to a minimum thickness of 6 inches (150 mm) and extend laterally a minimum of 6 inches in front and behind the wall unit.

B. Soil leveling pad materials shall be compacted to a minimum of 95% of Standard Proctor density per ASTM D697 or 92% Modified Proctor density per ASTM D1557.

C. Leveling pad shall be prepared to insure full contact with the base surface of the concrete units.

3.03 CONCRETE BLOCK UNIT INSTALATION

A. Concrete block units should be installed per manufacturer specifications.

3.04 STRUCTURAL GEOGRID INSTALLATION

A. Geogrid shall be installed with the highest strength direction perpendicular to the wall alignment.

B. Geogrid reinforcement shall be placed at the strengths, lengths and elevations shown on the construction drawings, or as directed by the engineer.

C. The geogrid shall be laid horizontally on compacted backfill and attached to the wall unit pins and within 1 inch of the face of the units. Place the next course of concrete block units over the geogrid. The geogrid shall be pulled taut and anchored prior to backfill placement on the geogrid.

D. Geogrid reinforcements shall be continuous throughout their embedment lengths and placed side-by-side to provide 100% coverage at each level. Spliced connections between shorter pieces of geogrid or gaps greater than 2 inches between adjacent pieces of geogrid are not permitted.

3.05 CAP INSTALLATION

A. Prior to placement of the cap units, the upper surface of the top course of wall units shall be cleaned of soil and any other material.

B. Cap units shall be adequately glued to the underlying wall units with an all-weather exterior construction adhesive.

3.06 AS-BUILT CONSTRUCTION TOLERANCES

A. Vertical alignment: ± 1.5 inches (40 mm) over any 10 foot (3 m) distance.

B. Wall batter: within 2 degrees of design batter. Overall wall batter shall be ≥ 0 degrees.

C. Horizontal alignment: ± 1.5 inches (40 mm) over any 10 foot (3 m) distance.

D. Corners and curves: ± 1 foot (300 mm) to theoretical location.

E. Maximum horizontal gap between erected units shall be ≤ 1/2 inch (13 mm).

3.10 FIELD QUALITY CONTROL

A. Quality Assurance – The owner shall/may engage inspection and testing services, including independent laboratories, to provide quality assurance and testing services during construction. This does not relieve the Contractor from securing the necessary construction quality control testing.

B. Quality assurance should include foundation soil inspection and testing and verification of the geotechnical design parameters and verification that the contractor's quality control testing is adequate as a minimum. Quality assurance shall also include observation of the construction for general compliance with the design drawings and project specifications. Quality assurance is usually best performed by the site geotechnical engineer.

C. Quality Control – The Contractor shall engage independent inspection and testing services to perform the minimum quality control testing described in the retaining wall design plans and

specifications. Only qualified and experienced technicians and engineers shall perform quality control testing and inspection services.

D. Quality control testing shall include soil and backfill testing to verify soil types and strengths, compaction and moisture conditions and verification that the retaining wall is being constructed in accordance with the design plans and specifications.

END OF SECTION